Міністерство освіти і науки України
Житомирський державний технологічний університет

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Automobiles

Навчальний посібник з англійської мови
для студентів денного відділення
спеціальності “Автомобілі та автомобільне господарство”

Ухвалено на засіданні Вченої ради ЖДТУ
протокол № 13 від 29.06.05

ЖДТУ – 2005

ББК 81.2 (Англ.) Я7
УДК 81.111
М30

Рецензенти:

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Навчальний посібник з англійської мови “Automobiles” для студентів денного відділення та аспірантів (спеціальність “Автомобілі і автомобільне господарство”). /Автори: Н.І. Марченко, Н.О. Курносова, О.В. Забашта, А.Ю. Сорочинська, С.В. Суховецька – Житомир: ЖДТУ, 2005. – 256 с.

Навчальний посібник з англійської мови “Automobiles” призначений для студентів денного відділення та аспірантів, які навчаються за спеціальністю “Автомобілі і автомобільне господарство”.

Мета посібника – підготувати студентів до читання і розуміння оригінальної літератури із спеціальності, навчити анотувати і реферувати тексти, а також виробити навички професійно-спрямованого мовлення у межах засвоєної фахової тематики.

В розділах посібника описані особливості конструкції, принципи робочого процесу і елементи технічного обслуговування сучасного автомобіля, історія створення автомобіля і двигунів, вплив автомобілів на довкілля, автомобільна електроніка, фрази, діалоги, жарти, тощо.

Посібник можна рекомендувати для підготовки бакалаврів, спеціалістів, магістрів та аспірантів за спеціальністю “Автомобілі та автомобільне господарство”.

ББК 81.2 (АНГЛ.) Я7

ПЕРЕДМОВА

Навчальний посібник з англійської мови “Automobiles” призначений для студентів денного відділення та аспірантів, які навчаються за спеціальністю “Автомобілі і автомобільне господарство”.

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Посібник складається з основного курсу, додаткових матеріалів і словників. Основний курс містить 26 тематичних розділів, де розміщені тексти, післятекстові лексичні вправи, завдання для обговорення, рольові ігри і додаткові матеріали для самостійного опрацювання. Більшість текстів посібника взяті з оригінальної англійської і американської літератури. В окремих випадках тексти були скорочені і адаптовані. Текстовий матеріал підібрано з врахуванням повторюваності основної фахової термінології. В розділах посібника описані особливості конструкції, принципи робочого процесу і елементи технічного обслуговування сучасного автомобіля, історія створення автомобіля і двигунів, вплив автомобілів на довкілля, автомобільна електроніка, тощо.

Система вправ кожного розділу побудована з урахуванням лексики поданого тексту і включає вправи на підбір синонімів і антонімів, на переклад термінів і словосполучень, переклад речень з англійської мови на українську і навпаки, відповіді на питання, вправи на підстановку потрібних термінів у речення та інші вправи. Для закріплення навичок перекладу технічної літератури введені додаткові тексти для перекладу із словником і без словника.

В додаткові матеріали вміщені тексти для усного і письмового перекладу, фрази, діалоги, жарти з автомобільної тематики.

В комплект до посібника крім англо-українського і україно-англійського словників входить також електронний словник та тестовий контроль знань лексики.

Посібник можна рекомендувати для підготовки бакалаврів, спеціалістів, магістрів та аспірантів за спеціальністю “Автомобілі та автомобільне господарство”.

Автори вдячні доктору технічних наук, професору Грабару І. Г. та кандидату філологічних наук, професору Сингаївській А.В. за допомогу у процесі рецензування рукопису посібника.

CONTENTS

BASIC COURSE

UNIT 1. WHY DO WE STUDY ENGLISH?

Knowledge of foreign languages opens doors before you, gives you many opportunities and advantages. Knowledge of foreign languages has always been a sign of high culture and erudition. It helps to promote cultural education and technical co-operation among nations. That's why one of the characteristic features of life in our country nowadays is a great interest in studying foreign languages, mainly English.

Though there are almost three thousand languages in the world, English is the most universal. It is the official language in over forty countries. It is the most used language in international business, science and medicine. Approximately 400 million people speak English as a mother tongue (700 million speak Chinese, 200 million speak Russian and 100 million speak German).

Even in the countries where English is not the first language, a number of English words are used. Words from no other language are borrowed more often than from English. Hundreds of words borrowed from English can now be found in other languages such as soda, hotel, golf, tennis, jeans, O.K., baseball, airport.

English is everywhere. It is on signs, clothing, soft drinks and other goods around the world. Over two thirds of the world's scientists write in English. Three quarters of the world's mail is in English. 85 per cent of the information in computers in the world is in English, too. English is also the language of pop music, advertising, teaching, international airlines.

Independent Ukraine has relations with many countries, hundreds of joint ventures have appeared in every city and town recently. Besides, a lot of foreign delegations come to our country. Our businessmen, tourists, experts often go abroad. That's why a lot of people study foreign languages in every possible way. A modern engineer, scientist or a production manager must have a good command of English. A specialist who can read the literature in his field in several languages has much better grasp of the subject. To read original scientific and technical literature in English is not an easy task. One has first to acquire everyday English with its grammar, vocabularies and rules of word-formation. Only on this basis one can understand the

peculiarities of the scientific-technical speech style. That's why one must work hard to master English. Besides, learning a foreign language enriches the native language, makes it clearer, more flexible and expressive. There is a proverb, "As many languages you know, as many times you are a person".

Exercise 1. **Answer the questions:**

1. Why is English so popular now?
2. What privileges can knowledge of foreign languages give you?
3. Do you agree with the mentioned proverb? Why?
4. What is easy and what is difficult for you in the English language?
5. What languages would you like to master in future? Why?

Exercise 2. **Fill in the blanks with a proper form of the verb "to be", "to have", or "to do".**

1. English … a Germanic language. It … a long and complicated history.

2. Each branch of science and technology … its separate vocabulary.

3. Language … a perfect means of expression and communication.

4. In some countries, such as China, Egypt and Mesopotamia writing … practised thousands of years ago.

5. Many people … professional need to know something about language.

6. Every national language … many functions.

7. A specialist who … not know foreign language … a problem of using foreign scientific and technical literature.

8. English … millions of native speakers.

Exercise 3. **a) Translate the following sentences into Ukrainian.**

1. We can easily recognize differences between Shakespeare's English and the English of modern authors. But the present-day English is also growing and changing.
2. The vocabulary of contemporary writers reflects today's developments in knowledge.
3. New ideas and notions must have new, up-to-date words to name them. Without new words and new word-combinations it is impossible to reflect the contemporary advance of human society.
4. The recent words and word-combinations are called neologisms.
5. A serious student of a foreign language needs a contemporary dictionary.

b) Find English equivalents of the Ukrainian word "сучасний" in the exercise.

Exercise 4. **Translate into English.**

1. Знання іноземної мови – це ознака високої культури та ерудиції людини.
2. Англійська мова - одна з найбільш розповсюджених мов на землі.
3. Англійська мова – одна з шести офіційних мов Організації Об'єднаних Націй.
4. Використання англійської мови у дипломатії, торгівлі і науці є ознакою її важливості.
5. Мова – найважливіший засіб спілкування людей. У світі налічується 5,5 тисяч мов.
6. Англійська мова належить до германської групи індоєвропейської сім'ї мов.
7. На заняттях студенти вчаться читати і розмовляти англійською мовою, перекладати і обговорювати тексти.
8. Практичне володіння іноземними мовами необхідне сучасному інженеру та науковцю.

UNIT 2. HIGHER EDUCATION IN UKRAINE

THE STRUCTURE OF HIGHER EDUCATION SYSTEM IN UKRAINE.

In general the structure of higher education in Ukraine corresponds to the education structure of developed countries of the world and to the principles, declared by UNESCO, UNO and the Council of Europe.

There are state higher educational institutions and higher educational institutions of other forms of property in the country. The network includes about one thousand higher educational institutions with first – fourth accreditation levels (technical schools, specialized schools, colleges, institutes, academies and universities).

The state educational institutions are created, reorganized and liquidated by the decision of Cabinet of Ministers of Ukraine. Creation, reorganization and liquidation of the private educational institution depends on their owner's (owners') decision.

The amount of payment for the total studying term is set by the contract between the higher educational institution and a person who wants to study or a juridical person who will pay for the studies of a student. Students who study well in the full-time form of study, receive scholarships which are provided by the state or a local budget.

According to the status of higher educational institutions there are four levels of accreditation in Ukraine:

- the first level – technical school, specialized school and other higher educational institutions equated to them;
- the second level – college and other higher educational institutions equated to it;
- the third and the fourth level – institute, conservatory, academy and university.

University is a multi-profiled higher educational institution of the fourth level of accreditation. It carries out educational activity, connected with obtaining certain higher education and qualification in a wide range of natural, humanitarian, technical, economic and other directions of science, engineering, culture and arts. It conducts fundamental and applied scientific research. It is a scientific and me-

thodological center, having developed infrastructure of educational, scientific and production subdivisions with a corresponding level of professional staff, material and technical provision. It supports propagation of scientific knowledge and carries out cultural and educational activity.

There can be developed classical and profiled (technical, technological, economic, pedagogical, medical, agricultural, art, cultural, etc.) universities.

At our higher educational institutions we have full-time and correspondence forms of training. Students get an all-round education. Besides special subjects the humanities are obligatory subjects for future specialists.

Higher educational institutions of the fourth level of accreditation have a system of Candidate's and Doctor's postgraduate studies for training the staff of the highest qualification and for defending theses to receive the degree of Candidate of Sciences or the degree of Doctor of Sciences.

***Exercise 1*. Answer the following questions:**

1. What higher educational institutions are there in Ukraine?
2. How many higher educational institutions does the network of higher education system include?
3. What accreditation levels of higher educational institutions exist in Ukraine?
4. What is a university?
5. In what directions does a university carry out its educational activity?
6. A university is a scientific and methodological centre, isn't it?
7. What types of universities do you know?
8. What forms of training are there at our higher educational institutions ?
9. What is the purpose of post-graduate studies?
10. Do all higher educational institutions have a post-graduate course?

Exercise 2. **Memorize the following words and word combinations:**

to enter the university	вступити до університету
faculty	факультет
department	кафедра, відділення
full time department	денне відділення
correspondence department	заочне відділення
year	курс (рік навчання)
first-year student	студент першого курсу
the humanities	гуманітарні науки
the natural sciences	природничі науки
the technical sciences	технічні науки
economics	економіка
national economy	народне господарство
research	дослідження
scientific supervisor	науковий керівник
thesis (pl. theses)	дисертація
term, semester	семестр
sessional examination (sessionals)	екзаменаційна сесія
test-credit	залік
graduation project	дипломна робота
to take an exam	складати екзамен
to pass an exam	скласти екзамен
vice-rector	проректор
dean	декан
head of department	завідувач кафедри
to graduate from the University	закінчити університет
scholarship, grant	стипендія
vacation	студентські канікули
on vacation	на канікулах
all-round education	всебічна освіта
tuition fee	плата за навчання
extra curricular activities	позааудиторна діяльність
I have a Bachelor's Degree (Master's Degree)	Я – бакалавр (магістр)

Exercise 3. **Make up sentences using words and word combinations from *Exercise 2*.**

Exercise 4. **Translate into English*:***

1. Кожен громадянин України має право на освіту.
2. У нашій країні існує денна та заочна форми навчання.
3. Держава забезпечує студентів стипендією та гуртожитком.
4. Держава гарантує студентам-заочникам багато пільг.
5. Лабораторії нашого університету оснащені найновішим устаткуванням.
6. Багато випускників університету очолюють промислові підприємства і державні установи України.
7. Великі зміни у системі вищої освіти відбулись в Україні за останні роки.
8. Головний принцип системи освіти в Україні - єдність навчального процесу і наукових досліджень, теорії і практики.
9. Кількість студентів у нашій країні збільшується з кожним роком.
10. Студенти здобувають знання в різних галузях науки і техніки

UNIT 3. OUR UNIVERSITY

I study at Zhytomyr State Technological University. It was founded in 1960 as the Zhytomyr General-Technical Faculty of Kyiv Polytechnic Institute. The faculty began to work in the building of the Zhytomyr Pedagogical Institute. In 1966 the General Technical Faculty continued training its students in a purpose-built four-floor building in Pushkinska Street. The part-time students studied at the faculty during three years and then they had the opportunity to complete their studies at other educational institutions of Ukraine and other republics of the former Soviet Union. Later the evening and full-time departments were opened with the full cycle of training in two specialities: "Technology of Machine-Building, Metal-Cutting Machines and Instruments" and "Automation and Telemechanics". In 1968, the construction of the educational-laboratory building in Chernyakhovsky Street began. In 1975, ZGTF KPI was reorganized into the Zhytomyr Branch of Kyiv Polytechnic Institute. In 1994, the Zhytomyr Institute of Engineering and Technology was founded on the basis of the Zhytomyr Branch of KPI. In 2003 the Institute was reorganized into Zhytomyr State Technological University. Its structure includes five faculties:

- the faculty of mechanical engineering;
- the faculty of information-computer technologies;
- the faculty of economics and management;
- the faculty of mining and ecology;
- the faculty of audit and finance.

The faculty of preliminary training and the faculty of specialists' retraining were established as important elements of the system of continuous education.

Almost 7 thousand students of full-time and part-time forms of training study at ZSTU in 17 specialities. The University provides training leading to the degrees of Bachelor, Specialist (engineers, economists, managers) and Master. The duration of training is 4 years to get Bachelor's degree and 5 years to get Specialist's (Master's degree). The students of the University have the possibility to study two specialities simultaneously and to get two diplomas: the first one in

the selected engineering speciality and the second one in economics or management.

There are two halls of residence, a refectory, a sanatorium and a recreation camp "Polytechnic" available at the university. There is a gym, tennis courts and a stadium at the University as well. The library and its own publishing department allow the University to provide students with educational and methodological literature. ZSTU has its own website in the Ukrainian and English languages. Local computer network is connected to the Internet. The electronic versions of some textbooks are located on the University server.

In 1994 a post-graduate course was founded for training scientific personnel, and since then a lot of theses have been defended.

"The journal of Zhytomyr State Technological University" is regularly issued. It is included into the list of scientific editions where the basic results of theses in technical sciences and economics can be published according to the decision of the Highest Certifying Commission of Ukraine.

ZSTU pays special attention to the strengthening of the international cooperation. It is a member of numerous international organizations.

Exercise1. **Answer the following questions:**

1. When was our University founded?
2. What faculties does the University consist of?
3. What forms of training are there at ZSTU?
4. What do you know about the publishing department of ZSTU?
5. What journal is regularly issued in the University?
6. Is there a computer network at the University?
7. When was a post-graduate course founded?
8. What do you know about the extra-curricular activities of our students?
9. What training does our University provide?
10. Who is the rector of our University (the dean of your faculty)?

Exercise 2. **Translate into English:**

1. Факультет інженерної механіки був заснований у 1977 році, він мав назву “Механічний факультет”.
2. Кафедри факультету виконують наукові дослідження як у фундаментальних, так і в прикладних науках.
3. Результати наукової діяльності професорсько-викладацького складу (academic staff) університету відомі за межами України. Вони становлять основу для захисту кандидатських і докторських дисертацій.
4. Університет має свої традиції у навчально-виховному процесі.
5. Університет має міжнародні зв’язки з багатьма університетами за кордоном.

Exercise 3. **a) Read the text and translate it into Ukrainian:**

ZSTU has many possibilities to make students’ life and their leisure time interesting and meaningful, to facilitate the development of abilities and talents of young people. For this purpose there is a sport complex and a cultural centre at the disposal of the students. The students’ collectives of amateur art activities work at the University. They are the choir, the brass band, the orchestra of folk instruments, the dance company “Harmony” and others. The “KVN” teams “Girls from Zhytomyr”, “Yoly-Paly”, “Stepukha” are known far outside Zhytomyr.

ZSTU has a recreation camp “Polytechnic” where students can have a rest and recover their health.

The University also holds the annual sports day. ZSTU teams actively participate in the city and regional sports days, in sports youth games and competitions of Ukraine.

b) give the title to the text.

Exercise 4. **Speak on the topic “Our University”.**

UNIT 4. ENGINEER AND TECHNOLOGICAL - PROGRESS

In the conditions of the scientific and technological progress the significance of engineers is increasing. Our country has taken on a course toward the market economy. Engineers have an important part to play in intensifying the national economy. In their work engineers are guided by the latest achievements in science and technology. Engineering means physical implementation of the design into machines, devices or systems. Only a well-trained engineer can cope with his tasks. In the practical work an engineer is faced with problems of choosing suitable engineering materials for construction different devices or machine parts. A modern engineer must have good knowledge of physics and mathematics, chemistry, computers, systems engineering computer-aided-design, management science, etc.

Engineers are trained at technical higher schools and at some departments of the universities. In spite of the fact that there are no single and absolutely identical curricula, the sets of subjects for training technical students have very much in common. Future engineers are trained in fundamentals, the students are offered a wide programme of humanities. A great attention at technical departments is paid to such subjects as history, philosophy, economics, management, sociology, ecology and foreign languages as well as to the development of the scientific world outlook of the future engineers. The engineer is the main motive power of the technological progress.

Exercise 1. **Memorize the following words and word combinations from the text:**

to be guided by	керуватись чимось
implementation	здійснення, реалізація
to cope with	справлятися з
engineering material	конструкційний матеріал
computer-aided-design	автоматичне проектування
in spite of	незважаючи на
curriculum (pl. curricula)	навчальна програма
set of subjects	набір предметів
to have very much in common	мати багато спільного

apart from	крім, не враховуючи
scientific outlook	науковий світогляд
motive power	рушійна сила

Exercise 2. **Answer the following questions:**

1. What is engineering?
2. What is the role of an engineer in the technological progress?
3. What should an engineer know to cope with his tasks?
4. Where are engineers trained?
5. What subjects and sciences are technical students trained in?
6. What must an engineer know to be a good specialist and a highly educated personality?
7. Is an engineer the main motive power in the technological progress?

Exercise 3**. Speak on the engineer using the following word-combinations:**

Engineer:

- to have an important part to play;
- to be guided by the latest achievements in science and technology;
- the result of his work to be implemented in engineering;
- to cope with his tasks must be well-trained;
- to be faced with problems of choosing materials for construction different devices;
- must know fundamental sciences;
- must know his speciality forming subjects;
- to be trained at higher schools;
- must have a thorough knowledge of humanities to be a highly educated personality.

Exercise 4. **Speak on mechanics using the following word-combinations:**

Speciality – mechanics:

- to be much interested in:
- to choose as speciality;

- to be trained at higher schools;
- to be a part of engineering and machine-building;
- to be linked with other branches of industries: machine-tool and instrument manufacturing, production mechanization, automation equipment, quality control devices, output of measuring and control instruments;
- to be a good specialist must know fundamentals and speciality forming subjects;
- training, to be done at the laboratories, scientific centres, plants and different enterprises;
- the results, to be implemented in the term papers and graduation theses.

UNIT 5. THE HISTORY OF LAND TRANSPORT

Introduction

The word transport means to carry people or goods from place to place. It is also used for the vehicles that carry people or goods – for example, motor transport includes buses, lorries, motor coaches and motor cars. The American word for the same thing is transportation, and the remark "transportation is civilization" was made by an American, the motor-car manufacturer Henry Ford.

The history of transport is divided into two stages. The first stage is that in which all forms of transport depended directly on the power of men or animals or on natural forces such as winds and current. The second stage began with the development of the steam engine, which was followed by the electric motor and the internal combustion engine as the main sources of power for transport.

Who introduced the first cheap motor car?

The first practical internal combustion engine was introduced in the form of a gas engine by the German engineer N. Otto in 1876.

Since then motor transport began to spread in Europe very rapidly. But the person who was the first to make it really popular was Henry Ford, an American manufacturer who introduced the first cheap motor car, the famous Ford Model "T".

When did diesel-engined lorries become general?

The rapid development of the internal combustion engine led to its use in the farm tractors, thereby creating a revolution in agriculture. The use of motor vehicles for carrying heavy loads developed more slowly until the 1930s when diesel-engined lorries became general.

The motor cycle steadily increased in popularity as engines and tyres became more reliable and roads improved. Motor cycles were found well suited for competition races and sporting events and were also recognized as the cheapest form of fast transport.

When were the buses and trams introduced first?

Buses were started in Paris in 1820. In 1828 they were introduced in London by George Shillibeer, a coach builder who used the French name Omnibus which was obtained from the Latin word meaning "for all". His Omnibuses were driven by three horses and had seats for 22 passengers. Then in the 20th century reliable petrol engines became available, and by 1912 the new motor buses were fast replacing horse-driven buses.

Trams were introduced in the middle of the 19th century. The idea was that, as the rails were smoother than the roads, less effort was needed to pull a tram than a bus. The first trams were horse-drawn but the later trams were almost all driven by electricity. The electric motor driving the tram was usually with electric current from overhead wires. Such wires are also used by trolleybuses, which run on rubber tyres and do not need rails.

Another form of transport used in London, Paris, Berlin, Moscow, St. Petersburg, Kyiv and some other crowded cities is the underground railway.

London's first underground railway of the "tube" type was opened in 1862, the Moscow underground – in 1935.

Exercise 1. **Answer the following questions:**

1. What does the word "transport" mean?
2. What are two stages in the history of transport?
3. What are the main sources of power for transport?
4. When, where and by whom was the first internal combustion engine introduced?
5. What do you know about Henry Ford?
6. What did the rapid development of the internal combustion engine lead to?
7. When did diesel-engined lorries become general?
8. When were buses introduced in London?
9. What is the origin of the word "omnibus"?
10. When did motor buses replace horse-driven buses?

Exercise 2. **Give English equivalents of the following:**

- транспортний засіб, автомобіль
- перевозити людей
- виробник автомобілів
- паровий двигун
- двигун внутрішнього згоряння
- поширюватися
- представити, запровадити
- швидкий розвиток
- надійний
- дешевий вид транспорту

Exercise 3. **Fill in the blanks with appropriate words:**

1. The word “transport” means …or goods from place to place. It is also used for the … that carry people or goods, for example buses, lorries, motor cars.
2. The American word for the same thing is … .
3. The remark “… is civilization” was made by an American, Henry Ford.
4. The second stage in the history of transport began with the development of … which was followed by the electric motor and the internal combustion engine.
5. The first practical … was introduced by the German engineer N. Otto in 1876.
6. Since 1876 motor transport began … in Europe very rapidly.
7. The American manufacturer Henry Ford made motor transport really popular when he … the first cheap motor car, the famous Ford Model “T”.
8. … of the internal combustion engine led to its use in the farm tractors, thereby creating a revolution in agriculture.
9. The motor transport steadily increased in popularity as engines and types became more ….
10. In 1828 buses were … in London by George Shillibeer, who used the name “Omnibus”.

UNIT 6. THE EARLY DAYS OF THE AUTOMOBILE

TEXT 1.

1. One of the earliest attempts to propel a vehicle by mechanical power was suggested by Isaac Newton. But the first self-propelled vehicle was constructed by the French military engineer Cugnot in 1763. He built a steam-driven engine which had three wheels, carried two passengers and ran at maximum speed of four miles. The carriage was a great achievement but it was far from perfect and extremely inefficient. The supply of steam lasted only 15 minutes and the carriage had to stop every 100 yards to make more steam.

In 1784, the Russian inventor Kulibin built a three-wheeled carriage. In this vehicle he used for the first time such new elements as brakes and gear-box.

The first Englishman to build a full-size self-propelled vehicle for use on the roads and to obtain practical results was Threvitheck. In the period of 1798-1800 he built several working models.

2. In 1825 a steam engine was built in Great Britain. The vehicle carried 18 passengers and covered 8 miles in 45 minutes. However, the progress of motor cars met with great opposition in Great Britain. Further development of the motor car lagged because of the restrictions resulting from legislative acts. The most famous of these acts was the Red Flag Act of 1865, according to which the speed of the steam-driven vehicles was limited to 4 miles per hour and a man with a red flag had to walk in front of it.

Motoring really started in the country after the abolition of the act.

3. In Russia there were cities where motor cars were outlawed altogether. When the editor of the local newspaper in the city of Uralsk bought a car, the governor issued these instructions to the police: “When the vehicle appears in the streets, it is to be stopped and escorted to the police station, where its driver is to be prosecuted.”

4. From 1860 to 1900 there was a period of the application of gasoline engines to motor cars in many countries. The first to perfect gasoline engine was N. Otto who introduced the four-stroke cycle of

operation. By that time motor cars got a standard shape and appearance.

In 1896 a procession of motor cars took place from London to Brighton to show how reliable the new vehicles were. In fact, many of the cars broke, for the transmissions were still unreliable and constantly gave trouble.

The cars of that time were very small, two-seated cars with no roof, driven by an engine placed under the seat. Motorists had to carry large cans of fuel and separate spare tyres, for there were no repair or filling stations to serve them.

After World War I it became possible to achieve greater reliability of motor cars, brakes became more efficient. Constant efforts were made to standardize common components. Multi-cylinder engines came into use, most commonly used are four-cylinder engines.

5. Like most other great human achievements, the motor car is not the product of any single inventor. Gradually the development of vehicles driven by internal combustion engine – cars, as they had come to be known, led to the abolition of earlier restrictions. Huge capital began to flow into the automobile industry.

From 1908 to 1924 the number of cars in the world rose from 200 thousand to 20 million; by 1960 it had reached 60 million! No other industry had ever developed at such a rate.

Exercise 1. **Memorize the following words and word combinations from the text:**

to propel a vehicle by mechanical power	приводити автомобіль в рух механічною силою
wheel	колесо
speed	швидкість
supply	постачання, запас
to lag	відставати
to be limited to	обмежуватися
restriction	обмеження
application	застосування
stroke	такт
fuel	паливо

spare tyre	запасна шина
repair	ремонт; ремонтувати
filling station	бензоколонка
brakes	гальма

Exercise 2. **Find synonyms*:***

A
1. to build
2. speed
3. to obtain
4. in front of
5. famous
6. application
7. to introduce
8. shape
9. take place
10. to achieve

B
1. to happen
2. form
3. to present
4. well-known
5. to get
6. velocity
7. to construct
8. use
9. before
10. to reach

Exercise 3. **Answer the following questions:**

1. What did Isaac Newton suggest?
2. Who constructed the first self-propelled vehicle and when?
3. What new elements did Kulibin use in his vehicle for the first time?
4. What do you know about the English inventor Trevitheck?
5. What do you know about the progress of motor cars in Great Britain at the end of the 19th century?
6. What did N. Otto introduce?
7. What engines came into use after World War I?
8. What can you say about the modern automotive industry?

Exercise 4. **Translate the following sentences using words and word combinations from the text.**

1. І. Ньютон запропонував приводити автомобіль у рух за допомогою механічної сили.

2. У 1763 році французький військовий інженер Кюньйо побудував автомобіль, що приводився у рух паровим двигуном і мав три колеса.

3. У 1865 році швидкість автомобілів з паровим двигуном обмежувалась 4 милями на годину.

4. Застосування двигунів, що працювали на бензині, було поширеним у багатьох країнах у період з 1860 по 1900 роки.

5. Німецький інженер Н. Отто удосконалив бензиновий двигун, запровадивши чотиритактний цикл роботи.

6. Водії перших автомобілів змушені були возити з собою великі каністри з паливом і запасні шини, тому що тоді не було ремонтних станцій і бензозаправок.

7. Після І світової війни вдалося досягти більшої надійності автомобілів завдяки удосконаленню гальм.

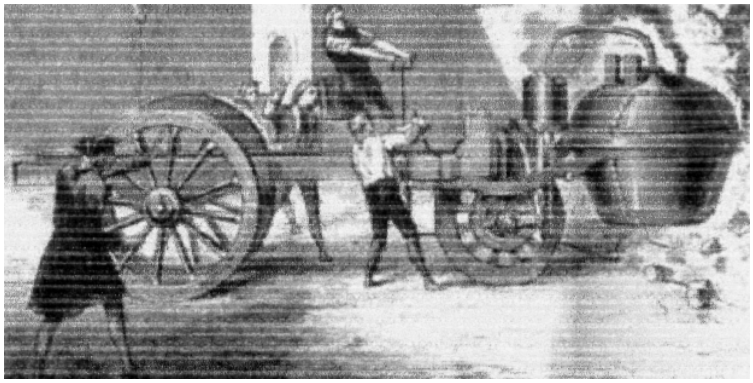
8. Сучасний автомобіль – результат винаходів багатьох інженерів і винахідників.

Exercise 5. **Translate into Ukrainian:**

Engineering milestones began to enhance the popularity of the car and improve its safety. They included the electric starter in 1911, introduced by Charles Kettering; the synchronized transmission for easier gear shifting; improved carburettors; heaters; mechanically operated windshield wipers; and interchangeable parts. Henry Leland, president of Cadillac Automobile Co., believed that car parts should be the same for similar models. Skeptics disagreed, so to prove his point, he shipped three cars to England, had them disassembled, their parts all mixed together, and then reassembled. This successful innovation increased production efficiency and reduced costs, adding to the affordability of the auto.

TEXT 2. THE HISTORY OF THE AUTOMOBILE

Early Steam Powered Cars



Old Engraving depicting the 1771 crash of Nicolas Joseph Cugnot's steam-powered car into a stone wall.

The automobile as we know it was not invented in a single day by a single inventor. The history of the automobile reflects an evolution that took place worldwide. It is estimated that over 100,000 patents created the modern automobile. However, we can point to the many firsts that occurred along the way. Starting with the first theoretical plans for a motor vehicle that had been drawn up by both Leonardo da Vinci and Isaac Newton.

In 1769, the very first self-propelled road vehicle was a military tractor invented by French engineer and mechanic, Nicolas Joseph Cugnot (1725-1804). Cugnot used a steam engine to power his vehicle, built under his instructions at the Paris Arsenal by mechanic Brezin. It was used by the French Army to haul artillery at a whopping speed of 2 ½ mph on only three wheels. The vehicle had to stop every ten to fifteen minutes to build up steam power. The steam engine and boiler were separate from the rest of the vehicle and placed in the front (see engraving above). The following year (1770), Cugnot built a steam-powered tricycle that carried four passengers.

In 1771, Cugnot drove one of his road vehicles into a stone wall, making Cugnot the first person to get into a motor vehicle accident. This was the beginning of bad luck for the inventor. After one of Cugnot's patrons died and the other was exiled, the money for Cugnot's road vehicle experiments ended.

Steam engines powered cars by burning fuel that heated water in a boiler, creating steam that expanded and pushed pistons that

turned the crankshaft, which then turned the wheels. During the early history of self-propelled vehicle – both road and railroad vehicles were being developed with steam engines. (Cugnot also designed two steam locomotives with engines that never worked well.) Steam engines added so much weight to a vehicle that they proved a poor design for road vehicles; however, steam engines were very successfully used in locomotives. Historians, who accept that early steam-powered road vehicles were automobiles, feel that Nicolas Cugnot was the inventor of the automobile.

After Cugnot Several Other Inventors Designed Steam-Powered Road Vehicles:

- Cugnot's vehicle was improved by Frenchman, Onesiphore Pecqueur, who also invented the first differential gear.
- In 1789, the first U.S. patent for a steam-powered land vehicle was granted to Oliver Evans.
- In 1801, Richard Trevitheck built a road carriage powered by steam – the first in Great Britain.
- In Britain, from 1820 to 1840, steam-powered stagecoaches were in regular service. These were later banned from public roads and Britain's railroad system developed as a result.
- Steam-driven road tractors (built by Charles Deitz) pulled passenger carriages around Paris and Bordeaux up to 1850.
- In the United States, numerous steam coaches were built from 1860 to 1880. Inventors included: Harrison Dyer, Joseph Dixon, Rufus Porter, and William T. James.
- Amedee Bollee Sr. built advanced steam cars from 1873 to 1883. The "La Mancelle" built in 1878, had a front-mounted engine, shaft drive to the differential, chain drive to the rear wheels, steering wheel on a vertical shaft and driver's seat behind the engine. The boiler was carried behind the passenger compartment.
- In 1871, Dr. J. W. Carhart, professor of physics at Wisconsin State University, and the J. I. Case Company built a working steam car that won a 200-mile race.

Early Electric Cars

Steam engines were not the only engines used in early automobiles. Vehicles with electrical engines were also invented. Between

1832 and 1839 (the exact year is uncertain), Robert Anderson of Scotland invented the first electric carriage. Electric cars used rechargeable batteries that powered a small electric motor. The vehicles were heavy, slow, expensive, and needed to stop for recharging frequently. Both steam and electric road vehicles were abandoned in favor of gas-powered vehicles. Electricity found greater success in tramways and streetcars, where a constant supply of electricity was possible.

However, around 1900, electric land vehicles in America outsold all other types of cars. Then in the several years following 1900, sales of electric vehicles took a nosedive as a new type of vehicle came to dominate the consumer market.

The History of the Automobile

The Internal Combustion Engine and Early Gas-Powered Cars

The very first self-powered road vehicles were powered by steam engines and by that definition Nicolas Joseph Cugnot of France built the first automobile in 1769 – recognized by the British Royal Automobile Club and the Automobile Club de France as being the first. So why do so many history books say that the automobile was invented by either Gottlieb Daimler or Karl Benz? It is because both Daimler and Benz invented highly successful and practical gasoline-powered vehicles that ushered in the age of modern automobiles. Daimler and Benz invented cars that looked and worked like the cars we use today. However, it is unfair to say that either man invented "the" automobile.

UNIT 7. COMPONENTS OF THE AUTOMOBILE

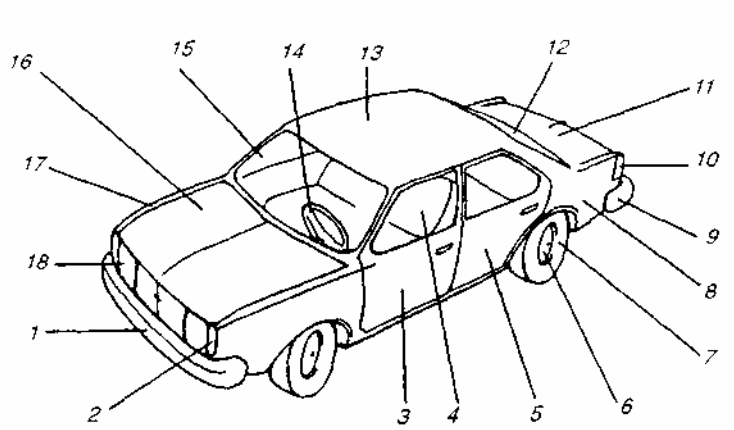
Automobiles are trackless, self-propelled vehicles for land transportation of people or goods, or for moving materials. There are three main types of automobiles. There are passenger cars, buses and lorries (trucks). The automobile consists of the following components: a) the engine; b) the framework; c) the mechanism that transmits the power from engine to the wheels; d) the body.

Passenger cars are, as a rule, propelled by an internal combustion engine. They are distinguished by the horse-power of the engine, the number of cylinders in the engine and the type of the body, the type of transmission, wheelbase, weight and overall length.

There are engines of various designs. They differ in the number of cylinders, their position, their operating cycle, valve mechanism, ignition and cooling system.

Most automobile engines have six or eight cylinders, although some four-, twelve-, and sixteen-cylinder engines are used. The activities that take place in the engine cylinder can be divided into four stages which are called strokes. The four strokes are: intake, compression, power and exhaust. “Stroke” refers to the piston movement. The upper limit of piston movement is called top dead centre, TDC. The lower limit of piston movement is called bottom dead center, BDC. A stroke constitutes piston movement from TDC to BDC or from BDC to TDC. In other words, the piston completes a stroke each time it changes the direction of motion.

You may find the following picture illustrating the vocabulary helpful:



1. front bumper; 2. front indicator light; 3. front door; 4. driver's seat; 5. rear door. 6. wheel (car wheel); 7. tyre (car tyre): 8. rear wing; 9. rear bumper; 10. rear light; 11. boot *(Am.E.* trunk); 12. rear window, 13. roof; 14. steering wheel, 15. windscreen; 16. bonnet *(Am.E.* hood); 17. front wing; 18. headlight

Exercise 1. **Memorize the following words and word combinations from the text:**

trackless	безрейковий
vehicle	автомобіль, засіб для перевезення
lorry, truck	1.вантажний автомобіль, 2. перевозити
to propel	рухати(ся)
internal combustion engine	двигун внутрішнього згоряння
transmission	передача, привід
valve	клапан
ignition	запалювання
wheelbase	колісна формула
cooling	охолодження
stroke	такт
intake	впуск
compression	стиск
power	робочий хід
exhaust	випуск
piston	поршень
top/bottom dead centre	верхня/нижня мертва точка
lubrication	змащування

Exercise 2. **Fill in the blanks with the proper words:**

1. Top dead centre is …
2. The lower limit of piston movement is called …
3. The activities that take place in the engine cylinder are called …
4. There are three main types of automobiles. They are …
5. The automobile consists of the following components: …

Exercise 3. **Find synonyms*:***

A	B
1. component	1. lorry
2. engine	2. quantity
3. truck	3. place
4. to consist	4. full
5. to distinguish	5. to apply
6. number	6. different
7. overall	7. to make up
8. various	8. to occur
9. position	9. to perform
10. to use	10. constituent
11. to take place	11. motion
12. movement	12. to contain
13. to constitute	13. to perceive
14. to complete	14. motor

Exercise 4. **Translate into Ukrainian*:***

1. The motor car is a form of mechanical transport and it is composed of many different working units and parts.
2. To provide the energy to make a car go it has an engine which in turn needs electric current, petrol and air.
3. The engine needs cooling so it does not become too hot, and oil to lubricate the bearing surfaces.
4. Modern motor vehicles are almost exclusively equipped with internal-expanding brakes acting on all wheels of the car.
5. A parking brake is an auxiliary mechanism that mechanically activates a vehicle's rear brakes for parking.

6. The mixture consisting of fuel vapour and air burned in the cylinder is produced in the carburettor.

7. Depressing the clutch pedal disconnects the engine from the transmission.

8. Without electricity the ignition system would not work, the car could not be started, and there would be no lights for parking or for driving the car at night.

9. The battery provides a means of storing electricity which can be used when the dynamo is not operating and it must be kept well charged.

10. The dynamo and starter are bolted to the engine, and this automatically "earthes" them to the chassis.

Exercise 5. **Answer the following questions.**

1. What types of automobiles do you know?
2. How many cylinders have automobile engines?
3. What components does an automobile consist of?
4. What is a passenger car propelled with?
5. What is a stroke?

UNIT 8. FROM THE HISTORY OF AUTOMOBILE ENGINES

1. Slowly but surely the auto industry is perfecting a number of alternatives to the conventional engines found in almost all of today's passenger cars.

Two prime factors lie behind the search for different engines – the necessity to reduce air pollution by requiring cleaner auto exhaust and the desire to produce cars that will run farther on a gallon of fuel.

While basic research is continuing on electric and steam powered engines, it is the diesel, turbine and Stirling that are current industry favourites.

Diesels get better mileage than gasoline engines, and the fuel is usually cheaper.

In 1890's, Rudolf Diesel, a German, invented the engine that bears his name. As air is drawn into the engine and compressed internal temperatures rise, and pressures reach two to three times those in a gasoline engine. The extreme pressures have meant diesels usually are much larger and heavier than gasoline engines of the same power potential.

The disadvantages of diesels as passenger-car engines are slow performance, noise and smoke.

All the companies investing diesels are trying to reduce noise and smoke, but the problems are not yet entirely solved. Even the 14,000-dollar Mercedes clatters when started on a cold morning. And the warm up period for all diesels seems too long to drivers accustomed to gasoline models.

2. The turbine and Stirling are multifuel engines, capable of running on any liquid that will burn, including such exotic types as peanut oil and perfume. This would be a major advantage if severe petroleum shortages develop.

The turbine cars now operating are hand-built models that cost more than 1 million dollars each. Alloys of precious metals of high durability are still required for certain vital turbine parts. Engineers believe that progress in ceramics holds the key to making turbines practical alternatives to present-day engines.

3. Experts say that the Stirling is the most promising among

the favoured engines.

The Stirling concept, first offered more than 150 years ago by a Scottish clergyman, involves external instead of internal combustion.

In 1816 Robert Stirling patented a new engine for pumping water out of mines and quarries. It could run on almost any fuel, he boasted – including whisky. Indeed the parson had such faith in his engine that he often cut his Sunday sermons short to work on it. However, when Stirling died in 1878 at the age of 88, his engine was still unperfected. Soon it was totally overshadowed by the newer gasoline-powered internal combustion engine.

Unlike typical internal combustion engines, the Stirling engine is powered by heat from an external source. In the new design, hydrogen gas is heated by a burner, which can run on virtually all kinds of fuel. Hydrogen then expands, enters one cylinder and pushes a sliding piston. As piston moves, it forces gas out of the other end of the cylinder; the emerging gas is cooled and then moves towards an adjacent cylinder where heat is applied once more and the process is repeated.

