Extend and challenge Section 1 p48

Q1 a) 11 m/s^2

b) 1 320 000 kg

c) 25 m/s^2

Q2 a) 32 000 N

b) 20 000 N

c) 1 m/s^2

d) 30 m/s

e) 450 m

f) Mass is less so acceleration is greater.
As the craft rises, *g* decreases, so the craft's weight also decreases, making the unbalanced force more.

g) Its weight would be 200 000 N on earth, so the thrust from the rockets (52 000 N) is too small.

Q3 a) This makes the test fair: a longer thread stretches more for the same force, a thicker thread stretches less for the same force.

b) The steel obeys Hooke's Law over a narrow range of forces. The spider's silk does not obey Hooke's Law.

c) 8.6 m N

d) 30 mm

e) When a fly hit the spider's silk it stretches much further than the steel. The time taken to stop the fly is longer with the silk, so the force acting on the silk is less because:

$$\text{force} = \frac{\text{change in momentum}}{\text{time}}$$

Q4 The important point to describe is how you would measure acceleration. Then $m = \frac{F}{a}$

Q5 a) 2.5 m/s^2

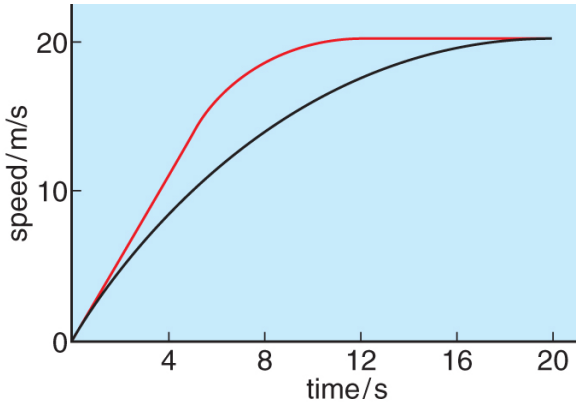
b) 1875 N

c) $m = \frac{F}{a}$

$= \frac{1875\ \text{N}}{1000\ \text{kg}}$

$= 1.875\ \text{m/s}^2$

So the graph is less steep. But the car reaches the same final speed.



Q6 1.6×10^7 m/s

Extend and challenge Section 2 p113

1 a) i) The lamp; it has the smallest current

ii) There is no earth for the metal cases. The wire is too thin.

b) i) $P = I \times V$

$= 11.5 \times 230$

$= 2645$ W

ii) $I = 5.75$ A

iii) $P = I \times V$

$= 5.75 \times 115$

$= 661$ W

The power is $\frac{1}{4}$ of the 230 V mains power. So the kettle takes 4 times as long to boil: that is 360 s.

Q2 a) 3 V

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

$= \frac{3}{0.2}$

$= 15\ \Omega$

c) i) 0.2 A

ii) 0.4 A

d) 9 V

e) 12 V

Q3 a) Current = $I + 0.2$

b) The voltage is the sum of the voltage across the 4 Ω resistor plus the voltage across one of the two resistors in parallel.

Therefore:

$12 = 4(I + 0.2) + 10 \times I$

$14I = 11.2$

$I = 0.8$ A

d) The voltage across R is the same as the voltage across the 10 Ω resistor which is:

