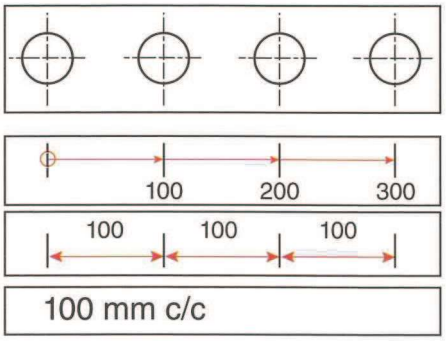
5 Locating and setting out

A Centrelines and offsets

The drawing below shows the position of some holes for bolts. The distances between the holes can be shown as **running dimensions** or as **chain dimensions**. In both cases, the **centreline** (**CL**) – a line through the centre of the hole – is **marked** (drawn), and the distances between the centrelines are given. Distances between centrelines are called **centre-to-centre** (**c/c**) dimensions. The holes below are **at** 100 mm **centres**.



Running dimensions

Chain dimensions

A written note

Centrelines are often used as **reference points**. These can be measured from, in order to **locate** – that is, give the position of – points on components. The measurements are **offset from** the centreline – each is at a certain distance from it, and the **offsets** are measured **at a right-angle to** the centreline (at 90 degrees to it).

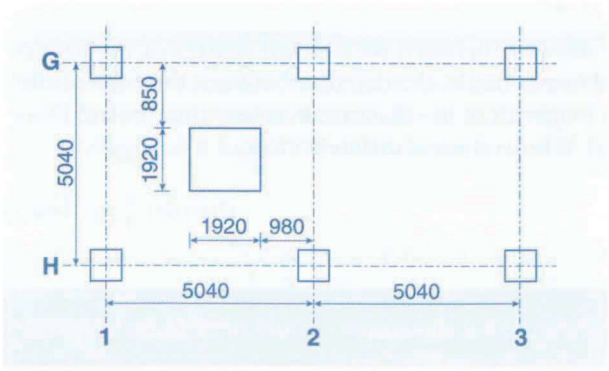
Note: We can say *at **a right-angle** to X*, *at **90 degrees** to X*, or *at **right-angles** to X*.

B Grids

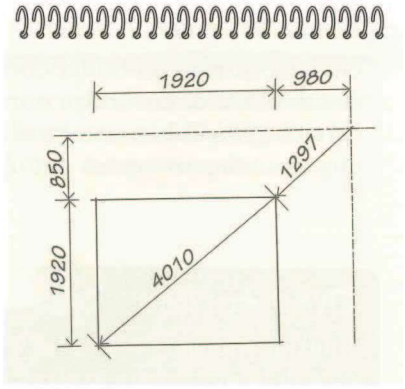
In large designs, notably those of structures, **grids** are used for horizontal positioning. The **gridlines** have numbers and letters. All numbered gridlines are **parallel with** one another – that is, they are straight, and are regular distances apart. Lettered lines also **run parallel with** one another, and are **perpendicular to** (at a right-angle to) the numbered lines.

The plan below shows part of the floor of an office building. The **perpendicular** gridlines **intersect at** (cross at) the centres of columns. An opening (hole) in the floor is shown using **coordinate dimensions**. These allow the site engineer to **set out** (mark the position of) the opening by **squaring off** the gridlines – marking lines that run at a right-angle to them – and then measuring along these lines using a **tape measure**.

A **theodolite** – an optical device used for measuring angles – can be used to square off gridlines accurately. To **double-check** dimensions – that is, carry out an extra check – **diagonal measurements** can be used, as in the engineer's sketch below. The length of **diagonals** can be calculated using Pythagoras's Theorem.



Drawing



Site engineer's sketch

5.1 Look at the sentences about the design of a ship. Replace the underlined words and expressions with alternative words and expressions from A opposite.