Engineers point out that a Stirling engine would be quieter than an equivalent internal combustion engine, would emit less toxic gases, and would use fuel more economically. Having no need for valves or cams, it would also have fewer parts. Stirling's old dream might yet become a reality.

Now, since experts seek fuel-saving, less-polluting alternatives to the modern auto engine, Stirling's machine has started a new life, they show great interest in the work of a giant Dutch electronics firm, which has tested Stirling prototypes in boats, large pumps (to help dry out Holland during 1952's floods) and even buses. In 1972, Ford signed an agreement with the firm for joint development of a Stirling engine for passenger cars.

4. As for electric cars, several types of small battery-powered vehicles are in production, but it is most unlikely that they will replace more conventional vehicles.

Yet, there is still opinion in the auto industry that the conventional gasoline powered engine – the type in almost universal use now – will continue to dominate until or unless outside circumstances dictate otherwise.

Exercise 1. **Answer the following questions:**

1. What are the main factors that are important in the search for different engines?
2. Why are these factors very important?
3. What are the advantages of diesels over gasoline engines?
4. What are disadvantages of diesels?
5. Will the turbine cars be widely used in the near future?
6. When was the Stirling engine invented?
7. Where is the Stirling engine used now?
8. Will electric cars replace the conventional vehicles?
9. What kind of engine will dominate in the near future?

Exercise 2. **Memorize the following words and word combinations from the text:**

to reduce air pollution	зменшити забруднення повітря
pressure	тиск
advantage	перевага
disadvantage	недолік
to solve the problem	вирішити проблему
to clatter	гуркотіти
to run on any fuel	працювати на будь-якому паливі
shortage	нестача
piston	поршень
valve	клапан
cam	кулачок
alloy	сплав

Exercise 3. **Find synonyms*:***

A
1. to reduce
2. disadvantage
3. to operate
4. to clatter
5. pollution
6. production
7. engine
8. include

B
1. to run
2. to lessen
3. to make noise
4. to involve
5. choice
6. to begin
7. shortcoming
8. contamination

9. alternative	9. manufacture
10. to start	10. motor

Exercise 4. **Translate the following sentences into Ukrainian.**

1. This review surveys the problem of the ignition taking place inside the automobile petrol engine.
2. The proposed design has certain advantages over conventional engine.
3. The new alloy has characteristics that make it perfect for use at low temperatures.
4. To solve the problem of energy crisis new more efficient engines with less fuel consumption must be developed.
5. In the Stirling engine power is achieved by applying heat to a cylinder containing gas which expands, drives pistons and then escapes into another to be cooled and reused.
6. One of the factors of the search for different engines is the necessity to reduce air pollution by requiring cleaner auto exhaust.
7. Compression is the reduction in volume of a mass of material due to externally applied pressure.
8. Each cylinder is provided with a piston which fits tightly within the cylinder walls.
9. When the exhaust valve opens, the smoke and gases are pushed out of cylinder.
10. Some engines have pistons made of cast iron, but cast iron pistons have the disadvantage of being too heavy for high-speed operation.

TEXT 2. HISTORY OF THE INTERNAL COMBUSTION ENGINE – THE HEART OF THE AUTOMOBILE

An internal combustion engine is any engine that uses the explosive combustion of fuel to push a piston within a cylinder – the piston's movement turns a crankshaft that then turns the car wheels via a chain or a drive shaft. The different types of fuel commonly used for car combustion engines are gasoline (or petrol), diesel, and kerosene.

A brief outline of the history of the internal combustion engine includes the following highlights:

- **1680** – Dutch physicist, Christian Huygens designed (but never built) an internal combustion engine that was to be fueled with gunpowder.
- **1807** – Francois Isaac de Rivaz of Switzerland invented an internal combustion engine that used a mixture of hydrogen and oxygen for fuel. Rivaz designed a car for his engine – the first internal combustion powered automobile. However, his was a very unsuccessful design.
- **1824** – English engineer, Samuel Brown adapted an old Newcomen steam engine to burn gas, and he used it to briefly power a vehicle up Shooter's Hill in London.
- **1858** – Belgian-born engineer, Jean Joseph Etienne Lenoir invented and patented (1860) a double-acting, electric spark-ignition internal combustion engine fueled by coal gas. In 1863, Lenoir attached an improved engine (using petroleum and a primitive carburettor) to a three-wheeled wagon that managed to complete an historic fifty-mile road trip.
- **1862** – Alphonse Beau de Rochas, a French civil engineer, patented but did not build a four-stroke engine (French patent #52,593, January 16, 1862).
- **1864** – Austrian engineer, Siegfried Marcus, built a one-cylinder engine with a crude carburettor, and attached his engine to a cart for a rocky 500-foot drive. Several years later, Marcus designed a vehicle that briefly ran at 10 mph that a few historians have considered as the forerunner of the modern automobile by being

the world's first gasoline-powered vehicle.

- **1873** – George Brayton, an American engineer, developed an unsuccessful two-stroke kerosene engine (it used two external pumping cylinders). However, it was considered the first safe and practical oil engine.
- **1866** – German engineers, Eugen Langen and Nikolaus August Otto improved on Lenoir's and de Rochas' designs and invented a more efficient gas engine.
- **1876** – Nikolaus August Otto invented and later patented a successful four-stroke engine, known as the "Otto cycle".
- **1876** – The first successful two-stroke engine was invented by Sir Dougald Clerk.
- **1883** – French engineer, Edouard Delamare-Debouteville, built a single-cylinder four-stroke engine that ran on stove gas. It is not certain if he did indeed build a car, however, Delamare-Debouteville's designs were very advanced for the time – ahead of both Daimler and Benz in some ways at least on paper.
- **1885** – Gottlieb Daimler invented what is often recognized as the prototype of the modern gas engine – with a vertical cylinder, and with gasoline injected through a carburetor (patented in 1887). Daimler first built a two-wheeled vehicle the "Reitwagen" (Riding Carriage) with this engine and a year later built the world's first four-wheeled motor vehicle.
- **1886** – On January 29, Karl Benz received the first patent (DRP No. 37435) for a gas-fueled car.
- **1889** – Daimler built an improved four-stroke engine with mushroom-shaped valves and two V-slant cylinders.
- **1890** – Wilhelm Maybach built the first four-cylinder, four-stroke engine.

Engine design and car design were integral activities, almost all of the engine designers mentioned above also designed cars, and a few went on to become major manufacturers of automobiles. All of these inventors and more made notable improvements in the evolution of the internal combustion vehicles.

UNIT 9. ENGINES

There are numerous types of motor cars. It is impossible to describe their particular construction in detail. But the classification into groups with respect to their general construction may be undertaken. These are motor cars with carburettor engines and motor cars with diesel engines.

The engine is the power plant of the vehicle. In general, internal combustion engines are used operating with some fuel (petrol, benzol, diesel oil). Depending on their combustion process, the engines are fundamentally classified as

carburettor engines and
diesel engines.

Sometimes, the carburettor engines are called light-oil engines and the diesel engines are called heavy-oil engines. Another difference results from the working method of the internal combustion engine. A difference is made between

four-stroke cycle engines end
two-stroke cycle engines.

The heat engine is a machine that converts heat energy to mechanical energy. The engines of motor cars, motor cycles, farm tractors, motor boats, etc. are heat engines, which belong to the subgroup of internal combustion engines. Combustion engines may be divided into several types according to the number of piston strokes. Most of modern automotive engines operate on four-stroke cycle. There are also engines which operate on two-stroke and six-stroke cycles.

A diesel engine is a machine which produces power by burning oil in a body of air which has been squeezed to a high pressure by a moving piston. Diesel engines are especially suitable where an independent source of power is required, as in ships, locomotives, mobile equipment of all sorts and isolated power plants.

Steam, gas and oil engines were known and used prior to the invention of the diesel engine. The steam engine converts the heat energy of steam to mechanical energy. A typical steam reciprocation engine consists of a cylinder fitted with a piston. A connecting rod and a crankshaft change the piston to-and-fro motion into rotary motion. The steam pressure on the piston varies during the stroke, and it is a flywheel which maintains a constant output velocity.

Exercise 1. **Memorize the following words and word combinations:**

numerous	багаточисельний
carburettor	карбюратор
engine	двигун
internal combustion engine	двигун внутрішнього згоряння
heat engine	тепловий двигун
oil engine	двигун, який працює на важкому паливі
petrol engine	бензиновий двигун
reciprocating engine	поршневий двигун
steam engine	паровий поршневий двигун
spark-ignition engine	двигун з іскровим запалюванням (з примусовим запалюванням)
compression-ignition engine	двигун внутрішнього згоряння із запалюванням від стиску, дизель
four-stroke engine **four-cycle engine**	чотиритактний двигун
fuel-injection engine	двигун з впорскуванням палива
Otto engine	чотиритактний двигун
to convert	перетворювати
piston	поршень
stroke	такт
squeeze	ущільнювати; стискати
pressure	тиск
suitable	підхожий, відповідний
power	енергія, сила, потужність
power plant	силова установка
prior to	до
connecting rod	шатун
crankshaft	колінчастий вал
to-and-fro motion	рух поперемінно в одному або іншому напрямку
rotary motion	обертальний рух
to vary	змінюватися

flywheel	маховик
to maintain	підтримувати
velocity	швидкість

Exercise 2. **Find synonyms*:***

A
1. engine
2. to convert
3. to press
4. suitable
5. prior to
6. motion
7. to vary
8. to maintain
9. velocity
10. particular
11. to classify
12. to divide
13. to operate
14. to require

B
1. before
2. movement
3. to differ
4. to squeeze
5. to work
6. specific
7. proper
8. speed
9. to change
10. to arrange
11. to support
12. to demand
13. motor
14. to distribute

Exercise 3. **Translate into English:**

1. Тепловий двигун перетворює теплову енергію в механічну.

2. Існує декілька типів теплових двигунів, які використовуються на багатьох видах машин.

3. Паровий двигун перетворює теплову енергію пари в механічну.

4. Рудольф Дизель сконструював свій двигун у 1892 році.

5. Дизельні двигуни широко використовуються в наші дні.

6. Парові, газові та двигуни, що працюють на важкому паливі, були у використанні до винаходу дизельного двигуна.

7. Назва “теплові двигуни” включає в себе багато видів двигунів і турбін.

8. Двигун – це джерело енергії.

9. Теплові двигуни втрачають багато теплової енергії, коли вони виконують механічну роботу.

10. Іскра запалює суміш бензинової пари і повітря.
11. Роботу двигуна можна розділити на чотири такти.

Exercise 4. **Translate into Ukrainian:**

1. If the rotary motion is transmitted to the car wheels, the car will move.
2. If a piston moves in a straight line, its up-and-down movement will be called a reciprocating motion.
3. If the shaft rotates, the crank will swing around in a circle.
4. If the ignition system produces a spark, the mixture will be ignited.
5. If crude oil is put through a refining process, we shall obtain gasoline.

Exercise 5. **Fill in the blanks with appropriate words:**

1. The heat engine is a machine that … heat energy to mechanical energy.
2. … engines may be divided into several types according to the number of piston strokes.
3. A typical steam reciprocating engine consists of a cylinder fitted with a … .
4. A connecting rod and … change the piston to-and-fro motion into … motion.
5. The steam pressure on the piston … during the stroke.

Exercise 6. **Change the following sentences according to the model:**

Model:

A diesel engine **is considered to be** a prime mover actuated by gases. → **It is considered that** a diesel engine is a prime mover actuated by gases.

1. Steam, gas and oil engines are known to have been used prior to the invention of the diesel engine.
2. The name “heat engines” is known to include many types of engines and turbines.

3. The engine is said to be a source of power.

4. The up-and down movement of the piston is known to be a reciprocating motion.

5. Heat engines are supposed to lose much heat energy when they do mechanical work.

Exercise 7. **Answer the following questions:**

1. What is a heat engine?
2. Into what types may combustion engines be divided?
3. What is a diesel engine?
4. Where are diesel engines especially suitable?
5. What parts does a typical engine consist of?

UNIT 10. ENGINE OPERATION.

TEXT 1. ENGINE OPERATION

An automobile, powered by a petrol engine, begins to operate when the driver turns a flywheel connected to the engine crankshaft. As the crankshaft revolves, a mixture of fuel and air is drawn from a carburettor into the engine cylinders. The ignition system provides the electric sparks that ignite this mixture. The resultant explosions of the mixture turn the crankshaft, and the engine starts moving. By regulating the flow of the fuel and air with a throttle, the driver controls the rotational speed of the crankshaft.

Exercise 1. **Memorize the following words:**

to turn	повертати
flywheel	маховик, махове колесо

Exercise 2. **Answer the following questions:**

1. When does an automobile begin to operate?
2. What ignites the mixture of fuel and air?
3. What do the resultant explosions of the mixture do?
4. How does the driver control the rotational speed of the crankshaft?

TEXT 2. THE CYLINDERS AND PISTONS

A car engine looks like a large block of metal. And it is. It is a large block of cast iron. In this block there are round holes. These holes are the cylinders. The cylinder block of a car usually has four or six cylinders. In the cylinder the power of petrol is controlled.

In each cylinder there is a piston. It can move up and down inside the cylinder. Its shape is like the bottom half of a bottle. It has steel rings round it. These piston rings help it to fit tightly inside the cylinder. A connecting rod comes from inside the piston.

The top of each cylinder is covered. There are three holes in the top. Two are for valves which open and shut. These are the inlet valve and the exhaust valve. The other hole is for the sparking plug.

When the inlet valve opens, a mixture of air and petrol is sucked into the cylinder.

This mixture fills the space above the piston. When the inlet valve is open the exhaust valve is closed. The sparking plug ignites (fires) the mixture of air and petrol by means of a spark and causes it to explode. Smoke and gases remain after the explosion of the petrol and air mixture. When the exhaust valve opens, the smoke and gases are pushed out of the cylinder.

Exercise 3. **Memorize the following words and word combinations:**

cast iron	чавун
inlet valve	впускний клапан
exhaust valve	випускний клапан
sparking plug	свічка запалювання

Exercise 4. **Answer the following questions:**

1. How many cylinders has the cylinder block of a car?
2. How many holes are there in the top of each cylinder?
3. How does the sparking plug ignite the mixture of air and petrol?
4. How do smoke and gases leave the cylinder?

TEXT 3. THE FOUR-STROKE CYCLE

To complete the firing cycle the piston must move along the cylinder four times. These movements are called strokes.

1. The suction (drawing in) stroke.

In this stroke the piston is moving down the cylinder. The inlet valve is open. A mixture of air and petrol is drawn into the cylinder above the piston.

2. The compression (pressing together) stroke.

In this stroke the piston is moving up the cylinder. Both valves are closed. The piston moves up as far as it can. It pushes the mixture of air and petrol in front of it. It compresses it into the space above the cylinder.

3. The explosion (firing) stroke.

In this stroke, the spark fires the mixture and it explodes. The energy released by the burning mixture forces the piston down the cylinder.

4.The exhaust (emptying out) stroke.

In this stroke the piston is moving up the cylinder. The exhaust valve is open. Smoke and gases remain after the explosion. The piston pushes them in front of it. They are pushed through the exhaust valve opening. They leave the cylinder through a pipe. Now the cycle begins again.

Exercise 5. **Describe the four-stroke cycle using the given words:**

to complete, firing, cycle, piston, to move, stroke, suction, inlet valve, to open, air and petrol mixture, to draw into, compression, both, to close, to push, space, explosion, spark, to fire, to explode, energy, to release, exhaust, smoke and gases, to leave, through a pipe.

Exercise 6. **Translate into English:**

1. Найвище положення поршня у циліндрі називається "верхня мертва точка", а найнижче – "нижня мертва точка".

2. Рух поршня від верхньої до нижньої мертвої точки називається тактом.

3. У камері згоряння суміш палива і повітря стискається при русі поршня вгору і запалюється електричною іскрою.

4. Чотиритактний цикл складається з таких тактів: всмоктування, стискання, робочий хід, вихлоп.

5. У карбюраторних двигунах суміш палива і повітря всмоктується в циліндр при русі поршня вниз.

6. Рідке паливо змішується з повітрям і випаровується в карбюраторі.

Exercise 7. **Find antonyms:**

A	1.	inside	B	1. large
	2.	left		2. exhaust
	3.	bottom		3. outside
	4.	to open		4. to stop

5. inlet	5. right
6. to fill	6. to let out
7. up	7. top
8. to start	8. to close
9. small	9. down
10. to push down	10. to emply

Exercise 8. **Find synonyms:**

A		B	
1.	power	1.	to draw in
2.	to shut	2.	to start
3.	to let out	3.	to operate
4.	to work	4.	energy
5.	to suck in	5.	to put off
6.	to begin	6.	to close
7.	to connect	7.	to finish
8.	to ignite	8.	drawing in
9.	to complete	9.	to link
10.	suction	10.	to fire

Exercise 9. **Translate into Ukrainian:**

The pistons move up and down in the cylinders. They are the first moving part to receive the push of the burning and expanding fuel in the cylinders. Some engines have pistons made of cast iron, but cast iron pistons have the disadvantage of being too heavy for high-speed operation. Other engines use pistons made of light-weight aluminium alloy. Light pistons can be moved up and down in the cylinder faster without wasting as much power.

Exercise 10. **Insert the proper terms in the blanks.**

accelerates	manual
bore	spark
capacity	stroke
compression ratio	torque

1. The inside diametre of a cylinder is called the … .
2. The total volume of the cylinders is called the … .

3. A … ignites the fuel-and-gas mixture.

4. The distance the piston moves is the … .

5. The ratio of maximum volume of a cylinder to its minimum volume is the … .

6. The force which produces a twisting movement is called … .

7. When a car speeds up, we say it … .

8. A … action is one performed by hand.

UNIT 11. THE PETROL ENGINE

In the internal combustion engine, heat is generated by the combustion of an inflammable charge inside a cylinder, and the heat energy is immediately converted into mechanical energy. Some heavy internal combustion engines use a gas fuel or else Diesel oil, and the fuel/air mixture may be ignited either by a spark or by compression of the mixture. However, for small i. c. engines, such as those which are used in motor-cars, the charge is a mixture of petrol and air, and is ignited by a spark from the distributor.

When the mixture is ignited, the products of combustion expand down the cylinder, which is fitted with a reciprocating piston. The downward movement of the piston is converted into a rotational movement of the crankshaft by means of a connecting rod. As the crankshaft rotates, the piston is driven upwards again, and the exhaust gases are expelled through the exhaust valve in the cylinder head. When the piston nears the top of this stroke, the inlet valve is opened and the exhaust valve closed. The piston then descends on the induction stroke, and draws a fresh charge into the cylinder. As the piston rises again on the compression stroke, the charge is compressed and ignited, and the cycle begins again. This is the four-stroke cycle which is in common use. An alternative cycle is the two-stroke cycle, which combines the exhaust and compression strokes into one.

The combustion of the mixture does not take place instantaneously. The spark is therefore timed to occur before the piston reaches top dead centre, otherwise maximum pressure would not be reached in time. By the time the piston is at top dead centre, combustion is well under way and the expansion of the gases is beginning. Once combustion starts, it should be carried through the mixture very rapidly, and this is assisted by making the clearance space above the piston as small as possible, and by careful design of the cylinder head. Rapid propagation of the flame through the compressed gas is also assisted by creating turbulence in the gas.

Most small i. c. engines in common use have four cylinders, which fire in a definite and regular sequence. This is necessary, otherwise the torque which the pistons impart to the crankshaft will be irregular and uneven. The torque is liable to be uneven in any case

when the engine is running slowly, and a flywheel is fitted to the crankshaft to damp out these variations.

It is essential for the inlet and exhaust valves to open and close at exactly the appropriate moment in relation to the position of the piston. Therefore they are actuated by a cam-shaft running in phase with the crankshaft.

Exercise 1. **Memorize the following words and word combinations:**

distributor	розподільник
reciprocating	зворотно-поступальний
induction stroke	всмоктування
to occur	відбуватися
to reach	досягати
clearance space	мертвий простір (у циліндрі)
propagation	розповсюдження
turbulence	турбулентність
sequence	послідовність
torque	обертовий момент
to damp	послаблювати, поглинати
cam-shaft	кулачковий вал, вал ексцентрика

Exercise 2. **Fill in the blanks with appropriate words:**

1. In the internal combustion engine, heat is generated by the … of an inflammable charge inside a cylinder, and the heat energy is … into mechanical energy.
2. When the mixture is ignited, the products of combustion … down the cylinder.
3. The downward movement of the piston is converted into a rotational movement of the crankshaft by means of a … .
4. The two-stroke cycle combines the … and … strokes into one.
5. The combustion of the mixture does not … instantaneously.
6. Rapid propagation of the flame through the compressed gas is also assisted by creating … in the gas.

7. Most small internal combustion engines have four cylinders, which fire in a definite and regular … .

8. Inlet and exhaust valves are actuated by a … running in phase with the crankshaft.

Exercise 3. **Translate into English:**

1. Суміш бензину і повітря – це запалювальна суміш у двигуні внутрішнього згоряння.

2. Рух поршня вниз перетворюється на обертальний рух колінчастого валу за допомогою шатуна.

3. Коли поршень піднімається, запалювальна суміш стискається і запалюється.

4. Двотактний цикл поєднує такти вихлопу і стиску в один такт.

5. Іскра повинна появитися до того, як поршень досягне верхньої мертвої точки.

6. Впускні і випускні клапани відкриваються і закриваються у відповідний момент відносно положення поршня.

Exercise 4. **Translate into Ukrainian:**

1. A fresh charge of petrol and air is drawn into the cylinder.

2. The burnt gases in the cylinder are exhausted by the rising piston.

3. The exhaust gases from the cylinder pass into the atmosphere.

4. The current is distributed to each of the plugs by the distributor.

5. Ignition can be produced by a spark or by compression of the mixture.

6. The piston movement is transmitted to the wheels through a crankshaft.

7. Although the performance of the modified engine is far better than that of the old one, it is interesting that maximum power speeds are similar in both engines.

8. This review surveys the problem of the ignition taking place inside the automobile petrol engine.

9. Spark ignition is known to be one of conventional means of igniting fuel-air mixture.

10. The simplest method of cooling an engine is to allow the air stream caused by the motion of the vehicle to carry the heat away by radiation.

Exercise 5. **Answer the following questions:**

1. By what is heat generated in the internal combustion engine?
2. What occurs when the mixture is ignited?
3. What is the two-stroke cycle?
4. Why must four cylinders fire in a definite and regular sequence?
5. What are inlet and exhaust valves actuated by?

UNIT 12. DIESEL ENGINE

The oil engine (diesel engine) is also a form of internal combustion engine. It has the usual arrangement of cylinder, piston, connecting rod, crank, inlet and exhaust valves as we find in petrol engine. In place of carburettor and sparking plug it has an injection pump and a fuel injection valve (injector). Unlike spark-ignition engines it uses the heat of the compression to fire the fuel and is, therefore, called compression-ignition engine.

It utilizes a fuel known as diesel oil, which is forced in the form of a fine spray through a suitable nozzle directly into the combustion space. No mixture of fuel and air is introduced into the cylinder, the compression-ignition (CI) engine draws in pure air only. This air is then compressed by the ascending piston to a high pressure. As a result of it the temperature of the air is raised considerably so that the fuel oil injected into the cylinder ignites rapidly. Thereafter the gaseous products expand providing the energy for the power stroke.

The high-output oil engines are nearly all of two-stroke type. The charge is filled into the cylinder by means of a blower which assists both the intake and exhaust processes. One cycle is completed within one revolution, i. e. in two strokes – compression and expansion.

Exercise 1. **Memorize the following words and word combinations:**

injection pump	паливний насос
inlet pipe	впускна труба
crank	кривошип, колінчатий важіль
pump	насос, помпа; (v) качати, викачувати
valve	клапан, золотник
compression-ignition engine	двигун згоряння від стиску
ascending piston	висхідний поршень
output	продукція, продукт, випуск; продуктивність, вироблення
provide	забезпечувати; постачати

Exercise 2. **Answer the following questions.**

1. In what way (how) does diesel engine fire the fuel?
2. What kind of fuel does diesel engine utilize?
3. What products provide the energy for the power stroke?
4. By what means is the charge filled into the cylinder?

Exercise 3. **Fill in the blanks with the proper words.**

1. The oil engine has the usual arrangement, i. e.: …
2. Injector is a …
3. The air is compressed by …
4. The gaseous products expand providing the … for the power stroke.
5. The oil engines are of … – stroke type.

Exercise 4. **Read the following sentences. Find out those which correspond to the text.**

1. Diesel engines are spark-ignition engines.
2. Diesel engine has carburettor and sparking plug as we find in petrol engine.
3. The oil engine uses the heat of compression to fire the fuel.
4. The high-output diesel engines are of two-stroke type.
5. The compression-ignition engine draws in the mixture of fuel and air.
6. Diesel engine has the usual arrangement of cylinder, piston, connecting rod, crank, inlet and exhaust valves.

Exercise 5. **Translate the following word combinations:**

1. private car ownership increase;
2. traffic noise reduction;
3. urban speed limits;
4. rubber and glass components;
5. car maintenance improvement;
6. air-cushion vehicle advantages;
7. rubber tyre wear;
8. spare parts output;
9. pedal transport increase;
10. pedestrian safety problems.

Exercise 6. **Translate into Ukrainian:**

The Wankel engine is a form of heat engine which has a rotary piston. In other words, instead of going up and down the Wankel piston rotates in the cylinder. Both cylinder and piston are quite different in shape from those of conventional engines. The Wankel piston is triangular with curved sides and the cylinder is roughly oval in shape.

The Wankel engine has many advantages over the reciprocating piston engine. Fewer moving parts are necessary because it produces a rotary movement without using a connecting rod and a crankshaft. Because of this rotary movement it has no vibration. In addition it has no valves, it is smaller and lighter than conventional engines of the same power, and it runs economically on diesel and several other fuels.

Exercise 7. **Translate into Ukrainian:**

West Germany's Daimler-Benz has produced the world's first four-chamber Wankel engine and is using it to power an experimental sports car known as the C-III and capable of a top speed of 186 mph.

The Wankel engine, which derives its power from a spinning, triangular rotor, eliminates the pistons and their up and down movements within the cylinder of a reciprocating engine.

The 400-horsepower Wankel used in the C-III renders the car practically vibration free at any speed and weighs little more than half as much as a conventional engine of similar power.

Daimler-Benz says the experimental car will undergo modifications to improve its durability and exhaust-emission control before a decision is made on commercial production.

Exercise 8. **Translate into English:**

УНІКАЛЬНИЙ ДВИГУН

Датська автомобільна корпорація випустила унікальний двигун. Колінчастий вал було замінено гідравлічною (hydraulic) трансмісією. Цей двигун значно менший за розмірами, ніж звичайні дизельні двигуни. Він має потужність від 8,000 до 40,000 к.с. Таким чином він може замінити (substitute) чотири звичайних дизельних двигуни.

UNIT 13. AIR-COOLED ENGINES

All vehicle engines are air-cooled to some degree. Even in water-cooled engines heat is transmitted first from cylinder to water and afterwards, in the radiator, from water to air. This method of cooling is not difficult to accomplish, because the heat taken off the hot cylinder walls by water can be distributed without difficulty upon the large cooling surface of the radiator, and so easy transmission of heat to air is made possible.

Reciprocating engines used in aircraft are almost entirely air-cooled. Aircraft engines cooled by air are manufactured today in sizes ranging from 50 to 3500 hp and they superseded water-cooled engines. The principal advantages of air-cooled aircraft engines are low weight, and greater reliability in operation. Modern motor-cycles are also designed almost exclusively with air-cooled engines.

New designs of air-cooled vehicle engines are notable for their easy maintenance, reliability and economical operation.

Exercise 1. **Memorize the following words and word combinations:**

air-cooled engine	двигун з повітряним охолодженням
transmission	коробка передач, швидкостей; трансмісія
radiator	радіатор; ребристий охолоджувач
to accomplish	здійснювати, виконувати
take off	відводити, забирати
to distribute	розподіляти, поширювати
surface	поверхня, площа; покриття
reciprocating	зворотньо-поступальний
supersede	заміняти, витісняти
design	1.дизайн, проектування, конструювання. 2.розрахунок; проект.
to design	проектувати, конструювати
maintenance	технічне обслуговування
reliability	експлуатаційна надійність

Exercise 2. **Answer the following questions:**

1. In what way is the method of air-cooling accomplished?
2. What kind of engines do we use in aircraft?
3. What is the size of aircraft engine manufactured today?
4. What are the principle aircraft engines?
5. How are the motor-cycles designed?
6. What are air-cooled vehicle engines notable for?

Exercise 3. **Read the following sentences. Find out those which correspond to the text.**

1. The method of water-cooling is difficult to accomplish.
2. The transmission of heat to air is not possible.
3. Engines used in aircraft are almost entirely air-cooled.
4. One of the principal advantages of air-cooled aircraft engines is a low weight.
5. Motor-cycles are not designed with air-cooled engines.

Exercise 4. **Make up sentences using the given words:**

1. vehicles, are, some, with, designed, engines, air-cooled.
2. aircraft, are, engines, almost, reciprocating, air-cooled.
3. are, weight, engines, aircraft, air-cooled, low.
4. are, notable, their, new, of designs, air-cooled, engines, for, easy, reliability, maintenance.

Exercise 5. **Translate into Ukrainian:**

1. Pedestrian safety problems were the subject of discussion.
2. By-products of combustion are expelled from the engine.
3. The fuel consumption per kilometre travelled indicates the efficiency of the engine.
4. In the 1880's the internal combustion engine was invented, and as a result the 20th century became the age of the automobile.
5. Radiator is a chamber, containing water for cooling the engine. The radiator should be cleaned twice a year.
6. For safe driving at night the paint reflecting light was used on the highway.

7. Exhaust gases of the automobiles are a source of atmosphere pollution.

8. The cooling system proposed by the designers proved to be inefficient.

9. To prevent heat from destroying the engine an improved cooling system is to be devised.

10. In the Stirling engine power is achieved by applying heat to a cylinder containing gas which expands, drives pistons and then escapes into another chamber to be cooled and reused.

UNIT 14. THE PETROL SYSTEM. THE CARBURETTOR.

TEXT 1. THE PETROL SYSTEM

A mixture of air and petrol explodes in the cylinder. This explosion forces the piston down. How does this mixture of air and petrol get into the cylinder? In the petrol system there are three units:

1. The petrol tank.

When we put petrol into a car, it goes straight into the petrol tank. The petrol tank is a large container that keeps the petrol safely.

2. The petrol pump.

The petrol pump pumps the petrol from the tank into the carburettor. The tank is a long way from the engine. It is usually at the back of the car. Pumps are of two kinds: electrically operated or mechanically driven from the engine.

3. The carburettor.

The carburettor mixes the air and the petrol. If there is more petrol, the mixture is rich. If there is more air, it is weak. The flow of the mixture is controlled by the accelerator pedal.

Exercise 1. **Answer the following questions:**

1. What keeps the petrol safely in a car?
2. How does the petrol get from the tank into the carburettor?
3. How is the flow of the mixture controlled in the carburettor?

TEXT 2. THE CARBURETTOR

The purpose of the carburettor is to provide a mixture of petrol and air for combustion in the engine. The mixture normally consists of one part (by weight) of petrol to fifteen parts of air, but this mixture varies quite considerably with temperature and engine speed. If there is a higher proportion of petrol the mixture is said to be “rich”. A higher proportion of air gives a “weak” mixture.

The carburettor has two main parts. There is a container (the chamber) which controls the flow of petrol. The pump forces the pet-

rol through a pipe into the chamber. There is a float in the chamber. If the chamber is full, the float rises. This causes the needle valve to close. Petrol cannot enter. As the chamber empties, the float sinks. The valve opens. More petrol enters the chamber. There is also a choke tube. This tube is open at the top so that air can be sucked in. Pipes lead from the bottom of the tube to the inlet valves of the cylinders. The air and petrol mixture is sucked through these pipes into the cylinders. This flow of mixture is controlled by a throttle valve. This is a round piece of metal like a large coin. It is moved by the accelerator pedal. A small pipe leads from the chamber to the choke tube. The petrol flows through this. There are very small holes (jets) at the end of the pipe. As the induction stroke sucks air down the tube, it also sucks petrol through these jets. The petrol is broken up into thousands of very small drops to form a vapour. It mixes with the air. The mixture is sucked into the cylinder. When the accelerator pedal is pushed down, the throttle is opened. More air is sucked into the carburettor, more petrol and air mixture goes to the cylinder. The explosions in the cylinders are stronger. The car goes more quickly. When the pedal is let out, the throttle closes. There is less mixture. The explosions are weaker. The car goes more slowly.

Exercise 2. **Memorize words and word combinations:**

chamber	камера
float	поплавок
flow	потік
choke tube	дифузор
to suck	всмоктувати
pipe	трубка
throttle valve	дросель, дросельна заслінка
jet	жиклер
branch in the pipe	патрубок
let out	звільняти, випускати
inlet manifold	впускний трубопровід
needle valve	голчастий клапан
nozzle	розпилювач

Exercise 3. **Fill in the blanks with appropriate words and word combinations:**

1. The mixture consisting of fuel vapour and air burned in the cylinder is produced in the … .
2. Two main parts of the carburettor are … and … .
3. The chamber controls the … of petrol.
4. The pump forces the petrol through a … into the chamber.
5. The … rises and sinks in the chamber.
6. The carburettor consists of a … through which air is drawn.
7. The flow of mixture is controlled by a … which is a round piece of metal like a large coin.
8. When the accelerator pedal is pushed down, the … is opened.

Exercise 4. **Translate into Ukrainian:**

1. The mixture of petrol mist and air is sucked along an inlet pipe (induction manifold) and then, by way of branches in the pipe, into each cylinder.
2. A float chamber in the carburettor provides a small reserve of petrol for the jets and ensures an even supply.
3. In case of unskilled operation and especially if the choke valve is kept open too long after the engine has started, the engine may be flooded with fuel to such an extent that it doesn't ignite. This leads to serious damages of the engine.
4. On modern engines, the starting devices are small secondary carburettors, which are equipped with a fuel nozzle and air jet. They are additionally incorporated in the main carburettor. After the engine has been warmed up the starting device is closed since the starting mixture is not required any more.

Exercise 5. **Translate into English:**

1. Призначення карбюратора – це забезпечення суміші бензину і повітря для згоряння у двигуні.
2. Потік повітря у карбюратор контролюється дросельною заслінкою.

3. У цьому двигуні використовуються два карбюратори.

4. Саме з карбюратора бензин подається у двигун.

5. Суміш, яка складається із пари палива і повітря і згоряє у циліндрі, виробляється у карбюраторі.

6. У 1866 році Н. Отто винайшов тип чотиритактного двигуна, який використовується сьогодні.

7. Німецькі винахідники Даймлер у 1885 році і Бенц у 1886 році виготовили бензинові двигуни.

8. Згоряння суміші повітря і бензину відбувається у двигуні внутрішнього згоряння.

Exercise 6. **Answer the following questions:**

1. What is the purpose of the carburettor?
2. What does a fuel mixture consist of?
3. What does a fuel mixture vary with?
4. In what case is a fuel mixture “rich”?
5. What gives a “weak” mixture?
6. What does a carburettor consist of?

UNIT 15. THE CARBURETION SYSTEM

Since it is essential to secure rapid and complete combustion in the cylinder of an internal combustion engine, the fuel and air mixture must be thoroughly mixed; and further, it must be in the correct proportions for all running conditions of the engine. This is accomplished by means of a device called a carburettor. In this carburettor, a steam of air blown over a jet mixes intimately with a spray of petrol drawn out of it. The jet is inserted into a choke or venturi in the intake manifold, and is supplied with petrol at atmospheric pressure.

During the suction stroke of the piston, the pressure in the intake manifold is below atmospheric, and air is induced through the intake and over the jet. As there is a further drop in pressure at the venturi, the pressure difference produced is large enough to draw petrol up out of the jet and atomise it. The level of the petrol in the jet is kept constant by the float and needle valve in the float chamber, which acts as a reservoir for the fuel. Above the venturi there is a throttle valve operated by the accelerator pedal, which controls the amount of mixture admitted to the cylinder.

However, this simple form of single-jet carburettor will not give correct mixture strength for all engine speeds. The chief difficulty encountered is that, at high running speeds, the amount of petrol taken up at the jet will increase faster than the increase in air-flow. Therefore a carburettor set to give correct mixtures at low speed will give a progressively richer mixture as the speed increases. To compensate for this, a second jet is provided, fed from a well open to the atmosphere and supplied with petrol from the float chamber. Owing to the fact that this compensating jet is larger than the main jet, it can supply petrol at a quicker rate than the main jet until the well is emptied. As the speed is increased, more and more of the petrol required is drawn from the main jet. The compensator jet can now supply only as much petrol as can pass through the small compensator orifice in the float chamber.

Another problem to be solved is that of starting. In order to obtain the rich mixture required for starting, the throttle must be almost closed. As the air velocity is then very low in the venturi, insufficient petrol is drawn out of the jet. This difficulty is overcome by the provi-

sion of an idler jet in the wall of the intake manifold near the throttle valve. This jet will only function when the throttle is nearly closed. When it is opened for faster running, the suction round the edge of the throttle decreases, and the idler automatically ceases to act.

Exercise 1. **Memorize the following words and word combinations:**

to accomplish	виконувати
stream	потік
to insert	вставляти
venturi	трубка вентурі, сопло
intake manifold	впускний трубопровід
to encounter	зустрічатися, наштовхуватися
well	джерело, відстійник
to supply	постачати
owing to	завдяки
orifice	жиклер, сопло
velocity	швидкість
idler jet	пусковий жиклер, жиклер холостого ходу

Exercise 2. **Find synonyms:**

A
1. suction stroke
2. flow
3. rapid
4. essential
5. complete
6. correct
7. to accomplish
8. to call
9. to supply
10. to equip
11. to insert
12. to operate
13. speed
14. orifice

B
1. quick
2. Jet
3. intake stroke
4. stream
5. to run
6. to install
7. full
8. velocity
9. important
10. right
11. to name
12. to provide
13. to put into
14. to perform

Exercise 3. **Translate into Ukrainian the following word combinations:**

internal combustion engine, needle valve, intake manifold, float chamber, suction stroke, pressure difference, throttle valve, accelerator pedal, engine speed, air velocity, idler jet, running speed.

Exercise 4. **Answer the following questions:**

1. What is essential to secure rapid and complete combustion in the cylinder of an internal combustion engine?
2. What is a carburettor?
3. By what is the level of the petrol in the jet kept constant?
4. Why is the compensator jet provided?
5. What is the function of an idler jet?

Exercise 5. **Translate into Ukrainian:**

AN OPTIMUM CARBURETTOR

M. Kovalevsky, a teacher at a polytechnical institute in Kirghizia, invented a special device to prevent pollution with exhaust fumes.

The device, called temperature corrector, is mounted on internal combustion engines in automobiles. It forces the engine to operate at an optimum regimen which almost reduces to nil the amount of toxic products of incomplete combustion ejected into the air.

280 Volga cars equipped with Kovalevsky's correctors were tested in Kirghizia. The results were excellent.

Exercise 6. **Translate into Ukrainian:**

OIL FOR AUTOMOBILE CARBURETTOR MOTORS

In summer industrial oil N50 (engine oil CY) is mostly used in carburettor engines of cars (at all seasons in southern areas).

The oil M-10B is used for carburettor-type motors with more force, whereas M-10A is for carburettor-type motors with low force. The letter "M" stands for motor and the number 10 shows the allowable kinematic viscosity of the oil.

UNIT 16. THE CRANKSHAFT. THE CAMSHAFT

TEXT 1. THE CRANKSHAFT

The piston goes up and down but the car wheels go round. So something must change the up-and-down movement to a round-and-round movement. The connecting rod makes the change. The little end of the connecting rod is connected to the piston. The connecting rod can swing from side to side. The big end is connected to a shaft (the crankshaft). The crankshaft can move round inside the big end. As the piston goes up and down, the connecting rod causes the crankshaft to go round.

When you ride a bicycle, your legs go up and down. The pedals and the chain wheel go round. The movement of the connecting rod is like your leg movement. So the connecting rod causes the crankshaft to go round. This circular movement goes through the gears to the car wheels.

Exercise 1. **Memorize the following words and word combinations.**

crankshaft	колінчастий вал
wheel	колесо
movement	рух, переміщення
round-and-round movement	обертальний рух
circular movement	круговий рух
up-and-down movement	зворотно-поступальний рух
connecting rod	шатун
to swing	коливатися
gear	передача, шестерня, зубчасте колесо

Exercise 2. **Answer the question:**

How does the up-and-down movement of the piston change to the circular movement of the car wheels?

