# Standard form in science

Worked solutions

**GCSE science calculations**

This topic online

**1** Write each quantity in standard form.

a. The energy stored in a fully charged car battery is about 3 400 000 J.

b. The thickness of a sheet of paper is 0.00062 m.

(2 marks)

a) the decimal point moves 6 places left

$3\,400\,000 = 3.4 \times 10^{6}$

$3.4 \times 10^{6}$ J

b) the decimal point moves 4 places right, so the power is negative

$0.00062 = 6.2 \times 10^{-4}$

$6.2 \times 10^{-4}$ m

**2** Write each quantity as an ordinary number.

a. Radio waves travel through air at $3.0 \times 10^{8}$ m/s.

b. The current in a small sensor is $4.5 \times 10^{-3}$ A.

(2 marks)

a) move the decimal point 8 places right

$3.0 \times 10^{8} = 300\,000\,000$

300 000 000 m/s

b) move the decimal point 3 places left

$4.5 \times 10^{-3} = 0.0045$

0.0045 A


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**3** Mega (M) means × $10^6$ and micro (μ) means × $10^{-6}$.

a. A wind turbine has a power output of 6.8 MW. Write the power in watts, in standard form.

b. The current through a smoke alarm sensor is 25 μA. Write the current in amperes, in standard form.

(2 marks)

a) mega means $\times 10^6$

$6.8\ MW = 6.8 \times 10^6\ W$

$\boxed{6.8 \times 10^6\ W}$

b) micro means $\times 10^{-6}$

$25\ \mu A = 25 \times 10^{-6}\ A$

$25 = 2.5 \times 10^1$, so add 1 to the power

$25 \times 10^{-6} = 2.5 \times 10^{-5}$

$\boxed{2.5 \times 10^{-5}\ A}$

**4** Microwaves used in a microwave oven have a frequency of 2.4 × $10^9$ Hz and a wavelength of 0.125 m.

Calculate the speed of the microwaves. Give your answer in standard form.

(2 marks)

Wave speed = frequency × wavelength

$v = 2.4 \times 10^9 \times 0.125$

$v = 300\ 000\ 000$

$v = 3.0 \times 10^8$

$\boxed{3.0 \times 10^8\ m/s}$

**5** A current of 3.2 × $10^{-3}$ A flows through a resistor for 1.5 × $10^3$ s.

Calculate the charge that flows through the resistor.

(2 marks)

Charge flow = current × time

$Q = 3.2 \times 10^{-3} \times 1.5 \times 10^3$

$Q = 4.8$

$\boxed{4.8\ C}$


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**6** An aircraft of mass $7.5 \times 10^4$ kg is flying at a height of 11 km.

Gravitational field strength = 9.8 N/kg.

Calculate the gravitational potential energy gained by the aircraft as it climbs from the ground to this height. Give your answer in standard form to 3 significant figures. (3 marks)

Gravitational potential energy = mass × gravitational field strength × height

11 km = 11 × 1000 = 11 000 m

$E_p = 7.5 \times 10^4 \times 9.8 \times 11\,000$

$E_p = 8\,085\,000\,000$

$E_p = 8.085 \times 10^9$

$8.09 \times 10^9$ J (3 s.f.)

**7** A mobile phone mast sends out radio waves with a wavelength of 0.12 m. Radio waves travel at $3.0 \times 10^8$ m/s.

Calculate the frequency of the radio waves. Give your answer in standard form. (3 marks)

Wave speed = frequency × wavelength

$3.0 \times 10^8 = f \times 0.12$

$f = 3.0 \times 10^8 \div 0.12$

$f = 2\,500\,000\,000$

$f = 2.5 \times 10^9$

$2.5 \times 10^9$ Hz

**8** A steel ball bearing has a mass of $2.0 \times 10^{-3}$ kg. The density of steel is $7.8 \times 10^3$ kg/m$^3$.

Calculate the volume of the ball bearing. Give your answer in standard form to 2 significant figures. (3 marks)

Density = mass ÷ volume

$$7.8 \times 10^3 = \frac{2.0 \times 10^{-3}}{V}$$

$$V = \frac{2.0 \times 10^{-3}}{7.8 \times 10^3}$$

Use brackets or the ×10^x key so the calculator divides by the whole of $7.8 \times 10^3$

$V = 2.564... \times 10^{-7}$

$2.6 \times 10^{-7}$ m$^3$ (2 s.f.)


