Maths skills

1 Measurements

Practice questions

1

Physical quantity	Equation used to derive unit	Unit	Symbol and name (if there is one)
frequency	period^{-1}	s^{-1}	Hz, hertz
volume	length^3	m^3	–
density	mass ÷ volume	kg m^{-3}	–
acceleration	velocity ÷ time	m s^{-2}	–
force	mass × acceleration	kg m s^{-2}	N newton
work and energy	force × distance	N m (or kg m^2 s^{-2})	J joule

2 **a** 19 m **b** 21 s
c 1.7×10^{-27} kg **d** 5.0 s

3 Resistance $= \frac{12\text{ V}}{1.8\text{ mA}} = \frac{12\text{ V}}{0.0018\text{ A}} = 6666.666...\Omega = 6.66666...\text{k}\Omega = 6.67\Omega$

4 **a** 5.7 cm ± 2% **b** 450 kg ± 0.4%
c 10.6 s ± 0.5% **d** 366 000 J ± 0.3%

5 **a** 1200 ± 120 W **b** 330 000 ± 1650 Ω

6 **D** 1400 ± 5 mm (Did you calculate them all? The same absolute error means the percentage error will be smallest in the largest measurement, so no need to calculate.)

2 Standard form and prefixes

Practice questions

1 **a** 1.35×10^3 W (or 1.350×10^3 W to 4 s.f.) **b** 1.3×10^5 Pa
c 6.96×10^8 s **d** 1.76×10^{11} C kg^{-1}

2 **a** 2 260 000 J in 1 kg, so there will be 1000 times fewer J in 1 g: $\frac{2\,260\,000}{1000} = 2260$ J/g

b 1 kJ = 1000 J, 2 260 000 J/kg $= \frac{2\,260\,000}{1000}$ kJ/kg $= 2260$ kJ/kg

c 1 MJ = 1000 kJ, so 2260 kJ/kg $= \frac{2260}{1000}$ MJ/kg $= 2.26$ MJ/kg

3 **a** 2.5×10^{-3} m **b** 1.60×10^{-15} m
c 1×10^{-8} J **d** 5×10^3 m
e 6.2×10^{-1} N

4 **a** 2.5 µm **b** 1.60 f m
c 10 nJ **or** 0.01 µJ **d** 5 km
e 0.62 N **or** 62 cN

5 **a** 0.009 m = 9×10^{-3} m = 9 mm
b 1×10^{-5} m = $1 \times 10 \times 10^{-6}$ m = 10×10^{-6} m = 10 µm

c 4.7×10^{-7} m = 4.7 × 100 × 10^{-9} m = 470 × 10^{-9} m = 470 nm

6 **a** 64000000 **or** 6.4×10^{7} **b** 99.99

c 800 **d** 10^{3}

7 **a** 3.0×10^{8} m s^{-1} ÷ 3.03×10^{-7} m = 1.0×10^{15} Hz

b 3.0×10^{8} m s^{-1} ÷ 1000 m = 3.0×10^{5} Hz

c 3.0×10^{8} m s^{-1} ÷ 1.0×10^{-10} m = 3.0×10^{18} Hz

3 Resolving vectors

Practice questions

1 **Scalars:** density, electric charge, electrical resistance, energy, frequency, mass, power, temperature, voltage, volume, work done

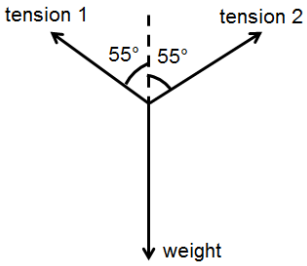
Vectors: field strength, force, friction, momentum, weight

2 **Scalars:** 3 ms^{-1}, 50 km, 273 °C, 50 kg, 3 A

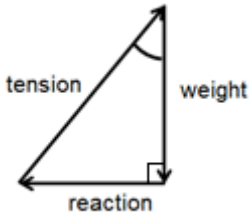
Vectors: **+**20 ms^{-1}, 100 m NE, −5 cm, 10 km S 30°W, 3 × 10^{8} m/s upwards

3 13 kN

4 **Free body force diagram:**



Triangle of forces:



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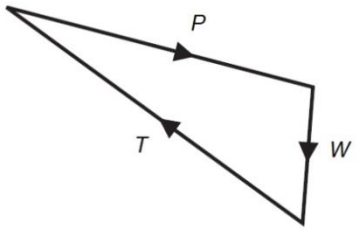

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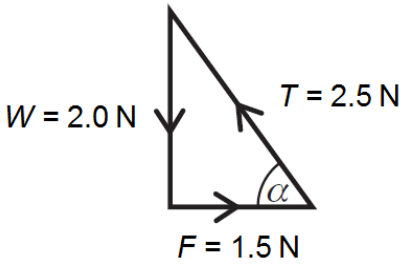

7 **a** 5.0 N at 37° to the 4.0 N force **b** 13 N at 23° to the 12.0 N force

4 Rearranging equations

Practice questions

1 V = 12 V and I = 0.25 A

$V = I\,R$ so $12 = 0.25 \times R$

$R = \frac{V}{I} = \frac{12}{0.25} = 48\ \Omega$

2 $\lambda = 650\text{ nm} = 650\times10^{-9}\text{ m}$ and $v = 3.0\times10^{8}\text{ m/s}$

$v = f\,\lambda$ so $3.0\times10^{8} = f \times 650\times10^{-9}$

$f = \frac{v}{\lambda} = \frac{3.0\times10^{8}}{650\times10^{-9}} = 0.00462\times10^{17} = 4.62\times10^{14}\text{ Hz}$

3 $E = 4.01\times10^{4}\text{ J}$ and $m = 0.120\text{ g} = 0.120\text{ kg}$

$E = mL$ so $4.01\times10^{4} = 0.120 \times L$

$L = \frac{E}{m} = \frac{4.01\times10^{4}}{0.120} = 334\,166\text{ J/kg} = 3.34\times10^{5}\text{ J/kg}$ in standard form

5 Work done, power, and efficiency

Practice questions

1 $22\times10^{3}\text{ N} \times 2\times10^{3}\text{ m} = 44\,000\,000\text{ J} = 44\text{ MJ}$

2 $\frac{62.5\times10^{3}\text{ J}}{500\text{ N}} = 125\text{ m}$

3 $\frac{260\,000\text{ N}\times25\text{ m}}{48\text{ s}} = 13\,541.6\text{ W} = 14\,000\text{ W}$ or 14 kW (2 s.f.)

4 $\frac{2500\text{ N}\times15\text{ m}}{5\text{ s}} = 7500\text{ W} = 7.5\text{ kW}$

5 $\frac{8400}{11200} \times 100 = 75\%$

6 $\frac{850}{1.2\times10^{3}}\times100 = 71\%$

7 $\frac{7.5}{8.0}\times100 = 94\%$

8 0.74 s