Exercise 3. **Translate into English:**

Поршні з'єднуються з шатуном за допомогою поршневого пальця (gudgeon pin). Це з'єднання знаходиться на малій головці шатуна (little end). Нижній кінець шатуна називається великою (кривошипною) головкою (big end), яка з'єднується з кривошипом за допомогою шатунного підшипника (big-end bearing).

TEXT 2. THE CAMSHAFT

As the crankshaft turns, it turns another shaft. This is the camshaft. There is a wheel with teeth at one end of the crankshaft. This wheel is connected by a chain to a bigger wheel. This bigger wheel is at the end of the camshaft. So when the crankshaft turns, the camshaft turns too. The camshaft has cams on it. There are two cams for each cylinder. They open and close the inlet and exhaust valves on each cylinder.

The cams turn with the shaft. As the high part of the cam comes up, it pushes up a rod. This rod pushes up one end of a lever (the rocker arm). The other end of the lever pushes down the valve and opens it.

On each valve there is a strong spring. As the lower part of the cam comes round, the spring forces the rocker arm up. This closes the valve. The turning of the shaft is set in a certain way. It makes the inlet and exhaust valves open and shut at the right time in the firing cycle.

There is a gear wheel in the middle of the camshaft. It does two things. It turns the distributor. It works the oil pump.

The camshaft turns the distributor. The distributor distributes electricity to the sparking plug. The sparking plug fires the petrol and air mixture in the cylinder, at the right time in the firing cycle. So the camshaft controls the firing cycle.

Exercise 4. **Memorize the following words and word combinations:**

camshaft	розподільний вал
chain	ланцюг
cam	кулачок

spring	пружина
rocker arm	хитний важіль (клапанне коромисло)
gear wheel	зубчате колесо
distributor	розподільник
sparking plug	свічка запалювання
projection	виступ
valve stem	стержень/шток клапана

Exercise 5. **Answer the following questions:**

1. What makes the camshaft turn?
2. What makes the valves move?
3. How many cams are there for each cylinder?
4. What is the purpose of the valve spring?
5. What does the camshaft control?

Exercise 6. **Translate into Ukrainian.**

The camshaft is driven by a chain or gear at half the speed of the crankshaft. It has specially-shaped projections, known as cams, set at varying angles. There are as many cams as there are valves, and as the camshaft revolves, each cam causes its corresponding valve to open. Then, as the cam moves further round, a coil spring fitted round the valve stem forces the valve to shut, and it is then ready to open again next time the cam comes round.

During every revolution of the camshaft all the valves open and close once. In a fast-moving car fitted with a four-cylinder engine, each valve opens and closes between thirty and forty times every second. This gives you some idea of the speed of operation and the accuracy needed to obtain correct timing.

Exercise 7. **Translate the following word combinations:**

petrol/air mixture, specially-shaped projections, camshaft revolution, valve stem, fast-moving car, four-cylinder engine, operation speed.

Exercise 8. **Translate into English:**

хитний важіль, пружина клапана, стінка циліндра, стержень клапана, впускний клапан, випускний клапан, масляний насос, клапанна пружина.

UNIT 17. THE ELECTRICAL SYSTEM

TEXT 1. THE BATTERY AND COIL

The battery is used to store electricity. The electrical pressure (voltage) of a car battery is only 12 volts. When high-voltage electricity jumps a space between two points it causes a spark. This happens in the sparking plug. A voltage of about 7,000 volts will cause a good spark. How do we get 7,000 volts from a 12-volts battery?

The coil does it. The coil is really two coils of wire: the primary coil and the secondary coil. The electricity (12 volts) from the battery flows through the primary coil. Suddenly stopping the flow the primary coil causes a very strong flow in the secondary coil. The flow through the primary coil is stopped by the contact breaker.

Exercise 1. **Memorize the following words and word combinations:**

Coil	котушка запалювання
to store	накопичувати
electrical pressure	електрична напруга
sparking plug	свічка запалювання
primary/secondary coil	первинна/вторинна обмотка
contact breaker	контактний переривник
ignition switch	замок запалювання

Exercise 2. **Translate into Ukrainian.**

THE IGNITION SWITCH

The ignition switch is an electrical switch that turns the current off or on in the ignition circuit. It operates in the same manner as the light switches in your home. It is usually located on the instrument panel and is operated by a key, so that only the person who has the key can turn on the switch. The ignition switch, in addition to completing the ignition circuit, usually has additional terminals which complete the circuits to the instruments or warning lights (fuel, temperature, oil pressure, charging), to the accessories (heater, radio, etc.), and to the starting motor. The ignition, instrument, and accesso-

ries circuits are completed when the switch is turned to the ignition position. The instrument and the accessories circuits are connected when the switch is turned to the accessories position. Only the starting circuit is connected when the ignition switch is in the start position.

TEXT 2. THE CONTACT BREAKER AND THE DISTRIBUTOR

The contact breaker stops or breaks the flow of electricity in the primary coil. The distributor distributes the high voltage electricity to the sparking plugs.

The electricity from the primary coil flows through the centre of the distributor. This rod is turned by the camshaft. There are points in the contact breaker. The points can be opened so as to break the flow of electricity to the primary coil. The points are opened by a cam. They are closed by a spring.

The cam of a four-cylinder engine fits on the rod from the camshaft. It turns when the rod turns. Each corner of the cam presses on the contact breaker. This opens the points of the contact breaker. (A condenser stops any spark at these points). Now high-voltage electricity flows through the secondary coil to the distributor rotor arm. The rotor arm is the contact breaker cam. It is turned by the same rod from the camshaft. As the rotor arm goes round it touches points. Each of these leads to a sparking plug. Each time the arm touches a point the contact breaker points are also open. Then high-voltage electricity flows from the secondary coil to the rotor arm. From the rotor arm it goes to the sparking plug. This causes a spark.

Let us look at this again. The cam opens the points. The flow of electricity to the primary coil stops. High-voltage electricity flows in the secondary coil. It flows through the rotor arm to the sparking plugs. The cam turns. The points close. Electricity flows again into the primary coil. The rotor arm turns also. Contact with the sparking plugs is broken. All this is controlled from the camshaft.

Exercise 3. **Memorize the following words and word combinations.**

breaker	переривник
distributor	розподільник
rod	стержень, шток, тяга
to fit	установлювати, монтувати
point	точка, контакт, клема
to touch	торкатися
to open	розмикатися

Exercise 4. **Answer the following questions:**

1. How do we get high-voltage electricity from a car battery?
2. What is the purpose of the contact breaker?
3. What causes a spark and how does it get to the sparking plug?
4. How does the high-voltage electricity get to the proper sparking plug?

TEXT 3. THE FIRING SEQUENCE

A car usually has four or six cylinders. It may have more. If all the cylinders fired together, the movement of the crankshaft would not be smooth. So they fire quickly one after the other. The camshaft controls this firing, and the crankshaft has a special shape for it. The sequence of firing in a four-cylinder engine is 1-3-4-2.

Cylinder 1 has fired. The piston is moving down. This movement is passed to the crankshaft through the connecting rod.

Cylinder 3 is compressing the air-petrol mixture.

Cylinder 4 is drawing in the air-petrol mixture from the carburettor.

Cylinder 2 is pushing out the smoke and gases after the explosion.

In this way a smooth movement is given to the crankshaft.

Exercise 5. **Speak on the sequence of firing in a four cylinder engine using the given words and word combinations:**

cylinder, to fire, piston, to move down, to pass to the crankshaft, through the connecting rod, to compress the air-petrol mixture, to draw in the mixture, carburettor, to push out the smoke and gases, explosion.

TEXT 4. THE BATTERY AND DYNAMO

The battery only stores electricity. If we use too much, all the electricity will be gone. So something must put electricity back into the battery. This is done by the dynamo. The dynamo is a small machine that makes electricity. It is turned by the crankshaft through a belt. (This belt also turns the cooling fan).

The electricity from the dynamo flows into the battery. This keeps the battery full of electricity (charged). A small instrument (the voltage regulator) stops too much electricity from flowing into the battery (overcharging). So the dynamo recharges the battery when the engine is running.

Exercise 6. **Answer the following question:**

What is a dynamo?

TEXT 5. THE STARTER MOTOR

The pistons turn the crankshaft. If the crankshaft is turned, the pistons will move. The coil, rotor arm, contact breaker, camshaft, sparking plugs will begin to work. The engine will start. How do we turn the crankshaft? This is done by the starter motor. This is a powerful electric motor. When the starter switch is turned, electricity from the battery flows to the starter motor. (Some cars have an ignition switch and a starter switch).

Two things happen:

1. A rod in the starter motor moves forward. There is a small gear wheel on the front of this rod. This meshes with the teeth of a large wheel (the flywheel). The flywheel is fixed on the back end of the crankshaft.

2. The starter motor turns. It turns the flywheel and the crankshaft. The engine starts. The gear of the starter motor moves back from the flywheel.

Exercise 7. **Memorize the following words and word combinations:**

starter motor	стартер
electric motor	електродвигун
switch	вмикач, перемикач
to mesh	зчіплятися
flywheel	маховик
to fix	закріплювати, встановлювати

Exercise 8. **Answer the following questions:**

1. What is the purpose of the starter motor?
2. Where does the starter motor get the electricity from?
3. What meshes with the teeth of the flywheel?
4. Where is the flywheel fixed?

Exercise 9. **Complete these statements with the correct words:**

1. The battery is used … electricity.
2. The electrical … of a car battery is 12 volts.
3. The electricity from the battery flows through the … coil.
4. The flow through the primary coil is stopped by the … .
5. The contact breaker … or … the flow of electricity in the primary … .
6. The rotor arm is the … … can.
7. The dynamo is a small machine that makes … .
8. The dynamo … the battery when the engine is running.

UNIT 18. THE COOLING AND LUBRICATION SYSTEM

TEXT 1. THE COOLING SYSTEM

Engines become very hot while they are running, due to the intense heat created by combustion. Some form of cooling must therefore be adopted and in most cars water is used.

The water enters the cylinder block near the bottom of the cylinders, and flows through special passages cast in the cylinder block and cylinder head. As it absorbs the engine heat its temperature increases and this causes it to flow upward. When it reaches the top of the engine the water is very hot. Now the water itself must be cooled, otherwise it would boil. This is done by means of a radiator. The hot water leaves the top of the engine and filters through the radiator where it is cooled by the passage of air. As it cools it falls to the bottom of the radiator from where it re-enters the engine. A pump, driven by the fan belt, helps to force the water through the system and so improves its cooling efficiency.

Some engines are cooled by air only, not by water.

Exercise 1. **Answer the following questions:**

1. What is the purpose of the cooling system?
2. How does a water cooling system work?
3. Are there engines cooled only by air?

Exercise 2. **Fill in the blanks with appropriate words:**

1. Engines become very hot while they are running due to the … created by … .
2. The water enters … near the bottom of the cylinders.
3. As water absorbs the engine heat its temperature … .
4. When water reaches … it is very hot.
5. Water is cooling by means of a … .
6. A pump, driven by … helps to force the water through the system.

Exercise 3. **Translate into English.**

Коли двигун працює, він нагрівається від спалахів у циліндрах. Як утримувати двигун холодним? Це виконується за допомогою води. Вода тече від радіатора. Вона витікає через отвори у блоці циліндрів. Коли вода нагрівається, вона піднімається до верхньої частини блоку. Звідси вона повертається до верхньої частини радіатора за допомогою невеликого насоса. Гаряча вода з двигуна повільно протікає через радіатор. Коли автомобіль рухається, повітря проходить через радіатор і охолоджує воду.

TEXT 2. THE LUBRICATION SYSTEM

Faithful and appropriate lubrication is an essential requirement for trouble-free operation and it increases the service life of motor vehicle. There are many places in an engine where metal rubs against metal. For example, the piston rings rub against the cylinder walls; the crankshaft rubs against the inside of the big end. When this happens, the metal gets hot. In an engine this extra heat must be avoided or the parts will wear out quickly and become damaged. Oil greatly reduces friction and allows the parts to run smoothly together.

An oil reservoir, or sump, is provided at the bottom of the engine. The sump holds over one gallon (4,5 litres) of oil. From the sump the oil is pumped under pressure through various pipes and passages to the moving parts where there is friction: the cylinder, the crankshaft, the camshaft, pistons and valve operating mechanism. The oil in the sump can be checked by a dipstick, and it must be maintained at the correct level by adding more when necessary. It is essential to watch permanently the oil-pressure gauge of the flashing of the pilot lamp when driving. Whenever the oil-pressure gauge fails to indicate, the engine has to be stopped immediately. Special care has to be taken that the oil supply line is tightly attached to the pressure gauge.

Exercise 4. **Memorize the following words and word combinations.**

lubrication	змащування
service life	строк служби
to rub	тертися
friction	тертя
big end	велика (кривошипна) головка (шатуна)
to reduce	зменшувати
sump	піддон (картера)
passage	прохід, протік
dipstick	щуп, штиковий показник рівня
gauge	вимірювальний прилад
pilot lamp	контрольна лампа

Exercise 5. **Find synonyms:**

A		B	
1.	trouble-free	1.	to operate
2.	motor vehicle	2.	to decrease
3.	to happen	3.	engine
4.	to reduce	4.	to occur
5.	to run	5.	to fit
6.	to hold	6.	automobile
7.	various	7.	safe
8.	to indicate	8.	different
9.	to attach	9.	to show
10.	motor	10.	to contain

Exercise 6. **Answer the following questions:**

1. What causes the engine to wear?
2. What is the purpose of lubricating system?
3. How does this system work?
4. How can the oil in the sump be checked?

Exercise 7. **Translate into English*:***

1. Важливою вимогою двигуна є змащування.
2. Перед виїздом автомобіля необхідно перевірити рівень мастила.
3. Рівень мастила у теплому двигуні потрібно перевіряти за декілька хвилин після зупинки двигуна.
4. Перевірте рівень мастила в картері (crankshaft) двигуна.
5. Ми можемо зменшити небезпеку перегріву деталей за допомогою змащування.
6. Плівка мастила на поверхні метала захищає його від корозії.
7. Після змащування проверніть вали декілька разів вручну.

UNIT 19. THE CLUTCH

Transmission system of a car is a series of assemblies whose purpose is to transmit the power of the engine to the road wheels. The first of these is the clutch assembly. This enables the remainder of the transmission system to be disconnected from the engine, when necessary, so that the various gears in the gearbox can be engaged.

At the back of the engine is a heavy flat wheel known as the flywheel. It is attached to the rear end of the crankshaft and revolves with it. A clutch plate, consisting of a metal disc with a friction lining round its outer edge, is held firmly against the flywheel by a spring-loaded pressure plate. As the flywheel revolves the clutch plate revolves, and it is simply the pressure of one against the other that provides the drive from engine to transmission.

The clutch is operated by the clutch pedal inside the car. When the driver depresses the pedal the clutch pressure plate is forced away from the flywheel, thus disconnecting the engine from the transmission. When the pedal is released, the pressure plate forces the clutch plate against the flywheel and the drive is taken up again.

Exercise 1. **Memorize the following words and word combinations:**

clutch assembly	механізм зчеплення
Gearbox	коробка передач, коробка швидкостей
Rear	задня сторона
clutch plate	диск зчеплення
friction lining	фрикційна накладка
spring-loaded pressure plate	нажимний диск, навантажений пружинами
road wheels	ведучі колеса

Exercise 2. **Answer the following questions:**

1. What system of a car transmits the power of the engine to the road wheels?
2. What device is used to engage or disengage the flow of power from an engine to a transmission?

3. Where is a flywheel placed?

4. What does a clutch plate consist of?

5. What does the pressure of the clutch plate against the flywheel provide?

6. What is the purpose of the clutch pedal?

Exercise 3. **Find equivalents:**

A. 1. clutch assembly; 2. road wheel; 3. rear end; 4. clutch plate; 5. friction lining; 6. outer edge; 7. (clutch) pressure plate; 8. spring-loaded pressure plate; 9. clutch pedal; 10. pedal linkage.

B. 1. нажимний диск зчеплення; 2. нажимний диск, навантажений пружинами; 3. педаль зчеплення; 4. важільний механізм; 5. механізм зчеплення; 6. ведуче (ходове) колесо; 7. задній торець (кінець); 8. ведучий диск зчеплення; 9. фрикційна накладка; 10. зовнішня кромка (периферія).

Exercise 4. **Translate into Ukrainian.**

1. In lorries (trucks) and buses equipped with air brakes, the clutch is sometimes operated by compressed air, that is not directly. Recently, the use of hydraulic clutches has gained ground.

2. Instead of the mechanical friction clutches, modern automotive engineering uses fluid flywheel clutches (automatic transmission). The clutch housing is filled with oil. This type of clutch results in smooth starting, and it works nearly without any slippage in the higher speed range.

UNIT 20. THE GEARBOX

The object of the gearbox is to provide a means of obtaining the most efficient engine speed in relation to the speed required, at the road wheels.

The gearbox is quite a complicated assembly of gears of different sizes, arranged so that certain combinations of gears can be engaged to enable one to drive another. If a larger gear drives a smaller one, a high ratio is produced, and if a smaller gear drives a larger one a lower ratio is provided. Most car gearboxes have four "speeds", which means that by moving the gear lever inside the car one of four different ratios can be selected in the gearbox. A reverse gear is also included to enable the car to be driven backwards for manoeuvring.

In a low ratio gear the engine runs fast while the car is moving quite slowly. As higher gears are engaged the engine speed drops but the car moves faster. A low ratio is therefore used when greater engine power is needed to start the car from rest, to accelerate quickly and to climb steep hills. For normal cruising along a road, a high gear is selected.

Exercise 1. **Memorize the following words and word combinations:**

gearbox	коробка передач
gear	передача, шестерня, зубчате колесо
to engage	зчіплювати
ratio	передаточне число
gear lever	важіль переключення передач
driving shaft	ведучий вал
driven shaft	ведений вал
lay shaft	проміжний вал

Exercise 2. **Answer the following questions:**

1. What is the object of the gearbox?
2. What does the gearbox consist of?
3. How are gears arranged in the gearbox?
4. When is a high ratio produced?
5. When is a lower ratio provided?

6. How many “speeds” have most car gearboxes?

7. What is used to enable the car to be driven backwards for manoeuvring?

Exercise 3. **Find equivalents:**

A. 1. top gear; 2. second gear; 3. bottom gear; 4. high ratio; 5. low ratio; 6. gear lever; 7. reverse gear; 8. assembly of gears; 9. in a low ratio gear.

B. 1. передача заднього ходу; 2. на нижніх передачах; 3. сукупність зубчатих коліс; 4. високе передаточне число; 5. низьке передаточне число; 6. важіль переключення передач; 7. другий ступінь (у коробці передач), друга передача; 8. вищий ступінь (у коробці передач), вища передача, пряма передача; 9. нижчий ступінь (у коробці передач), перша передача.

Exercise 4. **Translate into Ukrainian.**

In the gearbox there are three shafts:

1. The driving shaft is turned by the crankshaft. It has a fixed gear wheel near its end.

2. The driven shaft leads to the back axle. On this shaft there are two gears. One gear is larger than the other. These gears can move along the shaft in grooves. They can move backwards and forwards. They are moved by the gear lever.

3. The lay shaft.

Exercise 5. **Translate into English:**

НЕЙТРАЛЬНА ПЕРЕДАЧА

Ведучий вал обертається, але він не передає ніякого руху веденому валу. Шестерні не зчіплюються. Двигун працює, але він не обертає колеса автомобіля. Ця передача використовується, коли автомобіль зупиняється на короткий час, наприклад, біля світлофора. Вона також використовується, коли двигун вперше запускається.

UNIT 21. THE BRAKES

Every car must have brakes so that it can be slowed or stopped once it has been set in motion. Modern cars can travel very fast, so good brakes are essential for safety.

Two kinds of brakes are in general use: drum brakes and disc brakes. Disc brakes have the more powerful stopping effect, so they are fitted to the bigger and faster cars. Some cars combine the two and have disc brakes for the front wheels and drum brakes for the rear. Drum brakes are of the internal expanding type, which means that two shoes with friction linings attached to them are forced, or expanded, against the inside of a drum at each wheel. The drum revolves with the wheel and the friction between the shoes and the drum causes the braking action. Disc brakes employ a similar principle except that friction pads are forced against the side surfaces of a revolving steel disc.

Most brakes today are fluid operated ("hydraulic"). When the driver presses the brake pedal, it causes a piston to move inside a "master cylinder". This forces the fluid along narrow pipes to each wheel where a small piston is pushed outward to operate the shoes.

Exercise 1. **Memorize the following words and word combinations.**

drum brakes	барабанні гальма
disc brakes	дискові гальма
expanding inside brake	гальмо з розтискними колодками всередині гальмівного барабана
shoe	колодка
brake lining	фрикційна гальмівна накладка
friction lining	фрикційна накладка
to attach	прикріплювати
pad	накладка
master cylinder	головний циліндр

Exercise 2. **Answer the following questions:**

1. What is the purpose of the brakes?
2. What kinds of brakes are in general use?
3. When are disc brakes used?
4. When are drum brakes used?
5. How do drum brakes work?
6. How do disc brakes work?

Exercise 3. **Find synonyms:**

A
1. motion
2. to travel
3. fast
4. essential
5. to fit
6. lining
7. to employ
8. similar
9. to operate
10. powerful

B
1. to use
2. same
3. pad
4. quick
5. movement
6. to run
7. to attach
8. important
9. strong
10. to move

Exercise 4. **Find equivalents:**

A. 1. drum brake; 2. disc brake; 3. friction lining; 4. braking action; 5. fluid-operated; 6. brake fluid; 7. master cylinder; 8. brake shoe; 9. brake lining; 10. hydraulic fluid.

B. 1. гальмівна рідина; 2. головний циліндр; 3. фрикційна гальмівна накладка; 4. гальмівна колодка; 5. рідина для заповнення гідравлічної системи; 6. гальмування; 7. фрикційна накладка; 8. з гідравлічним приводом; 9. дискове гальмо; 10. барабанне гальмо.

Exercise 5. **Translate into Ukrainian.**

When the brake pedal is pushed down, it forces oil (hydraulic fluid) through small pipes. These pipes lead to the brakes. A drum is fixed to each wheel. This goes round with the wheel. The fluid forces

the brake shoe to rub against the drum. The friction between the brake shoe and the drum slows down the wheel.

Exercise 6. **Translate into English:**

1. Кожен автомобіль має два незалежних гальма.
2. Гальмування автомобіля залежить від тертя між шинами і поверхнею дороги.
3. Гальма мають таку класифікацію: механічні, гідравлічні і повітряні.
4. В залежності від дії гальм на передні чи задні колеса, або на передачу, розрізняють гальма передніх коліс, задніх коліс або гальма трансмісії.
5. Сучасні автомобілі обладнані в основному гальмами з розтискними колодками.

UNIT 22. STARTING A CAR

Inside the car on the driver's side there are three pedals. They are the brake pedal, the clutch pedal and the accelerator pedal. There is a steering wheel. There is a gear lever and a handbrake. There is a hole for the ignition key.

The steering wheel and the pedals may be on the left or the right side. If the car transmission is automatic, there is no clutch pedal. When the driver gets into a car he does this. He puts the ignition key into the hole. He turns it. The engine starts. He pushes down the clutch pedal. He puts the gear lever into first gear. He puts the handbrake off. He lets the clutch pedal out slowly. He pushes down the accelerator pedal. The car moves off. How does it move? We shall start with petrol. We know that petrol burns. At all petrol stations there are NO SMOKING signs. Petrol changes very easily into a vapour. A vapour is small drops of liquid which mixes easily with air. Petrol vapour mixed with air burns very easily. If a flame, or even a spark, goes near it, it burns suddenly and releases a lot of energy: it explodes. The energy of petrol is used in a car engine, but in the car engine the energy is controlled.

Exercise 1. **Memorize words and word combinations from the text:**

brake	гальмо
clutch	зчеплення
accelerator	акселератор
steering wheel	рульове колесо, кермо
gear	передача, шестерня, зубчасте колесо
lever	важіль
ignition key	ключ запалювання
to release	виділяти
to explode	вибухати, спалахувати
petrol station	бензозаправка

Exercise 2. **Fill in the blanks with appropriate words:**

1. There are three pedals on the driver's side inside the car. They are …
2. While driving, a driver always holds … in his hands.
3. When starting a car, first of all make sure that the … is in neutral position.
4. For putting the vehicle in motion, all internal-combustion engines require some connection between engine and axle drive. It is a …
5. He left the … key in a car.
6. At all … there are "No Smoking" signs.
7. Petrol vapour mixed with air burns and … a lot of energy and it … .

Exercise 3. **Find synonyms*:***

A
1. discussion
2. main
3. sure
4. to switch on
5. to move forward
6. to accelerate
7. to watch
8. to change
9. to use
10. liquid

B
1. certain
2. to utilize
3. to observe
4. talk
5. chief
6. to turn on
7. to advance
8. fluid
9. to speed up
10. to alter

Exercise 4. **Find antonyms*:***

A
1. to push
2. liquid
3. to accelerate
4. to start
5. easy
6. to release
7. quiet
8. main
9. quick
10. to reduce

B
1. to finish
2. slow
3. to pull
4. to absorb
5. noisy
6. to slow
7. solid
8. difficult
9. to raise
10. secondary

Exercise 5. **Read and translate the following dialogue:**

A DRIVING LESSON

After great discussion Mr. Howard agreed to teach his wife to drive their car. They go out to a quiet place of the main road, and Mr. Howard pulls up.

Mr. Howard: Now, pay attention, I shall explain everything to you. Here, at my feet, are three pedals – the clutch on the left, then the foot brake and the accelerator on the right. Here is the gear lever. Now, I first of all make sure that the gear lever is in neutral position, then I switch on the ignition and press the starter. (The engine begins to tick gently). Now I let in the clutch and engage first gear. Then, while gently letting out the clutch I gradually press down the accelerator. (The car starts to move forward). Now we'll change places and see if you can do that. (He stops the car).

Mrs. Howard: It seems easy enough. (She switches on the engine, gets into first gear and lets out the clutch. The car gives a jolt and stops).

Mr. Howard: You didn't accelerate. Try again! Don't look at your feet! Watch the road ahead! We were nearly in the ditch that time.

Mrs. Howard: What do you do now?

Mr. Howard: Get into second gear! There it is. Don't let out the clutch so suddenly! Oh, my poor engine! Now change up to third! That's better. Keep to the left! A car behind is going to overtake us. Now, brake gently, get into neutral and stop!

Mrs. Howard: I think that's enough for today.

Mr. Howard: So do I.

Exercise 6. **Speak on the driver's sequence of actions when he starts a car.**

UNIT 23. THE ENVIRONMENTAL COST OF CARS

Motor vehicles have brought enormous social and economic benefits. They have enabled flexibility in where people live and work, the rapid and timely distribution of goods and ready access to a variety of services and leisure options. Many people are very attached to their cars. They say that having a car is an essential part of their lives – it offers mobility, power, freedom and convenience. The typical car owner spends 1,600 hours (over 50 days) each year in his car: driving, parking and cleaning it.

The car industry is the largest industry in the world economy. It is dominated by huge American, Japanese and European companies like General Motors, Toyota and Volkswagen. General Motors is the largest transnational corporation.

In most parts of the world the motor car is seen as a sign of progress and development.

The widespread use of cars has real environmental and economic costs. Vehicles are major sources of urban air pollution and greenhouse gases emissions. They make our towns and cities dirtier, noisier and more dangerous places to live. Vehicles also represent an important threat to the economic security of many nations because of the need to import oil to fuel them.

Car engines use only 10 to 20% of energy in the fuel – the rest is lost as noise, heat and pollution.

Road traffic is the source of one third of all harmfull air pollution in the world. Car exhausts contain nitrogen oxide, which contributes to acid rain, carbon dioxide, which contribute to global warming, and lead, which damages human brain and kidneys.

Besides greenhouse gases, car exhausts contain lead, which is added to gasoline to improve the engine performance.

Lead is particularly toxic to the brain, kidneys, reproductive system and cardiovascular system. It is very dangerous because it can accumulate in the body. Lead is a special hazard for young children. Lead exposures can significantly reduce the IQ of school-aged children; they also cause aggressive behavior, delinquency and attention disorders.

Many countries introduced catalytic converters into their cars,

which require unleaded gasoline. But despite widely recognized damage to the health, most countries still use leaded fuel. By 1996 only 14 countries had completely phased out the use of leaded gasoline.

Gasoline and diesel fuel are distilled at huge refineries which produce both toxic waste and toxic air emissions. The refineries are located in towns, that have the highest cancer rates and are populated by workers with the highest occupational disease rates.

Road building withdraws large areas of land from agricultural use, requires tremendous amounts of resources and causes great changes in the environment. In places where roads are built, the topsoil is pushed aside, the vegetation is stripped away and animal habitats are destroyed.

In cities close to one third of all land goes to accommodate the car-parking lots, expressways, roundabouts, bridges, petrol stations and garages. Parking lots devour huge stretches of land and are empty 80 per cent of the time.

From the 1960s onwards more and more people protested against the motor car. Some pressure groups and local councils opposed traffic in towns, the building of new roads, the closure of railways and the loss of bus services. Some councils restricted the use of cars, improved public transport and created better facilities for pedestrians and cyclists.

Now car manufacturers are trying to make more environmentally friendly cars, which use fuel more efficiently and cause less pollution. From 1992 all new cars in Europe had to be fitted with catalytic converters.

In the future cars may run on solar power, alcohol from plants or fuel cells using methanol or hydrogen. They will be much lighter with aerodynamic design and advanced electronics.

Exercise 1. **Answer the following questions:**

1. What are social and economic benefits of motor vehicles?
2. Why are many people so attracted to their cars?
3. What automobile companies of the world do you know?
4. What does the widespread use of cars cause to the environment?
5. What do car exhausts contribute to?

6. Why is lead a special hazard for children?
7. Do all countries use unleaded gasoline?
8. Do refineries produce hazardous waste and toxic emissions?
9. What are car manufacturers trying to do now?
10. What will a car be in future?

Exercise 2. **Give English equivalents of the following:**

транспортний засіб	небезпечний
зручність	каталітичний конвертор
джерело	потребувати
паливо	очисний завод
містити (в собі)	удосконалювати, поліпшувати

Exercise 3. **Fill in the blanks with appropriate words:**

1. The widespread use of … produces environmental problems.	fuel
2. Car engines use only 10 to 20% of energy in the ….	catalytic converters
3. Towns with oil … have the highest cancer rates.	vehicles
4. Many countries use … in their cars which require unleaded gasoline	refinery
5. An automobile offers mobility, power, freedom and … .	dangerous
6. Vehicles are major … of urban air pollution and photochemical smog.	convenience
7. Car exhausts are … for human health.	source
8. Road building and motor car industry … tremendous amounts of resources and causes changes in the environment.	improved
9. Many towns … their public transport and created better facilities for pedestrians.	contain
10. Car exhausts … nitrogen oxide and lead.	require

UNIT 24. ROLE PLAYS

I. TRANSPORT FOR TOMORROW

Problem

Like most big cities, Kyiv has a serious traffic problem on its hands: people's journeys to work are long, tiring and uncomfortable; there are traffic jams in rush hours and continuous congestion in the city throughout the day; and there is much noise and air pollution. The city council – an enterprising and forward-looking body – has decided to study the problem in order to make a comprehensive long-term plan which will make the city a better place to live in.

They have commissioned a number of experts to study the problem from all angles: scientists and engineers who will forecast possible developments in the motor industry and propose radical new solutions for public transport; traffic experts who will calculate the traffic flow; town planners and architects who will design shopping centres and residential areas adapted to the transport system. In addition they have taken the original step of conducting a survey to find out what citizens think on the problem.

Exercise 1. **The questions to be answered are:**

1. What is most important for you – comforts? low cost? speed? frequency?
2. Do you prefer to live near the city centre or in the houses spread out into the suburbs?
3. Are you ready to pay higher rates for the improvements?

Kyiv TV Channel has asked experts to come and talk on the prospect of "Tomorrow's Transport in the City". A town planner, a representative of the car industry, a manager of the autoplant, a sociologist have been asked to give their views on the problem. The programme has a telephone link with listeners who can telephone in to ask questions or express their opinions.

***Exercise 2*. Words and word combinations to be remembered:**

traffic jam/congestion	затор, скупчення транспорту
commission	уповноважити, одержати
rush hours	година пік
residential areas	жилі квартали
from all angles	з усіх точок зору

***Exercise 3.* Analyse the case.**

Questions:

1. Why is the traffic problem in the centre of attention of the city council?
2. From what angles is the problem examined?

ROLES

The host of the programme

You introduce a regular weekly programme on topical questions. Your job is to keep the discussion to the point, make sure everybody has an opportunity to express his opinion and to gain the listener's interest by provoking disagreement and argument.

A town planner

You are in charge of the city's town planning department. You have original ideas which you would like to put into practice. You have designed an underground car park in the centre which would leave it completely free for pedestrians. You also have in mind a futuristic complex of shops and flats. When you hear from people that it will cost too much, you get impatient.

A representative of the car industry

The arguments you put forward are somewhat defensive – the car industry provides considerable employment and wealth for the city. The autoplants have made some progress in reducing noise and pollution.

A sociologist from a Western country

You have studied the problems of life in big cities. You think that in future people will move away from towns. In your opinion big cities produce aggression and nervous tension.

Exercise 4. **Useful Language:**

1. Today's talking point is … .
2. Who'd like to begin?
3. Who'd like to start the ball rolling?
4. What's your opinion on that, Mr. …?
5. Did you agree with that attitude?
6. There seem to be some contradictions between your points of view.
7. It seems to me obvious that … .
8. I'm convinced that … .
9. Let's look at the whole question from a realistic point of view.
10. Let's face the facts.
11. There's only one way of dealing with the problem.
12. Our research has shown that … .

Exercise 5. **Further Subjects for Discussion:**

1. What do you think is likely to be the means of transport of tomorrow?
2. Would you consider it is better to invest in road or rail transport?
3. What effects do air pollution, noise and traffic jams have on people? Look at some of the ways of reducing the bad effects.
4. What are the main causes of road accidents?

What should be done to reduce the number of accidents on the roads?

2. City traffic of future

You are invited to the conference of town planners to speak on city traffic of future. You are supposed to describe in detail one means of transport. Present information on:

1) the forms of city traffic which will be forced out in future;

2) the kinds of traffic which will appear in the streets;
3) the vehicle you think the people will use mostly in their everyday life;
4) the kind of fuel it will run on;
5) the speed it will go at;
6) the passenger capacity this vehicle will have;
7) how often it will operate;
8) the accessories it will have;
9) the advantages it will have.

Exercise 6. **Discussion.**

The first cars appeared on the roads at the end of the 19th century. Nowadays there are a lot of cars in the streets. In some towns it is very difficult to find parking. We can't imagine our life without a car. At the same time driving a car causes a lot of problems. So, is a car our friend or enemy?

a) Read the following arguments. Think of some more.

A car is our friend	*A car is our enemy*
1. It saves out time.	1. It gives noise.
2. It carries our luggage.	2. It causes air pollution.
3. It gives us comfort while travelling.	3. Many people are killed or injured in car accidents.
4. It gives us the opportunity to travel and see the world around.	4. It causes traffic jams.
5. It brings help quickly (police, ambulance, fire engines).	5. You don't walk enough and it does harm to your health.

b) Discuss the problem in groups of 3-5 students in order to make a decision.

c) Fill in the chart and give your reasons.

	Group 1	Group 2	Group 3	Group 4
A car is our friend.				
A car is our enemy.				

UNIT 25. INVENTORS OF AUTOMOBILE

TEXT 1. INVENTORS AND INVENTIONS

Rudolf Diesel was a German engineer. He was born in 1858 and died in 1913. In 1897 he invented a new internal combustion engine. This engine is known as a diesel engine and it began a transport revolution in cars, lorries, trains and ships. The main advantage of diesels is that they run on rather cheap fuel.

Charles Rolls was born in 1881 in Great Britain. He died in 1910. He was an aristocrat and a businessman. He was especially interested in cars. Once he met another enthusiast of cars Henry Royce. Henry Royce was a famous car engineer. They decided to design the most comfortable and reliable car. At the beginning of the 20th century it seemed the world-famous Rolls-Royce car. It was so comfortable that one of the models of Rolls-Royce cars "Silver Ghost" hadn't changed greatly for 20 years since 1907.

Gottlieb Daimler and Charles Benz were two inventors. They lived in Germany. They were both interested in car production. At the end of the 19th century each of them designed a car. At the same time they organized two independent firms to produce them.

All the cars produced by the firm of Daimler were called 'Mercedes". Mercedes was a daughter's name of one of the stockholders of the firm. This man saved the firm of Daimler from the financial crisis at the beginning of the 20th century. But after the Word War I the firm of Daimler met with financial difficulties again. This time it had to join the firm of Benz. Since that time all the cars produced by the firm "Daimler-Benz" have been called "Mercedes-Benz".

TEXT 2. HENRY FORD

Henry Ford (1863-1947), was the leading manufacturer of American automobiles in the early 1900's. He established the Ford Motor Company, which revolutionized the automobile industry with its assembly line method of production. The saving from this technique helped Ford sell automobiles at a lower price than anyone had

before. From 1908 to 1927, more than half of the cars sold in the United States were Fords.

Early life. Ford was born on a farm in what is now Dearborn, Mich. He became a machinist at the age of 16 and later worked as an engineer at a Detroit electric company. As a young man, Ford became interested in automobiles. He built his first successful gasoline engine in 1893 and his first automobile in 1896.

Industrial accomplishments. In 1903, Ford organized the Ford Motor Company. At first, the company produced only expensive cars, as its competitors did. But Ford soon began working to make a simple car that many people could afford. He achieved one of the first such cars with the Model T, which appeared in 1908. In 1909, Ford decided to produce only Model Ts.

The original price of $850 for a Model T touring car was too high for many customers. To lower the price, Ford and his executives created an assembly line method in which conveyor belts brought automobile parts to workers. Each worker performed a particular task, such as adding or tightening a part. This system helped reduce the assembly time of a Ford automobile from about 12,5 worker-hours in 1912 to about 1,5 worker- hours in 1914.

Ford Motor Company began to produce its own parts instead of buying them from independent suppliers at a higher price. Ford also shipped automobile parts, rather than assembled automobiles, to market areas, where assembly plants put the parts together. Parts cost less to ship than whole automobiles did. In addition, the company began to make its own glass and steel.

As the company's production costs fell, Ford passed much of the saving on to his customers. The price of a Model T touring car dropped to $550 in 1913, $440 in 1915, and $290 in 1924, putting the automobile within reach of the average family.

In 1914, Ford raised the minimum wage to $5 a day for his employees 22 years of age and over. This rate was more than twice what most wage earners received. Ford also reduced the workday from 9 to 8 hours. To encourage productivity, Ford introduced a profit-sharing plan, which set aside part of the company's profits for its employees.

During the mid-1920's, Ford continued to produce the Model

T even though its popularity had declined. He also continued to offer only basic transportation at a low cost. The Model T changed little from year to year, and until 1926 it came in only one colour, black.

Ford finally introduced a new design, the Model A, in 1927, after more than 15 million Model Ts had been sold. In 1932, Ford introduced the first low-priced car with a V-8 engine, a powerful engine that had eight cylinders arranged in a V. Ford Motor declined throughout the 1930's, and some people began to question Henry Ford's management skills. In 1945, Henry Ford II, one of Ford's grandsons, took over the company.

Political and charitable activities. Ford had long taken an interest in political affairs. In 1915, during World War I, he and about 170 other people travelled to Europe at his expense to seek peace. The group, which lacked approval by the U. S. government, failed to persuade the warring nations to settle their differences.

In 1918, the year the war ended, Ford ran as a Democrat for a Senate seat from Michigan. He lost the election and did not seek public office again, but he continued to speak out on political issues. He made statements critical of Jews. He also opposed labour unions.

Ford devoted much time and money to educational and charitable projects. He established Greenfield Village and the Henry Ford Museum, both in Dearborn. The village is a group of restored historical buildings. The museum included exhibits in science, industry, and art. In 1936, Ford and his son, Edsel, set up the Ford Foundation, the world's largest foundation, which gives grants for education, research, and development.

Ford wrote four books with author Samuel Crowther. They are "My Life and Work" (1922), "Today and Tomorrow" (1926), "Edison As I Know Him" (1930), and "Moving Forward" (1931).