1 The handrail is fixed by 115 brackets, which are 175 mm apart, between their centres.
2 The dimensions are measured from the line down the middle of the ship.
3 How far is the widest point of the ship located away from the centreline?
4 Are the adjacent lengths of handrail at 90 degrees to each other?
5 These dimensions allow you to establish the position of the hole.

5.2 Look at the extracts from technical discussions on a construction site. Complete the sentences using the words in the box. Look at B opposite to help you.

gridline	intersect	parallel	perpendicular	set out	square off

1 According to this drawing, ... 8 runs along the external wall of the structure.

2 The positions were marked accurately – they were ..... by our site engineer.

3 The external wall runs along gridline 1, and the internal corridor wall runs along gridline 2, so the walls are ..... with each other.

4 I've marked a cross on the concrete floor, showing where the two gridlines ..... .

5 We need to show the position of the corner of the staircase with coordinate dimensions. There should be two ..... dimensions, taken from two gridlines.

6 We'll use the theodolite to ..... the gridline and mark a ninety-degree offset.

5.3 Match the two parts of the sentences to complete the extract from a training manual. Look at A and B opposite to help you.

In civil engineering, the following precautions can help to prevent costly setting-out mistakes.

(1) Always use a steel tape measure (never a plastic one)
(2) Check that both diagonals of rectangular shapes are equal
(3) Measure dimensions in two directions, from parallel gridlines,
(4) Add up chain dimensions to give running dimensions

a to check that corners are right-angles.

b to ensure it does not stretch under tension.

c to prevent slight errors being multiplied.

d to double-check your measurements.

Over to you

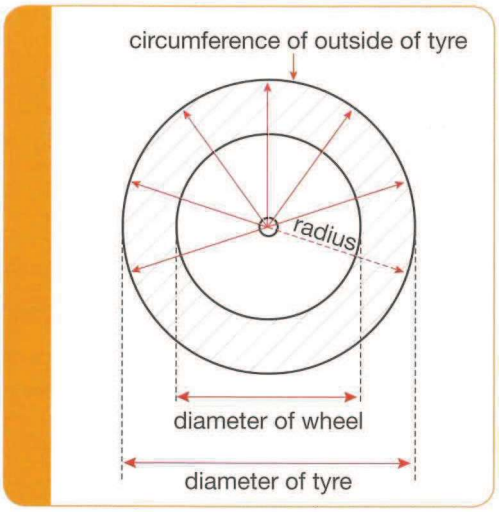
Choose a nearby object, or part of a building. Describe it, using language from A and B opposite. (You could also give approximate measurements.) Then imagine you are designing the object or the part of the building. What dimensions and lines will be needed on the drawings in order to locate its features?

6 Dimensions of circles

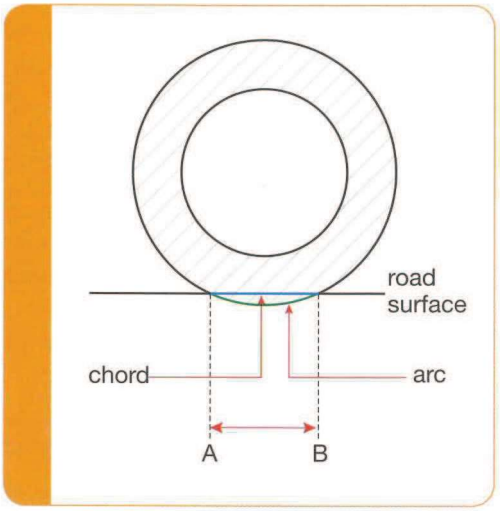
A Key dimensions of circles

An engineer is giving a training course to a group of technical sales staff who work for a tyre manufacturer. During the talk, she mentions a number of dimensions relating to circles.