$10I = 10 \times 0.8 = 8\ \Omega$

So $R = \frac{8}{0.2}$

$= 40\ \Omega$

Extend and challenge Section 3 p125

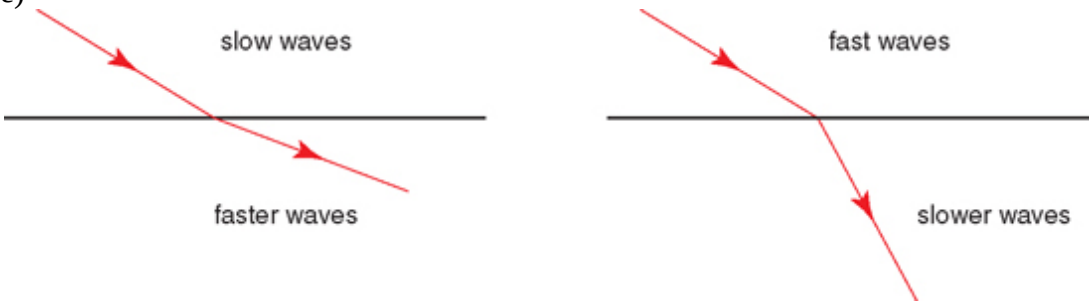
1 a) Sounds are turned back to the surface, so the sound is trapped in a thin layer at the surface of the ocean.

b) Sound goes upwards rather than along the bottom of the sea.

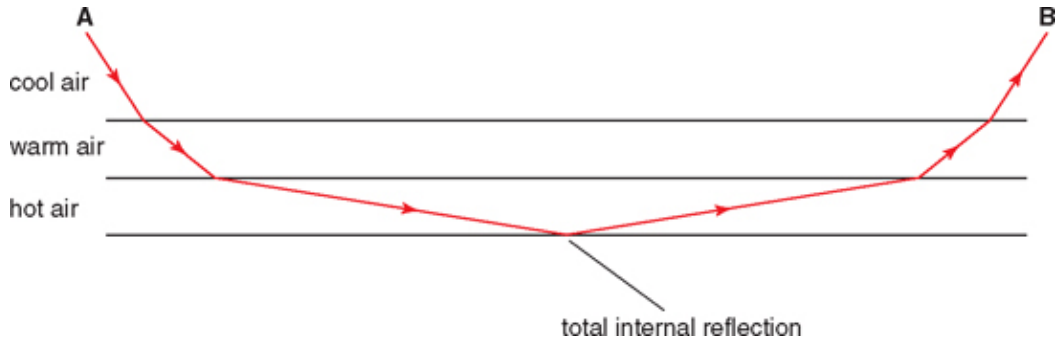
c) Yes, Wendy is 315 km away and Wallis can swim 360 km in a day. (However, Wendy might have moved on).

d) Because the sounds take such a long time to reach the other whale.

e)



f)



Light travels from A towards the road. A might be a mountain for example. Light travels faster in warm air than cold air; light travels even faster in hot air. The light is refracted as shown, and undergoes total internal reflection when the angle of incidence between successive layers is shallow. Then the light is refracted to B. Someone looking from B can see the mountain reflected in the road surface.

Q2 a) 40 s

b) 0.025 Hz

c) $\lambda = \frac{v}{f}$

$= \frac{6}{0.025}$

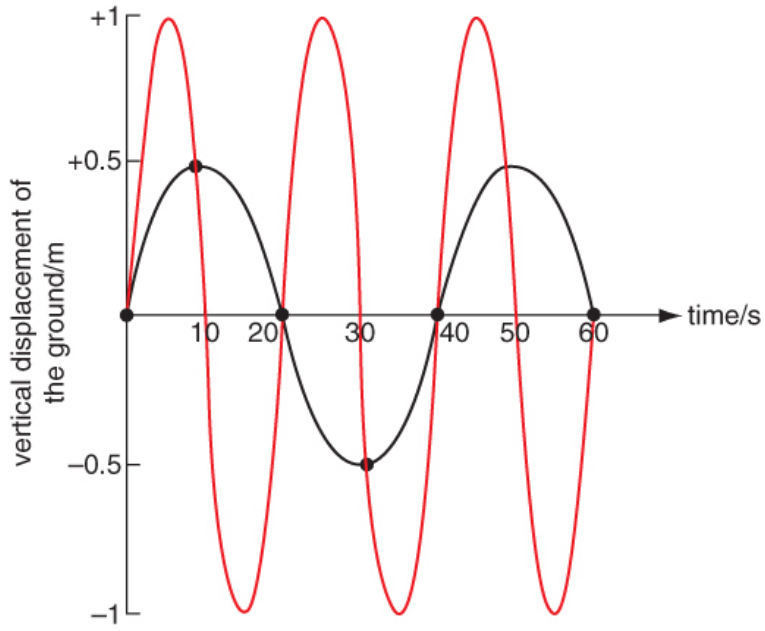
= 240 km

d) The velocity is the gradient of a displacement–time graph. The gradient is steepest at C and E.