Exercise 1. **Memorize words and word combinations from the text:**

savings	збереження
gasoline	бензин
engine	двигун, мотор
accomplishment	досягнення
competitor	конкурент

customer	клієнт, покупець
executive	посадова особа
tighten	ущільнювати
supplier	постачальник
ship	відправляти
costs	витрати
within reach	доступний
wage	заробітна плата
share	розподіляти
employee	службовець
decline	спадати
question	піддавати сумніву
take over	вступати у володіння
charitable	добродійний
at smb's expense	за чий-небудь рахунок
approval	схвалення; санкція
persuade	переконувати
run	балотуватися
public office	пост державного службовця
issue	суперечність; проблема
devote	приділяти, віддавати
exhibit	експонат

***Exercise 2*. Answer the following questions:**

1. Who established the Ford Motor Company?
2. Tell about Ford's early life.
3. What was Ford's first car?
4. Discribe the industrial accomplishments on the Ford Motor Company?
5. Who was Henry Ford's follower in his Company business?
6. Did Henry Ford take an interest in political affairs?
7. Was Henry Ford engaged in charitable projects?

***Exercise 3*. Make the short plan of the text and retell the text according to it.**

***Exercise 4*. Translate into English.**

1. Форд був одним з основних виробників автомобілів в Америці на початку XX століття.
2. Форд заснував свою власну компанію і вперше запропонував конвеєрний метод виробництва автомобіля.
3. Автомобілі Форда були дешевшими ніж будь-які до нього.
4. Перша модель широкого вжитку, що з'явилась в 1908 році, була Модель Т.
5. В 1932 році компанія Г. Форда вперше запропонувала дешевий автомобіль з 8-ми циліндровим двигуном.

***Exercise 5.* Read the following sentences. Find out those which correspond to the text.**

1. Henry Ford was the prominent scientist of the 18th sentury.
2. From 1908 to 1927 about the half of the cars sold in United States were Fords.
3. The Ford Motor Company was organized in 1910 and started to produce four different models at once.
4. The Model T was an expensive car for rich customers.
5. In 1932 Ford produced a low-priced car with a V-8 engine.
6. Henry Ford II took over the company in 1945.
7. Ford took an interest in political affairs.
8. Ford ran as a Conservator for a Senate but he lost his elections.
9. Henry Ford devoted much time and money to charitable projects.
10. Ford wrote many books.

TEXT 3. ENGINE DESIGNERS

Engine design and car design were integral activities, almost all of the engine designers also designed cars, and a few went on to become major manufacturers of automobiles. All of these inventors and more made notable improvements in the evolution of the internal combustion vehicles.

The importance of Nicolaus Otto

One of the most important landmarks in engine design comes from Nicolaus August Otto who in 1876 invented an effective gas motor engine. Otto built the first practical four-stroke internal combustion engine called the "Otto Cycle Engine", and as soon as he had completed his engine, he built it into a motorcycle. Otto's contributions were historically significant, it was his four-stroke engine that was universally adopted for all liquid-fueled automobiles going forward.

The importance of Karl Benz

In 1885, German mechanical engineer, Karl Benz designed and built the world's first practical automobile to be powered by an internal-combustion engine. On January 29, 1886, Benz received the first patent (DRP No. 37435) for a gas-fueled car. It was a three-wheeler; Benz built his first four-wheeled car in 1891. Benz & Cie., the company started by the inventor, became the world's largest manufacturer of automobiles by 1900. Benz was the first inventor to integrate an internal combustion engine with a chassis – designing both together.

The importance of Gottlieb Daimler

In 1885, Gottlieb Daimler (together with his design partner Wilhelm Maybach) took Otto's internal combustion engine a step further and patented what is generally recognized as the prototype of the modern gas engine. Daimler's connection to Otto was a direct one; Daimler worked a as technical director of Deutz Gasmotorenfabrik, which Nikolaus Otto co-owned in 1872. there is some controversy as to who built the first motorcycle Otto or Daimler.

The 1885 Daimler-Maybach engine was small, lightweight, fast, used a gasoline-injected carburettor, and had a vertical cylinder. The size, speed, and efficiency of the engine allowed for a revolution in car design. On March 8, 1886, Daimler took a stagecoach and adapted it to hold his engine, thereby designing the world's first four-wheeled automobile. Daimler is considered the first inventor to have invented a practical internal-combustion engine.

In 1889, Daimler invented a V-slanted two cylinder, four-stroke engine with mushroom-shaped valves. Just like Otto's 1876

engine, Daimler's new engine set the basis for all car engines going forward. Also in 1889, Daimler and Maybach built their first automobile from the ground up, they did not adapt another purpose vehicle as they had always been previously. The new Daimler automobile had a four-speed transmission and obtained a speed of 10 mph.

Daimler founded the Daimler Motoren-Gesellschaft in 1890 to manufacture his designs. Eleven years later, Wilhelm Maybach designed the Mercedes automobile.

TEXT 4. THE HISTORY OF MERCEDES-BENZ

Mercedes-Benz: The Early Years of Daimler and Benz through World War I

Gottlieb Daimler and Carl Benz were born only 60 miles apart in southern Germany. Daimler was born on March 17, 1834. A decade later, on November 25, Carl Benz was born.

Although they grew up with little in common, both boys were fascinated by machines from an early age. Because their approach to building cars was quite different, it is doubtful, though, that they met or even knew what the other was doing.

In 1886, Carl Benz built a motorized tricycle. His first four-wheeler, the Victoria, was built in 1893. The first production car was the 1894 Benz Velo which participated in the first recorded car race, the Paris-Rouen race. In 1895, Benz built his first truck.

In 1886, Gottlieb Daimler literally built a horseless carriage. In 1888 Daimler made a business deal with William Steinway (of piano fame) to produce Daimler's products in the US. From 1904 until a fire in 1907, Steinway produced Mercedes passenger cars, Daimler's light trucks, and his engines on Long Island.

Ironically, history says Daimler, generally considered to be the father of modern automobiles, never liked to drive, if, indeed he ever learned to drive. On March 6, 1990, Daimler died, leaving control of his company to his chief engineer Wilhelm Mayback.

By November 22 of that year, Daimler-Motoren-Gesellschat had produced a special car for Emil Jellinek. Jellinek named the car after his ten-year-old daughter Mercedes. Lighter and smaller, the new Mercedes had 35 hp and a top speed of 55 mph!

The 1903 Parsifil was Benz's answer to Mercedes. A two cy-

linder vertical engine produced a top speed of 37 mph in this car.

Aware of the promotional potential of racing, both Daimler and Benz entered many of them. However, up until 1908, Daimler had overshadowed Benz in racing endeavors. At the 1908 French Grand Prix, Benz took the second and the third place behind Lautenschlager driving a Mercedes. From that point on, both Benz and Daimler did well in racing.

At the beginning of the first World War, both factories were converted into production sites for war materials, although both resumed producing cars after the war.

Mercedes-Benz: From WWI's End to the Mercedes-Benz Merger

Social unrest and a falling economy characterized post-war Germany. Little or no fuel for cars and a 15% luxury tax made automobile production increasingly disastrous. This market sent Benz and Cie seeking a strong partner. The only one the board considered worthy of Benz and Cie was DMG.

Thus, in 1919, Karl Jahn, a Benz board member since 1910, approached Daimler-Motoren-Gesellschat about a possible merger. The merger attempt looked promising, then was abandoned in December of 1919.

The German economy continued to worse and a new Benz automobile eventually cost 25 million marks.

Although nearly 15 million cars were registered in the world in 1923, over 80% of them were registered in the US and over 1/2 were Fords. Benz and Cie. built 1,382 cars in 1923 while DMG only built 1,020. German auto makers were at a low point although racing success for the companies continued.

In 1924, from sheer economic necessity, Benz and DMG signed an "Agreement of Mutual Interest." Although both companies retained their identities, the agreement was valid until the year 2000. The two companies merged with relative ease on June 28, 1926.

Mercedes-Benz: From the Mercedes-Benz Merger Through the 20s

A symbol was chosen for the combined products of DMG and Benz. The new insignia was a three-pointed star wreathed with laurel. The word "Mercedes" was at the top and the word "Benz" was at the

bottom.

Then merger did the new company well. Production of Mercedes-Benz rose to 7,918 Mercedes-Benz automobiles in 1927. The Mercedes-Benz diesel truck was put into production in 1927, also.

The first two automobiles to sport the Mercedes-Benz name were the Stuttgart and the Mannheim. Then in 1928 the Mercedes SS was introduced by Mercedes-Benz. This graceful body was made possible by a hood line that barely cleared the engine.

Mercedes-Benz: 1930 and beyond for Mercedes-Benz

Mercedes-Benz launched their biggest and most prestigious car to date in 1930. The 770 Grosser was powered by an 8 cylinder, 7.6 liter engine. A car for the truly wealthy of the world, it was quite an automobile for showing off in a world economy still reeling from the Wall Street Crash of 1929.

The cars of the 1930s produced great racing success for Mercedes-Benz. The silver metal bodywork gave rise to the name Silver Arrows when the W25 racer (of Rudolph Caracciola fame) had the white paint removed to lower its weight.

W125 (200 mph top speed) won seven out of thirteen races in 1937 followed by the successful W154. In 1939 Mercedes-Benz built a small V8 races specifically to win the Tripoli GP It did win!

The Mercedes-Benz 170V gave Mercedes the capability of surviving and then recovering from WW II.

Mercedes-Benz: Classic Cars for Mercedes Benz.
Mercedes-Benz Classics produced from 1930 - 1970.

Mercedes Benz Type	Production: Years	Length: Inches	Weight: Pounds
Mercedes-Benz 770 Grosser	1930-37	210	6000+
Mercedes-Benz 380K/500K/540K	1933-1939	185-205	4500-5100
Mercedes-Benz 770 Grosser	1938-1940	246	7600-8100
Mercedes-Benz Type 300	1951-1962	195	3860-4400
Mercedes-Benz Type 300S/Sc	1952-1958	186	3600
Mercedes-Benz 300SL	1954-1963	180	2750-3000
Mercedes-Benz 190SL	1955-1963	169	2515
Mercedes-Benz Coupe/Cabriolet	1959-1971	192	3330-3650
Mercedes-Benz Type 600	1963-1980	218-246	5445-5820
Mercedes-Benz 230/250/280SL	1963-1971	169.5	2855-2900
Mercedes-Benz 300SEL 6.3	1967-1972	196.9	4010

Mercedes-Benz: Back to Bikes!

Well, it's not exactly the tricycle of Carl Benz' days, but Mercedes-Benz of North America introduced an advanced mountain bike in 1996. Although estimating it might sell 250 bikes in the first four months, Mercedes-Benz sold out the entire 250 in a few weeks.

A serious mountain bike that is suitable for dry pavement also, the bike has car-type disc brakes that stop quickly without locking the wheels. All of this in a bike that weighs a mere 24 pounds!

More suited to the open road is the new sport cruiser bike. It has seven gears inside the rear hub with a unique retro style and a full suspension and disc brakes up front.

For collectors, the CART Special Edition Mountain Bike may still be available. With only 50 being made and each numbered in sequence, if this bike is still available, it is priced at about $5,000!

What would Benz and Daimler think of this!?!

ROLE PLAY

TV COMPETITION OF INVENTORS

The Situation

A TV competition for people who build their own cars is planned to be organized and broadcast. The creators of the most realistic, fantastic, complicated models will be awarded special prizes. Prizes for the most industrious inventor and an audience prize will also be awarded. Inventors from different cities of Ukraine and other countries are going to take part in the competition. The programme will be broadcast to foreign countries and its official language will be English.

The List of Prizes and Criteria

1. The most realistic model.
   a) materials available in industry;
   b) fuel produced in industry;
   c) equipment produced by industry at present;
   d) low cost.

2. The most imaginative model.
   a) original purpose;
   b) fuel available only in the future;
   c) revolutionary new technology;
   d) materials of the future.
3. The most complicated model.
   a) complexity of the design;
   b) complexity of the car-making process;
   c) complexity of the equipment used.
4. The prize to the most industrious inventor.
   a) the inventor doesn't work in the automobile industry;
   b) the model which took the most time to produce;
   c) the inventor had to overcome a lot of difficulties to find the necessary materials, equipment, the place where he could work at his model, etc.
5. Audience prize.

There are no objective criteria. This prize is awarded by the TV audience.

Official Programme

- Registration of the participants.
- Opening of the competition. Report by the Chairman of the Jury.
- Reports by the inventors and their answers to the questions.
- Discussion and the prize-awarding ceremony.
- Closing of the competition.

Registration card

Surname_____
First name_____
Age_____
Country_____
Address_____
Profession or field of study_____

The list of roles

1. CHAIRMAN OF THE JURY.
2. JURYMAN, an optimist.
3. JURYMAN, a pessimist.
4. JURYMAN, a representative of the automobile industry.
5. REPORTER.
6. INVENTORS.

The description of the roles

Chairman of the jury

According to the official programme of the competition you are to open it, pointing out the importance of the event, its main goals, the prizes to be awarded and the number of the participants. You are to introduce all the speakers, to conduct the competition and to close it.

This is the way you may open the competition:

LADIES AND GENTLEMEN! DEAR FRIENDS!

WE HAVE GATHERED HERE TO SHOW YOU THE LASTEST MODELS OF CARS. WE ARE VERY PLEASED WITH THE FACT THAT … PEOPLE OF DIFFERENT PROFESSIONS FROM … COUNTRIES TAKE PART IN OUR COMPETITION. LET ME INTRODUCE … FROM … . HE/SHE IS … BY PROFESSION …, etc.

Juryman, an optimist

You are to award the inventor who made imaginative model a prize. Think of questions for each of the inventors so as to acquire the information necessary to make your decision. In your speech during the ceremony you should give reasons for your choice. And don't forget about the prize itself.

Juryman, a pessimist

You are to award the inventor who made a complicated model a prize. Think of questions for each of the inventors so as to acquire the information necessary to make your decision. In your speech during the ceremony you should give reasons for your choice. And don't forget about the prize itself.

Juryman, a representative of the automobile industry

You are to award the inventor who made a realistic model a prize. Think of questions for each of the inventors so as to acquire the information necessary to make your decision. In your speech during the ceremony you should give reasons for your choice. And don't forget about the prize itself.

Reporter

You are a reporter of the journal "Za Rulyom". On behalf of the journal you are to award the most industrious inventor a prize and afterwards to publish an article on the event. Think of the prize and the necessary questions.

Inventors

You are going to participate in the competition. You've got the list of vehicles allowed to the competition:

- a passenger motor car;
- a buggy;
- a lorry;
- a tourist car;
- a motor cycle;
- a sports car;
- a jeep;
- a tourist coach;
- a taxi;
- a bicycle;
- any vehicle you like.

Along with the invitation card you've received the list of problems you should touch upon in your report at the competition. Here they are:

1. What is the car designed for?
2. What is its name?
3. What colour is it?
4. What kind of engine is used?
   Where is it placed?
   What is its power?
5. What is the maximum speed of the car?
6. What distance has the car covered?

7. How many wheels, seats, brakes, headlights are there in the car?

8. What materials are used?

9. What accessories are included?

(a tape-recorder, player, radio set, rear seat speakers, antenna, conditioner, electric door locks, carpets, safety belts, speedometer, fuel tank, clock, etc.)

Any extra information is most welcome.

The inventors should make reports describing the vehicles they have built and illustrate them with some sketches and schemes. They must fill in the registration cards and be ready to answer the questions of the jurymen, the press and the audience.

UNIT 26. COLLECTIONS AND MUSEUMS OF AUTOMOBILES

TEXT 1.

There are about 3,000 Americans who like to collect antique cars. They have several clubs such as Antique Automobile Club and Veteran Motor Car Club, which specialize in rare models. The clubs practise meetings where members can exhibit their cars. Collectors can also advertise in the magazines published by their clubs. Some magazines specialize in a single type of a car such as glorious Model "T". A number of museums have exhibitions of antique automobile models whose glory rings in automobile history. But practically the best collection – 100 old cars of great rarity – is in possession of William Harrah. He is very influential in his field. The value of his collection is not only historical but also practical: photographs of his cars are used for films and advertisements.

In England there is the famous "Beaulieu Motor Museum" – the home for veteran cars.

The founder of the Museum is Lord Montague, the son of one of England's motoring pioneers, who opened it in 1952 in memory of his father. Lord Montague's father was the first person in England to be fined by the police for speeding. He was fined 5 pounds for going faster than 12 miles per hour!

In the Museum's collection there is a car called the Silver Ghost which people from near and far go to see. It was built by Rolls-Royce in 1907, and called the Silver Ghost because it ran so silently and was painted silver.

There is a car called The Knight. It is the first British petrol-driven car. Its top speed was only 8 m.p.h.!

In the Museum there is also a two-seater car built in 1903.

Exercise 1. **Answer the following questions:**

1. What do motor car clubs specialize in?
2. Do motor car clubs publish their magazines?
3. Who has the best collection of old cars in America?
4. What is the value of his collection?
5. What is the famous museum of veteran cars in England?

6. What do you know about the owner of this museum and his father?

7. What are some of the cars in the Museum's collection?

Exercise 2. **Find synonyms*:***

A
1. speed
2. to build
3. to recall
4. maker
5. title
6. reason
7. to apply
8. to start
9. steam
10. to emerge
11. to reveal

B
1. vapour
2. to use
3. to construct
4. velocity
5. to begin
6. to appear
7. cause
8. manufacturer
9. name
10. to recollect
11. to disclose

Exercise 3. **Fill in the blanks with the proper words:**

1. Americans who like to collect antique cars have several clubs such as … .

2. The clubs … meetings where members can … their cars.

3. Clubs … magazines where collectors can advertise.

4. Lord Montague's father was the first person in England to be fined by the police for … .

5. Pittsburgh had all the raw materials – steel, glass and paint – to become … center in the early 1900s.

6. Detroit earned the … of America's "Motor City."

7. Ford and Packard eventually set up … plants on Baum Boulevard in Oakland.

8. A collection of horse-driven carriages show the influence they had on the … of early automobiles.

Exercise 4. **Topic "The Museum of Land Transport".**

The authorities of your region have decided to open a museum of land transport. Now you have the opportunity to describe your own project. Present information on:

1) the city in which the museum should be situated;
2) the building it will be housed in;
3) the types of land transport which should be included in the exhibition;
4) the vehicles of the past which will be shown in the museum;
5) the vehicles of the present which will be shown in the museum;
6) transport engineers and scientists whose portraits should be exhibited;
7) the people who will visit the museum;
8) why do you think the museum of land transport will be popular?

TEXT 2. MUSEUM REVEALS CITY'S AUTO HISTORY

Sitting on a stool next to a rare two-door Model A Ford he is restoring, Bill Artzberger vividly recalls the stories his grandfather told of building steam-powered cars in the early 1900s in a small shop on the North Side.

"Those days were some exciting times," said Artzberger, 77, of West View, who owns one of the cars built in 1901 by his grandfather. "Most guys who liked to tinker around with motors were trying to build cars using whatever ideas and parts they could come up with. It was truly an age of innovation."

Artzberger's grandfather was among at least 20 car makers in Pittsburgh at the turn of the last century who were trying to gain a toehold in the "horseless carriage" business.

Pittsburgh had all the raw materials – steel, glass and paint – to become an auto manufacturing center in the early 1900s, but it was Detroit that earned the title of America's "Motor City."

"There are multiple reasons for why Detroit became the auto manufacturing center instead of Pittsburgh, but the short answer is Henry Ford," said Thomas Smart, director of museum programs at the Frick Art & Historical Centre in Point Breeze.

The museum has a collection of early motor vehicles, including several produced by Pittsburgh-area companies.

"Detroit, like Pittsburgh, had access to raw materials and ports for shipping," Smart said. "But when Ford and others applied econo-

mies of scale to mass-produce automobiles, the industry really started to build up around them."

Problems in 1907 such as a major flood on March 18 and the financial panic touched off by the collapse of the Knickerbocker Trust and Westinghouse Electric Co. also hurt Pittsburgh's chances of becoming a center for automobile production, said David Hounshell, professor of history at Carnegie Mellon University.

"These events created an atmosphere in Pittsburgh that lasted up until World War I, in which there were very few new businesses being started," Hounshell said.

Ford and Packard eventually set up assembly plants on Baum Boulevard in Oakland, but no local car makers survived.

Cars made in the Pittsburgh area that are in the Frick collection include a 1911 Penn 30 Touring Car, a 1917 Standard Model E Touring Car, a 1931 American Austin Coupe and a 1940 American Bantam Convertible Coupe.

A collection of horse-drawn carriages owned by the Frick family also is on display at the museum. These vehicles show the influences they had on the designs of early automobiles, Smart said.

"One of the things that people can see with our collection is that at the time the automobile was developing, there were a number of technologies being used to power them – steam, electric and gasoline," Smart said.

Two electric-powered cars – a 1909 Baker Electric Stanhope and a 1909 Bailey Electric Phaeton – are in the museum's collection. A Stanley Steamer Model 60 Runabout also is on display.

"It's nice for people to be able to see the point were there were many different paths available, but only one of them was taken," Smart said. "Likewise, it is intriguing to see that automobile technology such as electric power that we are looking at for the future was used in some early cars."

Ron Lotz, 65, of the South Side, who has gone to the Frick Car & Carriage Museum several times, said every visit provides a new experience.

"Each time I come here, there are details that emerge about these vehicles and automotive history that I wasn't aware of," Lotz said. "It's quite an intriguing place."

***Exercise* 5. Answer the following questions:**

1. What city earned the title of America's "Motor City" and why?
2. What cars made in the Pittsburgh area are there in the Frick collection?
3. What electric-powered cars are there in the museum's collection?
4. What do the visitors of the museum say?

ADDITIONAL TEXTS

TEXT 1.

NATIONAL AUTOMOBILE MUSEUM

(Reno – Nevada)

When the National Automobile Museum (The Harrah Collection) opened in 1989, it was reported to have set the standard for the world of automobile museums with its dramatic displays, in-depth interpretation, extensive collection and exciting opportunities for visitor participation.

The Museum displays more than 200 cars from 1892 to present, the majority of which are from the world famous collection of the late gaming pioneer and avid collector, Bill Harrah.

The idea for the Museum developed after Mr. Harrah's death in 1978. Holiday Corporation purchased Harrah's Hotels/Casinos and the world-renowned Harrah's Automobile Collection in 1980. Following an announcement by Holiday Corporation of its intent to sell Harrah's Automobile Collection, there was a tremendous public outcry from the citizens of Nevada to save the collection.

In 1981, in response to this outcry, Nevada Governor Robert List helped form a private nonprofit corporation. Holiday Corporation donated 175 cars and the research library, among other artifacts. At the time, this was the largest corporate philanthropic gift in our nation's history.

Thanks to the generosity of many, the land and construction of the Museum were funded by public and private contributions, most notably from the City of Reno Redevelopment Agency, a State of Nevada legislative appropriation and philanthropic individuals.

Located along the banks of the Truckee River in downtown Reno, the 105,000 square foot building incorporates smooth, rounded, exterior walls and chrome trim reminiscent of automotive styling. The popular 1950s car paint color, Heather Fire Mist, was chosen for the exterior walls.

Inside the Museum, it's like driving a century in just two hours, letting visitors travel through time like few other places. Four period street scenes represent each quarter of the 20th century, with facades, autos and artifacts reflecting each era's styles and moods. A timeline of events and achievements on each street chronicles the history and progress of the automobile.

Beyond the streets, visitors discover a century of automobiles--more than 200 antique, vintage, classic and special interest vehicles ranging from 1892 to present. The Museum, considered to have one of the finest horseless carriage collections in the world, is also known for its many rare, experimental and one-of-a-kind automobiles.

However, the road doesn't end there. Each year the Museum offers a series of new exhibits. Masterpiece Exhibits feature car displays and the Changing Exhibits Gallery covers a variety of topics from art to historical features. The annual calendar also includes a variety of fun family events, and informative and entertaining educational programs.

The Museum Store is filled with an array of automotive-related gifts and merchandise, and offers a large selection of books. The extensive Automotive Research Library is world-renowned and the Museum actively conducts research for scholars, journalists, restorers, enthusiasts and the interested public. Spanning more than one hundred years of automotive history from an 1895 Horseless Age to the latest Autoweek, the library holdings include technical books, sales literature, restoration manuals, shop and owner's manuals, wiring diagrams, upholstery samples, paint color chips and formulas, photographs, and much more.

The Museum has several annual membership programs, for those wishing to become involved and informed about new exhibits, events and activities. All categories offer generous and valuable benefits. Membership fees are an important source of revenue for the Museum and a portion of the annual membership fee is tax-deductible.

The Museum has become a favorite of both residents and visitors to northern Nevada. It was named among the "Top Ten Museums" by Car Collector magazine and selected the "Best Museum in Northern Nevada," year-after-year, in Nevada Magazine's annual reader's poll

The National Automobile (The Harrah Collection) is an internationally recognized museum and a nonprofit organization formed solely for educational purposes. The Museum's mission is to collect and preserve the automobile for future generations, and to tell the story of the impact of the automobile on American society.

TEXT 2. MANITOBA ANTIQUE AUTO MUSEUM
(Elkhorn, Manitoba, Canada)

History

Isaac Clarkson, "Ike" to his hundreds of friends, had a boyhood dream of being able to collect and display for future generations some of the machines of his youth; here, the dream came true.

Mr. Clarkson for many years worked on a farm only about three miles from where the Museum stands today, and it was on this farm that the Elkhorn Antique Auto Museum really began, back in 1946. A fairly successful farmer at the time, Mr. Clarkson one day located the sad remains of what once was a lovely car, a 1909 Hupmobile two-passenger roadster. One of the first cars built by the Hupp Motor Car Co., the little roadster, if it could be restored, would also be one of the very oldest Hupmobiles in existence. The major problem was that it was a mess, to put it very politely. What Ike started with was about two-thirds the total weight of a finished Hupmobile and in pretty poor condition. And so the hunt was on: ancient spare parts had to be located, photographs of what the car had originally looked like had to be found, swatches of the original upholstery had to be obtained and mechanical detail had to be unearthed from old books, old memories, any source which may have them.

But parts for a 1909 Hupmobile are hard to get and many are more than hard to get: they are ***impossible*** to obtain. In those cases, Ike simply got to work in his shop and *made* the parts from scratch, starting with simple hand tools, bits of metal and an immense amount of patience.

Gradually, the 1909 Hupmobile roadster took shape as Ike pieced it together, one part at a time. Wooden wheels were rebuilt from new wood to the old designs, brasswork painstakingly duplicated from original pieces, leather buttoned upholstery handmade from raw materials, working always from photos and drawings of the car when new.

Finally came the day when the little Hupp was rolled from the garage. Fill the gas tank, turn the magneto on, retard the spark and push the throttle lever forward, turn the engine slowly over a couple of times, then snap the crank upward and hope she doesn't kick back and the Hupp was running like the day it was made.

That 1909 Hupmobile was the first car that Ike Clarkson restored. Today it stands in the Museum, surrounded by dozens more of the more than *fifty* vehicles Ike either restored or did major work on.

The collection grew, storage did present problems. The cars were stored at the home of Marguerite Ablett whose farm Ike worked on a shared-basis. Miss Ablett supported Ike in his endeavors whenever she could. And the word spread about the farmer with the buildings stuffed with ancient vehicles, all in perfect running order, and the visitors began to turn up at the Clarkson farm.

After 15 years of this, Ike had been approached several times by single people and by groups interested in purchasing his collection, or parts of it. At one point, he was offered $100,000 for a part of the collection. The offer was turned down, for the cars would have left Manitoba on their purchase. Instead, the entire collection, numbering, at that point, 47 restored vehicles and about as many more for parts, plus buildings full of farm equipment and antique household effects, were offered to the province. Free.

In the end, it was decided by all concerned that the community had to preserve the fine Clarkson collection of ancient autos, in Manitoba. Manitoba Automobile Museum Foundation was set up and an Agreement between the Foundation and Mr. Clarkson was made on April 8, 1961. The Agreement specified that the Foundation would, within five years, construct a Museum to house the Clarkson collection of vehicles and employ qualified personnel to keep the entire property in good order. Mr. Clarkson, at a small salary, was to be-

come the first Curator of the collection and, during his lifetime, was to have a great deal of input into the enlargement of the collection.

For Ike his greatest dream had come true. A museum was opened in 1967 and he continued to work on the cars until his passing in 1971 at the age of 58. After Mr. Clarkson's death, Miss Ablett as the beneficiary turned over the entire estate to the museum. Today she is recognized as being a co-founder of the museum.

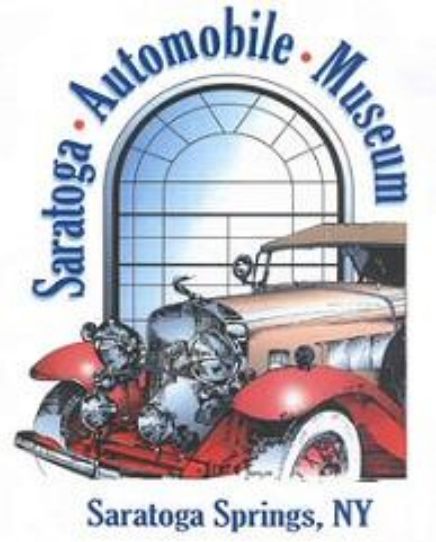
A cairn with a plaque has been raised in front of the museum to commemorate the two individuals for their dedication in preserving the heritage of the museum.

Currently, the Museum has a small group of local historical buildings, all of which will eventually be restored as a part of the Museum complex and, as well, a large, modem storage building which also houses the Museum's workshop.

The majority of work on the collection, is done during the winter months and often is done by volunteer laborers from the area, expecting and receiving no compensation whatever for their many hours of loving labour on the exhibits. In common with nearly ***all*** museums, there is never enough funding available to do everything which could be done, so the Museum also depends on donations from the community, local clubs and the general public to help keep the collection in good condition and to undertake further mechanical restoration of vehicles, farm implements, furniture and other exhibits.

TEXT 3. SARATOGA AUTOMOBILE MUSEUM

The Saratoga Automobile Museum, USA, preserves, interprets and exhibits automobiles and carriages, and artifacts. The focus is to celebrate and educate the general public, students and enthusiasts about the role of automobiles in this region and country's social and economic development, and the important engineering and design accomplishments these vehicles represent.



The mission of the Saratoga Auto-

mobile Museum is to display significant cars, trucks, and vehicles that not only represent the automotive heritage of new York State but the entire world of motorized transportation. In addition to a permanent collection of vehicles, a variety of workshops, interactive displays, lectures, and outdoor shows will expand the scope of the Museum.

The Museum is chartered by the Board of Regents of the State of New York Department of Education as a not-for-profit institution. The Museum is a member of the American Association of Museums and the National Association of Automobile Museums.

SUPPLEMENTARY MATERIALS

TEXTS FOR ADDITIONAL READING

TEXT 1. HISTORY OF CARS

The birth of the car as we know it today occurred over a period of years. It was only in 1885 that the first real car rolled down on to the streets. The earlier attempts, though successful, were steam powered road-vehicles.

The first self-propelled car was built by Nicolas Cugnot in 1769 which could attain speeds of up to 6 kms/hour. In 1771 he again designed another steam-driven engine which ran so fast that it rammed into a wall, recording the world's first accident.

In 1807 Francois Isaac de Rivaz designed the first internal combustion engine. This was subsequently used by him to develop the world's first vehicle to run on such an engine, one that used a mixture of hydrogen and oxygen to generate energy.

This spawned the birth of a number of designs based on the internal combustion engine in the early nineteenth century with little or no degree of commercial success. In 1860 thereafter, Jean Joseph Etienne Lenoir built the first successful two-stroke gas-driven engine. In 1862 he again built an experimental vehicle driven by his gas-engine, which ran at a speed of 3 kms/hour. These cars became popular and by 1865 could be frequently espied on the roads.

The next major leap forward occurred in 1885 when the four-stroke engine was devised. Gottlieb Daimler and Nicolas Otto worked together on the mission till they fell apart. Daimler created his own engines which he used both for cars and for the first four wheel horseless carriage. In the meanwhile, unknown to them, Karl Benz, was in the process of creating his own advanced tri-cycle which proved to be the first true car. This car first saw the light of the day in 1886.

The season of experiments continued across the seas in the United States where Henry Ford began work on a horseless carriage in 1890. He went several steps forward and in 1896, completed his first car, the Quadricycle in 1896. This was an automobile powered by a two cylinder gasoline engine. The Ford Motor Company was launched in 1903 and in 1908 he catapulted his vehicle, Model T Ford to the pinnacle of fame. Continuing with his innovations, he produced

this model on a moving assembly line, thus introducing the modern mass production techniques of the automobile industry.

The modern car, therefore comes, from a long list of ancestors, and its lineage will hopefully grow longer as we progress!

TEXT 2. THE MOTOR CAR

The motor car is a form of mechanical transport and it is composed of many different working units and parts. To provide the energy to make it go, it has an engine which in turn needs electric current, petrol and air. The engine needs cooling so that it does not become too hot, and oil to lubricate the bearing surfaces.

Also, there is the transmission system of clutch, gearbox, propeller shaft and axle, which transmits the power from the engine to the wheels to move the car along the road. Steering mechanism is needed to guide the car in the right direction, brakes to slow it down and stop it, and suspension to smooth out most of the bumps and jolts.

Memorize the following words and word combinations:

propeller shaft	карданний вал
axle	вісь
suspension	підвіска
steering mechanism	рульовий механізм

TEXT 3. ENGINE

An engine produces power by burning air and fuel. The fuel is stored in a fuel tank. The fuel tank is connected to a fuel pipe. The fuel pipe carries the fuel to a fuel pump. The fuel pump is connected to the carburettor. The fuel pump pumps the fuel into the carburettor. In the carburettor the fuel is mixed with air. The fuel and air are drawn into the engine cylinder by the piston. Then the fuel and air are compressed by the piston and ignited by the spark plug. They burn and expand very quickly and push the piston down. Thus the power is produced. The burned fuel and air are expelled from the cylinder by the piston.

The flow of gases into and out of the cylinder is controlled by two valves. There is an inlet valve allowing fresh fuel mixture into the cylinder and an exhaust valve which allows the burnt gases to escape.

There are two basic engine operating cycles:

a) the four-stroke cycle;

b) the two-stroke cycle.

The complete four-stroke cycle comprises:

1). the induction stroke (the piston moves downwards);

2). the compression stroke (the piston moves upwards);

3). the power stroke (the piston moves downwards);

4). the exhaust stroke (the piston moves upwards).

TEXT 4. DIFFERENT ENGINE DESIGNS

In addition to the different methods available for driving the wheels, there are also many different engine designs.

Some years ago the sidevalve (s. v.) engine was very popular. In this not-very-efficient design the valves were placed at the side of the cylinders. The great majority of modern engines are of the over-head-valve type (o. h. v.) in which the valves are positioned above the pistons with their heads facing downward. Because the valve stems, in this arrangement, are some distance from the camshaft, "push-rods", and "rockers" are normally used to provide the necessary means of operation.

A variation of the overhead-valve design is the overhead cam-shaft (o. h. c.). this does away with push-rods and sometimes rockers, because the camshaft is fitted above the valve stems and can operate directly on them.

There are also the V-type and "horizontally-opposed" engines, and others.

The whole subject of cars and engines is a fascinating one. Now when you know more about it you will be able to take a greater interest in your own family car and in those you see on the roads. And when you begin to drive you will understand what is happening as you operate the various controls.

Memorize the following words and word combinations:

side-valve engine	двигун з боковим розміщенням клапанів
overhead valve engine	двигун з верхнім розміщенням клапанів, верхньоклапанний двигун
valve stem	шток/стержень клапана
push rod	штанга штовхача (клапана)
rocker	коромисло
V-type engine	V- подібний двигун (з V-подібним розміщенням циліндрів)
horizontally-opposed engine	двигун з горизонтально розміщеними опозитними циліндрами

TEXT 5. THE FOUR-STROKE CYCLE OF ENGINE OPERATION

Most modern car engines operate on a four-stroke cycle. This means that each piston travels down twice and up twice after each ignition of the petrol/air mixture, making four strokes in all. To simplify the operating sequence, we will assume that our engine has only one cylinder.

Induction. This begins with the piston at the top of its stroke and the inlet valve open. As the piston goes down it draws the petrol/air mixture into the cylinder past the open inlet valve.

Compression. When the piston has completed its down-stroke, the inlet valve closes. The revolving crankshaft then pushes the piston up again, and the mixture now in the cylinder is compressed upward into the combustion chamber. At the top of the stroke it is fully compressed.

Ignition (Firing). At this point a spark occurs between the electrodes of the sparking plug. This ignites the petrol/air mixture. The heat from the explosion causes high pressure on the top of the piston which is thus forced downward.

Exhaust. At the end of this down-stroke, the exhaust valve opens and during the following up-stroke the products of combustion

are pushed past the valve and out of the engine. This cycle is constantly repeated so long as the engine is running.

TEXT 6. AUTOMATIC TRANSMISSION

While many drivers like to control their cars by the normal gearbox and gear lever, some motorists prefer to drive with as little effort as possible. Automatic transmission takes much of the work away from the driver who only has to accelerate when he wants to go faster and brake when he wishes to slow down or stop. All the necessary gear changing is done quite automatically within the transmission. There is no clutch pedal, only an enlarged brake pedal and an accelerator. A selector lever replaces the normal gear lever.

Several types of automatic transmission are available. In one of the well-known types there are six selector positions – 1, 2, D (Drive), N (Neutral), R (Reverse), P (Park).

In position "P" the transmission is locked and the car cannot be moved. At "N" the engine can be started but the transmission is not engaged. Fully automatic operation is obtained by putting the lever at "D", and all normal driving can be done in this position. On the other hand, first or second gears of the transmission can be engaged and help by using positions "1" or "2". This may be useful for starting on a steep slope, climbing steep hills or for holding a lower gear whilst accelerating quickly.

TEXT 7. SEQUENCE OF ACTIONS

We shall now look again at what happens after the driver turns the ignition key. These things do not all happen one after the other. Many happen at the same time.

1. The driver turns the key. Electricity flows to the starter motor.

2. The starter turns the engine. The crankshaft and the camshaft turn. The pistons go up and down.

3. The cam in the distributor turns. Electricity flows into the primary coil.

4. Air is sucked into the carburettor. Petrol and air go to the cylinders.

5. The sparking plug fires the mixture. It explodes.

6. The engine is now running.

7. The dynamo is working. It is charging the battery. The battery is supplying electricity for the sparking plugs, the coil, the lights, etc.

8. The gear is in neutral. The clutch pedal is pushed down.

9. The gear lever is put to first gear. The brake is put off.

10. The clutch pedal is let out. The clutch plate touches the flywheel.

11. The accelerator pedal is pushed down. More mixture flows to the cylinders. The explosions are stronger.

12. The car moves.

13. As the car moves faster the gears are changed to higher ones.

TEXT 8. VALVES AND CAMSHAFT

There are two valves to each cylinder: one inlet and one exhaust. The inlet valves let the petrol/air mixture into the engine, while the exhaust valves allow the burnt gases after combustion to escape from the engine. Both sets of valves have to be arranged, to open and close at just the right moment. This is done by means of camshaft.

The camshaft is driven by a chain or gear at half the speed of the crankshaft. It has specially-shaped projections, known as cams, set at varying angles. There are as many cams as there are valves, and as the camshaft revolves, each cam causes its corresponding valve to open. Then, as the cam moves further round, a coil spring fitted round the valve stem forces the valve to shut, and it is then ready to open again next time the cam comes round.

During every revolution of the camshaft all the valves open and close once. In a fast-moving car fitted with a four-cylinder engine, each valve opens and closes between thirty and forty times every second. This gives you some idea of the speed of operation and the accuracy needed to obtain correct timing.

Memorize words and word combinations*:*

chain	ланцюг
projection	виступ
cam	кулачок
coil spring	спіральна пружина
valve stem	шток (стержень) клапана
revolution	оберт
accuracy	точність

TEXT 9.

Large-scale production of automobiles began in the early 1950s. New automotive features included air conditioning, electrically operated car windows, seat adjusters, and a change from a 6-volt to a 12-volt ignition system which improved engine performance. American cars tended to borrow design features normally found on aircraft and ships. Cars increased in size and weight, but power steering and brakes made them easier to handle. Across the Atlantic, Europeans were making smaller and lighter cars that weighed less than 2800lb. Their sports cars had hand-fashioned aluminium bodies over a steel chassis and a framework.

In the early days of the car, the biggest worry was keeping it running. Today we are concerned with aerodynamic designs for speed and fuel efficiency, passenger safety issues, and pollution control systems. In 1900 a car might have a total of 100 parts, while today it has some 14,000. Design innovations include breakthroughs in computerization, high-strength plastics, and alloys of steel and nonferrous metals. Accessories can include CD players, tape decks, television and phone installations, and separate sound and temperature controls in the front and back of a vehicle. Some cars come equipped with satellite-aided global positioning system (GPS) locator beacons, enabling a remote operator to locate a vehicle, map its location, and, if necessary, direct repair or emergency workers to the scene.