'Obviously, the outside edge of a tyre forms a **circle**, as you can see in this simple diagram. The **outer circle** in the diagram is the outside of the tyre, and the **inner circle** – the circle with the smaller **diameter** – represents both the inside of the tyre and the outside of the wheel. And, clearly, the inner circle is right in the middle of the outer circle – it's exactly in the **centre**. So because it's **central**, that means the inside and outside of the tyre form **concentric circles**. And as the tyre is **circular**, simple geometry tells us that measurements of the **radius**, taken from the centre of the circle to different points on its edge – points on the **circumference** – are equal. All the **radii** are the same. In other words, the tyre has a **constant radius**.'



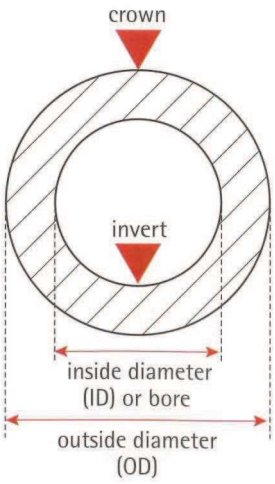
'But when a tyre is fitted to a vehicle, it's compressed against the road surface. That means its geometry changes. So while the wheel – the inner circle – obviously remains **round**, the circumference of the tyre – the outer circle – changes shape. It **deforms**. Before **deformation**, this part of the tyre forms an **arc** of the circle, between points A and B. So, as you can see in this diagram, it's not a straight line – it's a **curved** line. But after deformation, it's no longer a **curve**. The tyre becomes **deformed** between points A and B. It becomes a **chord** of the same circle, forming a straight line between A and B. However, the length of a chord and the length of an arc, between the same two points on a circle, are different. So the design of the tyre has to allow for this change in shape – from a **rounded** edge to a straight edge.'



Note: See Appendix II on page 99 for more on shapes.

B Pipe dimensions

Specific terms are used to describe the circular dimensions of pipes. The width of the inside of a pipe is called the **inside diameter** (ID). It can also be called the **bore**. The outside width is called the **outside diameter** (OD). When pipes are laid horizontally, the top of the outside of the pipe is called the **crown**, and the bottom of the inside of the pipe is called the **invert**.



6.1 Complete the notes, made by a salesperson attending the engineer's talk, using the words in the box. Look at A opposite to help you.

arc	circular	constant	deformed	radius
chord	circumference	curved	diameter	

Before tyres are fitted to vehicles:
- shape is round – outside edge is perfectly (1) .....
- distance from centre of wheel to edge of tyre = (2) .....
- total distance across tyre = 2 x radius = (3) ..... of tyre
- all measurements from centre to points around tyre's (4) ..... are equal - tyre has (5) ..... radius
- bottom of tyre is (6) ..... of a circle

When fitted to vehicle, bottom of tyre is compressed and (7) ..... – changes from (8) ..... line to straight line. Straight line is (9) ..... of a circle.

6.2 Find words and expressions in B opposite with the following meanings. One question has two possible answers.

1 the highest point of a horizontal pipe
2 the lowest point of the inside of a horizontal pipe
3 the maximum overall external width of a pipe
4 the maximum internal width between the pipe walls

6.3 Change one word in each of the sentences below to correct them. Look at A and B opposite to help you.

1 The distance travelled by the vehicle each time its wheels turn completely is equal to the radius of one of its tyres.
2 The diameter of the tyre is measured from the centre of the wheel to the outside edge of the tyre.

3 The radius of the curve in the motorway is constant, so the edges of the road follow chords of a circle.
4 The curve in the motorway has a constant radius, so the inside and outside edges of the road are arcs of two deformed circles that have the same centre.

5 The invert is on the circumference of the external face of the pipe, and therefore cannot be in contact with the liquid flowing inside the pipe.
6 The thickness of the wall at the bottom of the pipe, plus the distance between the invert and the crown of the pipe, is equal to the inside diameter of the pipe.

Over to you

- Choose an object which has circular and/or curved shapes. Describe it using language from A opposite. (You could also give approximate measurements.)
- Imagine you are designing the object. What measurements and lines will be needed to define its circular/curved features?