e) At B and D, because the velocity is changing direction.

f) 0.07 m/s (this is quite hard to measure from the gradient of the graph).

g)



h) High-frequency waves are more dangerous as the vertical speed is greater.

i) The XX_1 movement is going to move the ground sideways. This will move the bottom away from the top. The YY_1 movement is less dangerous as the building will be compressed along the same line.

Extend and challenge Section 4 p157

Q1 a) i) Each graph square represents 10 m × 10 m = 100 m^2. [1]
Each rotor blade is approximately 2.5 squares in area × 2 = 500 m^2 [1]

ii) work per second = $F \times v$ [1]
= 90 N × 10 m/s [1]
= 900 J/s [1]

iii) 450 J/s × 500 = 225 kJ/s [1]

iv) 225 kW [2]

v) 900 MW = 225 kW × n (turbines) [1]
n = 900 MW / 225 kW [1]
= 4000 [1]

b) i) Gravitational potential energy [1]

ii) $W = mg$
= 1000 × 10
= 10 000 N [1]
Work = force × distance [1]
= 10 000 N × 7 m
= 70 000 J (for 1 m^3) [1]

iii) Volume = 200 million m^2 × 5 m [1]
= 1000 million m^3 [1]

iv) Energy = 70 000 J × 1000 million [1]
= 7×10^4 J × 10^9
= 7×10^{13} J [1]

v) P = energy/time [1]
= 7×10^{13} / 20 000 [1]
= 3.5×10^9 W = 3500 MW [1]

c) Advantages: regular large quantities of power [1];
this is green energy – there is no production of CO_2 [1]

Disadvantages: power available at different times of the day depending on the tide [1];
the dam would destroy the habitat of birds and fish. [1]

Extend and challenge Section 5 p186

1 a) $2 \times 2 \times 2 = 8$ times

b) $2 \times 2 = 4$ times

c) $\frac{F}{A} = \frac{8}{4} = 2$ for Boris

$\frac{F}{A} = \frac{1}{1} = 1$ for Vladimir

Twice the pressure under Boris's paw.

d) The pressure under the paws or stress in the bones gets larger for larger animals. This is why a lion's legs are proportionally thicker in comparison with a cat.

2 a) i) It takes time for energy to be conducted through the metal.

ii) Again, it takes time for energy to be conducted through the metal.

b) i) 6°C per min (ii) 4°C per min (iii) –2°C per min

ii) At DE the gradient is only 4°C per min because 1/3 of the energy is being transferred to the surroundings.

energy supplied = energy supplied to heat the block + energy transferred to the surroundings

c) Electrical work done in one minute by the heater equals the thermal energy transferred to the metal.

This assumes that at low temperatures there are no energy transfers to the surroundings. So the gradient of 6°C per min is chosen.

$$VIt = mc\Delta\theta$$
$$12 \times 4.5 \times 60 = 1 \times c \times 6$$
$$c = 540 \text{ J/kg °C}$$

d) i)

	Moles	Specific heat capacity in J/mol °C
Lithium	144.9	24.0
Aluminium	37.04	23.8
Copper	15.74	24.1
Gold	5.07	25.2