In one form or another, the vehicle has become the major transporter of people and goods in the world. Its basic design and

power systems have been widely adapted to vehicles such as the ambulance, jeep, police car, limousine, pickup truck, and tractor trailer.

Today's automobile industry has helped to shape the financial world, and is a major barometer of the economic health of a nation. Automobile sales represent more than one-fifth of U.S. wholesale business, and more than one-fourth of its retail trade. Japan and Western Europe are rapidly approaching these levels.

Memorize words and word combinations:

large-scale	масовий
adjuster	пристрій регулювання
to borrow	запозичити
to handle	керувати
safety	безпека
breakthrough	прорив
alloy	сплав
non-ferrous metal	кольоровий метал
equipped	оснащений
retail trade	роздрібна торгівля

TEXT 10. TRANSPORTATION SECTOR IN UKRAINE

In Ukraine, the share of transportation energy consumption (about 10%) is still substantially lower than in western countries (about 30%). The increase in transport activity in Ukraine is inevitable and necessary to economic growth, and the best hope for curbing energy related problems is the conservation and improvement of the public transport system. Before 1990, Ukraine had a relatively energy efficient transportation system with high shares of public transportation. The importance of public transport has been recognized in the Government of Ukraine's national strategies, but the means to pursue them are lacking, while more open markets and the push for individual mobility create constantly increasing demand for road based transportation.

The GHG emissions from the transportation sector are not easy to calculate. Estimates are based on the use of fuel by the sector and the emission factors. The most common energy resources used in the

transportation sector in Ukraine are: petrol, motor fuel (including liquid), diesel, aviation spirit, natural gas, gas turbine fuel, heat and electric energy, coal, and mazut.

Traditionally, the major transport load in Ukraine was carried by public transportation, of which, the auto transport and railway used to carry up to 90% of all passengers and freight. Within the residential areas up to 50% of passenger travel is by bus, while underground, trams, and trolley buses share the rest. The majority of inter-city transportation is by railway.

Road transportation, private and public, is the most popular mode for passenger travel, accounting for 44% of the total. It is also the most energy intensive and environmentally dangerous transportation form. Vehicles emit many greenhouse gases, as well as many other pollutants, such as heavy metals. Since the mid-90s, the number of private cars has been growing rapidly, this growth is expected to continue, along with the accompanying GHG emissions. The stock of public vehicles in Ukraine has not been renewed over the last decade, nor has it been maintained according to the technological practices and standards.

Methods to improve efficiency in transportation

There are three key policy areas where the energy efficiency in the transportation sector can be promoted: general development strategy, economic instruments to reduce demand, and technological solutions. These policies, in turn, will curb the growth of GHG emissions in the transportation sector.

General development strategy

The focus of the national strategy in Ukraine is the transportation system infrastructure. There is a need in careful planning to accommodate the growing private transportation fleet while adjusting the public transport that is reliable, convenient, affordable, and safe. By increasing individual vehicle load and distances traveled, this strategy will limit long-term growth of fuel consumption.

Economic instruments to reduce demand

Economic policy mechanisms to reduce demand for transportation are usually aimed at integrating economic and environmental decision-making. Some of the studies show that tariffs, tax incentives and other similar mechanisms can bring about significant fuel use efficiency, trips length reduction, infrastructure modification (Ministry of Transport of Ukraine 1999).

Fuel efficiency and alternative fuels

The efficiency of fuel use is a major objective of current transportation technology. It is estimated that the average fuel consumption of the current fleet of motor cars could be reduced 50% by using more efficient engines, lightweight construction, and low-air resistance design. In addition, larger use of liquefied petroleum gas and compressed natural gas, introduction of alternative fuels (natural gas, propane, electric transport) could reduce CO_2 emissions by 10-30% (Ministry of Transport of Ukraine, 1999).

Summary

The transportation sector is the fastest growing source of greenhouse gases emissions and there is a high abatement cost to reduce emissions. Hopefully, Ukraine can learn from the Westerns' mistakes, which shows that the extensive road infrastructure did not solve congestion problems, but often generates more problems, and find its own way.

AUTOMOBILE ELECTRONICS

THE EARLY YEARS

Automotive history began in the middle of the eighteenth century when a Frenchman, Nicholas Cugnot, produced the world's first automobile. It used the power of the industrial revolution – the steam engine – to open up the possibility of moving people and goods quickly and conveniently from door to door. In the early part of the twentieth century this dream turned to reality for millions of people when Henry Ford developed the technique of the production line - the 'second industrial revolution'. Mass-production enabled the production of automobiles at low cost and spawned the world's greatest manufacturing industry. With advances in technology, the performance of the motor car has increased beyond even the most exaggerated predictions of those early years, but so too has the number of vehicles on the road and their impact on the global environment.

ELECTRONICS AND AUTOMOBILES

Although car radios, using valve circuits, had been manufactured as early as the 1930s, it was the invention of the transistor in 1948 and the integrated circuit (1C or 'silicon chip') in 1959 which enabled automobile electronics to become a reality.

One of the earliest automotive applications for these new electronic devices was in transistorized ignition systems, the first of which was designed in 1962 by General Motors. Progress was comparatively swift and by 1967 Bosch had a simple electronic fuel injection control system in series production. Further new products followed in the late 1960s, including cruise control and anti-lock braking systems (ABS). Unfortunately, although novel, all of these added electronic features were expensive and were based around the relatively unreliable analogue circuits of the time, making them costly to maintain. Not surprisingly, they gained little popularity with the motoring public.

It was the environmental impact of automobiles which ultimately stimulated one of the most significant changes in car design -

the widespread adoption of microcomputer-based engine control technology. The US Clean Air Act of 1971 required that harmful automobile exhaust emissions be drastically reduced and, by fortunate coincidence, 1971 was also the year that the microprocessor, the heart of all modern microcomputer-based automobile control systems, was first manufactured. This 'third industrial revolution' -the application of microcomputer technology – ultimately led to a complete change in the concept of the motor car. Engine designers quickly seized upon the microprocessor as the solution to their emission control problems and vital links between computer technology and automobiles were soon forged. The first automotive application of the microprocessor was in GM's MISAR ignition timing control system, introduced in 1976. It enabled very precise control of spark timing, leading to increased engine output and efficiency, together with much lower exhaust emissions. Other car makers soon followed GM's lead and ignition systems are now almost universally of this type.

Pressure to install more advanced microprocessor engine control systems arose in the late 1970s, when a host of US federal and state government exhaust emission and fuel economy requirements were introduced. These regulations posed a unique problem; to meet all of the requirements simultaneously and yet still maintain good driveability required interactive engine controls. Mechanical controls of the necessary sophistication were either not possible or not cost-effective. This gave rise to ‘acceptance-through-necessity’ of the microprocessor by the US motor industry. For example, by 1981 microcomputer-based engine controls were incorporated into the entire US petrol-engined car production of General Motors, requiring the manufacture of 3.7 million electronic control units (ECUs) per year for that company alone (a rate of 22 000 ECUs per day).

Europe has traditionally lagged well behind the USA and Japan in exhaust emission legislation and it was not until January 1993 that US-style emission control systems were made a mandatory requirement for all cars sold in EC countries. This means that almost the entire passenger car production of the advanced nations, about forty million vehicles per year, is now fitted with microcomputer-based engine controls.

ENHANCED VEHICLE PERFORMANCE

The 1980s saw an explosion in the manufacture of ‘high-tech’ microprocessor-based consumer products, ranging from washing machines through to video cassette recorders. In parallel with this growth came ever-increasing consumer expectations of performance, functionality and reliability improvements in motor cars. Vehicle manufacturers, by now confident and proficient in the application of microprocessors to engine control, began to diversify into new areas of automobile electronics.

Microprocessor control of automatic transmissions (introduced by Toyota in 1981) provides smoother shifting and more fuel-efficient gearboxes. Traction control systems (TCS) can assist when accelerating on slippery road surfaces. ABS is an invaluable braking aid when driving conditions are poor. Ever more sophisticated chassis control is possible via electronically-controlled 4-wheel steering (E4WS), which precisely steers the rear wheels in sympathy with those at the front to increase stability when cornering or changing lanes. Electronic control of the suspension system is also increasingly utilized as a means of improving vehicle handling without compromising comfort.

Within the passenger cabin, electronics have been used to drastically improve comfort; as well as the ubiquitous in-car stereo system, many vehicles now feature such luxuries as electrically-operated seats, mirrors, sunroof and windows. Electronically-controlled air-conditioning systems are commonly found on 'high-line' vehicles and are gradually being introduced onto smaller vehicles as purchaser expectations rise.

Safety and security are the latest beneficiaries of electronic technology. Air-bag systems are a proven safety feature and are now a mandatory fitment on US cars and a standard fitment on many European cars. Side-impact air-bags have also been introduced by some manufacturers, thanks to recent developments in sensor technology.

Car security is a particularly important issue in the UK, where the level of car crime is the highest in the world. Most UK-market vehicles are now supplied with a factory-fitted burglar alarm and engine immobilization system; a trend which is helping to reduce the cost of insurance for late-model vehicles.

CURRENT AND FUTURE TRENDS IN AUTOMOBILE ELECTRONICS

The enormous advances in electronic technology throughout the 1980s and early 1990s have brought about great changes in the status of automobile electronics. Reliability has improved greatly and costs have been reduced. Electronic components are now much smaller, drastically reducing weight, space and electrical power requirements. Thanks to the availability of powerful and inexpensive microprocessors, computing power is no longer a limitation to the development of electronic control systems. Future developments are therefore likely to centre on the refinement of existing automotive electronic systems, coupled with advances in sensor and actuator technology. These changes will have an impact in the four main areas of vehicle operation;

1 environmental;
2 safety;
3 ergonomics;
4 social infrastructure.

Environmental considerations

With approximately four hundred million vehicles on the world's roads, the environmental impact of the automobile is awesome. For example, German government research has shown that, from 'cradle to grave', a typical car produces 59.7 tonnes of carbon dioxide (the 'greenhouse gas'), 2 040 million cubic metres of polluted air, and 26.5 tonnes of solid rubbish to add to the problems of waste disposal experienced by most Western countries.

If valuable fuel reserves are to be preserved and the global ecology is to be maintained, it is imperative that electronic systems are developed to improve engine efficiency. Currently, most governments fnsist that cars are fitted with a 'catalytic converter' which cleans up the exhaust gasses as they leave the engine. Unfortunately, in order to function properly, the catalyst requires that the engine be operated in a relatively inefficient manner - a situation that may be aptly described as 'the tail wagging the dog'. Around the world, automobile engineers are working on solutions which allow more efficient

combustion to take place. Improving combustion efficiency achieves two important aims; it maximizes fuel economy, thereby conserving valuable hydrocarbon resources, and it reduces the emission of carbon dioxide and other pollutants.

Many vehicle manufacturers have already developed so-called 'lean-burn' engines which, together with advanced electronic control of the spark and fuel-injection systems, provide fuel efficiency gains of up to 25% over conventional engines, as well as lower pollution levels.

A reduced environmental impact may also be attained through the use of 'alternative fuels' and as we enter the twenty-first century it is likely that interest will increase. Methanol, electric and hybrid (hydrocarbon/electric) propulsion systems may become increasingly viable as petrol prices rise through a combination of scarcity and 'carbon tax'. Research will concentrate on making the required motors, sensors, actuators and controllers smaller, faster and smarter.

Safety

Annual road accident statistics have relatively little impact in the UK, where death or injury through car accidents is accepted almost as a fact of life. However, when these statistics are compared with vehicle use and hours of life lost, road traffic accidents emerge as a major cause of death, particularly for young people. Every car produced, on average over its lifetime, is responsible for about 800 hours of life lost through a fatality and about 3 000 hours of life damaged through injury. Statistically, about one person in every 100 will be killed in a road traffic accident. Thankfully, over the past few years safety has taken a rising profile in the marketing of automobiles. The application of advanced electronic technology focuses on two main areas: (1) *active safety,* assisting the driver in avoiding an accident and promoting safer driving; and (2) *passive safety,* protecting the vehicle occupants once a collision has become inevitable.

Active safety

As electronic control systems have been incorporated into automobiles the driver 'workload' has been reduced and driving has become less fatiguing and safer. The extreme swiftness with which

electronic systems can process data and intervene in chassis control means that in an emergency situation they can be invaluable. Currently, traction control systems (TCS) and anti-lock braking systems (ABS) can rescue a driver from a situation that would otherwise result in an accident. Improved sensing technology, such as the use of radar and infrared detectors, can enable obstacle recognition systems to be linked to speed control, TCS and ABS, in order to provide even greater levels of safety. Electronically-controlled four-wheel steering has been used as an aid to chassis stability since the late 1980s. In future, such systems will be enhanced by the use of additional sensors to monitor rate of yaw and the cornering forces generated by each tyre. Using this information a powerful electronic controller will be able to individually steer each end of the vehicle to maintain the desired path through a curve. Other important developments could include driver monitoring systems, which can warn a driver if his behaviour or reactions become abnormal, and improved warning and display systems which present information to the driver without requiring him to look away from the road.

Passive safety

Seatbelts have been fitted to UK-market cars since the 1960s and have had a proven and dramatic impact on preventing injury when an accident occurs. Air-bag systems were developed to supplement seatbelts and were originally mechanically triggered. Fast-acting electronics have considerably enhanced their performance however, and modern air-bag controllers can detect the onset of an impact and initiate air-bag inflation in less than one-hundredth of a second. In future, air-bag controllers could be designed to predict a collision before it actually occurs, possibly using radar-based speed and distance measurement systems. Such technology would enable the bag to be already inflated at the time of impact.

Ergonomics

A primary requirement of any passenger car is that it should be comfortable and easy to operate; in other words 'ergonomically designed'. Controls need to be light and precise in operation, driver information should be presented in a clear and logical fashion.

Electronic systems can improve vehicle ergonomics by providing power-assisted and 'intelligent' controls. For example, some manufacturers have produced vehicles in which the steering wheel and column automatically swing towards the dashboard to give easier access when the driver enters or leaves the car. Others have introduced cars with electronic 'keys', which not only operate the door and ignition locks but also hold data to automatically adjust the seat, mirrors and steering column to a personalized position. Further common examples include 'speed-sensitive' power steering and cruise-control, which reduces driver fatigue on long journeys. In future, such systems will be enhanced by using additional microcomputers and sensors to assess road surface and traffic flow conditions, enabling control system behaviour to be modified accordingly.

As cars have become more sophisticated, the increase in the amount of information available to the driver has led to a proliferation in the number of indicators and warning lights on the dashboard. Some instrument panels have become very complex indeed. Electronics are now being used to simplify the presentation of this data and improve legibility through the use of liquid crystal displays (LCDs) and vacuum fluorescent displays (VFDs). Many manufacturers are currently researching novel display systems which project an image of the instrument onto the inside of the windscreen, just below the driver's line of sight. These so-called 'head-up displays' (HUDs) are proving easy to read in all lighting conditions, without requiring the driver to look away from the road. Further developments may include the use of audible warnings to augment visual information, as in aircraft cockpits.

Social infrastructure

As society becomes more information oriented, cars will increasingly be fitted with equipment to provide drivers and passengers with information from extravehicular sources. Future on-board communication systems will enable drivers to avoid traffic jams and accidents, and to take advantage of information relating to the availability of parking spaces or the location of particular stores and shops.

Currently, most vehicles are fitted with an AM/FM radio which provides entertainment and a basic level of traffic information

from 'traffic bulletins', read by station announcers. In the early 1990s the highly successful Radio Data System (RDS) was introduced in Europe as a means of enhancing the information-carrying ability of FM broadcasts by transmitting digital data along with the radio signal. Many vehicles are now supplied with RDS radios as a standard fitment.

Future traffic data systems will be far more comprehensive; road information systems have already been demonstrated and incorporate a large-area display screen to provide navigation and route guidance facilities. The navigation system is able to display the current location of the vehicle and an ideal route to follow to reach the destination in a minimum time. Vehicle position is continuously updated using data from vehicle speed sensors, an in-car gyroscope and signals received from the GPS (Global Positioning System) satellite network. The predicted position can then be compared with a road map, held on a CD-ROM data disc.

Other navigation devices include AutoGuide, a low-cost system which relies on roadside beacons to undertake two-way communication with the vehicle's navigation electronics. The beacons are linked to a central traffic-control computer which tries to keep traffic flowing smoothly and safely by guiding drivers away from troublespots.

Since all of these systems depend upon the provision of a large-scale communications infrastructure for their operation, governments around the world are supporting developments in this area. In Europe, the EU countries are promoting the DRIVE and PROMETHEUS initiatives. In the USA, the federal government is working with universities to develop the IVHS (Intelligent Vehicle-Highway System), and in Japan VICS (Vehicle Information and Communication System) is being developed.

AUTOMOBILE ELECTRONICS

The 1970s brought stringent exhaust emission regulations and the first oil crisis, stimulating a demand for clean, energy efficient automobiles which was satisfied only through the application of elec-

tronic engine controls. Initial difficulties in using electronics in the harsh automotive environment were quickly overcome.

During the 1980s, the development of microprocessor control systems in tandem with precision mechanical systems made cars faster, safer, more comfortable and still more fuel efficient. Excellence in powertrain performance is now taken for granted. In the early 1990s, consumer demands became even more sophisticated. Familiarity with domestic electronic products, such as video cassette recorders, home computers and satellite television receivers has led to increased expectations of automobile comfort, safety and convenience features to the extent that CD players, mobile telephones, ABS and air-bags have become the norm on luxury vehicles.

The key issues in automobile design for the next century will be safety and the environment. Fortunately, rapid developments in electronics will help in these areas. The time delay between the development of new automotive electronic devices and their introduction into series production is continuously reducing. Each year, as the capabilities of electronic systems improve, their size, weight, cost and power consumption is reduced. Predictions by the large automotive electronics suppliers suggest that the demand for electronic systems will grow at a rate of about 12% per year through the 1990s. By the end of the 1990s it is estimated that over one-third of a typical car's components will be electrical or electronic and a typical vehicle will be fitted with as many as 50 electronic sensors. Automotive electronics will continue to grow even further in importance in the next century, requiring all those involved in designing, selling and maintaining vehicles to have a sound knowledge of these systems.

THE AUTOMOBILE ELECTRICAL SYSTEM

The electrical systems of vehicles manufactured up to the mid-1970s were comparatively simple, consisting of just a few circuits for lighting, wiper and heater motors, and a points-type ignition system. The 1980s saw remarkable advances in electronics technology which brought about a corresponding growth in electrical system functionality and a rapid increase in the number and complexity of electrical modules incorporated into vehicles. However, everything has to be in-

terconnected and that means that vehicle electrical wiring systems have become alarmingly complex, with more and more connectors, terminals, relays and control units being required.

In order to allow the automobile technician to grasp the operation of the vehicle electrical system it is normal to decompose it into a number of smaller subsystems. If an electrical fault arises, diagnosis can then be confined to the particular sub-system affected.

Vehicle sub-systems

Although there are no formal definitions for vehicle sub-systems, the following will be applicable to most automobiles:

Battery and charging system

The battery is a device cable of converting chemical energy into electrical energy, and vice versa. It acts as a store of energy to operate electrical equipment when the electrical load exceeds generator output and when the engine is off. A major task of the battery is to provide the power necessary to crank the engine and get it started. Once the engine is started the charging system (comprising an ac generator, rectifier circuit and voltage regulator) maintains the battery in an optimally charged state and supplies electrical power at a regulated dc voltage to the whole vehicle.

Engine starting system

The engine starting system comprises a powerful (1-2 kW) dc starter motor which cranks the engine when the ignition key is turned. The starter motor is invariably the greatest electrical load on any vehicle and so the whole starting system must be designed to handle very large currents (up to 500 A in some cases).

Lighting system

Legal requirements for vehicle lighting vary from country to country, but in general all vehicles must be equipped with lights that allow the vehicle to be seen by other drivers and its movements anticipated (via brake, turn signal and reversing lights). In order to en-

sure safe night-driving, most countries enforce minimum requirements for headlight brightness and aim.

Engine management system

The engine management system controls the basic fuelling and ignition parameters for the engine. It generally consists of a microcomputer-based electronic control unit (ECU) to which various sensors and actuators are connected. The ECU's microcomputer is programmed to ensure that the engine is always operating at a condition for minimal exhaust-gas emissions and maximum power and economy. The engine ECU is generally the most powerful control system on the vehicle and may well have overriding control of heater/air-conditioner systems, automatic transmission control systems and so on.

Chassis control systems

This area is generally taken to include anti-lock braking systems (ABS), traction control systems (TCS), four-wheel steering systems (4WS) and electronically controlled suspension systems. They provide enhanced safety and comfort by assisting the driver in controlling the vehicle, especially when driving in adverse or unpredictable conditions.

Body electrical systems

These systems are largely concerned with passenger comfort and safety. They include a broad range of electrical and electronic equipment such as the heater/ air-conditioner, instrument pack, washer-wipers, power windows, sunroof, mirrors, seats, etc. As customer expectations have risen, the available range of body electronic systems has expanded enormously in recent years and now includes features such as the supplementary restraint system (SRS or 'air-bag').

In-car entertainment (ICE)

Most vehicles are supplied with a radio-cassette unit ready fitted and many also have provision for a CD player. The ICE system

will include a radio aerial, power amplifier and a number of loudspeakers.

VEHICLE ELECTRICAL DISTRIBUTION SYSTEM

The increased application of electrical and electronic systems in automobiles has resulted in the need for complex electrical distribution systems. A mid-priced, medium-size car of the 1990s typically contains more than 1.5 km of wiring and more than 2 000 terminals, connectors and relays. The weight of such an electrical distribution system exceeds 30 kg.

The major component of the electrical distribution system is the wiring harness. This consists of bundles of cables that connect all of the electrical parts in a vehicle. It has two primary functions; (i) to act as a power distribution network, and (ii) to act as an information distribution network, connecting sensors and actuators with electronic control units.

As may be imagined, the wiring harness presents vehicle manufacturers with many problems; it is very expensive to produce (often only the engine and transmission cost more) and it cannot be accurately specified until late in the car design process (when the exact location of all components has been defined). Moreover, since the majority of vehicle breakdowns are caused by electrical failure, vehicle reliability is critically dependent upon good wiring harness design and installation.

In general, the wiring harness is divided into a main harness that runs the length of the vehicle (connecting the battery to the charging system, vehicle interior, lighting and accessory circuits) and various sub-harnesses (door wiring sub-harnesses, tailgate wiring sub-harness, roof wiring sub-harness). In order to aid vehicle assembly and servicing it is normal for the sub-harnesses to connect to the main harness via connector blocks.

BATTERIES

Batteries are electrochemical devices for storing electrical energy in a chemical form. Active materials in the battery react chemi-

cally to produce a flow of direct current whenever motors, lights or other current consuming loads are connected across the terminals.

In automotive applications the battery performs four functions:

1) It supplies current to accessories when the engine is not running.
2) It supplies energy to the starter motor and ignition system when the engine is started.
3) It intermittently supplies current for the lights, heater and other accessories when the electrical demands of these devices exceed the output of the generator.
4) It acts as a voltage stabilizer for the electrical system.

The basic cell

A basic battery cell is formed when two plates of dissimilar material are placed in a solution called an electrolyte. In automobile batteries the plates are made of lead (chemical symbol Pb) and lead dioxide (PbO_2). and the electrolyte is a solution of sulphuric acid and water (H_2SO_4 and H_2O).

Due to the chemical reaction that occurs between the electrolyte and the dissimilar plates, a voltage of about two volts exists between the two plates. If the cell is connected to a 2 V bulb, current flows from one plate through the electrolyte to the other plate, and then through the bulb to complete the circuit (Figure 3.5).

Since virtually all car electrical systems are designed to operate at a voltage of about 12 V, a car battery is comprised of six separate 2-volt cells, connected in series.

Service requirements of batteries

Batteries constructed with lead-calcium grids require no maintenance other than a periodic check on the cleanliness and security of the terminals. Since these batteries are usually 'sealed for life', no other checks are possible. A useful feature of these batteries is that they are less susceptible to overcharging than the conventional type and seldom give trouble.

Batteries constructed using lead-antimony grids consume a certain amount of water and periodic 'topping-up' with distilled water is required. Filler caps are fitted for this reason. A major shortcoming

of these batteries is that over a period of time antimony migrates from the positive grid to the negative grid. This makes the battery susceptible to overcharg ing, leading to positive plate oxidation and hence crumbling of the plate material.

Batteries are generally very reliable components and, providing that the charging system is operating correctly, will give at least 4 years of reliable service. Due to their relative cheapness (and the great amount of inconvenience that results when one loses charge) it is normally wise to simply replace them at the first sign of trouble.

MICROPROCESSOR SYSTEMS

Most automobiles carry a number of electronic control units (ECUs) which control the operation of various mechanical and electrical systems. The term 'ECU' is very general, and many ECUs contain just one or two ICs to perform simple timing functions such as courtesy-light delay or heated rear window operation. Other ECUs are much more sophisticated however, and control complex systems such as fuel injection, ignition, automatic transmission and anti-lock brake operation. These ECUs are actually *microcomputers* and so rely upon *microprocessors* for their operation.

Microprocessors are comparatively low-cost digital ICs which are able to perform numerical calculations and make simple decisions using data coded in the form of binary numbers (combinations of logical ' 1's and 'O's). When a microprocessor (which is sometimes called a *central processor unit* or CPU) is combined with other components, such as *memory ICs* and *input/output circuits,* a microcomputer is formed. A microcomputer takes information from the outside world, in the form of electrical signal from *sensors,* and makes decisions based on a sequence of predefined instructions (the *computer program)* which is permanently stored in memory. According to the results of these decisions, the microcomputer then commands *actuators,* such as solenoids, relays and motors, to achieve the required outcome. This basic configuration is illustrated in Figure 1.

The power of the microcomputer arises from the microprocessor's ability to execute instructions very quickly; for example, a high-performance microprocessor can add two numbers in under one mil-

lionth of a second. Microcomputers are thus able to perform many automobile control functions with great speed, accuracy and reliability, and with a precision that cannot be matched by mechanical, hydraulic or vacuum devices. Typical applications include the control of the engine's air/fuel ratio, exhaust gas recirculation (EGR), ignition timing and automatic transmission gear change execution.

A significant economic advantage in using microcomputers is that the same ICs and circuit board (known in computer jargon as the *hardware)* can be used in many different control applications; it is just the computer program (the *software)* that must be changed. For example, it is usual for a vehicle manufacturer to use the same fuel injection system across a wide range of engine types and sizes, it is only the ECU's software that is modified to suit each variant.

Other advantages lie in the field of fault monitoring and diagnostics. Many automobile microcomputers are provided with additional memory space in which the microprocessor can store information relating to any abnormal operation of the electrical or mechanical systems. This data can be retrieved from the computer's memory when the service technician is undertaking diagnostic work, thus ensuring that faults are quickly identified and corrected.

Microprocessor fundamentals

Microprocessors first became available in 1971 when the Intel Corporation launched a low-cost 4-bit microprocessor, code-named the 4004, fabricated on a single silicon chip. Since that time, microprocessors have undergone very rapid development which has increased their speed and computing power to the extent that they are now indispensable in the control of sophisticated consumer products such as camcorders, washing machines and automobiles. Even the most basic of cars carry at least one microprocessor (in the engine-management ECU) and luxury-specification vehicles can have ten or more located in various ECUs. Nowadays, there are virtually hundreds of different types of microprocessor available, each optimized for a particular range of tasks, however the basic operational concepts remain the same for all.

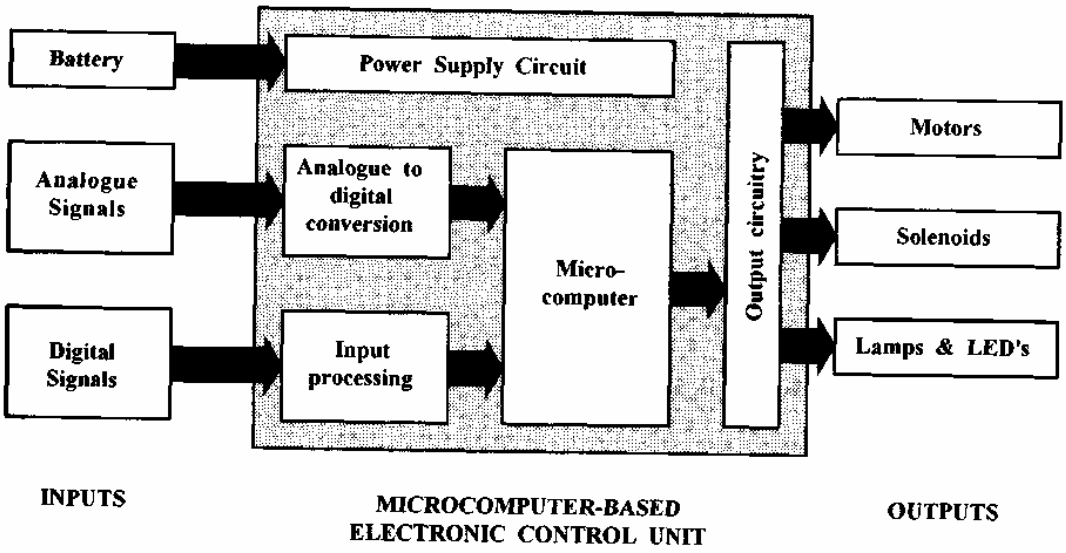


Figure 1. Configurartion of a microcomputer-based ECU

CONTROL STRATEGIES

As its name implies, the function of an electronic control unit is to control the operation of a system and provide an optimum response to counter the influence of external disturbances. The *controlled system* can be entirely mechanical, for example an engine, or it can be electromechanical, for example an automatic heater/air-conditioner system. Whatever the case, the ECU outputs a *control signal* which commands a *controlling element* (usually an actuator) so as to keep the system operating within a given specification. The signal applied to the controlling element is determined by the control strategy, which takes the form of a *control algorithm* that is incorporated into the ECU's software. Control algorithms are designed to quickly respond to disturbances in the controlled system's operating conditions and so re-establish stable operation.

Control systems divide into two main categories; *open-loop* and *closed-loop.*

Open-loop control

An open-loop control system is illustrated diagram-matically in Figure 2 (a). The *input variables* to the system are the *reference variable,* or *set-point, w,* and the *disturbance variables,* z, and z_2 The control unit monitors *w* and z, and uses its *control algorithm* to gener-

ate an *output variable, y,* which modifies the operation of the controlled system.

The major characteristic of this type of control system is that it is only able to respond to the disturbances, z,, that are *directly measured* by the control unit. There is no compensation for disturbances of type z_2 that are not measured. For example, in a control unit designed to control the air-fuel (A/F) ratio of a non-catalyst engine, *w* would be the ideal A/F ratio, say 15:1, and the z, disturbance inputs would be air and coolant temperatures, and engine speed and load. The control unit would process this information to provide an output signal, *y,* to open a fuel injector and deliver the appropriate amount of fuel. Any variation in engine condition, perhaps due to a build-up of combustion chamber deposits, would not be detected by the control unit and therefore could lead to a deviation from ideal operation and a consequent drop in performance.

Although open-loop systems can be used when relatively coarse control is required they are not suited to systems that require accurate control over a long service life. For this reason they have been largely superseded by closed-loop control systems.

Closed-loop control

Figure 2 (b) illustrates the configuration of a closed-loop control system. It differs from the open-loop system in that the control unit is placed within a closed loop and so can act to compensate for *all* types of disturbance (z, *and* z,) that affect the controlled system.

The control unit accepts a *feedback signal, x,* which represents the output from the controlled system, and then performs the function of comparing this value with the set-point value, *w,* to establish an *error value, (x - w),* between the two. A control algorithm is then applied to the error value to determine the appropriate corrective action which would eliminate the error. The controller then outputs the required corrective signal value, *y.*

The sophistication of closed-loop systems means that they can respond quickly and accurately to any changes in operating conditions, leading to smooth, stable and precise control over the life of the vehicle. It is for these reasons that closed-loop strategies have become almost universally adopted for automobile control tasks.

Feedforward control

The principle of closed-loop feedback control (described above) is that the controller implements cor rective action *after* the external disturbances, z_2, have influenced the output, *x,* of the controlled system. In contrast, a feedforward control system measures the external disturbances directly and takes corrective action *before* they can influence the output.

Feedforward control is useful when there are just a few external disturbances that can easily be measured. A good example is in an engine management system, where the use of a feedforward signal from an airflow meter is combined with a feedback control system based around an exhaust-gas oxygen sensor (X sensor) to give a sharp engine response and optimum control of fuelling.

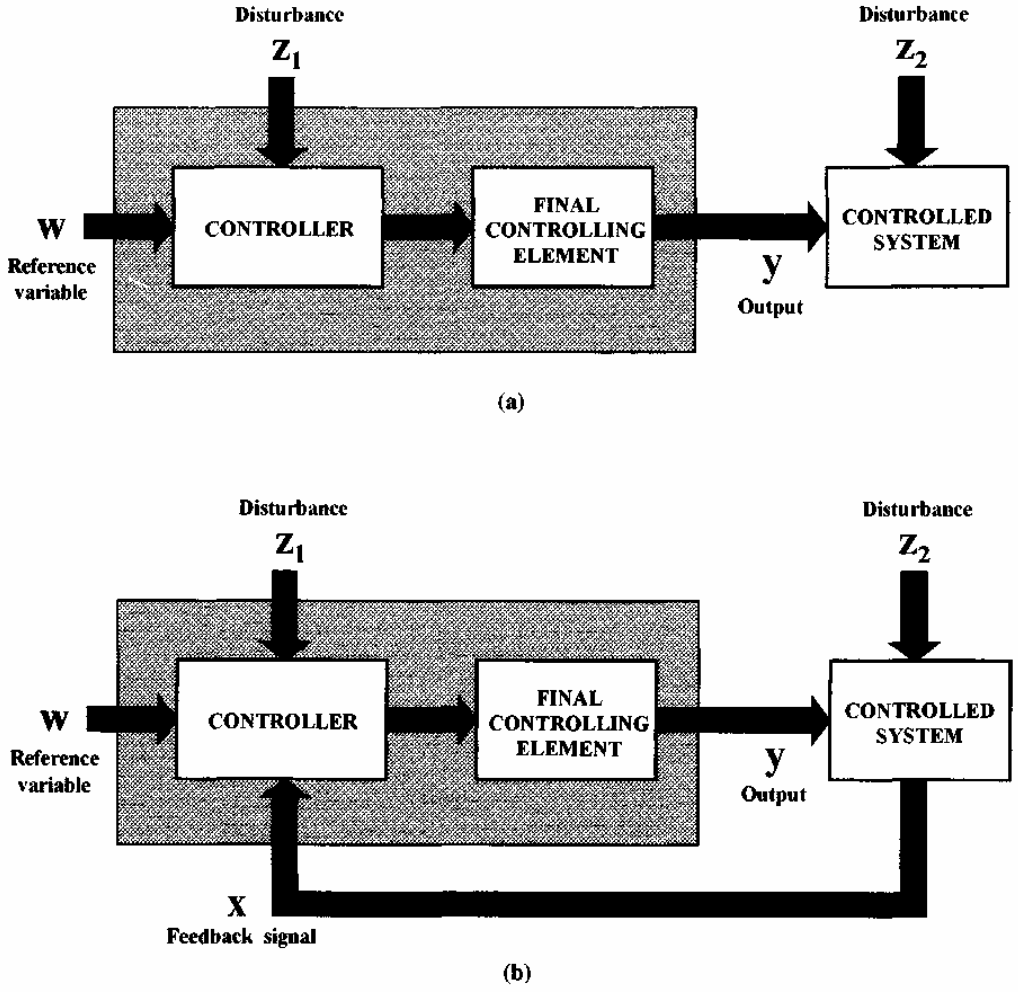


Figure 2. The two types of control system: (a) open-loop control; (b) closed-loop control

ENGINE MANAGEMENT

Today's car engines must offer low exhaust emissions, good fuel economy and excellent driving performance under all driving conditions. Many factors are important in achieving this aim. Improvements in the mechanical design of the engine, such as the shape of the combustion chamber, location of the spark plug and number of intake valves are very significant. However, precise control of the air-fuel mixture ratio and spark timing have become of central importance in maximizing an engine's power and efficiency, and minimizing its emissions. For a modern engine this task is now considered to be beyond the capabilities of simple mechanical control systems and electronic engine management must be used. Such a system consists of a microprocessor-based electronic control unit (ECU) and a large number of electronic and electromechanical sensors and actuators. It is the job of this system to:

1) Provide accurate control of the air-fuel mixture ratio via a fuel injection system.
2) Assure accurate and precise ignition timing for all engine operating conditions.
3) Monitor and control numerous additional parameters such as idle speed, exhaust-gas recirculation, air conditioner operation and fuel evaporative emissions to ensure consistently good performance under all circumstances.

Combustion processes in the spark-ignition engine

To understand the operation of the engine management system it is first of all vital to develop an appreciation of the combustion process itself and the factors that influence it. A vast amount of research has been done in this area, perhaps most notably by the British engineer Sir Harry Ricardo who was responsible for many of this century's remarkable advances in combustion engineering. Since 1913, when Ricardo started his pioneering research work at Cambridge, the mechanical design and construction of engines has been enormously improved. But perhaps the greatest improvements have come about quite recently, as a result of the precise control afforded by electronic

systems.

In a four-stroke spark-ignition (SI) engine the fuel and air are normally mixed in the engine intake passages and drawn into the engine during the intake stroke. Turbulence within the cylinder causes further air-fuel mixing to occur as the piston rises on its compression stroke. As the piston nears the top of its compression stroke, a precisely timed electrical spark starts the combustion process. A 'flame-front' of burning gas then propagates away from the spark with a velocity of 20-40 ms^{-1}, progressively consuming the unburnt mixture until it is eventually extinguished on contact with the cold cylinder wall. The hot gases produced by this combustion process raise the cylinder pressure to about 30 bar (about 450 psi) and so force the piston downwards, turning the crankshaft and hence the roadwheels. The burnt gases are subsequently expelled to atmosphere on the exhaust stroke and the cylinder is ready to be refilled.

It is the composition of the inducted air-fuel mixture and the timing of the ignition spark which so radically influences this combustion process, and hence the performance and economy of the engine and the quantity of pollutants in its exhaust.

FUEL CONTROL SYSTEMS

The function of the fuel control system is to introduce fuel into the incoming air stream in precise accordance with the engine operating conditions, and then uniformly distribute it to the individual cylinders. For most of the history of the motor car, the carburettor has been the most common device used to achieve these requirements. It uses a restriction ('venturi') in the intake passage upstream of the throttle valve to create a pressure drop which sucks fuel from a small *nozzle* called a 'jet'. The pressure difference between the air inlet and the throat of the venturi depends upon the intake air flow rate and so is used to meter the appropriate amount of fuel to intake air. By careful selection of jet size and throat diameter it is possible to achieve a suitable air-fuel ratio. Traditionally this is set at about 13:1 ($\lambda = 0.9$) when maximum power is required, or about 16:1 ($\lambda = 1.1$) for maximum economy.

Although carburettors can be designed to meter fuel with great

accuracy, the introduction of emission legislation requiring the use of three-way catalysts soon highlighted certain shortcomings, specifically:

1) Difficulty of A/F ratio feedback control from an exhaust gas oxygen sensor.
2) Many moving parts, leading to rapid wear (80 000 km lifetime).
3) Poor mixture distribution through the intake manifold.
4) Poor mixture control during cold running and transient conditions such as acceleration and deceleration.

In an attempt to overcome these deficiencies some manufacturers designed carburettors that were fitted with electronic control systems, for example the Bosch Ecotronic, however the problem of rapid wear-out and poor transient response remained. The more precise and controllable method of fuel injection has therefore completely superseded the carburettor.

Fuel injection

The idea of injecting fuel into an engine first arose in the aircraft industry, when the need to deliver a constant air-fuel mixture at varying altitudes and engine angles led to the development of a variety of novel fuelling systems. In the period prior to World War II. the Bosch company of Germany designed a mechanical 'direct injection' system in which petrol was sprayed directly into each combustion cylinder. The system drew on Bosch's expertise in diesel injection and worked on a similar principle, with a plunger-type high-pressure pump and spring-load injector nozzles. Its good performance led to it becoming a standard fitment on German warplanes and, after the war, on Mercedes sports cars. In the mid-1950s the modern practice of indirect injection was developed, whereby fuel is injected into the intake manifold just behind the inlet valves. This had the great advantage that the injector was no longer exposed to the combustion process and a much lower fuel pressure could be used.

The desirability of continuously controlling the quantity of injected fuel soon led manufacturers to consider electronically controlled systems. The first truly electronic petrol injection system used valve circuits and was developed in 1957 by the Chrysler Corpora-

tion. Subsequently many other companies worked on electronic systems using transistors, most notable amongst these was the Bendix Corporation which pioneered *intermittent indirect injection* using solenoid valve injectors. This is the system which was brought to market by Bosch in the early-1970s and is now fitted as standard on virtually all cars. It is simply referred to as electronic fuel injection (EFI).

