Rearranging science equations

Worked solutions

GCSE science calculations

This topic online

1 a. Rearrange $V = IR$ to make I the subject.

b. Rearrange $P = \frac{E}{t}$ to make t the subject.

(2 marks)

a)

$V = I \times R$

$\div R$: $\frac{V}{R} = I$ $\div R$

$$I = \frac{V}{R}$$

b)

$P = \frac{E}{t}$

$\times t$: $P \times t = E$ $\times t$

$\div P$: $t = \frac{E}{P}$ $\div P$

$$t = \frac{E}{P}$$

2 A car headlamp has a resistance of 2.4 Ω. The potential difference across it is 12 V.

Calculate the current through the headlamp.

(2 marks)

Potential difference = current × resistance

$12 = I \times 2.4$

$\div 2.4$: $I = 12 \div 2.4$ $\div 2.4$

$I = 5$

5 A

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

3 A motorbike and its rider have a resultant force of 600 N acting on them. They accelerate at 1.5 m/s^2.

Calculate the total mass of the motorbike and rider. (2 marks)

Resultant force = mass x acceleration

$600 = m \times 1.5$

$\div 1.5$ $\quad m = 600 \div 1.5$ $\quad \div 1.5$

$m = 400$

400 kg

4 Oliver uses a 1.5 kW hairdryer for 4 minutes.

Calculate the energy transferred by the hairdryer in joules. (3 marks)

Power = energy transferred ÷ time

1.5 kW = 1500 W

4 minutes = 4 x 60 = 240 s

$1500 = \frac{E}{240}$

$\times 240$ $\quad E = 1500 \times 240$ $\quad \times 240$

$E = 360\,000$

360 000 J

5 A bottle contains 0.0025 m^3 of olive oil. The density of olive oil is 920 kg/m^3.

Calculate the mass of the olive oil. (2 marks)

Density = mass ÷ volume

$920 = \frac{m}{0.0025}$

$\times 0.0025$ $\quad m = 920 \times 0.0025$ $\quad \times 0.0025$

$m = 2.3$

2.3 kg

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

6 A petrol lawnmower has an efficiency of 0.35. It transfers 2800 J of useful energy.

Calculate the total energy input to the lawnmower. (3 marks)

Efficiency = useful output energy transfer ÷ total input energy transfer

$$0.35 = \frac{2800}{E}$$

$\times E$ $\quad 0.35 \times E = 2800$ $\quad \times E$

$\div 0.35$ $\quad E = 2800 \div 0.35$ $\quad \div 0.35$

$$E = 8000$$

8000 J

7 **Higher tier**

A spring in a toy launcher has a spring constant of 40 N/m. It stores 0.20 J of elastic potential energy.

Calculate the extension of the spring. Give your answer in centimetres. (3 marks)

Elastic potential energy = 0.5 × spring constant × extension^2

$$0.20 = 0.5 \times 40 \times e^2$$

$$0.20 = 20 \times e^2$$

$\div 20$ $\quad e^2 = 0.20 \div 20$ $\quad \div 20$

$$e^2 = 0.01$$

$$e = \sqrt{0.01}$$

$$e = 0.1 \text{ m}$$

0.1 m = 0.1 × 100 = 10 cm

10 cm

8 **Higher tier**

A resistor in a heater circuit has a resistance of 4.0 Ω. The power transferred by the resistor is 36 W.

Calculate the current through the resistor. (3 marks)

Power = current^2 × resistance

$$36 = I^2 \times 4.0$$

$\div 4.0$ $\quad I^2 = 36 \div 4.0$ $\quad \div 4.0$

$$I^2 = 9$$

$$I = \sqrt{9}$$

$$I = 3$$

3 A

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

9 **Higher tier**

Jamal and his bike have a total mass of 80 kg. Their kinetic energy is 1440 J.

Calculate their speed. Show your working.

(3 marks)

Kinetic energy = 0.5 × mass × speed²

$1440 = 0.5 \times 80 \times v^2$

$1440 = 40 \times v^2$

÷40 $v^2 = 1440 \div 40$ ÷40

$v^2 = 36$

$v = \sqrt{36}$

$v = 6$

6 m/s

10 A train speeds up from 12 m/s to 28 m/s over a distance of 400 m.

Calculate the acceleration of the train. Show your working.

(3 marks)

$v^2 - u^2 = 2 \times \text{acceleration} \times \text{distance}$

$28^2 - 12^2 = 2 \times a \times 400$

$784 - 144 = 800 \times a$

$640 = 800 \times a$

÷800 $a = 640 \div 800$ ÷800

$a = 0.8$

0.8 m/s²

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

11 An immersion heater of power 1.5 kW is used for 2 minutes to heat 2.0 kg of water in a tank. The water starts at 15 °C.

The specific heat capacity of water is 4200 J/kg °C. Assume all the energy from the heater goes into the water.

Calculate the final temperature of the water. Give your answer to 2 significant figures.

Show your working.

(5 marks)

Energy transferred = power × time

1.5 kW = 1500 W and 2 minutes = 120 s

$E = 1500 \times 120$

$E = 180\,000$ J

Change in thermal energy = mass × specific heat capacity × temperature change

$180\,000 = 2.0 \times 4200 \times \Delta\theta$

$180\,000 = 8400 \times \Delta\theta$

÷8400 $\Delta\theta = 180\,000 \div 8400$ ÷8400

$\Delta\theta = 21.42...\ ^{\circ}C$

keep the full value in the calculator

final temperature = 15 + 21.42...

final temperature = 36.42...

36 °C (2 s.f.)

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

12 **Higher tier**

The heating element in an electric oven has a resistance of 26 Ω and a power of 2.0 kW.

Calculate the charge that flows through the element in 5 minutes. Give your answer to 2 significant figures.

Show your working.

(5 marks)

Power = current² x resistance

2.0 kW = 2000 W

$2000 = I^2 \times 26$

÷26 $I^2 = 2000 \div 26$ ÷26

$I^2 = 76.92...$

$I = \sqrt{76.92...}$

$I = 8.770...$ A

keep the full value in the calculator

Charge flow = current x time

5 minutes = 5 x 60 = 300 s

$Q = 8.770... \times 300$

$Q = 2631.1...$

2600 C (2 s.f.)

13 Marta pushes a 40 kg crate 6.0 m across a warehouse floor. It takes her 12 s. She does 1500 J of work on the crate.

Assume her pushing force acts in the direction the crate moves.

Calculate the force Marta uses to push the crate.

(2 marks)

The 40 kg and the 12 s are not needed

Work done = force x distance

$1500 = F \times 6.0$

$F = 1500 \div 6.0$

250 N

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

14 In a Year 10 practical, Hassan heats 0.80 kg of cooking oil in a beaker. The oil starts at 20 °C and ends at 65 °C. The heater transfers 75 600 J of energy to the oil.

Calculate the specific heat capacity of the oil. (3 marks)

Use the temperature change, not the final temperature

$\Delta\theta = 65 - 20 = 45\ ^\circ C$

Change in thermal energy = mass × specific heat capacity × temperature change

$75\,600 = 0.80 \times c \times 45$

$75\,600 = 36 \times c$

$c = 75\,600 \div 36$

$2100\ J/kg\ ^\circ C$

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.