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**9** Kemi charges her phone. A charge of $2.7 \times 10^4$ C flows into the battery. The charging current is 1.5 A.

Calculate the charging time in seconds. Give your answer in standard form. (3 marks)

Charge flow = current x time

$2.7 \times 10^4 = 1.5 \times t$

$t = 2.7 \times 10^4 \div 1.5$

$t = 18\,000$

$t = 1.8 \times 10^4$

$1.8 \times 10^4$ s

**10** The radius of an atom is about $1 \times 10^{-10}$ m. The radius of its nucleus is about $1 \times 10^{-14}$ m.

a. How many times larger is the radius of the atom than the radius of the nucleus?

b. How many orders of magnitude larger is the radius of the atom? (2 marks)

a) divide the bigger radius by the smaller one

$$\frac{1 \times 10^{-10}}{1 \times 10^{-14}} = 1 \times 10^4$$

10 000 times

b) one order of magnitude is a factor of 10

$10\,000 = 10^4$

4 orders of magnitude


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**11** A gas-fired power station has a power output of 1.8 GW.

a. Calculate the energy transferred by the power station in 1 hour. Give your answer in standard form to 2 significant figures.

b. An LED light bulb has a power of 8.0 W. Calculate how many of these bulbs the power station could supply at the same time. Give your answer in standard form.

Show your working.

(4 marks)

a) Energy transferred = power x time

1.8 GW = $1.8 \times 10^9$ W

1 hour = 60 x 60 = 3600 s

$E = 1.8 \times 10^9 \times 3600$

$E = 6.48 \times 10^{12}$

$6.5 \times 10^{12}$ J (2 s.f.)

b) divide the station power by the power of one bulb

$1.8 \times 10^9 \div 8.0 = 225\,000\,000$

$225\,000\,000 = 2.25 \times 10^8$

$2.25 \times 10^8$ bulbs

**12** A lightning strike has a current of $3.0 \times 10^4$ A for a time of $2.0 \times 10^{-4}$ s. The potential difference between the cloud and the ground is $1.5 \times 10^8$ V.

Calculate the energy transferred by the lightning strike. Give your answer in standard form.

Show your working.

(4 marks)

Charge flow = current x time

$Q = 3.0 \times 10^4 \times 2.0 \times 10^{-4}$

$Q = 6.0$ C

Energy transferred = charge flow x potential difference

$E = 6.0 \times 1.5 \times 10^8$

$E = 9.0 \times 10^8$

$9.0 \times 10^8$ J


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**13** A phone mast is $2.4 \times 10^3$ m from Leila's house. It sends out radio waves with a frequency of $1.8 \times 10^9$ Hz. Radio waves travel at $3.0 \times 10^8$ m/s.

Calculate the wavelength of the radio waves. Give your answer in standard form to 2 significant figures.

(3 marks)

The $2.4 \times 10^3$ m distance is not needed

Wave speed = frequency × wavelength

$3.0 \times 10^8 = 1.8 \times 10^9 \times \lambda$

$\lambda = (3.0 \times 10^8) \div (1.8 \times 10^9)$

$\lambda = 0.1666...$ m

Standard form, 2 significant figures

$1.7 \times 10^{-1}$ m

**14** On a windy day, the wind supplies a total power input of $5.0 \times 10^6$ W to an offshore wind turbine.

The useful power output of the turbine is $2.1 \times 10^6$ W.

Calculate the useful energy transferred by the turbine in 24 hours. Give your answer in standard form to 2 significant figures.

Show your working.

(4 marks)

Useful energy, so use the useful power output $2.1 \times 10^6$ W, not the total power input

Energy transferred = power × time

1 hour = 3600 s

24 hours = $24 \times 3600 = 86\,400$ s

$E = 2.1 \times 10^6 \times 86\,400$

$E = 1.8144 \times 10^{11}$ J

Round to 2 significant figures

$1.8 \times 10^{11}$ J


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