ELECTRONIC TRANSMISSION CONTROL

The idea of using automatic and semi-automatic gear-changing systems to lessen driver fatigue is almost as old as the car itself. Early motorists were confounded by heavy and obstructive crash gearboxes, leading many car designers to investigate ways of providing a more satisfactory means of changing gear.

German engineers were particularly active in the area of transmission design, and during the period up to World War I a variety of gearless drive systems were developed. The 1901 Manurer-Union car used two friction discs, mounted at a steep angle to each other, to create a stepless transmission system. An idea that is known today as continuously variable transmission (CVT). The driver still had to effect ratio changes by manually moving the edge of the driven disc radially across the drive disc, but was relieved of the fatiguing task of manipulating gears, clutch and throttle.

As the power output of engines increased, crude friction drives proved unreliable and so a variety of semi-automatic transmissions were developed, mostly based around conventional stepped-ratio gearboxes, but with automated operation of the clutch. Unfortunately most of these experiments were shortlived, due largely to poor reliability and inadequate materials.

American car manufacturers, in particular, were eager to eliminate the need for gear changing on their luxury vehicles, and it was with this in mind that General Motors Corporation established a new division to develop a type of fully-automatic transmission which they called Hydramatic. Hydramatic utilized variations in hydraulic fluid pressure to control an epicyclic gear train that was driven from the engine through a fluid coupling. The transmission used a low gear

to start the vehicle moving, before shifting to a higher gear for cruising. The project was spectacularly successful and the world's first truly automatic transmission, with two self-selecting forward gears, was available on the 1939 Oldsmobile saloon.

Competition between manufacturers resulted in rapid improvements in transmission design, and three-speed units were soon developed. Since these transmissions were ideally suited to American motoring conditions the market for automatics grew strongly, so that today only one in ten cars sold in the US is equipped with a manual gearbox.

In Europe automatic transmissions have never been particularly popular and currently only account for about 10% of the market. This is partly because automatic gearboxes are less efficient than their manual counterparts, giving rise to a noticeable deterioration in vehicle performance when coupled with the small capacity engines that are common in Europe. Another factor is that European roads tend to be less well graded than those of North America, and so the additional driver control afforded by a manual gearbox is often to be valued. Finally, automatic transmissions are generally only available as an extra-cost option, with a price premium of around 10% of the total vehicle cost, and this often deters potential purchasers.

The impact of electronics on transmission control

The potential of electronics to offer enhanced control of semi- and fully automatic transmissions has long been realized. Many transmission manufacturers, including AP (in the UK), ZF (in Germany), Renault (in France) and, naturally, the US car makers, were experimenting with electrohydraulic transmission controls as early as the mid-1960s. These early analogue systems had no processing power but simply used transistors to switch current to solenoid valves and actuators on the transmission casing. The first such system to enter series production was available on a 1968 model Renault. Toyota and Nissan soon followed with their own versions in 1970. Since they were expensive and offered few advantages to the driver they failed to gain popularity.

The arrival of microcomputers allowed much more sophisticated control of automatic transmissions and enabled Toyota to intro-

duce one of the first computer controlled automatic gearboxes on their 1982 model year cars. In 1983 the evolution of powertrain control electronics was continued in Europe when Bosch announced their Motronic system, which incorporated both engine and transmission control in one unit.

Today, sophisticated microprocessor control is a standard feature of almost all passenger car automatic transmissions, including those using CVTs; additionally the first truly driver-friendly semi-automatic transmissions have now been made possible.

ELECTRONICALLY CONTROLLED SEMI-AUTOMATIC TRANSMISSION

The rationale behind the development of electronically controlled semi-automatic transmissions is to produce a gearbox with the efficiency and controllability of a manual transmission, but the ease of driving offered by a clutchless automatic. In all cases, semi-automatic transmissions have been based around layshaft or epicyclic-type gearboxes, with automated actuation of clutch engagement and disengagement.

Early designs of the 1960s and 1970s, such as the Manumatic gearbox (developed by AP and subsequently installed in some Hillman cars) and the system developed by NSU for their Wankel-engined Ro80, used a microswitch under the gear lever knob to detect the driver's hand-pressure and hence his intention to change gear. When the switch was operated, a solenoid valve was energized to allow either vacuum or hydraulic pressure to actuate the clutch mechanism. Since clutch control was of a rather 'on-off nature, these transmissions were not particularly smooth and therefore fluid couplings were sometimes used to cushion the drive. Deficiencies in the control electronics remained, however, and these systems made little impact on the market.

Electronic clutch control

During the late 1980s renewed interest in semiautomatic transmissions, coupled with the ready availability of cheap and powerful microprocessors, led to the development of low-cost semi-

automatic gearboxes with good performance. In Europe, the Valeo company in France, Fichtel and Sachs in Germany, Magneti Marelli in Italy and AP Borg and Beck in Britain have all developed fully commercialized systems that enable semi-automatic operation of a conventional layshaft gearbox. At the heart of all of these systems is a microcomputer-based electronic control unit that monitors engine and transmission speeds, as well as detecting the positions of the accelerator pedal and gear lever. Commands issued by the control unit then energize an electric, vacuum or hydraulic actuator to engage or disengage a conventional dry-plate clutch. In this way the driver can have all the advantages of a manual gearbox without the fatigue of manipulating the clutch. This basic idea has been modified to give a variety of semi-automatic control strategies, as detailed below.

Electronic clutch control

This is the basic semi-automatic system described above. With the vehicle at rest, the driver simply engages a gear and depresses the accelerator pedal to move away. Once moving, gear changes are effected simply by moving the gear lever, permitting very fasi gear changes. Clutch operation is fully automated, but during the gear-change interval the driver must still control engine speed with the accelerator pedal. When the vehicle is slowed, the clutch is not disengaged until the vehicle is almost at a standstill. This maximizes engine braking but avoids a stall. Among the first vehicle applications of electronic clutch control are the Ferrari Modial (introduced in 1993 with the Valeo TEE2000 system), Renault Twingo Easy (introduced into Europe during 1994 with an AP Borg and Beck system) and Volkswagen's Golf diesel Ecomatic, also introduced in 1994.

Electronic clutch and engine speed control

This is an enhancement to the system described above. The accelerator cable is replaced by an electrical connection between a position sensor mounted on the accelerator pedal and a servomotor operating the engine's throttle disc. Normally, the throttle disc is actuated directly at the command of the driver, but during gear changing the control unit intervenes and takes command of engine speed to synchronize it with transmission speed for the newly selected gear. This strat-

egy ensures smooth and comfortable clutch reengagement and minimizes clutch wear.

Remote gear selection

With this system the features described above are enhanced by the addition of a remote gear selector. The usual gear selection linkage is replaced by an electrical connection between the gear change switch (usually a small lever or a push-button) and a transmission-mounted electrohydraulic actuator. Gear changes are requested simply by flicking the small lever forwards or backwards to shift down or up a gear. Since the gear lever is simply an electrical switch it can be sited in a location best suited to the driver and requires only a small operating pressure.

Automatically shifted manual transmission

Having designed a transmission that is equipped with electronically controlled clutch and remotely selected gears it is comparatively straightforward to entirely automate the gear-selection process. The result is a small, light and highly efficient automatic transmission, well suited to small- capacity cars for which the provision of a conventional automatic transmission (with torque-converter and epicyclic gears) would cause an excessive performance degradation.

ELECTRONICALLY CONTROLLED CONTINUOUSLY VARIABLE TRANSMISSION (ECVT)

A continuously variable transmission (CVT) is a type of automatic transmission that can provide a smoothly varying gear ratio. Unlike a conventional automatic gearbox the CVT has no fixed gears. It varies the drive ratio continuously by changing the operating diameters of two pulleys that are linked by a steel V-belt. The transmission can thus alter its ratio imperceptibly, with no interruption of drive.

Potentially, the CVT offers the ease of driving associated with an automatic gearbox together with the , efficiency of a manual transmission, without any loss of vehicle performance. Unlike a conventional automatic, no torque converter is used and so there are no

hydraulic slippage losses. The CVT can respond instantly to throttle pressure, giving smooth and rapid acceleration. Unfortunately the difficulties of manufacturing a reliable and durable system have meant that few car makers offer such a transmission.

The history of CVT

The idea of using a belt drive system with variable diameter pulleys dates from about 1908, when the Rudge company developed their 'Multi' motorcycle. The Rudge Multi employed a CVT system consisting of a variable-diameter drive pulley fitted to the engine, coupled by a leather belt to a fixed-diameter pulley on the rear wheel. By rotating a small hand-wheel fitted next to the fuel tank the rider could vary the running diameter of the drive pulley to alter the gear ratio. Simultaneously, the position of the rear wheel was also slightly altered to maintain the drive-belt tension. So successful was this system that the Rudge Multi had to be banned from the Isle of Man TT race in order to give other motorcycles some chance of winning. The first practical CVT system for cars was developed in 1955 by the Van Doorne brothers of Eindhoven in Holland. Called the 'Variomatic' it was manufactured by DAF (Van Doorne's Automobielfabriek NV) and launched in their tiny Daffodil saloon car. The system used a pair of V section rubber belts running under tension between primary and secondary pulleys that had variable groove widths. Control of the pulley running diameters (and therefore the drive ratio) was achieved using servos operated by an inlet manifold vacuum. A centrifugal clutch was used for setting off from rest.

Although it remained in production until 1992 the Variomatic suffered from several drawbacks, in par ticular its torque capacity was limited and it occupied a large installation volume.

DAF engineers, meanwhile, established a new company called VDT (Van Doorne's Transmissie BV) to continue work on CVT in an attempt to improve the technology. Their efforts were rewarded in 1979 when VDT launched a new CVT system using a seg mented steel thrust belt. This new system offered increased torque capacity and was much lighter and more compact than the Variomatic system. It has subsequently been used in small cars manufactured by Rover, Ford, Fiat, Subaru and Nissan.

The Subaru ECVT

The Subaru ECVT was co-developed by Fuji Heavy Industries in Japan (Subaru's parent company) and VDT in Holland. It was the world's first practical electronically controlled CVT. The system uses an electromagnetic powder clutch and electronic control unit developed by Subaru, together with VDT's steel thrust belt and pulleys.

ECVT was introduced in Japan in February 1987 on the Subaru Justy and has since been used on sev eral other small vehicles (most notably the Nissan Micra) with considerable success. The microcomputer based transmission controller ensures that the engine is always operating in its most efficient speed range, reducing emissions and improving fuel economy.

The ZF Ecotronic ECVT

In contrast to the Subaru ECVT, which is designed for use on small cars, the ZF company of Germany have designed an ECVT suitable for use on medium size cars. The ZF Ecotronic operates on the same principle as the Subaru ECVT, but uses a wider 30 mm steel thrust belt to give a higher torque capacity of 210 Nm, making the transmission suitable for use with engines of up to 2.5 litres displacement. The transmission ratio varies from 2.44:1 to 0.46:1 and a lockup torque converter (rather than electromagnetic clutch) is used to transfer power from the engine. An inter esting feature of the electronic control system is that it 'learns' driver behaviour and so optimizes the inter action of the engine and transmission to give best performance and economy. This results in a fuel saving of about 10% when compared to a conventional four-speed automatic transmission.

Driving with ECVT

The ECVT is equipped with a selector lever very similar to that of a conventional automatic transmission. When 'D' is engaged the driver can accelerate away, with the transmission operating at the optimum ratio for the desired engine rpm. In comparison with their manual counterparts, ECVT cars are generally much quicker from a standing start.

Once underway the ECVT is characterized by a very wide ratio span, roughly equivalent to that of a six-speed manual transmission. Theoretically, this should enable exceptional fuel economy to be obtained by keeping the engine at the optimum speed and load point for a given road speed. Unfortunately, frictional losses in the transmission waste a considerable amount of energy and so ECVT cars are about 5% less fuel efficient than their equivalent manual transmission counterparts.

ELECTRONICALLY CONTROLLED AUTOMATIC TRANSMISSIONS

An automatic transmission is a type of gearbox that selects the most appropriate gear ratio for the prevailing engine speed, powertrain load and vehicle speed conditions, without any intervention by the driver. All gear-shifting is undertaken by the transmission system itself, the driver merely selects the desired operating mode with the selector lever. The Society of Automotive Engineers (SAE) recommends that the selector be sequenced **P R N D 3 2 1** (in the case of a four-speed transmission) where the letters have the following meanings:

P (Park) In this mode the transmission is in neutral and the transmission output shaft is locked by means of a 'parking pawl'.

R (Reverse) A single-speed reverse gear is selected and held. Engine braking is effective.

N (Neutral) The same as Park, but the output shaft is not locked.

D (Drive) This is the normal gear selection for forward motion. The vehicle may be operated from a standstill up to its maximum speed, with automatic upshifts and downshifts being made by the gearbox depending upon its assessment of vehicle speed and engine load. When rapid acceleration is required for overtaking, the driver can push the throttle pedal to its full travel to invoke a speedy 'kick-down' downshift into a lower gear.

3 (Third) Operation varies between manufacturers; in general the transmission operates as in D range, but is prevented from upshifting into fourth gear.

2 (Second) Again, operation varies between manufacturers, but normally the transmission can only operate in first and second gear. 2 is usually selected to provide engine braking when driving in hilly country or when towing.

1 (First) Locks the transmission in first gear to provide powerful engine braking. Used when driving on steep hills or when towing.

To prevent the vehicle being inadvertently started in a gear, a gearbox 'inhibitor switch' (sometimes called a 'neutral switch') is wired in series with the starter motor solenoid supply. The inhibitor switch contacts are closed only when the selector lever is in Park or Neutral and so the engine may be started only in these positions. Additional safety is provided by having the selector lever fitted with a mechanical interlock that prevents, for example, the lever being moved out of Park unless a spring-loaded release button is pressed.

Although automatic transmissions are usually less fuel-efficient than their manual counterparts, they do offer many driving advantages, especially in urban road conditions:

1) Driver fatigue is reduced since there is no clutch or gear lever to manipulate. This is very significant when driving in dense traffic.
2) Both hands can remain on the steering wheel at all times, so increasing safety.
3) Since the transmission always engages the correct gear for the prevailing driving conditions, the possibility of labouring or over-revving the engine is eliminated.

The use of a microcomputer control system enhances the performance of the automatic transmission by precisely controlling the hydraulic system, offering:

1) Crisp and smooth gear shifts with consistent quality.
2) Perfectly timed gear shifts,

3) Elimination of 'hunting shifts'.
4) Protection of the transmission by constant monitoring of engine and transmission speed, temperature and so on.
5) Driver-selectable shift pattern options for extra performance or economy, or for icy road conditions.
6) A simplified hydraulic control system.

An additional advantage of electronic control is the ability of the microcomputer to store diagnostic trouble codes, greatly assisting in the speedy repaid of faulty transmission units.

CHASSIS SYSTEMS

Chassis systems are those elements of the automobile that are associated with controlling the motion of the vehicle; accelerating, braking, turning and vertical movements over bumps.

Driving a car represents the operation of a closed-loop control system. The controller is the driver, who interacts with the chassis systems to control the motion of the vehicle within its surroundings. The vital link between the vehicle and its surroundings is the frictional contact between tyres and road surface. All control forces are fed through the tyres, and so any loss of grip results in a loss of control of the vehicle. Good chassis control is therefore vital to the promotion of active safety - the avoidance of accidents through driver action. A key aspect of this is the precision of the vehicle's response to a driver input and its relationship to the road surface.

Under normal driving conditions the chassis behaviour remains entirely predictable and 'comfort' features such as power-assisted steering and semi-active suspension enable the driver to operate the vehicle with minimal stress and effort.

Occasionally, however, most drivers are faced with the need to unexpectedly make emergency manoeuvres. Under these circumstances an electronically controlled braking or traction control system can assist the driver by intervening more rapidly and precisely than human reactions permit. Such systems enable the vehicle to maintain stability in situations where even an experienced driver would be unable to cope.

Anti-lock braking systems (ABS)

During heavy braking on wet or icy roads it is very easy for the driver to inadvertently lock the wheels. If the rear wheels lock, the car tends to yaw, becoming very difficult to control and possibly spinning. Conversely, if the front wheels lock, all steering action is lost. Experienced drivers avoid these situations by rapidly pumping the brake pedal, repeatedly taking the wheels to the point of locking and then allowing them to roll again. This technique, called cadence braking, requires a high level of skill and concentration under panic conditions.

An anti-lock braking system (ABS) allows even an unskilled driver to retain control of a vehicle during emergency braking. By rapidly increasing and decreasing the braking pressure, the rate of wheel deceleration is maintained at a desired value to prevent the wheels from locking. This allows the vehicle to be stopped quickly and, most important, steering control and stability are maintained.

Development of ABS

During the 1950s design engineers working on aircraft braking systems found that aeroplane tyres gave their greatest grip just before locking. Using entirely mechanical techniques, they managed to design braking systems that released the braking force the moment locking was detected. This allowed the tyre to be continuously operated in the region of maximum grip, close to locking, reducing braking distances. These early anti-lock braking systems therefore allowed much safer aircraft landings, especially on slippery surfaces.

Automotive engineers soon realized the potential of ABS to maintain directional stability and steering control during emergency braking. One of the first vehicles to use ABS was the 1965 model Jensen FF. This was fitted with the Dunlop Maxaret mechanical ABS system, adapted from aircraft use. Although it provided comparatively good performance, the Maxaret was too expensive and bulky for use on anything other than very high-priced cars and so automobile ABS was shelved until technology improved.

During the late 1960s many vehicle manufacturers started to experiment with anti-lock braking systems that were controlled by

analogue electronic circuits. Ford demonstrated such a system in 1968 and Chrysler showed a pioneering 4-wheel ABS controller in 1971. In Japan, both Nissan and Toyota announced electronic ABS and in Germany a joint-venture company formed by Telefunken and Bendix attempted to market an ABS system called Teldix. Unfortunately the electronic design and manufacturing techniques of that time were insufficiently developed for a safe and reliable system to be developed and so none of these systems was commercially successful.

Development work continued however, and in 1978 Bosch announced the availability of their pioneering *Anti-Blockier System* (German for anti-skid system and from which the abbreviation ABS actually derives).

Although initially available only as optional equipment on German prestige vehicles, the good performance and reliability of Bosch ABS made it the first commercially successful system and it was subsequently fitted to many cars. Although Bosch still commands a large share of the European ABS market, many other companies also supply systems. Today, most drivers understand the benefits of ABS and it is a standard fitment on most large and medium size cars, and a low-cost option on most small cars. In 1995, approximately 50% of automobiles manufactured in Europe were fitted with ABS.

Limitations of ABS

Despite the widely accepted advantages of ABS, it does have limitations. In particular, the laws of nature still apply to an ABS-equipped vehicle. If the driver takes a corner at too great a speed the car will still slide off the road.

Moreover, there are some circumstances in which ABS is of only limited effectiveness, these include:

1) Deep snow or loose chippings which may buildup to form a wedge in front of the wheel.
2) Driving at speed on a very wet road, when aquaplaning may occur.
3) Frost or shallow snow, where a locked wheel may usefully 'bite' down to the road surface.

Tyre dynamics

To appreciate the operation of an anti-lock braking system it is essential to understand tyre dynamics. Tyres are involved with the transference of accelerating and decelerating forces between the road surface and the vehicle. The grip exerted by the tyre on the road surface is measured in terms of the coefficient of friction, u, (pronounced 'mew'). The value of \\. depends on the nature of the two surfaces; for example, it reaches a maximum of about 1.0 on a dry tarmac road, falls to about 0.7 on wet tarmac, but is only about 0.2 on a snow-covered road. Thus a greater value of *i* means more braking grip and a shorter stopping distance. Tyre grip also depends on the slip ratio; the ratio of the tyre speed to the road speed. When a car is travelling at a steady speed there is no slippage between the road and the tyre, and so the slip ratio is zero. On the other hand, the application of a powerful braking (or accelerative force) may cause the wheel to lock (or spin) and the tyre then has a slip ratio of one.

During gentle braking the tyres are slowed to slightly less than the vehicle speed and so some slip occurs. The value of *fi* rises proportionately with this slip, reaching a maximum at a slip ratio of about 0.15-0.30. Heavier braking causes increasing slip, resulting in *i* falling sharply and rapid locking of the wheel. Maximum braking force is thus achieved with a slip ratio of about 0.15-0.30. Lateral grip (the resistance to sideways forces on the tyres) also varies with the slip ratio, falling from a maximum at zero slip to almost nil at a slip ratio of one. These characteristics are illustrated in Figure 7.1, which shows tyre grip as a function of slip ratio for both negative slip (braking) and positive slip (acceleration). As may be seen, the maximum values of frictional coefficient and lateral grip do not occur at the same slip ratio. However, by setting a target braking slip ratio of about 0.20 the vehicle will be stopped very swiftly, and with adequate lateral grip. Under dry road conditions stopping distances are typically reduced by about 15% when using ABS operating at this slip ratio. This advantage increases to about 40% when braking on a wet road surface.

The function of the ABS control system is therefore to continuously monitor the speed of each wheel and then modulate the hy-

draulic braking pressures to keep the slip ratio in the range 0.15-0.30. The ABS control module does this not by directly calculating slip but rather by calculating wheel deceleration, which increases sharply just after the coefficient of friction, *H,* reaches a maximum. By controlling the braking force to limit wheel deceleration, wheel locking is avoided.

SUSPENSION SYSTEM

The function of the vehicle suspension system is to minimize the transmission of road surface irregularities to the vehicle body. At the same time the tyres must be kept in contact with the road and made to behave in a controlled fashion. This improves the ride comfort and minimizes undesirable motions of the body, resulting in increased stability and safety.

All suspension systems comprise springs, dampers (often inappropriately called 'shock absorbers') and locating arms to keep the components correctly aligned. It is the combined characteristics of the springs and dampers that determine the ride and handling qualities of a vehicle. Unfortunately the fundamental laws of mechanics dictate that the requirements for both good ride and good handling cannot be simultaneously achieved with a single value of spring stiffness and damping resistance. Good ride comfort, for example, demands soft springs to allow for generous vertical wheel movement on an uneven road. Good stability, on the other hand, demands firm spring and damper characteristics to limit undesirable body motion, such as rolling when cornering, diving when braking and squatting when accelerating. Suspension design therefore inevitably involves the adoption of a 'ride-handling compromise', where ride comfort and vehicle handling are traded against each other to provide the best compromise for the individual vehicle model.

In general, the ride-handling compromise of modern cars is so good that many automotive engineers would question the need to introduce the refinement of electronic suspension control. Nevertheless, during the 1980s many manufacturers introduced 'semi-active' suspension systems on luxury models. These systems work to automatically alter the suspension characteristics according to the prevailing

driving conditions. For example, on a twisting road the suspension becomes firmer to give better handling, while on a smooth and straight highway the suspension softens to give a more comfortable ride.

AUXILIARY BODY ELECTRONICS

Central control unit (CCU)

Vehicles designed since the mid-1980s incorporate many luxury and convenience features such as central door locking, power windows, heated rear window timer and so on. Since most of these features require a basic timing function, many manufacturers now fit a single central control unit (CCU) which replaces the numerous smaller ECUs that were previously used. The CCU offers numerous advantages; just one microprocessor can simultaneously perform many timing functions, cable harness bulk is reduced, reliability is improved and cost is reduced. Examples of features controlled by a CCU include:

1) Intermittent windscreen wipe.
2) Programmable wash/wipe.
3) Rear window wash/wipe.
4) Courtesy light delay.
5) Lights-on alarm.
6) Heated rear window timer.
7) Headlamp dip/main switchover.
8) Headlamp-on delay after ignition switch-off.
9) Window lift/sunroof operation with ignition off.
10) Power seat operation with ignition off.
11) Central door lock motor control,
12) Security/anti-theft alarm system.

The CCU is connected to all of the switches, relays and actuators associated with each function. The status of each switch can thus be continuously assessed by the CCU's microprocessor, which then uses preprogrammed data to determine the most appropriate output to each relay or actuator.

Central door locking

Central door locking systems are a convenience feature which allow all of a vehicle's door locks to be simultaneously actuated from either the driver's or front passenger's door lock. Most systems also incorporate a boot/tailgate lock and some provide additional functions such as lock disablement if the key is left in the ignition, or automatic central locking when the car first exceeds a preset speed after driving away. For safety reasons all central locking systems allow the locks to be operated from within the car by the conventional mechanical locking button.

The central locking system may either be operated by a dedicated controller or by a CCU. Where a CCU is used it often links the door locking system to a remote-controlled anti-theft facility and automatic sunroof/window closure ('lazy-locking' system).

A simple central locking circuit is illustrated in Figure 8.18. It consists of a digital lock control unit, two actuator/trigger-switch units (one in each front door), an actuator in each rear door and one each in the boot lid and fuel filler flap.

When the front doors are locked or unlocked the switch wiper is moved to provide a ground on either the control unit's LOCK or UNLOCK inputs, respectively. The control unit detects this ground signal and provides a timed LOCK or UNLOCK pulse output, as appropriate, to all of the actuators. In the event of an accident an inertia switch provides a ground signal to the UNLOCK terminals of the controller via the ignition switch and the diodes BD1 and BD2.

Electronically controlled air conditioners

Electronically controlled air conditioners are marketed as 'Automatic Temperature Control' or 'Automatic Climate Control' systems and provide automatic regulation of the cabin temperature to a value preset by the occupants. The system comprises a microprocessor-based ECU, connected to sensors which monitor variables such as cabin air temperature, outside air temperature, engine coolant temperature and the level of solar radiation (sunlight) entering the car. In response to these inputs, the ECU automatically adjusts air tempera-

ture and distribution so that the cabin environment always remains comfortable.

The system operates by having the driver set the desired cabin temperature on the temperature control switch pack. The ECU adjusts the air temperature by first selecting either fresh or recirculated air. The incoming air is then cooled and dehumidified by the evaporator matrix. The hot/cold mixing air flap is set to feed a proportion of the cooled air through the heater matrix, after which it is mixed with unheated air until the desired temperature is reached. Air is then delivered to the cabin through various vents. According to the temperatures recorded in and around the vehicle, the temperature control ECU automatically provides the following controls:

1) Air-flow rate. The air-flow rate through the cabin is controlled by varying the blower motor speed.
2) Air vent selection. The ECU selects either fresh or recirculated air inlets, and heating (windscreen, floor) or cooling (face) air outlets.
3) Temperature control. The ECU modifies the hot/ cold mixing air flap to maintain the desired temperature.
4) Compressor clutch. The compressor electromagnetic clutch is switched on and off to cycle the air conditioner, maintaining the desired cooling level.

Electronic alarm systems

Electronic alarm systems are a standard fitment on most new cars and are also available as an aftermarket accessory for older vehicles. A wide variety of systems are in production and generally offer a level of protection that increases with the cost of the product. In assessing alarm systems the primary concerns relate to their effectiveness, reliability, durability and immunity to external influences such as radio interference. It is very important that the installation of such systems does not compromise the vehicle's safety.

Current legal requirements in the UK and Europe cover a wide range of vehicle security issues. The most important standard in Britain is the British Standard BS AU209, which gives guidelines for manufacturers. It covers the specification of door locks, security of radios and central locking systems. A separate British Standard, BS

6803, specifically covers vehicle alarm systems. In Europe, the European Community requirements covering ignition key locks and alarm systems are detailed in the directive 74/6I/EEC.

German insurance companies have been particularly keen to bring car theft to a halt. All German market cars supplied from October 1995 onwards are required to have electronically operated engine immobilization as standard equipment. Furthermore, European Community guidlines state that from 1995 electronic anti-theft protection is a must for all new cars; non-protected vehicles may be excluded from comprehensive insurance.

Vehicle security systems can offer protection at three levels.

(a) Perimetric protection. The system protects the vehicle by using switches to monitor the position of the opening panels of the vehicle (doors, boot, bonnet, etc.). A siren is activated if tampering is detected. The level of protection may be enhanced by adding sensors to detect movements of the body.

(b) Volumetric protection. Volumetric protection systems use ultrasonic, microwave or infra-red sensors to detect unauthorized movements within the passenger compartment of the vehicle. Ultrasonic sensors operate on the Doppler principle whereby any movement inside the vehicle causes a small shift in the received frequency of a 40 kHz ultrasonic transmission. Microwave sensors operate on the same principle, but use a high frequency radio transmission at about 10 GHz. Microwave sensors are less prone to false triggering by air currents and are therefore mostly used on cabriolet vehicles.

Infra-red sensors are mounted within the passenger compartment, on the roof rails^at the top of the 'B'-post. Each sensor comprises a transmitter/receiver unit which transmits an invisible 'curtain' of infra-red radiation vertically downwards towards the floor. The receiver constantly monitors the strength of the reflected signal and any sudden disturbance, such as would be caused by an intruder, triggers the alarm system.

(c) Engine immobilization. Engine immobilization operates by having the security ECU inhibit the op-

eration of the engine starting system when the alarm is activated. This may be achieved in one of two ways:

1) Hardware immobilization, in which vital starting circuits are interrupted by relays or solid-state switching devices. The security of these systems is critically dependent on their installation and the use of 'hidden' or non-colour coded wiring is necessary to prevent bypassing of the cut-out devices.
2) Software immobilization, in which the alarm sys tem ECU is coupled to the engine management ECU to cause 'scrambling' of the fuel or igni tion calibration maps so that although the engine can be cranked, it will not run continuously. These systems can be highly effective, provided that the engine ECU cannot be readily exchanged for a fully functional unit.

The specification of a manufacturer's standard-fit security system will depend upon the type of car to which it is fitted. In all cases perimetric protection is provided, most systems also offer immobilization and some offer volumetric protection. Usually the system can be activated and deactivated using either the door lock key or a remote controller that also operates the central door locking system. Upon leaving the parked vehicle, the driver locks the doors and activates the security system by pressing a button on the remote controller. An indicator LED ('confidence light') flashes rapidly for a moment, informing the driver that the system is armed, and then flashes at a con tinuous slow rate to deter thieves.

If unauthorized entry is attempted, the security system enters an alarm state, sounding a siren and flashing the indicators or headlights. The engine im-mobilizer prevents the vehicle from being driven away.

After a period of about 30 seconds the siren is shut off (to prevent nuisance and battery drain due to false alarms) but engine immobilization remains in force until the vehicle owner deactivates it with his key or remote controller.

RELIABILITY OF AUTOMOBILE ELECTRONIC SYSTEMS

When electronic systems were first introduced onto cars they were usually installed in the relatively benign environment of the pas-

senger compartment. Even so, electronic failures were not unusual and many early systems gained a reputation for unreliability.

Car buyers will no longer tolerate unreliable operation however; the days of drying out 'wet' sparking plugs and cranking the engine with a starting handle on cold mornings are long gone. Consumer expectations are now such that a vehicle must operate efficiently over a life of 100 000 miles with little more than routine servicing and the odd minor repair. When a fault does occur, it must be detected and successfully repaired as quickly as possible to reduce 'vehicle off road' time.

Consumer demand, together with the falling cost of microprocessor controllers, has been a significant factor in stimulating the wide availability of electronic systems such as engine management, ABS, TCS and semi-active suspension systems. In the next decade, electronic control of throttle, transmission, braking, steering and intelligent cruise control will become common fitments. If well designed, these developments should improve the safety of road transport. However there are also disadvantages; increased complexity generally leads to decreased reliability. Manufacturers will try to prevent this, but will find difficulty in doing so throughout a vehicle's life, particularly in the later years when third or fourth owners may not be able to afford the cost of franchised dealer servicing.

It is therefore becoming essential that major safety or emissions-related defects are automatically detected and brought to the attention of the driver, and then easily identified by service technicians, especially during MoT tests.

AUTOMOBILE ELECTRONIC SYSTEM DIAGNOSTICS

The word 'diagnosis' is generally taken to mean the process of identifying the root cause of a problem by examining the symptoms of the problem. Although this is the primary purpose of automotive diagnostics it is also necessary to include the equally important task of simply detecting that a problem exists in the first place. The excellent reliability of automobile electronic systems, allied to the very high level of technology used, has led to a reduction in the number of simple or 'routine' defects encountered by the service technician,

while multiplying the possible causes of failure. This has greatly increased the problem of fault diagnosis on present-day vehicles. The way in which fault diagnosis is performed in a modern repair shop is therefore very different to the 'traditional' approach employed ten or twenty years ago.

Traditional fault diagnosis techniques

Before the widespread application of automotive electronics, car electrical systems were composed of just a few simple independent sub-circuits powered directly from the battery. Such circuits typically consisted of a switch controlling a lamp or motor, perhaps via a relay. Since there were so few electrical components, they were readily identified, even on vehicles that the technician had never encountered before. Simple components could easily be checked using a test-lamp or a multimeter (a voltmeter, ammeter and ohmmeter combined into one unit) and more complicated components, such as flasher units and relays, could be checked by substitution.

This approach had many attractive features, in particular it required only low-cost test equipment and allowed the technician to use his knowledge and experience to optimize the diagnostic process.

In the late 1970s, the arrival of electronic fuelling and ignition systems led to a breakdown of the traditional diagnostic strategy, for three main reasons.

(a) Using the traditional approach, the electronic system was tested by disconnecting the ECU from the other components and then checking them individually. If no fault was found then the ECU was deemed (usually wrongly) to be defective by default. For the car owner this sometimes led to a long repair time and the unnecessary replacement of an expensive component. For the technician it led to a lot of frustration and many unhappy customers.

(b) The interconnection of many sensors and ECUs made it difficult for the technician to hold a mental picture of the functional interactions of all the components. Vehicle manufacturers provided help by distributing service documents giving flow-charts and diagnostic tables, but even then the technician was unlikely to fully understand how the systems interacted. This became a particular problem

for multi-franchise and independent repair shops, where technicians serviced a wide range of vehicle types.

(c) The wiring on older cars usually carries just two types of signal; battery voltage and ground. Modern electronic systems augment these circuits with wires carrying complex low-voltage signals between various ECUs and the numerous sensors and actuators. Traditional test-lamp checks are therefore of little value; a multimeter may be of no additional help and may even cause damage if incorrectly used.

During the 1980s, the rapid introduction of engine management electronics produced a requirement for new testing techniques, new test hardware and higher-quality service data. The great diversity of systems also led to the need for rapid access to information relevant to the particular vehicle under repair. The solution to these requirements has been the development of a range of on-board (i.e. incorporated into the ECU) and off-board diagnostic facilities that fall into three categories.

(a) *Off-board diagnostic stations.* These do not connect directly to the ECU and therefore do not rely upon any on-board diagnostic features. Off-board diagnosis is usually restricted to the engine fuelling and ignition systems and therefore off-board testers are generally referred to as *engine testers* or *engine analysers.*

(b) *On-board diagnostic software that provides direct indication of fault codes.* An ECU's software may incorporate self-test routines that can store a 'fault code' when a system fault is detected. The ECU then flashes a lamp or LED in a specific sequence for each stored code. The technician reads the flash-code and interprets its meaning from service literature.

(c) *On-board diagnostic software accessed via an off-board diagnostic tool.* When a vehicle is taken for service a handheld diagnostic tester, usually known as a *scanner* or *scan tool,* can be connected to a diagnostic terminal fitted to certain ECUs. Data and fault codes are then read directly from the ECU's memory and interpreted by the technician. Advanced developments of these tools can be connected to the entire vehicle harness to provide a 'whole-vehicle' diagnostic facility complete with comprehensive repair information.

CLASSIC CARS

The car industry was born in 1886 when the Benz Tricycle was built, by the turn of the century the motor car industry was booming especially in France. However, the first classic masterpiece was born in Britain, when in 1904 Henry Royce and Charles Rolls joined forces, by 1907 Rolls-Royce produced the Silver Ghost. Similarly the Ford Model T was an Edwardian design that remained good sellers long after other models had become outmoded thanks to their inherent qualities of design and the use of superior materials.

Henry Ford having set up his company in 1904, broke the speed record the following year in his 999 special, which reached a speed of 91 mph on the frozen Lake Michigan. In Europe during the 1920s, motoring was still largely for the rich only. As a result, it became the heyday of sports motoring, this was the time for classic Alfa Romeo, Bugatti and Bentley cars to make their mark.

Over in the US on the other hand, cars were affordable for ordinary people, by 1929 the US were building over five million cars a year.

CLASSIC CAR AC COBRA

In October of 1961, American racing driver Carroll Shelby contacted AC cars with the notion of fitting a 4.2-litre V-eight Ford engine into their light alloy Ace sports car. AC agreed and by March 1962 a prototype was built.

The first cars were fitted with the 4.2-litre engine and the now famous top-loader gearbox, not long after a 4.7-litre unit was fitted. This boosted power from 165 to almost 200 bhp and a top speed of 140 mph. More stunning was the acceleration 0-60mph in just over 5 seconds. This was the first Cobra for Britain, introduced in 1964.

Shelby was still not satisfied; in 1965 he managed to squeeze a 7-litre unit under the hood, 350bhp in standard form, or race tuned to give 490bhp. This was now the world's fastest accelerating production car, 0-60mph in 4.3 seconds.

In reality the 7-litre version was really an all-new Cobra, but it did share the doors and the bonnet with the earlier 289 cars. The chassis was totally new and much stiffer; the suspension was also brought up-to-date using coil springs rather than the old leaf springs. Production of Cobras stopped in 1968. However Brian Angliss revived the car in 1983 - The MkIV Cobra.

CLASSIC CAR ASTON MARTIN

Aston Martin, founded in a small London workshop in 1914 by Lionel Martin and Robert Bamford have grown into one of the worlds finest producers of luxury sports cars. In almost 90 years the company has only produced just over 16,000 cars, such is the time consuming craftsmanship and attention to detail that goes into building these remarkable cars. It says much of the company that 80% of all Aston Martins ever built are still in use today.

All Aston Martin customers can visit the company's workshop in Newport Pagnell to see their own unique Aston Martin being created. Aston Martin say "sports cars should be built to the highest standards", without doubt Aston Martin do the job admirably, nobody does it better.

Because of his love of motor sports, tractor tycoon David Brown bought the company in 1947; to be honest the first DB was a

bit of let down an underpowered 4-cylinder. However he quickly redeemed himself with the DB2, a powerful straight six that could achieve 130mph and the build quality was superb, this car would set the pace for all subsequent Aston Martins.

In 1964 the DB5 became world famous, appearing in the James Bond film Goldfinger. Even today James Bond's name is still synonymous with the marque, (the little BMW didn't really suit him)

ASTON MARTIN V-8 VANTAGE (1977)

The World's Fastest Four-Seater in 1977 - 172mph (277kph)

Engine, V-8 Aluminium, four-cam, 5340cc - Power, 375 bhp @ 6000 rpm Acceleration, Engine, 0-60 5.5 seconds.

CLASSIC CAR BENTLEY

Bentley 3-litre

Bentley Motors Ltd was founded in 1919; between 1919 and 1931 Bentley built six different models, all of which were of high quality, and extremely well built. During this period Bentley was the major force in motor sport, winning the Le Mans 24-hr race on five occasions.

This speed model built in 1925 had a top speed of 85mph, the three litre model had great success in the Le Mans 24-hour race winning two races in the mid-20's.

In 1931 Bentley became Rolls-Royce owned, some say because Rolls-Royce were getting nervous of Bentley's undoubted reputation for excellence and were losing sales to Bentley, they had better buy the company now before it was too late!

When World War II ended, production moved to Crewe, and the first pressed steel bodies originated, although coach built bodies

were still available for special order. Shortly after, the car to earn the reputation as the finest car in the world would be built - The Bentley Continental. Not only was this car as stunningly beautiful as anything from the fashionable design houses in Italy, it was also the fastest 4-seater saloon in the world - it could cruise at 125mph.

People have said the Continental was influenced by the Cadillac 62 series of 1949, although of course no one at Bentley will admit it.

Bentley Continental S1 1958

This top-of-the-range car came in chassis form and was supplied to coachbuilders, 450 units were sold in the late 50's. The engine was a powerful 4.9 litre straight six.

Bentley Azure

Most of the rich and famous have owned Bentley's in years gone by, this latest Bentley should prove to be no exception. Launched in 1995 with a 6.7 litre V-8 engine and cruising at 150mph in absolute comfort should have the latter day movie stars drooling.

CLASSIC CAR BMW

During World War 1 the "Red Baron" realised the fine quality of BMW engines, and it was aero engine production that set BMW on the road to success. It would be 10 years later before they built their first motor car, the Austin Seven, built under license at their Bavarian Motor Works in Munich.

1938
BMW produced only 470 328's.

In the early 1930's BMW enjoyed tremendous success in motorsport with their new BMW 328 sportscar. All the BMW Company's motor sport engines to this day are based on the production unit.

