Percentages

The word **percent** means "out of 100".

All calculations involving percentages relate to 100.

You will need to find **a percentage of an amount**...

$$y \text{ percent of } x = \frac{y}{100} \times x$$

Worked example 1

Decrease 45 kg by 8%

$$\frac{8}{100} \times 45 = 3.6$$

$$45 - 3.6 = \mathbf{41.4\ kg}$$

Worked example 2

At birth the mass of a puppy is 0.8 kg. During each of the first two weeks of its life, its mass is expected to increase by 15%.

Calculate an estimate of its mass after two weeks.
Give your answer to a sensible degree of accuracy.

Week 1; $\frac{15}{100} \times 0.8 = 0.12$; total mass is 0.8 + 0.12 = 0.92

Week 2; $\frac{15}{100} \times 0.92 = 0.138$; total mass is 0.92 + 0.138 = 1.058

Estimate of mass after two weeks is 1.1 kg (1 decimal place).

...or **express as a percentage**;

$$y \text{ as a percentage of } x = \frac{y}{x} \times 100\%$$

Worked example 3

As it is heated, the volume of a gas increases from 55 litres to 78 litres.

Find the percentage increase in the volume.

Note: this is the **original** amount

Increase is 78 − 55 = 23

$$\frac{23}{55} \times 100\% = \mathbf{41.8\%}$$

Now you try

1 **(a)** Find 24% of £650;

(b) Find 16% of 230 ml;

(c) Find 9% of 7.4 kg;

(d) Find 60% of 85 metres;

2 **(a)** Increase 850 ml by 28%;

(b) Decrease 87 kg by 45%;

(c) Decrease £26 by 3.5%;

(d) Increase 6 500 tonnes by 150%.

3 **(a)** Express 45 kg as a percentage of 80 kg;

(b) Express 16 ml as a percentage of 35 ml;

(c) Express 84 pence as a percentage of £6;

(d) Express 27 g as a percentage of 3.6 kg;

4 The value of a car falls from £12 500 to £ 8 000

Find the percentage by which the value of the car has fallen.

5 The speed of a rocket increases from 8 miles per second to 11 miles per second.

What is the percentage increase in the speed of the rocket?

Examination style questions

6 **(a)** When a human is resting and breathes normally, the amount of air inhaled is 500 ml. About 21% of the air that is inhaled is oxygen.

How much oxygen is inhaled in a single breath while resting and breathing normally?

..... ml

(b) When exercising vigorously, the amount of air exhaled in a single breath is 1 800 ml. About 15% of the air that is exhaled is oxygen.

How much oxygen is exhaled in a single breath when exercising vigorously?

..... ml

7 Estimates of the population of sparrows in the UK are given in the table.

Year	1995	2005	2015
Population	13.2 million	9.5 million	7.6 million

(a) Between 2005 and 2015 the population of sparrows fell by 20%.
It is predicted that the population will fall by a further 20% from 2015 to 2025.

Find an estimate for the population of sparrows in 2025.

.....

(b) Find the percentage by which the population of sparrows fell between 1995 and 2005.

..... %

Significant figures

Rounding numbers is intended to make them easier to work with. It is not about changing their size. If a number is rounded off, it will still be about the same size as it was before. Decimal places can be useful, but **significant figures** are generally the best way to round off a number in a scientific context.

Remember, as with decimal places, to use the '**deciding digit**' to decide whether to round the number down (if the 'deciding digit, is 4 or lower) or up (if the 'deciding digit' is 5 or higher).

To find where to round the number, start counting digits from the first non-zero digit.

Once you have started counting digits, remaining zeroes are "significant", so count them.

You may need to add zeroes to the end of a larger number, when you round it.

Worked example 1

Round these numbers to 3 significant figures.

(a) 43.69128 **(b)** 0.023957 **(c)** 50742

In all three cases, the rounding line is placed three digits after the first non-zero digit...

(a) 43.6|9128 — the deciding digit is 9, so round up

43.7

(b) 0.0239|57 — this zero is "significant" — the deciding digit is 5, so round up

0.0240

(c) 517|42 — the deciding digit is 4, so round down

51700

these zeroes are needed to make the **size** of the number correct

Worked example 2

Round these to the number of significant figures indicated.

(a) 63.874 to 2 significant figures

64

(b) 0.000 259 75 to 3 significant figures

0.000 260

(c) −238.74 to 2 significant figures

−240

(d)* 5.6487×10^5 to 3 significant figures

5.65×10^5

Now you try

1 Round to the number of significant figures indicated:

(a) 3.1415 to 2 significant figures

(b) 0.008 562 5 to 3 significant figures

(c) 4472 to 2 significant figures

(d) 90 125 to 3 significant figures

(e) 45.89 to 2 significant figures

(f) 894 536 to 1 significant figure

(g) 87.42 to 2 significant figures

(h) 19.823 to 1 significant figure

(i) 0.004 036 to 2 significant figures

(j) 7.3954 to 3 significant figures

(k)* 2.584×10^{6} to 2 significant figures

(l)* 1.94×10^{9} to 1 significant figure

(m)* 3.258×10^{-5} to 2 significant figures

(n)* 7.089×10^{-14} to 3 significant figures

2 Use your calculator to calculate each of the following. Give each of your answers to the number of significant figures indicated.

(a) $18.457 \times 0.002\,58$ to 2 significant figures

(b) $59.2 \div 0.006\,84$ to 3 significant figures

(c) $\sqrt{7894.56}$ to 2 significant figures

3 The distance between the Earth and the Sun, at different times of year, is given in the table.

Time of year	Distance (km)
Vernal equinox	149 856 347
Summer solstice	152 637 021
Autumnal equinox	148 332 889
Winter solstice	147 129 341

Eric says that, to 2 significant figures, the distance between the Earth and the Sun is always the same.

Is Eric correct?

Give working to show how you know.

.

Examination style questions

4 I connect a resistor to a cell for 3 minutes.
The current through the resistor is 3.59 A

Calculate the charge flow.

Use the equation

charge flow = current × time

Give your answer to 2 significant figures.

..... C

5 An antibiotic is used to kill bacteria growing on an agar plate.
The part of the agar plate in which the bacteria are killed is a circle, with diameter 8.4 mm

Use the equation

$$\mathbf{A = \pi r^2}$$

to find the area of this circle.

Give your answer to 3 significant figures.

..... mm^2

6* The pigments used to make a coloured ink are separated using chromatography.
The table shows the R_f values and the distances moved by the individual pigments.

	Distance moved	**R_f value**
Red	9.1 cm	0.38
Yellow	4.6 cm	
Blue		0.74

Use the equation

$$R_f = \frac{\textbf{distance moved by the compound}}{\textbf{distance moved by the solvent}}$$

to complete the table.

Give your answers to 2 significant figures.