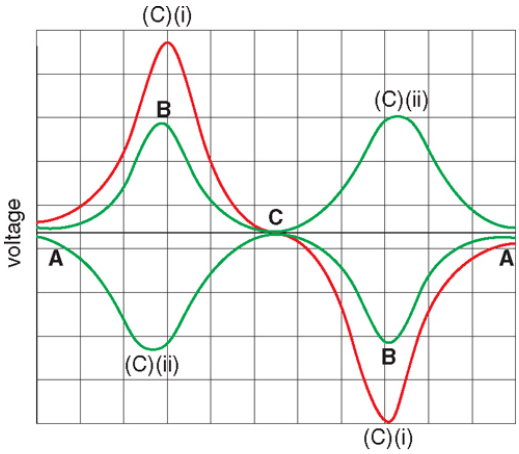
ii) The four metals have similar molar specific heat capacities. This tells us that an atom of each metal requires about the same energy to warm it by 1°C.

Extend and challenge Section 6 p217

Q1 A: The voltages add up to push the current in the same direction. The voltages from 2 wires in B cancel out.

Q2
i) The peaks increase as the magnet moves faster.
ii) The peaks get narrower as the magnet passes more quickly through the coils.
iii) The gaps become smaller – again the magnet is moving faster.
iv) As the magnet falls it increases its speed. As a north pole enters a coil there is a positive voltage; as the south pole leaves the other end the voltage is reversed.

Q3 a) The field is strongest. The pendulum is moving fastest.
b) and c)



d) i) Potential energy in the pendulum is converted to kinetic energy and thermal energy as current flows through R.
Potential energy is also converted to heat in the air due to wind resistance.
ii) Potential energy is converted to thermal energy due to air resistance.

e) The pendulum stops more quickly with the switch closed because energy is also converted to thermal energy in the circuit.

f) i) No change because the pendulum moves at the same speed.
ii) The swings take longer to die away because the pendulum has greater initial potential energy (*mgh* – mass is more).

Extend and challenge Section 7 p247

Q1 a) Atoms of an element can have differing numbers of neutrons. Each type is an isotope. [1]

b) i) Gamma [1]

ii) Geiger-Müller tube [1]

c) i) 150 counts/hour, as 46 hours is two half-lives [2]

ii) 20% has been worn away. [1]

This assumes that the wear is at a constant rate through the 46 hours. [1]

iii) The half-life must be short so that there is a reasonably high count rate. However, the half-life must be long enough to allow time for the investigation. [1]

Q2 a) i) Two isotopes of an element have the same number of protons but a different number of neutrons.

ii) A radioactive nucleus disintegrates and emits alpha, beta or gamma radiation.

b) 29 years +/– 1 year

Show the working on your graph

c) i) An alpha particle is a helium nucleus.

ii) At the start, there is a greater number of nuclei, and the decay rate is high. After 10 years there are fewer nuclei left, so the decay rate is slower. The power depends on the rate of decay, so it is less after 10 years.

iii) After 20 year the count rate is 620 Bq which is 62% of the initial count. So the power is 62% of 500 W = 310 W.

d) Americium-241 has a longer half-life than Curium-243, so it decays more slowly. To get the same power using curium, the spacecraft would have to carry a heavier mass of americium.

Extend and challenge p274

Q1 a) The velocity has both speed and direction. So although speed is constant, the direction changes and therefore the velocity changes.

b) acceleration = $\frac{\text{change of velocity}}{\text{time}}$

So if velocity changes, there must be an acceleration.

c) The acceleration is towards the Earth.

$F = ma$

There is a resultant force due to the pull of gravity towards the Earth.

Q2 a) If the star clusters were stationary they would fall into M87.

b) $v = \frac{2\pi r}{T}$

$T = \frac{2\pi r}{v}$

$r = 120\,000 \times 3 \times 10^8 \times 365$ (or 365.25) $\times 24 \times 3600$

$= 1.1 \times 10^{21}$ m

$v = 5.6 \times 10^5$ m/s

$T = \frac{2\pi \times 1.1 \times 10^{21}}{5.6 \times 10^5}$

$= 1.2 \times 10^{16}$ s

= 380 million years