In the mid 1950's BMW needed a new flagship car to boost their sales, especially in America. Albrecht Goertz was the man for the job, BMW asked him to design a new sportscar. He came up with the legendary BMW 507, a V-8 3.2 litre, supercar capable of 140mph.

The car was primarily aimed at the Mercedes 300SL market, serious drivers turned to the new BMW.

BMW M1 6-cylinder 3.5 – 277bhp – Top speed 160mph – 0-60 5.6 seconds

Italian styling and German engineered reliability, the M1 was launched in 1979 to take on Porsche's dominance on the race circuits. However, due to Lamborghini's financial troubles production was delayed. By the time the car eventually went into production racing rules had changed and the heavy M1 was not suited to the new racing formula. Just 426 M1's were built.

BMW have a long history of producing fast coupe's, the latest 850CSi is no exception, a V-12 or V-8, the V-12 (5.6 litre) will get you from Munich to Berlin at 170mph... If you so wish! The M5 has similar performance with a 6-cylinder 3.8 unit.

Not only is the 850CSi extremely quick, the car is luxuriously comfortable. The seats and steering wheel can be adjusted to suit the driver and this information is retained electronically, the steering wheel can also be moved out of position to allow easy access. Manufacturers who can build a high speed car and at the same time superb comfort, are very rare, undoubtedly BMW do the job admirably with the 850.

CLASSIC CAR CITROEN

At the time of the First World War, Andre Citroen had great success in armament production. When the war ended, Citroen, a man

with a great eye for business opportunities, decided automobile production for the masses would be his next venture. He set his company up in 1919, and his first car would be the first mass produced car in Europe. It would also be the first car to have electric lighting and starter. The car (A-Type) soon became very popular.


Early Citroen 2-CV

Citroen, always innovative, introduced the first network of dealerships and repair garages in Europe. In 1948 the company realised they needed to build a car everybody could afford - the 2CV. The car was the beginning of the legendary "Tin Snail".

In the late 60's, Citroen acquired a controlling interest in the Italian sportscar builders Maserati. The first car to be produced in this new partnership was the impressive Citroen SM GT. Power came from V-six quad-cam unit, a smaller version of Maserati's V-eight masterpiece. At 2.7 litres it was just within French tax laws, which came down heavily on engines over 2.8 litres. Sales were in the beginning very good, but it was to be short lived due to the fuel crisis of 1973, at 18mpg it became expensive to run. Production finally ended in 1975.

The first front-wheel drive Citroens came in 1934, the costs of development forced the company into bankruptcy. Michelin came to the rescue. The 11CV went into production in 1935, almost 20 years passed before the line was discontinued.

In 1974 Citroen went under control of Peugeot, but even today the Citroen name lives on with great success.

CLASSIC CAR FERRARI

Enzo Ferrari raced in the 1920's, in the 30's he went on to run the Alfa Romeo works team as Scuderia-Ferrari. He became frustrated with Alfa's decision to concentrate its efforts on road car production and felt Alfa were neglecting their racing heritage, he left the company and began building his own cars...

Many, many racing successes followed, but he soon realised road car production was vital to finance his racing ambitions. His first engine was a simple V-12 with a light alloy block and cylinder heads, narrow valve angles, 1500cc with tiny 125cc cylinders, 3 twin-choke webers and twin ignition distributors (remember this is in 1947).

Ferrari hit the world headlines in 1964 with the launch of the 275 GTB, a Ferrari with all new suspension, and a comfortable to drive Ferrari and of course, extremely quick.

In 1968 the Ferrari Daytona 365GTB/4 was launched, the last GT front-engine Ferrari supercar. The car was named in honour of Ferrari's success in the American 24-hour race of the same name, 365 denotes the capacity of each cylinder, four stood for the number of camshafts. This sensational motor car had a top speed of 70mph, in reverse gear that is! Forwards just 175mph.

To celebrate 40 years of production Ferrari built the F40, a road-legal racer, a twin turbo 3-litre 478 bhp 200mph supercar.

Enzo said, if it's not enough we can fit a wider camshaft and larger turbos.....then you have 678bhp!

F40

Ferrari 365 California

Sadly Enzo did not live to see the F50, a similar car to the F40 but with a 4.7 litre engine and no turbo's. Performance of both the F40 and F50 was almost identical (the F50 slighter quicker acceleration and top speed) The F50 is really an out-and-out racer for the road, not a developed road car. The V-12 engine is bolted directly to the carbon-fibre chassis. De-

spite more power than the F40, maximum speed will be no greater, ground effect is more important.

The1958 250 GT Spyder California had the body built by Scaglietti although the design came from Pinnin Farina. Just over 100 Spyder's were built, Ferrari thought this would be an ideal competition road car, but most owners thought this car was just too nice to race! In the early 60's the California was modified to a short-wheelbase form, many thought it even better looking than the 1958 version. Production ceased in 1963.

CLASSIC CAR FORD

Henry Ford started his working life as an engineer for the Edison Lighting Company Detroit, in 1884. Ford by chance, came across a science journal written by Nicholas Otto, a German engineer who was developing the internal combustion engine. Ford became very interested, some say infatuated, and he decided to build his own.

He soon got to work, building and developing a car in his spare time in a small shed in his garden. His car, the "Thin Lizzie" was completed in 1896. Ford was now desperate to start his own motor company; by 1899 he had secured enough investors to begin a production run. Initially his first attempts were unsuccessful, he failed to produce a car that could be sold. Eventually however, Ford produced the Model A, sales were good, by 1908 profits soured to over one million dollars. In 1909 Ford decided to concentrate production on the Model T, he wanted to mass produce this car, and build each unit in the shortest time possible, and as inexpensive that could be achieved. By improving his production methods he went on to build each car in just 90 minutes, and at a price of less than four hundred dollars his competitors were left floundering.

His famous " you can have it in any colour you want, as long as it is black" arose because black paint, was the only colour available in America that was quick drying. By 1926 Ford had sold over fourteen million Model T cars.

GT40 Mk III - V-8 4727 cc - 165 mph

The Ford GT40 was a product of the merged interest of Ford USA and Lola Cars, for one aim - to win the Le Mans 24 hr race. Ford after having their bid for Ferrari turned down, set to work on the GT40. Initially unsuccessfully, then Ford handed over control to Carroll Shelby. Eventually, Ford in 1966 gained their greatest ambition and won Le Mans. Ford then went on to dominate the race for the next few years, with four successive victories in total.

The Ford Mustang is one of the great American success stories, a sporty design which appealed to all and caught the spirit of the times perfectly when it was launched in 1964.

The Mustang went on to become one of the fastest selling car of all time, over 400 000 in the first year of production and one-million units sold by 1966. In all 2.2 million Mustangs would be sold during the production run, 1964-73. A range of options were a great selling point, from a straight 6 to a V-eight - 2790cc to a monster 6997cc giving 395bhp, and 135mph.

CLASSIC CAR JAGUAR

William Lyons and William Walmsley began to get noticed for their flair and imagination in building stylish sidecars. In 1927 the Austin-7 was introduced, Lyons decided to build a more stylish body that could be mounted on the Austin chassis. Henly, who happened to be one of the major garage owners in the country, immediately placed an order for 500.

When sales of the cars and sidecars continued to increase the company moved to Coventry, the traditional car-manufacturing centre of England. The Swallow Company had now been in existence 9 years, the young company was very successful, but Lyons was not impressed, he wanted to expand the company further.

Works D-type 1955-57 Le Mans winners

At the London Motor Show of 1931, the SS class was launched, the public were stunned, and especially that such a beautiful car could be bought for considerably less than J350. William Walmsley was less enthusiastic and began to lose interest in his partner's ambitions; he left the company in 1934. In 1935 Lyons was persuaded to change the company name to Jaguar, subsequently SS became the SS Jaguar. Jaguar entered a team of three factory SS Jaguars in the prestigious RAC Rally of 1937, unfortunately, a privateer won the race, in an SS100.

Jaguar Mk II

At the 1948 Earls Court Motor Show, Jaguar introduced the fastest motor car to date, the XK 120 Roadster with a top speed of 120 mph, superb road holding and styling plus a smooth ride.

In Britain just after the war, it is little wonder this car caused such a sensation; initially it was meant to be a limited volume production car. However the car went on to be a big money earner for Jaguar, most cars were destined for America, the car went on to become one of the greatest classics of all time.

During the 1950's Jaguar had reached a point in its history of selling only luxury and sports cars. The company also sold a great deal of its cars abroad.

This put Jaguar in a risky position, Jaguar needed to build a car that could be sold at home and to a larger market. To address this, the Jaguar Mk I was launched in 1955. The Jaguar MK II evolved as an instant success in 1959 with a much larger glass area and a redesigned dash. Leather seats were fitted as standard until 1967 when leather

became optional to keep the standard cost down. Another Jaguar classic, its fog / spot lights, also became an optional extra.

The MK II was loved by all, including bank robbers; this was hardly surprising, because this was another record for Jaguar, the fastest saloon in standard production. The 3.8 versions well over 200bhp, and 125mph.

The Jaguar E-Type was an instant classic, launched in 1961. The car was in huge demand from 1961-75, to begin with the company struggled to meet orders. In all, 74000 cars were sold. Some say the best Jag ever made, and the old XK engine now 13 years old, was still used in the early E-Types. The 4.2 Series 1 are generally considered the best.

Sir William Lyons died in 1985.

XK 120

Jaguar XK8

CLASSIC CAR MERCEDES-BENZ

Mercedes 60

Daimler-Benz was formed in 1883, with Karl Benz, Max Rose and Friedrich Wilhelm Esslinger. The first motor cars were built in 1886. The Benz prototype motor car was first publicly seen in the summer of the same year. At the same time, Daimler was busy with his first motor car. In 1890, Daimler founded the Daimler-Motoren-Gesellschaft group (DMG) in Stuttgart.

The USA's first practical internal combustion engine was produced in Connecticut, and was designed with the plans produced by Daimler. In 1924 Daimler and Benz merged companies and became known as "Mercedes-Benz".

Jellinek the Austro-Hungarian consul in France had the rights to sell Daimler's cars in Europe and the USA. Mercedes was the name used by Jellinek to sell Daimler's cars, and was in fact the name of his daughter.

Mercedes quickly moved on to become one of the premier manufactures of motor vehicles in the world.

The Mercedes Benz 300SL of the 1950's was one of the fastest road cars available. Only Ferrari and Maserati could get near the performance of this sensational motor car.

The original Gullwing coupe, with its incomparable roof-hinged doors, was launched in 1954, however, the Le mans winning prototypes had already been seen in 1952.

The famous "Gullwing" launched in 1954 was not only famous for its doors but also leading the way in fuel injection road cars. The car was roughly twice the price of the Jaguar XK140, so a car only for the very rich. Being rich however, did have its pitfalls, if you were in an accident and the car turned over you couldn't get out. It was a car with handling problems, a car really for expert drivers only.

In 1962 Mercedes set out to build the ultimate saloon car. Paying little attention to costs, with electric or hydraulic everything. The Mercedes-Benz 600 was launched in 1963. Rolls-Royce had found a match. The car was hugely expensive and was only produced in small numbers; nevertheless it stayed on the Mercedes-Benz production list until 1981.

The Mercedes-Benz 600 was enormous, the standard version was 18 ft (5.5 metres) long. The 6.3 litre V-8 managed to move this car to over 120 mph (190 kph) Between 1963 and 1981 only 2700 Mercedes-Benz 600's were sold and mainly to heads of state!

In 1997 Mercedes-Benz unleashed the CLK-GTR - Welcome to the 200 mph club! This car was intended to shed Mercedes' image, perhaps an unfair description for such a refined marque, but such remarks tend to stick. The car is aimed at the younger generation obviously, but at $750 000 + ? Who can afford one?

CLASSIC CAR PORSCHE

Ferdinand Porsche set up his design consultancy in 1931, but the first car to bear his name would be 15 years later. The 356's were built in 1946, and went into production in 1948, a close relative of another Porsche design - The VW Beetle. Like the Beetle the 356 was fitted with a flat-four pushrod air-cooled engine, and very similar suspension.

The early cars built in Austria, had split windscreens and 1100cc versions of the flat-four engine, produced just 40bhp. Later there would be a 2-litre model, producing a very respectful 150bhp.

The 356 improved dramatically over it's sixteen year production run, and became ever more remote from its Beetle roots. These later 356's were to set the pace for the now famous reputation of Porsche Cars. In 1965 Porsche stopped producing 356's, much to the disappointment of enthusiasts, however the Porsche 911 was waiting in the wings.

A cheaper 912 was released which still used the pushrod engine of the 356, but with the 911 bodywork.

For the launch, Porsche moved production of the 911 to Stuttgart, Germany, in 1964.

Quick and nimble the 911 are one of the most practical of all supercars, and have a superb reputation for reliability. There have been many variations of the 911, but pre-1974 cars are seen as the most classic. Today's 911 is still going strong and as popular as ever.

There has been a 911 Turbo in the Porsche line-up since the 70's. Since then the basic design has been considerably revised and improved. Although the 1991 Turbo shares the same basic rear-engined set up, it is dissimilar in some respects, most importantly in having a chassis derived from that in the 911 Carrera 2. This makes the 911 Turbo's power safer to use.

The Porsche 928 front-engined car arrived in 1977, with the new 4-5-litre V8, on option was a Mercedes auto transmission - but then lost it's sports car listing. The 928S soon followed, with a 4.7 litre unit, then in 1986 - a five-litre 170mph supercar.

The road-going GT1 closely resembles the sports racer on which it is founded. Being 911 related, it is powered by a flat-six 3.2 litre turbo engine, although mid - rather than rear positioned. It returns a weighty 555 bhp - which is only 40 bhp less than the competition car! Top speed 195 mph (312kph).

CLASSIC CAR ROVER

Like many motor car manufacturers Rovers history started in bicycle production. After John Starley, the company's founder, powered a tricycle in 1901, he quickly moved on to introduce his first four-wheeler in 1904. The company soon built up a solid reputation for quality. An early Rover feature was the free

wheel, which gave, “silent coasting and easy gear change”. The famous Rover badge was first to be seen in the 1920s.

This late 1930’s design was resurrected after World War II, and customarily built in saloon form. The four-seat open tourer was built in 1947. The 1.5-litre engine did not give a rousing performance,

but for the period this was a pleasing car to drive, and now is becoming very rare.

Dispensing at last with the separate chassis of the P4, the 3-litre of 1958, or P5, was a Rolls-Royce for the middle classes. With modern but dignified styling by David Bache and a conventional interior with wood on the dash, superb Wilton carpets and good quality leather, this was a gentleman’s drawing room on wheels.

To begin with nobody minded that the car was a bit on the slow side, its softening style and elegance being all that was asked by most owners. By the mid 60’s, however, style was not enough, the 3-litre struggled to reach 95mph the car was becoming embarrassing. Rover, through sheer fortune came across an end-of-line bargain by care of Buick, a 185bhp 3.5 litre V-8. The engine fitted perfectly under the P5’s bonnet; suddenly the P5 was a car it always should have been. The P5 was renamed the 3.5 litre in 1967. The car was held in such high regard some of the last cars produced (production ended in 1973) were kept for government ministers duties well into the 80’s.

The Rover 2000 (P6) was an immediate hit, unlike the previous Rover the new P6 appealed to a variety of people, and age groups. Not least the police, in V-8 form, here was a real Jag-catcher. The Rover 2000 was one of the great saloons of the 60’s, a car just as innovative as the Mini, especially as the P6 was getting worldwide praise for the cars safety features.

Rover is one of the few names from the early motoring years that still appear on cars today.

CLASSIC CAR VOLVO

Assar Gabrielsson and Gustav Larson founded Volvo, in 1924. The first Volvo car was the 1950cc Jakob, production got underway in 1927. Volvo's idea was to build a motor car more appropriate to the Scandinavian climate than the US manufacturers were offering, Swedish steel would be used along with imported components.

Gabrielson financed the production of a dozen prototypes, with bodies styled in Sweden by Helmer Mas Olle. Ship builders Pentaverken built and supplied the engines, and SKF agreed to fund the production of the first 1000 cars, to be built at the Lundby factory near Gothenburg from 1927.

By 1932, the company were showing profits and output was around 1000 cars a year, although demand eased slightly due to the mid-30's recession. SKF surrendered control of Volvo in 1935, and at the same time Volvo took over Pentaverken, which went on to become the marine-engineering side of Volvo.

The first production of Volvo's modish-Ghia designed P1800 (launched in 1960) coupe was somewhat complicated. The steel bodies were tooled-up for and built in Britain by Pressed Steel in Scotland and then forwarded to Jensen, who with chassis parts supplied from Sweden, assembled the complete cars.

Although not a true sports car, the high-waisted P1800 was a good cruiser and with its overdrive gearbox had an acceptable top speed of more than 100mph. Attractive and practical, the P1800 rapidly gained popularity despite its high price tag, and its profile was further increased by its weekly appearances in the television series The Saint, driven by the star of the show Roger Moore, who happened to own the car in real life. Volvo, however, were never happy with the quality of the Jensen-built cars, and eventually moved production to Sweden in 1964, the new car to be known as the 1800S.

Throughout the 1980's, Volvo launched several new models, including the enormously popular 240, the 740, the 760, the 940, and the 960.

In 1999, Ford took a controlling interest in Volvo.

CLASSIC CAR VW BEETLE

The Volkswagen Beetle was born from an idea by Adolf Hitler's to provide affordable motoring for the masses. During the deepening recession in mid-30's Germany, Hitler decided that a huge road building scheme would cure Germany's immediate unemployment problems and then a car would be produced that Germany's ordinary citizens could afford.

Ferdinand Porsche was asked to design such a car but under the strict guidelines Hitler proposed. Porsche designed the first rear-engined, air-cooled car, Hitler gave the go-ahead for production to begin and a factory was built in Wolfsburg. However, very few cars were produced, W.W.II was about to begin, the company's attention turned to aero engine production.

Production began again in 1945 with a very basic 1100cc model with a none-synchromesh gearbox, and cable brakes. In the USA, the model started a small-car revolution as millions of drivers looking for a cheap second car, fell in love with the Beetle's good build quality, practicality and thrifty running costs. The size of the flat-four pushrod engine increased from 1131 to 1200cc in the 50's. Demands for a speedier, more modern Beetle were replied to in the 60's with the 1300 and 1500cc models, which now had gained an all-synchromesh gearbox and was available with disc brakes and even a semi-auto transmission. Ultimately, however, VW's faith in one basic model had a serious effect on sales in the late 60's. Buyers began to tire of the noisy, slow Beetle. Today the Beetle has cult status and the older cars, especially the split window model from the early 50's command high prices, while the 60's and 70's models are still abundant and cheap. Between 1945 and 1977 VW sold approximately 21 MILLION Beetles.

SOME USEFUL PHRASES AND DIALOGUES

I. SOME USEFUL PHRASES

1.	Ось...	Here…
	моя реєстраційна карта	is my registration form
	мої міжнародні права водія	is my international (driver's) license
	мої документи на машину	are the documents on the car
2.	Покажіть, будь-ласка, дорогу на...	Please show me the road to…
3.	Як попасти на шосе?	How do I get to the … highway?
4.	Куди веде ця дорога?	Where does this road go to?
5.	Чи правильно я їду в ...?	Am I on the right road for…?
6.	Чи є по тій дорозі...?	Are (is) there any … along this road?
	авторемонтні майстерні	service stations
	станція техобслуговування	technical service station
	автомобільна стоянка	rest areas
	мотель	motel
	автозаправна станція	filling station
7.	Який податок за проїзд по...	What is the toll on this …
	дорозі	road
	мосту	bridge
8.	Де найближча бензоколонка?	Where is the nearest filling station?
9.	Мені потрібно ... літрів бензину (дизельного томлива).	I need … litres of petrol (diesel fuel)
10.	Наповніть, будь ласка, бак.	Fill the tank up, please.
11.	У вас є...?	Do you have …?
	моторне масло	motor oil
	гальмова рідина	brake fluid
	дистильована вода	distilled water
	антифриз	antifreeze.

12. Прошу вас...	Please …
помити машину	wash the car
заправити машину	fill it up
долити воду (антифриз) у радіатор	put some water (antifreeze) in the radiator
замінити масло	change the oil
замінити свічки (підшипник)	change the spark-plugs (bearing)
накачати шини	pump up the tyres.
13. Де можна поремонтувати автомобіль?	Where can I have this car fixed?
14. Які неполадки в машині?	What's wrong with the car?
15. Машина не заводиться.	The car won't start.
16. Де можна дістати буксир?	Where can I get a tow?
17. Гальма дуже слабкі. Перевірте, відремонтуйте, будь ласка.	The brakes are rather low. Test and adjust them, please.
18. Гальма послабшали.	The brakes are slack.
19. У мене була аварія в дорозі.	I had an accident along the way.
20. Спустило колесо.	The wheel is flat.
21. Я думаю, що несправне (запалювання, живлення, зчеплення, рульове управління, гальма)	I think the ignition (fuel system, clutch, steering gear, brakes) is (are) out of order.
22. Несправний двигун.	The motor is not working properly.
23. Двигун не працює (іноді, зовсім, на великих оборотах, на малих оборотах).	The engine does not run (sometimes, at all, at high speed, at low speed).
24. Акумулятор розрядився.	The battery has run down.
25. Зробіть профілактику машині	I want my car to be serviced.
26. У мене (нас) не має запчастин	I (we) have no spare parts
27. З цією несправністю можливо їхати далі?	Can I go on without fixing this?

28.	Скільки триватиме ремонт?	How long will the repairs take?
29.	Скільки я вам винен за послуги?	What do I owe you?
30.	Ось гроші. Дякую.	Here you are. Thank you.
31.	Скільки палива споживає машина?	What's the fuel consumption of the car?
32.	Яка найбільша швидкість машини?	What's its top speed?
33.	З якою швидкістю ми їдемо?	At what speed are we driving?

II. DIALOGUES

1.

- Donald, I know you are a driver of long standing. I would like you to have a look at my car.
- What's wrong with your car?
- I don't know yet. I can't trace the fault.
- Let me have a look. When did you have your plugs checked?
- Three days ago. I thought I had run out of gas but the tank is half full.
- Have a look at the petrol gauge once more.
- All right. The tank is half full, as I have already said.
- The carburettor is in order. The engine is misfiring.
- So it is.
- I guess the battery has run down. It needs recharging.
- Too bad.
- Don't get upset about it. It won't take you long to have your battery recharged.
- Do you really think so?
- I am sure of it. The other day I went to the gas station to have the brakes adjusted. They did it in no time.
- Where is the gas station?
- It's three miles south of the supermarket. Do you know the place?
- I think so. In my car the brakes are a bit stack. I hope they can easily be adjusted.

- I advise you to have the engine greased.
- I'll follow your advise. Thank you, Donald.
- Don't mention it, Paul. I'm very sorry I couldn't help you.
- Well, you have helped me to trace the fault. I wish I had bought a new car…
- Well, this one is much cheaper. It hasn't got too many miles on it. It's practically new.
- I must admit it runs smoothly. It was in good condition when I bought it.
- When was it?
- A year ago.

2. AT THE GAS STATION

- Forecourt Attendant - Yes, sir?
- Mr Stock - Five gallons, please.
- Forecourt Attendant - Certainly, sir. Which grade did you want?
- Mr Stock - Oh, the best, please.
- Forecourt Attendant - Right you are, sir. That'll be five ninety exactly.
- Mr Stock - And could you just check the oil.
- Forecourt Attendant - Right.
- Mr Stock - And perhaps top up the battery while you're about it.
- Forecourt Attendant - Would you mind just opening the bonnet, please, sir?
- Mr Stock - Yes, of course. I forgot.
- Forecourt Attendant - Shall I look at the radiator?
- Mr Stock - No, that's all right. I saw to that this morning.
- Forecourt Attendant - Did you know your oil-filler cap was missing?
- Mr Stock - No! Well, I'm blowed! I wonder how that happened?
- Forecourt Attendant - Shall I see if we've got one round the back?

- Mr Stock - If you'd be so kind.
- Forecourt Attendant - Yes, we've just got one left. Your oil's O.K., by the way.
- Mr Stock - I get air over there, do I?
- Forecourt Attendant - Yes, that's right, sir.

3. AT THE GARAGE

Here we are! Mr. Williams opened the window and asked the attendant: "Could I have 4 gallons of Esso, the top grade, please?"

"Yes, sir. Would you mind backing towards the pump a bit? I can't reach your tank."

Mr. Williams reversed a couple of feet. When the attendant had finished, he said: "I think you need a bit of air in your tyres, sir. The nearside rear is a bit flat."

Mr. Williams got out of the car to have a look. "It certainly needs it! It hasn't got puncture, has it?"

"No, it's all right," said the attendant. "It only needs a bit of pumping up."

"By the way," Mr. Williams said, "Could you tell me how to get to Wood Green Lane?"

"Wood Green Lane…? Ah, I don't know. I'll call my mate. He can bring us a street-map."

The other man came up and they looked up the street name in the index. He showed Mr. Williams the map.

"Look," the attendant said, "It's right the other side of the town."

"Thank you", said Mr. Williams, I think I'll be able to find it now."

"It's lighting-up time," said the attendant. "You'd better switch your side-lights on."

"Oh, yes, it gets dark early these days. We'd better hurry up."

4. THROUGH THE TOWN

They drove off and went through the town. But Mr. Williams wasn't quite sure where to turn off to Wood Green Lane. He pulled

into the kerb just past a zebra crossing and Mr. Potter opened his window to catch the attention of a passer-by.

"Excuse me," he called out to a young man, "do you know where we turn off for Wood Green Lane?"

"Oh, dear," the stranger answered, "you've passed the turning. You'll have to go back to the traffic lights there and then you turn off to the right; go straight on for about half a mile until you get to the roundabout and take the left-hand turning there. Do you follow me?"

Mr. Williams: "I do."

"And then, I think it's the second or third on the left. You can't miss it."

"Thanks very much," Mr. Williams said.

They had to wait to turn round, and went back the way they had come.

"I'm glad we're getting out of the town now," Mr. Williams said. "We can get up a bit of speed. I'd better switch on the headlights too."

A big lorry came towards them, with its headlights full on. Mr. Williams flashed his headlights on and off to make the lorry driver dip his lights.

Mr. Potter exclaimed: "Oh, I'm glad we've passed him. I don't much like driving at night. I get very irritated by cars coming towards me. And it's so dangerous, too."

"Oh, I don't mind," Mr. Williams said. "I like driving at any time of the day or night. The only things I don't like are those big lorries with trailers. They're so difficult to overtake. But with this car, the acceleration is so good, I can overtake any car. You needn't worry, I'm not a careless driver, as you know. I wouldn't take any risks."

5. THE JOYS OF MOTORING

(Jane and Robert are taking their friend Barbara for a ride in Robert's car.)

Jane: Oh, Robert! Can't you drive more carefully?

Robert: I'm sorry. According to the map this is supposed to be an "A" road but it has not been repaired for a long time.

Jane: Are you sure it's just the road, Robert? Perhaps the tyres need pumping up.

Robert: They were all checked this morning at the garage. I think I had better have a look at them. May be we have got a flat *(the car stops and all get out)*.

Jane: Look, Robert, this tyre's flat. It must be a puncture.

Robert: I suppose it'll have to be changed. I hope I'll manage. It looked so easy when the man at the garage did it. Jane, you'd better help me with the jack.

Jane: Oh, I think I'd better prepare lunch, Robert. I can't crawl under cars.

Robert: As usual I'm to do the unpleasant job, I suppose. Give me a drink at least.

Jane: Where's the beer?

Robert: I think it was packed in the boot.

Jane: I'll get it out in a minute. How are you getting on with the wheel?

Robert: All in good time, all in good time! Rome wasn't built in a day, you know. Will you give me some beer?

Jane: Oh, Robert, something terrible has happened. The bottle wasn't closed properly and all the beer's run out. You'll have to have tea.

Robert: Tea? That's not a man's drink!

Barbara: Tea is said to be a very good stimulant. Much better for drivers than alcohol.

Robert: Well, what's to be done! Drinking tea at a picnic! There, that's the wheel back on. Let's be off! *(Robert starts the car)*. Strange, it doesn't seem to be better. There must be something wrong. I'll have to get out and have another look. *(Robert stops the car and gets out)*. Oh! The spare tyre must have had a puncture as well.

Jane: You simple forgot to pump it up, Robert.

Robert: Well, so I did.

Exercise 1. **Translate phrases into English in the following dialogues:**

1.

- Не уявляю, що трапилося з моєю машиною.
- Let me trace the fault.
- Будь-ласка. Буду радий, якщо ти мені допоможеш. Ти ж досвідчений водій, чи не так?
- Yes, I am. I have been driving a car for fifteen years now. Maybe you have run out of gas.
- Це неможливо. Бак майже повний.
- When did you have your plugs checked?
- Нещодавно. Карбюратор теж у порядку.
- У цьому разі сідай у мою машину та поїдемо до найближчої автозаправної станції.
- Good idea. They will have the car fixed.
- Немає сенсу сидіти тут всю ніч.
- I quite agree with you here.

2.

- Коли тобі відремонтували машину?
- Last month. The engine is in good condition now. It was well greased.
- Добре. Мені теж потрібно ремонтувати машину. Послабшали гальма (The brakes are slack), та й акумулятор розрядився (The battery has run down).
- It can be easily done.
- Радий це чути.

3.

- Яку машину ти збираєшся купити?
- I want a second hand car if it hasn’t got too many miles on it. Could you help me?
- З великим задоволенням.
- I hear there are good cars on sale at 42nd Street dealer’s.
- Я знаю цей магазин. Давай туди поїдемо.

- Good idea. If I choose a car there, I won't have to bother any more.
- Саме так.

Exercise 2.

These are some of the signs used on roads in the United States.

divided highway ends	hospital to right	no left turn
pedestrian crossing	railroad crossing	road work ahead
steep hill	slippery road	falling or fallen rocks
deer crossing	no U-turn	school crossing
traffic light ahead	two-way traffic ahead	hairpin curve

Look at the expressions in the box and put the correct ones under the signs

1. *Pedestrian crossing*

2. ……
……
……

3. ……
……
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4. ……
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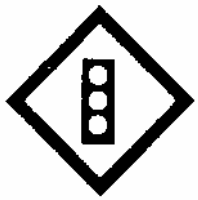
……



5. ……
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6. ……
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7. ……
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8. ……
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9. ……
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10. ……
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11. ……
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12. ……
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13. ……
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14. ……
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15. ……
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Exercise 3.

A	B
If you park in the wrong place …	… you'll get a flat tire.
If you drive too fast ...	… the engine will overheat.
If you drink and drive …	… you'll have an accident.
If you don't put water in the radiator …	… you'll get a speeding ticket.
	… you'll pay a fine.
If you don't drive carefully …	… you'll get a parking ticket.
If you drive over broken glass …	

If you don’t drive carefully, you’ll have an accident.

Now make five more sentences.
1. …….
2. …….
3. …….
4. …….
5. …….

Exercise 4. **You are preparing for a driving test. Say what a driver must do when he sees the following road signs.**

Pedestrian crossing

Speed limit

No entry

Railroad crossing

Two way traffic

Other dangers

Intersection with the main road

Load limit

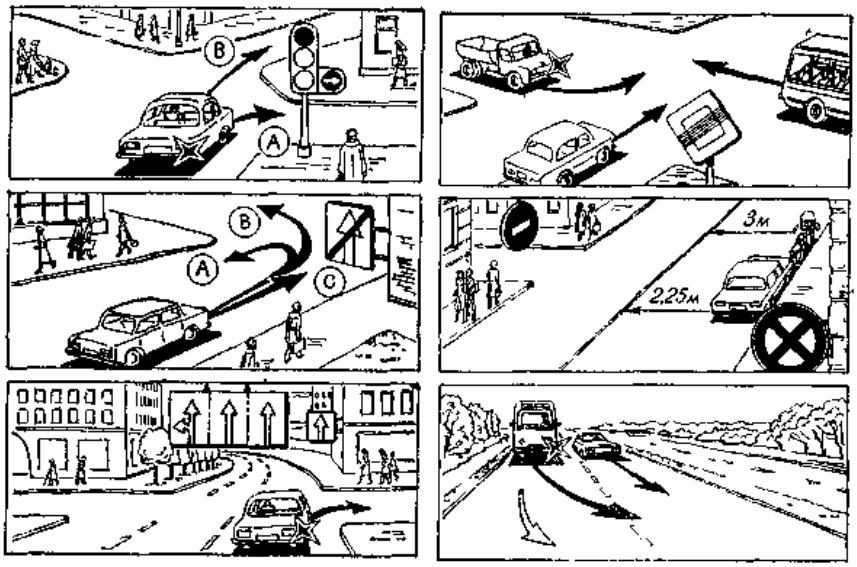
No right turn

Hotel or motel

No parking

Road works

Exercise 5. **You are a traffic inspector. You are examining a group of students who are going to get a driving license. Here are some pictures and questions you may ask your students. Think of some more.**



1. In what direction may the car move depending on the traffic lights? a) in any direction; b) only in A direction. 2. In what direction may the driver of the car move? a) in any direction; b) in B direction; c) in C direction; d) in A and B direction. 3. Is it possible to turn to the right here? a) yes; b) no. 4. What vehicle has the right to move first? a) the bus; b) the lorry; c) the car. 5. Which of the drivers has the right to park here? a) none of them; b) both have; c) only the motorcyclist. 6. Which of the drivers may move on and who must slow down and wait?

* * *

A traffic expert declared that the only way to solve the parking problem was to find a new place for the city.

Two Drivers

Two motor cars met in a very narrow lane in London. Neither of the drivers wanted to reverse and clear the road.

The driver of the first car took out the newspaper ‘Times” and began reading.

In an hour the second driver asked politely:

“When you finish reading, won’t you give the newspaper to me?”

For Tyres

A Bulgarian from Gabrovo (the famous town of humorists) was driving a car. Suddenly a man appeared on the road. The driver pressed the brakes so that the types squeaked.

“I owe you my life”, said the frightened man. “It is all my fault. I have got fifty levs here (a “lev” is the Bulgarian money unit) – forty are yours”.

‘And five more for the squeaking of tyres”, said the Gabrovite quietly.

* * *

Judge: “The witnesses all agree that you neither slowed down nor tried to avoid hitting the pedestrian.”

Driver: “I did everything any driver could be expected to do: I blew my horn and cursed at him!”

After an Accident

Two motorists lying in their beds at the hospital looked attentively at each other. At last one of them said:

“It seems to me that I’ve already seen you somewhere.”

"Of course," answered the other, that is the reason why we are both lying here, at the hospital."

Look After My Car!

A. Can you drive?
B. No, I'm sorry, I can't.
A. That's good! Will you look after my car for an hour?

I've Run Over Your Cat!

One day a man ran over Mrs. Brown's cat in the street. He went to Mrs. Brown and said: "I'm terribly sorry. I've run over your cat and I'd like to replace it."

"It's all right with me," said Mrs. Brown. "But can you catch mice?"

The Best Driver

An establishment wanted a lorry driver and advertised for one. Three men came on the same day to apply for the job. The manager asked the first man:

"How near can you drive to the edge of the precipice without going over?"

The driver said, "Within an inch."

"Very well," said the manager, "you can go now and I shall let you know whether we want you or not."

The second man said, "I can drive within half an inch of the edge, in fact I have done it more than once."

When the third man came, the manager said:

"Well, my man, and how near can you drive to the edge of the precipice?"

"Indeed, sir, I have never tried and I don't want to."

"Ah," said the manager, "you are just the sort of man we want."

A Resourceful Woman

Taking a wrong turn into a busy one-way street, a woman driver caused an immediate standstill in the large flow of traffic. As

the situation grew worse, the woman sat in her car unable to go either forward or back.

Finally a policeman appeared, his face a study of rage, but the woman beat him. As soon as he came within her range, she stuck her head out of the window and shouted, "And where were you?"

She Learns to Drive

Woman learning to drive: "But I don't know what to do!"

Her husband: "Just imagine that I'm driving."

If You Bought a New Car

"What would your wife say if you bought a new car?"

"My wife will say: Look out for the traffic light! Be careful now! Don't hit the truck! Why don't you watch where you're going? Will you never learn? And so on."

She Has No Licence

"Have you got the licence?" asked the police patrol driver.

"Don't be funny, officer!" said the woman-motorist who had just hit a lamp-post. "Who would give me a licence the way I drive?"

Drive On, My Friend**!**

A motorcycle policeman was about to write up a ticket charging a motorist with speeding, when a woman in the back seat who could restrain herself no longer, began saying:

"There! Didn't I tell you to watch out? But you kept right on speeding all morning, getting out of line, not blowing your horn, passing stop streets and everything else. Didn't I tell you you'd get caught? Didn't I? Didn't I?"

"Who is this woman?" asked the officer.

"My wife," said the motorist grimly.

"Drive on, my friend!" exclaimed the officer pityingly, as he began to tear up the ticket. "Drive on – and may the Lord have mercy on you!"

"Where are you going"

A young man was in a hurry. He jumped into a passing taxi.

"Drive like fury!" he yelled to the driver.

They turned corners at a terrific speed, and escaped collisions by a miracle. After about ten minutes the young man put his head out of the window.

"Where are you going?"

"I don't know," replied the driver, "you haven't told me yet."

Nothing New To Him

The motor car was driven by an energetic young woman who had knocked down a man without injuring him much. She did not try to get away. Instead, she stopped the car, got out and faced him.

"I'm sorry it happened," she said, "but it was all your fault. You must have been walking carelessly, I am an experienced driver. I've been driving a car for seven years."

"Well," replied the man angrily, "I am also an experienced walker. I've been walking for fifty-seven years."

What She Remembered

A woman came to the police commissar to say that a careless driver had injured her.

"Do you remember the number of the car?" asked the policeman on duty.

"No, I don't. But I remember that an elderly woman was driving the car in a white hat and a red blouse. Her skirt was of green jersey".

She Has Left Her Glasses At Home…

When the evening party was over, the hostess offered to drive one of her guests home. It was a cold night, and frost settled thickly over the windscreen. Twice there was nearly an accident, and the nervous guest suggested that it might help if the frost was cleared from the windscreen.

"That wouldn't help much," answered the driver. "Like a fool I've left my glasses at home!"

She Will Not Get Her Driving Licence

Motor vehicle official to applicant for licence: "Don't be upset,

madam. It's true, you've failed your test – but you've probably increased your life."

What Happened?

Two cars crashed and a crowd collected, while a policeman tried to sort out the facts. "Suppose you tell me what happened, "he said to the woman driver.

"I turned the way I signaled," she said.

"Exactly!" cried the man who'd been driving the other car. "That's what fooled me."

Wasn't She Afraid?

The old lady was going to take a taxi. "Driver," she said, "I want you to take me to the station."

"Yes, madam," said the driver.

"And you must drive slowly and carefully. Don't go until the policeman lowers his arm, and, please, don't rush round the corners as the road is very wet."

The driver was getting angry.

"All right, madam," he said, "But if we do have an accident, what hospital would you like to be taken to?"

The Hardest For Her

"Tell me, please, what seemed to be the hardest when you were learning to drive?"

"The trees!"

After the Accident

"…Yes, and my mother-in-law under the wheels of the ruined car…"

"What a misfortune! Was she old?"

'No, I bought it only two months ago."

To Avoid an Accident

"Why are you driving at such a high speed?"

"You see, the brakes on my motor car are out of order, and I wanted to come home as quickly as possible to avoid an accident."

Not So Sure

Thompson: “Do you know how to run a motor car?”

Jackson: “Why, I thought I did, until I had a short talk with a policeman yesterday.’

A Driving Test

Mr Shaw took the driving test for the first time in May. After the test the examiner said: "I'm sorry, Mr Shaw, you failed the test You didn’t drive well enough You turned left on the comer of Wilson and King and the sign there says: "No left turn". Then you drove 40 m.p.h. in King Street and the sign there says: "Speed limit 30 m.p.h." Then you went through two red lights. And you didn't park well."

"Can I take the test again?" asked Mr. Shaw. "Sure," said the examiner, "but you'll have to pay again." "That's all right," said Mr Shaw "I'll pass it next time. I'll drive more slowly and more carefully."

Mr. Shaw came back in June and took the test for the second time He had the same examiner. After the test the examiner said: "I'm sorry, Mr Shaw, you failed the test again. You drove too carelessly again. This time you turned right on the comer of Wilson and Elm and the sign there says: "No right turn". You drove too quickly. You drove 35 m.p.h in Princess Avenue and the speed limit there is 30 m.p.h. Then you parked at a "No parking" sign."

"Can I take the test again?" asked Mr. Shaw.

"Sure," said the examiner, "but you'll have to pay for the test again."

"That's all right," said Mr. Shaw "I'll pass it next time. I won't drive so quickly and so carelessly."

In July Mr. Shaw came back and took the driving test for the third time. This time the examiner said: "Congratulations, Mr. Shaw, you've passed the test! You drove very well this time. You didn't go through any red lights. You didn't drive too quickly. And you parked beautifully. What happened?"

Mr. Shaw smiled and said: "I went to a doctor He told me to get a pair of glasses. Now I can read."

UKRAINIAN-ENGLISH VOCABULARY OF SPECIAL TERMS

А

аварія	emergency
автоматичне проектування	computer-aided-design
автомобіліст	motorist
автомобіль, засіб для перевезення	vehicle
авторемонтна майстерня	auto-repair shop
автофургон	auto caravan
акселератор	accelerator
акумулятор; батарея	battery
амортизатор	absorber
амортизатор	shoker
атлас автомобільних шляхів	road-map

Б

багаточисельний	numerous
бак, резервуар	tank
бензобак	petrol tank
паливний бак	storage tank
бампер	bumper
балотуватися	run for
барабан	drum
барабанні гальма	drum brakes
безпека	safety
безрейковий	trackless
бензин	gasoline
бензин; моторное паливо	petrol
бензиновий двигун	petrol engine
бензозаправка	petrol station
бензозаправочна станция	petrol starter
бензоколонка	filling station

блокування	locking
брати на буксир	tow
буксир, трос	tow-line
бути несправним	be out of repair

В

вагон	carriage
важіль	lever
важіль переключення передач	change gear lever
важіль, рукоятка; рука	arm
вал	shaft
піввісь	axle half-shaft
вантаж, навантаження	load
вантажна автомашина	truck
вантажний автомобіль	lorry, truck
перевозити	to ~
ввід; впуск; вхід	inlet
ведуча шестерня головної передачі (хвостовик)	pinion
велика (кривошипна) головка (шатуна)	big end
верхня/нижня мертва точка	top/bottom dead centre
вести машину	drive a car
вибух	explosion
вибухати, спалахувати	explode
вибухобезпечний	flame-proof
вигин	bend
виділяти	release
визначати	determine
визначати, характеризувати	define
визначений, точний	definite
виключати, викидати	expel
викрутка	screwdriver

виконувати	carry out
вимір; розмір; величина	dimension
вимірювальний прилад	gauge
випуск	exhaust
випускний клапан	exhaust valve
виступ	projection
висхідний поршень	ascending piston
витісняти, зміщати	displace
витрати	costs
витягати, одержувати	derive
виявляти	detect
вихлопна труба	exhaust pipe
виходити зі строю	break down
відбивати	reflect
відбуватися	occur
відводити, забирати	take off
відновлення, реконструкція	rehabilitation
відношення, пропорція	ratio
відправляти	ship
відривати, роз'єднувати	detach
відсік	compartment
відставати	lag
відхилення	deviation
відцентровий	centrifugal
вільний, холостий	loose
вісь	axle
вісь обертання; центр обертання; точка опори	pivot
задня вісь	back axle
задня вісь	rear axle
поворотний кулак, цапфа, на якій обертається колесо	stub axle
вітрове скло	windscreen (Br.); windshield (U.S.)

властивість; власність	property
вмикач, перемикач	switch
вогонь; запалювати	fire
вода	water
дистильована вода	distiller water
водій	driver
впуск	intake
впускна труба	inlet pipe
впускний клапан	inlet valve
впускний трубопровід	inlet manifold
впускний трубопровід	intake manifold
всебічна освіта	all-round education
всмоктування	induction stroke
всмоктувати	suck
вставляти	insert
вступати у володіння	take over
втулка; маточина	hub

Г

галузь; філія	branch
гальмо	brake
барабанне гальмо	drum brake
гальмо з розтискними колодками усередині гальмового барабана	expanding inside brake
дискове гальмо	disk brake
ручне гальмо	handbrake
гальмівна рідина	brake fluid
гараж	garage
гнучкий	flexible
година пік	rush hour
головний циліндр	master cylinder
голчастий клапан	needle valve
гуманітарні науки	(the) humanities
гуркотіти	clatter

Д

давати можливість	enable
двигун, мотор	engine, motor
V-подібний двигун, двигун з V-подібний розташуванням циліндрів	V-type engine
автомобіль з двигуном спереду	front-mounted engine
бензиновий двигун	petrol engine
газовий двигун; двигун внутрішнього згоряння	gas engine
горизонтальний двигун, двигун з горизонтальним розташуванням циліндрів	flat engine
двигун внутрішнього згоряння	combustion (explosion) engine
двигун внутрішнього згоряння	internal combustion engine
двигун з боковим розміщенням клапанів	side-valve engine
двигун з верхнім розміщенням клапанів, верхньоклапанний двигун	overhead valve engine
двигун з верхнім розподільним валом	overhead cam engine
двигун з впорскуванням палива, дизель	fuel-injection engine
двигун з горизонтально розташованими протилежними циліндрами	horizontally-opposed engine
двигун з іскровим запалюванням (з примусовим запалюванням)	spark-ignition engine

двигун з повітряним охолодженням	air-cooled engine
двигун з чотирма горизонтально розташованими циліндрами	flat four engine
двигун згоряння від стиску	compression-ignition engine
двигун, що працює на важкому паливі	oil engine
дизельний двигун, дизель	diesel engine
електрична напруга	electrical pressure
електродвигун	electric motor
парова машина	steam engine
поршневий двигун	reciprocating engine
стартер	starter motor
тепловий двигун	heat engine
чотирициліндровий двигун	four-cylinder engine
декан	dean
демпфер, гаситель (коливань), амортизатор	damper
денне відділення	full time department
джерело, відстійник	well
дизайн, проектування, конструювання; розрахунок, проект; проектувати, конструювати	design
дипломна робота	graduation project
дисертація	thesis (pl. theses)
диск зчеплення	clutch plate
дискові гальма	disc brakes
дифузор	choke tube
діаметр	diameter
внутрішній діаметр	minor (root) diameter

дія	action
гальмування	breaking action
дія, вплив; здійснювати	effect
гальмова дія	stopping effect
до, раніше	prior to
добавка; присадка	additive
добродійний	charitable
домішка, нечистота	impurity
домкрат	jack
допоміжний	pilot
допоміжний, запасний	auxiliary
дорожня пригода	motor accident
дорожній знак	road sign
дослідження	research
доступний	within reach
досягати	reach
досягнення	accomplishment
дросель, відбивна перегородка	baffle
дросель, дросельна заслінка	throttle valve
дужка; кронштейн, консоль	bracket

Е

екзаменаційна сесія	sessional examinations (sessionals)
економіка	economics
експлуатаційна надійність	reliability
експонат	exhibit
еластичність; пружність	elasticity
електропроводка	wiring harness
електрорушійний; електровоз	electromotive
елемент	cell

Ж

жиклер	jet
жиклер, сопло	orifice
жилі квартали	residential areas

З

з усіх точок зору	from all angles
за чий-небудь рахунок	at smb's expense
забезпечувати; постачати	provide
завдяки	owing to
завідувач кафедри	head of department
задня сторона	rear
закріплювати, встановлювати	fix
залізничний переїзд	railway crossing
залік	test-credit
заміняти	replace
заміняти, витісняти	supersede
замок запалювання	ignition switch
заочне відділення	correspondence department
запалювання	ignition
запалення від стиску	compression ignition
запалювати	ignite
запальна свіча	sparking plug
запасна шина	spare tyre
заправлятися	fill up
запозичити	borrow
запускати двигун	put the engine in gear
запчастини	spare parts
заробітна плата	wage
застосовувати; звертатися; відноситися	apply
застосування	application

затор, скупчення транспорту	traffic jam/congestion
зачіпляти(ся); зчіплення	mesh
збереження	savings
зберігати, містити	keep
підтримувати роботу двигуна	to keep the engine running
збільшувати, розширювати	enlarge
збори; зборка; агрегат	assembly
механізм зчеплення	clutch assembly
звільняти, випускати	let out
зворотно-поступальний	reciprocating
зв'язок, зв'язка; скріплювати, зв'язувати	bond
згоряння, згорання, горіння	combustion
здатність; ємність; продуктивність	capacity
здійснення, реалізація	implementation
здійснювати, виконувати	accomplish
здобувати	acquire
з'єднувати	connect
змащування	lubrication
зменшувати	reduce
зменшуватися	decrease
зміна, деформація	alteration
змінюватися	vary
зміцнювати (ся)	consolidate
змішувати	admix
знаряддя, інструмент; інвентар	implement
зношення	wear
зовнішній	external
зубчасте колесо	gear wheel
зустрічатися, наштовхуватися; зустріч, зіткнення	encounter

зчеплення	clutch
виключати зчеплення	to clutch out
включати зчеплення	to clutch in
зчеплення	linkage
з'являтися, здаватися	appear

І

ізоляція	insulation
індикатор; лічильник	indicator
іскра, спалах	spark
іскрове запалювання	spark ignition

Ї

їзда, поїздка; їхати	ride

К

камера	chamber
каністра	petrol/gas can
капот	bonnet (Br.), hood (U.S.)
карбюратор	carburettor
карданний вал	propeller shaft
каркас, остов	framework
кафедра, відділення	department
керування кермом	steering
керувати	handle
кислота	acid
клапан, золотник	valve
випускний клапан	exhaust (outlet)
впускний клапан	inlet
голчастий клапан	needle
днище поршня	piston
дросельна заслінка,	throttle

дросель	
інжекторний клапан	injection
клема	terminal
клема акумуляторної батареї	battery terminal
клієнт, покупець	customer
ключ запалювання	ignition key
кожух, обшивка	casing
колесо	wheel
ведуче колесо	driving wheel
ведучі колеса	road wheel
заднє ведуче (ходове) колесо	rear road wheel
рульове колесо	steering wheel
шестерня, зубчате колесо	toothed wheel
коливання; відхилення	fluctuation
коливати(ся); повертати(ся)	swing
колінчастий вал	crankshaft
колодка	shoe
гальмова колодка	brake shoe
кольоровий метал	non-ferrous metal
кольцо	ring
поршневе кольцо	piston ring
компресор	compressor
конкурент	competitor
конструктор	designer
контактний переривник	contact breaker
контрольна лампа	pilot lamp
коробка	box
картер (корпус) рульового механізму	steering box
коробка передач, коробка швидкостей	gearbox
корозія, іржа	corrosion
коромисло	rocker

котушка запалювання	coil
первинна/вторинна обмотка	primary/secondary coil
кривошип, колінчатий важіль	crank
крім, не враховуючи	apart from
круг, окружність	circle
круговий рух	circular movement / motion
кулачок	cam
курс (рік навчання)	year

Л

ламатися	break
ланка; зв'язувати	link
ланцюг	chain
ланцюжок проти ковзання	(antiskid) chains
легковий автомобіль	passenger car
лигроїн, нафта; керосин	naphta
лінійний	linear

М

масло (мастило)	oil
масляний насос	oil pump
масовий	large-scale
мастильне масло, рідке мастило	oil
дизельне паливо	diesel oil
маховик, махове колесо	flywheel
машини; механізми; устаткування	machinery
машиніст	operator
мертвий простір (у циліндрі)	clearance space
механізм зчеплення	clutch assembly
механізм, що подає	feeder

механічний	power-operated
містити, включати в себе	comprise
містити, охоплювати	embrace
міцний, тривалий	durable
молоток	hammar
монтаж, установка	fitting
установка двигуна ззаду	backward fitting of engine
установка двигуна спереду	forward fitting of engine
мотор	motor
муфта, зчеплення	coupling

Н

набір предметів	sets of subjects
навантаження	loading
навчальна програма	curriculum
надавати роботу	employ
нажимний диск, навантажений пружинами	spring-loaded pressure plate
наймати; зачіпати	engage
накачувати колесо	pump up a tyre
накладка	pad
фрикційна накладка	friction pad
накладка; прокладка	lining
накопичувати	store
накопичувати, акумулювати	accumulate
нанесення на карту	mapping
народне господарство	national economy
насос, помпа; (v) качати, викачувати	pump
масляний насос	oil pump
бензонасос	petrol pump
наука	science
технічні науки	the technical sciences

природничі науки	natural sciences
науковий керівник	scientific supervisor
науковий світогляд	scientific outlook
нафта; керосин	petrolium
недолік	deficiency, disadvantage
незважаючи на	in spite of
несправність	trouble
нестача	shortage

О

обгін	overtaking
оберт	revolution
обертовий момент	torque
обладнання, зручності	facility
обмеження	restriction
обмеження швидкості	speed limit
обмінювати (ся)	exchange
обмотка, виток	winding
обов'язок; режим; потужність	duty
обробляти; машина	machine
обслуговування	maintenance
об'їзд	detour
опора; стояк	prop
опорний диск	cover plate
оснащений	equipped
особливість	feature
осьовий	axial
отвір	port
впускний (усмоктувальний) отвір	inlet port
охолодження	cooling
охолоджувати	cool
очищення; збагачення	cleaning

П

палець	pin
поршневий палець	gudgeon pin
паливний насос	injection pump
паливо	fuel
панель	panel
панель приладів	driving panel
пар	vapour
паровий поршневий двигун	steam engine
патрубок	branch in the pipe
перевага	advantage
перевищення швидкості	speeding
перевозити, передавати	convey
передача, привід; коробка передач, швидкостей; трансмісія	transmission
передача, шестерня, зубчасте колесо	gear
головна передача	differential gear
коробка передач	change gear
переконувати	persuade
переривник	breaker
перетворювати	convert
питома вага; щільність	density
підвіска	suspension
підвіска задніх коліс	rear suspension
підвіска передніх коліс	front-wheel suspension
незалежна підвіска передніх коліс	independent front suspension
передня підвіска	front suspension
піддавати сумніву	question
піддон (картера)	sump
підігрівач	economizer
підтримувати	maintain
підхожий, відповідний	suitable

підшипник ковзання	plain
піна	froth
пішохід	pedestrian
пластинка, плита	plate
ведений диск зчеплення	clutch centre plate
натискний диск зчеплення	clutch pressure plate
диск зчеплення	clutch plate
ведений диск зчеплення	clutch driven plate
плата за навчання	tuition fee
плоскогубці	pliers
плунжер, поршень	plunger
пневматичний, повітряний	pneumatic
повертати	turn
поверхня, площа; покриття	surface
повітряний потік	airstream
поворот	turn
поглинати	absorb
погрузка; перевозка	shipping
подвійний, здвоєний	binary
подія; такт	event
поза аудиторна діяльність	extra curricular activities
поїздка	trip
показувати; вимірювати	indicate
потужність машини індикатором	
полірувати, шліфувати	polish
поломка	breakage
попереджувальний знак	warning sign
поплавок	float
порівнювати	compare
порушувати правила руху	break the regulation
порушення правил руху	violation of traffic regultions
поршень	piston
поршневий двигун	reciprocating engine
посадова особа	executive
посібник; довідник; ручний	manual

послаблювати, поглинати	damp
послідовність	sequence
пост державного службовця	public office
постачальник	supplier
постачання, запас	supply
потік	flow; stream
правила дорожнього руху	traffic regulations
працювати (про машину)	run
приводити до	bring about
придатність до обробки	machinability
приділяти, віддавати, присвячувати	devote
приймати (форму); припускати	assume
прикріплення; пристосування	attachment
прикріплювати	attach; fasten
прилад	device
пристрій що блокує	locking device
прискорення	acceleration
прискорювати	accelerate
пристрій регулювання	adjuster
пристрій; монтаж	arrangement
причеп	trailer
пробка; штепсельна вилка	plug
провідник	conductor
провідність	conductivity
продуктивність	efficiency; productivity
продукція, продукт, випуск; продуктивність, вироблення	output
проректор	vice-rector
прорив	breakthrough
прохід, протік	passage
проходи (протоки), виконані в блоці циліндрів	passages cast in the cylinder block

прохолоджувати; гартувати	chill
пружина	spring
спиральна пружина	coil spring
пружина клапана	valve spring
задня ресора	rear spring
листова ресора	leaf spring
пусковий жиклер, жиклер холостого ходу	idler jet

Р

радіатор; ребристий охолоджувач	radiator
рама, корпус	frame
регулювання часу відкриття і закриття клапана	valve timing
регулювати	adjust, tune
ремінь, стрічка, смуга	belt
ремонт; ремонтувати	repair
рідина	liquid
рідина, рідке середовище	fluid
робота (машини); продуктивність	perfomance
робочий хід, енергія, сила, потужність	power
кінська сила	horse power
розбирати	dismantle
розбирати, демонтувати	disassemble
розвантажувати; розвантаження	discharge; dump
розворот	U-turn
роздрібна торгівля	retail trade
розмикатися	open
розміщення; видалення; усунення	disposal
розпилювач; сопло; патру-	nozzle

бок	
розповсюдження	propagation
1. розподільний вал	camshaft
2. кулачковий вал	
3. вал ексцентрика	
розподільник	distributor
розподіляти	share
розподіляти, поширювати	distribute
розрізняти, характеризувати	distinguish
розташовувати, закріплювати	arrange
руйнування, знищення	destruction
руйнувати	destroy
рульове колесо, кермо	steering wheel
рульовий механізм	steering mechanism
рух попеpемінно в одному або іншому напрямку	to-and-fro motion
рух, переміщення	motion
обертальний рух	rotary motion
рух, переміщення	movement
зворотньо-поступальний рух	up-and-down movement
обертальний рух	round-and-round movement
рухати(ся)	propel
рухливий	mobile
рушійна сила	motive power
рушійна сила; поштовх, імпульс	impetus

С

світло; ліхтар, фара	light
світлофор	traffic lights
габаритні або стояночні ліхтарі	lights for parking

задні габаритні ліхтарі	rear lights
підфарник	side light
свічка запалювання	sparking plug
семестр	term, semester
середня величина	mean
сигнал	signal lamp
силова установка	power plant
система	system
система електроустаткування	electrical system
трансмісія	transmission system
система запалювання	ignition system
система змащення	lubricating system
система охолодження	cooling system
система рульового управління	steering system
система упорскування палива	fuel injection system
паливна система, система живлення	petrol system
система упорскування палива	petrol injection system
скат	wheel
склад, структура	make-up
складати, призначити	constitute
складати; збирати	compile
складна речовина; змішаний	compound
складова частина	constituent
склоочисник "двірник"	wind-shield wiper
скріплення болтами; просівання	bolting
службовець	employee
спадати	decline
спіральна пружина	coil spring
сплав	alloy
спонукувати; індуктувати	induce

справлятися з	cope with
стартер	starter motor
стержень, шток, тяга	rod
стипендія	scholarship, grant
стиск	compression
стискати, здавлювати	compress
стискати; ударяти (ся); вплив	impact
стоп-сигнал	break light
стоянка; ставити автомобіль на стоянку	park
строк служби	service life
структура, будівля; конструкція, пристрій	structure
каркас кузова, конструкція кузова, несуча частина	body structure
студент першого курсу	first-year student
студентські канікули	vacation
на канікулах	on vacation
суміш	mixture
суперечність; проблема	issue
схвалення; санкція	approval
схема; мережа; ланцюг; цикл	circuit
такт впуску (всмоктування)	induction stroke
такт згоряння	explosion stroke

Т

тверда пайка	brazing
тендітний	brittle
тепловий двигун	heat engine
теплообмінник	exchanger
тертися	rub
тертя	friction

техніка, машинобудування; будівництво	engineering
енергетика	power engineering
конструкційний матеріал	engineering material
організація виробництва	industrial engineering
радіотехніка	radio engineering
тиск, напруга	pressure
тиск у шинах	tyre pressure
тіло, корпус; організація	body
кузов легкового автомобіля	car body
торкатися	touch
точка, контакт, клема	point
точний	precise
точність	accuracy
тримач, сполучна муфта	adapter
тріщина, щілина	crack
трубка	pipe
трубка вентурі, сопло	venturi
турбулентність	turbulence
тягти; утягувати; креслити; малювати; усмоктувати	draw

У

уповноважити, одержати	commission
уражати, впливати	affect
установка (автомобіля) на стоянку	parking
установка, пристрій; впровадження	installation
установлювати, монтувати	fit
устаткування, спорядження	equipment
усунути несправність	correct a trouble

утома	fatigue
ушкодження, збиток	damage
ущільнювати	tighten
ущільнювати; стискати	squeeze

Ф

фаза, фація	phase
фактор; коефіцієнт	factor
коефіцієнт потужності	power factor
факультет	faculty
фільтр	filter
масляний фільтр	oil filter
повітряний фільтр	air filter
фрикційна гальмівна накладка (колодка)	brake lining
фрикційна накладка	friction lining
фрикційний	frictional

Х

хитний важіль (клапанне коромисло)	rocker arm
хід, такт	stroke
робочий хід	compression (power) stroke
хід випуску	exhaust stroke
хід впуску	intake (suction) stroke
хід поршня	piston stroke

Ц

цикл, такт	cycle
робочий цикл	firing cycle
чотиритактний цикл	four-stroke cycle

Ч

чавун	cast iron
чистий	pure
чорний метал	ferrous metal
чотиритактний двигун	Otto engine

Ш

шарнір; цапфа; пазур	knuckle
шасі	chassis
шатун	connecting rod
швидкий; безперешкодний; прискорювати	expedite
швидкість	speed
максимальна швидкість	top speed
швидкість	velocity
шина	bus, tyre
шків, блок	pulley
шматок; деталь	piece
штанга штовхача (клапана)	push rod
шток (стержень) клапана	valve stem

Щ

щуп, штиковий показник рівня	dipstick

ENGLISH-UKRAINIAN VOCABULARY OF SPECIAL TERMS

A

absorb поглинати
absorber амортизатор
accelerate прискорювати
acceleration прискорення
accelerator акселератор
accomplish здійснювати, виконувати
accomplishment досягнення
accumulate накопичувати, акумулювати
accuracy точність
acid кислота
acquire здобувати
action дія
breaking action гальмування
adapter тримач, сполучна муфта
additive добавка; присадка
adjuster пристрій регулювання
admix змішувати
advantage перевага
affect уражати, впливати
air-cooled engine двигун з повітряним охолодженням
airstream повітряний потік
alloy сплав
all-round education всебічна освіта
alteration зміна, деформація
apart from крім, не враховуючи
appear з'являтися, здаватися
application застосування
apply застосовувати; звертатися; відноситися
approval схвалення; санкція
arm важіль, рукоятка; рука
arrange розташовувати, закріплювати

arrangement пристрій; монтаж
ascending piston висхідний поршень
assembly збори; зборка; агрегат
clutch assembly механізм зчеплення
assume приймати (форму); припускати
at smb's expense за чий-небудь рахунок
attach прикріплювати
attachment прикріплення; пристосування
auxiliary допоміжний, запасний
axial осьовий
axle вісь
back axle задня вісь
rear axle задня вісь
stub axle поворотний кулак, цапфа, на якій обертається колесо

B

baffle дросель, відбивна перегородка
battery акумулятор; батарея
belt ремінь, стрічка, смуга
bend вигин
big end велика (кривошипна) головка (шатуна)
binary подвійний, здвоєний
body тіло, корпус; організація
car body кузов легкового автомобіля
bolting скріплення болтами; просівання
bond зв'язок, зв'язка; скріплювати, зв'язувати
borrow запозичити
box коробка

steering box картер (корпус) рульового механізму

brake гальмо

disk brake дискове гальмо

drum brake барабанне гальмо

expanding inside brake гальмо з розтискними колодками усередині гальмового барабана

handbrake ручне гальмо

bracket дужка; кронштейн, консоль

brake lining фрикційна гальмівна накладка (колодка)

branch галузь; філія

branch in the pipe патрубок

brazing тверда пайка

breaker переривник

breakthrough прорив

bring about приводити до

brittle тендітний

bus шина

C

cam кулачок

camshaft 1.розподільний вал
2.кулачковий вал
3.вал ексцентрика

capacity здатність; ємність; продуктивність

carburettor карбюратор

carriage вагон

carry out виконувати

casing кожух, обшивка

cast iron чавун

cell елемент

centrifugal відцентровий

chain ланцюг

chamber	камера
charitable	добродійний
chill	прохолоджувати; гартувати
choke tube	дифузор
circle	круг, окружність
circuit	схема; мережа; ланцюг; цикл
circular movement / motion	круговий рух
clatter	гуркотіти
cleaning	очищення; збагачення
clearance space	мертвий простір (у циліндрі)
clutch	зчеплення
to clutch in	включати зчеплення
to clutch out	виключати зчеплення
clutch assembly	механізм зчеплення
clutch plate	диск зчеплення
coil	котушка запалювання
primary/secondary coil	первинна/вторинна обмотка
coil spring	спіральна пружина
combustion	згоряння, згорання, горіння
commission	уповноважити, одержати
compare	порівнювати
compartment	відсік
competitor	конкурент
compile	складати; збирати
compound	складна речовина; змішаний
compress	стискати, здавлювати
compression	стиск
compression-ignition engine	двигун згоряння від стиску
compressor	компресор
comprise	містити, включати в себе
computer-aided-design	автоматичне проектування
conductivity	провідність
conductor	провідник
connect	з'єднувати
connecting rod	шатун
consolidate	зміцнювати (ся)

constituent складова частина
constitute складати, призначити
contact breaker контактний переривник
convert перетворювати
convey перевозити, передавати
cool охолоджувати
cooling охолодження
cope with справлятися з
correspondence department заочне відділення
corrosion корозія, іржа
costs витрати
coupling муфта, зчеплення
crack тріщина, щілина
crank кривошип, колінчатий важіль
crankshaft колінчастий вал
curriculum навчальна програма
customer клієнт, покупець
cycle цикл, такт
firing cycle робочий цикл
four-stroke cycle чотиритактний цикл

D

damage ушкодження, збиток
damp послаблювати, поглинати
damper демпфер, гаситель (коливань), амортизатор
dean декан
decline спадати
decrease зменшуватися
deficiency недолік
define визначати, характеризувати
definite визначений, точний
density питома вага; щільність
department кафедра, відділення
derive витягати, одержувати
design 1.дизайн, проектування,

	конструювання. 2.розрахунок; проект. 3.проектувати, конструювати
designer	конструктор
destroy	руйнувати
destruction	руйнування, знищення
detach	відривати, роз'єднувати
detect	виявляти
determine	визначати
deviation	відхилення
device	прилад
locking device	пристрій що блокує
devote	приділяти, віддавати, присвячувати
diameter	діаметр
minor (root) diameter	внутрішній діаметр
dimension	вимір; розмір; величина
dipstick	щуп, штиковий показник рівня
disadvantage	недолік
disassemble	розбирати, демонтувати
disc brakes	дискові гальма
discharge	розвантажувати; розвантаження
dismantle	розбирати
displace	витісняти, зміщати
disposal	розміщення; видалення; усунення
distinguish	розрізняти, характеризувати
distribute	розподіляти, поширювати
distributor	розподільник
draw	тягти; утягувати; креслити; малювати; усмоктувати
driver	водій
drum	барабан
drum brakes	барабанні гальма

dump розвантажувати; розвантаження

durable міцний, тривалий

duty обов'язок; режим; потужність

E

economics економіка

economizer підігрівати

effect дія, вплив; здійснювати

stopping effect гальмова дія

efficiency продуктивність

elasticity еластичність; пружність

electromotive електрорушійний; електровоз

embrace містити, охоплювати

emergency аварія

employ вживати, надавати роботу

employee службовець

enable давати можливість

encounter 1. зустрічатися, наштовхуватися; 2. зустріч, зіткнення

engage наймати; зачіпати

engine двигун, мотор

combustion (explosion) engine двигун внутрішнього згоряння

diesel engine дизельний двигун, дизель

flat engine горизонтальний двигун, двигун з горизонтальним розташуванням циліндрів

flat four engine двигун з чотирма горизонтально розташованими циліндрами

four-cylinder engine чотирициліндровий двигун

front-mounted engine автомобіль з двигуном спереду

gas engine газовий двигун; двигун внутрішнього згоряння

heat engine тепловий двигун

horizontally-opposed engine двигун з горизонтально розташованими протилежними циліндрами

internal combustion engine двигун внутрішнього згоряння

oil engine двигун, що працює на важкому паливі

overhead cam engine двигун з верхнім розподільним валом

overhead valve engine двигун з верхнім розташуванням клапанів

petrol engine бензиновий двигун

reciprocating engine поршневий двигун

side valve engine двигун з боковим розташуванням клапанів

steam engine парова машина

V-type engine V-подібний двигун, двигун з V-подібний розташуванням циліндрів

engineering техніка, машинобудування; будівництво

industrial engineering організація виробництва

engineering material конструкційний матеріал

power engineering енергетика

radio engineering радіотехніка

enlarge збільшувати, розширювати

equipment устаткування, спорядження

equipped оснащений

event подія; такт

exchange обмінювати (ся)

exchanger теплообмінник

executive посадова особа

exhaust випуск

exhaust valve випускний клапан

exhibit експонат
expedite швидкий; безперешкодний; прискорювати
expel виключати, викидати
explode вибухати, спалахувати
exploration дослідження
explosion вибух
external зовнішній
extra curricular activities поза аудиторна діяльність

F

facility обладнання, засіб; pl. обладнання, зручності; техніка, апаратура
factor фактор; коефіцієнт
  power factor коефіцієнт потужності
faculty факультет
fasten прикріплювати
fatigue утома
feature особливість
feeder механізм, що подає
ferrous metal чорний метал
filling station бензоколонка
filter фільтр
  air filter повітряний фільтр
  oil filter масляний фільтр
fire вогонь; запалювати
first-year student студент першого курсу
fit установлювати, монтувати
fitting монтаж, установка
  backward fitting of engine установка двигуна ззаду
  forward fitting of engine установка двигуна спереду
fix закріплювати, встановлювати
flame-proof вибухобезпечний

flexible гнучкий
float поплавок
flow потік
fluctuation коливання; відхилення
fluid рідина, рідке середовище
flywheel маховик, махове колесо
frame рама, корпус
framework каркас, остов
friction тертя
frictional фрикційний
friction lining фрикційна накладка
from all angles з усіх точок зору
froth піна
fuel паливо
fuel-injection engine двигун з впорскуванням палива, дизель
full time department денне відділення

G

gasoline бензин
gauge вимірювальний прилад
gear передача, шестерня, зубчасте колесо
change gear коробка передач
differential gear головна передача
gear wheel зубчасте колесо
gearbox коробка передач, коробка швидкостей
graduation project дипломна робота

H

handle керувати
harness
wiring harness електропроводка
head of department завідувач кафедри

heat engine тепловий двигун
hub втулка; маточина
(the) humanities гуманітарні науки

I

idler jet пусковий жиклер, жиклер холостого ходу
ignite запалювати
ignition запалювання
compression ignition запалення від стиску
spark ignition іскрове запалювання
ignition key ключ запалювання
ignition switch замок запалювання
impact стискати; ударяти (ся); вплив
impetus рушійна сила; поштовх, імпульс
implement знаряддя, інструмент; інвентар
implementation здійснення, реалізація
impurity домішка, нечистота
in spite of незважаючи на
indicate показувати; вимірювати потужність машини індикатором
indicator індикатор; лічильник
induce спонукувати; індуктувати
induction stroke всмоктування
injection pump паливний насос
inlet ввід; впуск; вхід
inlet manifold впускний трубопровід
inlet pipe впускна труба
inlet valve впускний клапан
insert вставляти
installation установка, пристрій; впровадження
insulation ізоляція

intake впуск
intake manifold впускний трубопровід
internal combustion engine двигун внутрішнього згоряння
issue суперечність; проблема

J

jet жиклер

K

keep зберігати, містити
to keep the engine running підтримувати роботу двигуна
knuckle шарнір; цапфа; пазур

L

lag відставати
large-scale масовий
let out звільняти, випускати
lever важіль
change gear lever важіль переключення передач
light світло; ліхтар, фара
lights for parking габаритні або стояночні ліхтарі
rear lights задні габаритні ліхтарі
side light підфарник
traffic lights світлофор
linear лінійний
lining накладка; прокладка
link ланка; зв'язувати
linkage зчеплення
liquid рідина
load вантаж, навантаження

loading навантаження
locking блокування
loose вільний, холостий
lorry, truck 1.вантажний автомобіль, 2. перевозити
lubrication змащування

M

machinability придатність до обробки
machine обробляти; машина
machinery машини; механізми; устаткування
maintain підтримувати
maintenance обслуговування
make-up склад, структура
manual посібник; довідник; ручний
mapping нанесення на карту
master cylinder головний циліндр
mean середня величина
mesh зачіпляти(ся); зчіплення
mixture суміш
mobile рухливий
motion рух, переміщення
- **rotary motion** обертальний рух

motive power рушійна сила
motor двигун
- **electric motor** електродвигун
- **electrical pressure** електрична напруга
- **starter motor** стартер

motorist автомобіліст
movement рух, переміщення
- **round-and-round movement** обертальний рух
- **up-and-down movement** зворотньо-поступальний рух

N

naphta	лигроїн, нафта; керосин
national economy	народне господарство
needle valve	голчастий клапан
non-ferrous metal	кольоровий метал
nozzle	розпилювач; сопло; патрубок
numerous	багаточисельний

O

occur	відбуватися
oil	мастильне масло, рідке мастило
diesel oil	дизельне паливо
oil engine	двигун, який працює на важкому паливі
open	розмикатися
operator	машиніст
orifice	жиклер, сопло
Otto engine	чотиритактний двигун
output	продукція, продукт, випуск; продуктивність, вироблення
overhead valve engine	двигун з верхнім розміщенням клапанів, верхньоклапанний двигун
owing to	завдяки

P

pad	накладка
friction pad	фрикційна накладка
panel	панель
driving panel	панель приладів
park	стоянка; ставити автомобіль

	на стоянку
parking	установка (автомобіля) на стоянку
passage	прохід, протік
passages cast in the cylinder block	проходи (протоки), виконані в блоці циліндрів
perfomance	робота (машини); продуктивність
persuade	переконувати
petrol	бензин; моторное паливо
petrol engine	бензиновий двигун
petrol station	бензозаправка
petrolium	нафта; керосин
phase	фаза, фація
piece	шматок; деталь
pilot	допоміжний
pilot lamp	контрольна лампа
pin	палець
gudgeon pin	поршневий палець
pinion	ведуча шестерня головної передачі (хвостовик)
pipe	трубка
piston	поршень
pivot	вісь обертання; центр обертання; точка опори
plain	підшипник ковзання
plate	пластинка, плита
clutch plate	диск зчеплення
clutch centre plate	ведений диск зчеплення
clutch driven plate	ведений диск зчеплення
clutch pressure plate	натискний диск зчеплення
cover plate	опорний диск
plug	пробка; штепсельна вилка
sparking plug	запальна свіча
plunger	плунжер, поршень
pneumatic	пневматичний, повітряний
point	точка, контакт, клема

polish полірувати, шліфувати
port отвір
inlet port впускний (усмоктувальний) отвір
power робочий хід, енергія, сила, потужність
horse power кінська сила
power-operated механічний
power plant силова установка
precise точний
pressure тиск, напруга
prior to до, раніше
productivity продуктивність
projection виступ
prop опора; стояк
propagation розповсюдження
propel рухати(ся)
propeller shaft карданний вал
property властивість; власність
provide забезпечувати; постачати
public office пост державного службовця
pulley шків, блок
pump насос, помпа; (v) качати, викачувати
oil pump масляний насос
petrol pump бензонасос
pure чистий
push rod штанга штовхача (клапана)

Q

question піддавати сумніву

R

radiator радіатор; ребристий охолоджувач

ratio	відношення, пропорція
reach	досягати
rear	задня сторона
reciprocating	зворотно-поступальний
reciprocating engine	поршневий двигун
reduce	зменшувати
reflect	відбивати
rehabilitation	відновлення, реконструкція
release	виділяти
reliability	експлуатаційна надійність
repair	ремонт; ремонтувати
replace	заміняти
research	дослідження
residential areas	жилі квартали
restriction	обмеження
retail trade	роздрібна торгівля
revolution	оберт
ride	їзда, поїздка; їхати
ring	кольцо
piston ring	поршневе кольцо
rocker	коромисло
rocker arm	хитний важіль (клапанне коромисло)
rod	стержень, шток, тяга
rub	тертися
run	працювати (про машину)
run for	балотуватися
rush hour	година пік

S

safety	безпека
savings	збереження
scholarship, grant	стипендія
science	наука
natural sciences	природничі науки
the technical sciences	технічні науки

scientific outlook	науковий світогляд
scientific supervisor	науковий керівник
sequence	послідовність
service life	строк служби
sessional examinations (sessionals)	екзаменаційна сесія
sets of subjects	набір предметів
shaft	вал
axle half-shaft	піввісь
share	розподіляти
ship	відправляти
shipping	погрузка; перевозка
shoker	амортизатор
shoe	колодка
brake shoe	гальмова колодка
shortage	нестача
side-valve engine	двигун з боковим розміщенням клапанів
spark	іскра, спалах
spark-ignition engine	двигун з іскровим запалюванням (з примусовим запалюванням)
sparking plug	свічка запалювання
speed	швидкість
top speed	максимальна швидкість
spring	пружина
coil spring	спиральна пружина
leaf spring	листова ресора
rear spring	задня ресора
valve spring	пружина клапана
spring-loaded pressure plate	нажимний диск, навантажений пружинами
squeeze	ущільнювати; стискати
starter	стартер
petrol starter	бензозаправочна станция
starter motor	стартер
steam engine	паровий поршневий двигун

steering керування кермом
steering mechanism рульовий механізм
steering wheel рульове колесо, кермо
store накопичувати
stream потік
stroke хід, такт
compression (power) stroke робочий хід
exhaust stroke хід випуску
explosion stroke такт згоряння
induction stroke такт впуску (всмоктування)
intake (suction) stroke хід впуску
piston stroke хід поршня
structure структура, будівля; конструкція, пристрій
body structure каркас кузова, конструкція кузова, несуча частина
suck всмоктувати
suitable підхожий, відповідний
sump піддон (картера)
supersede заміняти, витісняти
supplier постачальник
supply постачання, запас
surface поверхня, площа; покриття
suspension підвіска
front suspension передня підвіска
front-wheel suspension підвіска передніх коліс
independent front suspension незалежна підвіска передніх коліс
rear suspension підвіска задніх коліс
swing коливати(ся); повертати(ся)
switch вмикач, перемикач
system система
cooling system система охолодження
electrical system система електроустаткування

fuel injection system система упорскування палива
ignition system система запалювання
lubricating system система змащення
petrol system паливна система, система живлення
petrol injection system система упорскування палива
steering system система рульового управління
transmission system трансмісія

T

take off відводити, забирати
take over вступати у володіння
tank бак, резервуар
petrol tank бензобак
storage tank паливний бак
term, semester семестр
terminal клема
battery terminal клема акумуляторної батареї
test-credit залік
thesis (pl. theses) дисертація
throttle valve дросель, дросельна заслінка
tighten ущільнювати
to-and-fro motion рух поперемінно в одному або іншому напрямку
top/bottom dead centre верхня/нижня мертва точка
torque обертовий момент
touch торкатися
trackless безрейковий
traffic jam/congestion затор, скупчення транспорту
transmission 1.передача, привід; 2.коробка передач, швидкостей; трансмісія

trip поїздка
truck вантажна автомашина
tuition fee плата за навчання
turbulence турбулентність
turn повертати
tyre шина
spare tyre запасна шина

V

vacation студентські канікули
on vacation на канікулах
valve клапан, золотник
exhaust (outlet) випускний клапан
injection інжекторний клапан
inlet впускний клапан
needle голчастий клапан
piston днище поршня
throttle дросельна заслінка, дросель
vapour пар
valve stem шток (стержень) клапана
valve timing регулювання часу відкриття і закриття клапана
vary змінюватися
vehicle автомобіль, засіб для перевезення
velocity швидкість
venturi трубка вентурі, сопло
vice-rector проректор
V-type engine V- подібний двигун (з V-подібним розміщенням циліндрів)

W

wage	заробітна плата
water	вода
distiller water	дистильована вода
wear	зношення
well	джерело, відстійник
wheel	колесо
driving wheel	ведуче колесо
rear road wheel	заднє ведуче (ходове) колесо
road wheel	ведучі колеса
steering wheel	рульове колесо
toothed wheel	шестерня, зубчате колесо
winding	обмотка, виток
wiring harness	електропроводка
within reach	доступний

Y

year	курс (рік навчання)

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Automobiles

Навчальний посібник

Редактор *Н. І. Марченко*
Комп'ютерний набір та верстка *В.В. Горбач*
Макетування *В.В. Кондратенко*

Підписано до друку 30.06.2005 р. Формат 60x84/16.
Папір друкарський. Гарнітура Times New Roman.
Умов. друк. арк. 16,25
Тираж 300 прим. Зам. 26.

Редакційно-видавничий відділ ЖДТУ
вул. Черняховського, 103, м. Житомир, 10005