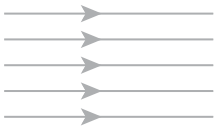
Cambridge IGCSE® Physics Practice Book

Answers

1 Light and sight

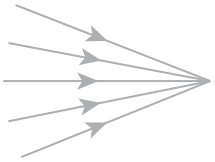
1 lines, direction, ray, beam, diverging, narrower, faster, before [4]

2 **(a)** [1]



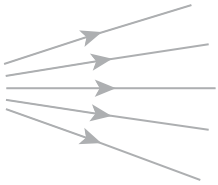
parallel

(b) [1]



converging

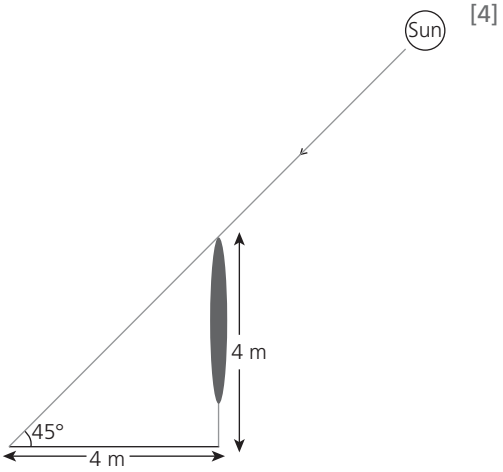
(c) [1]



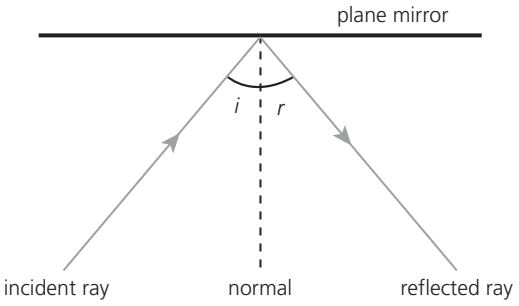
diverging

3 B [1]

4 4 m [4]



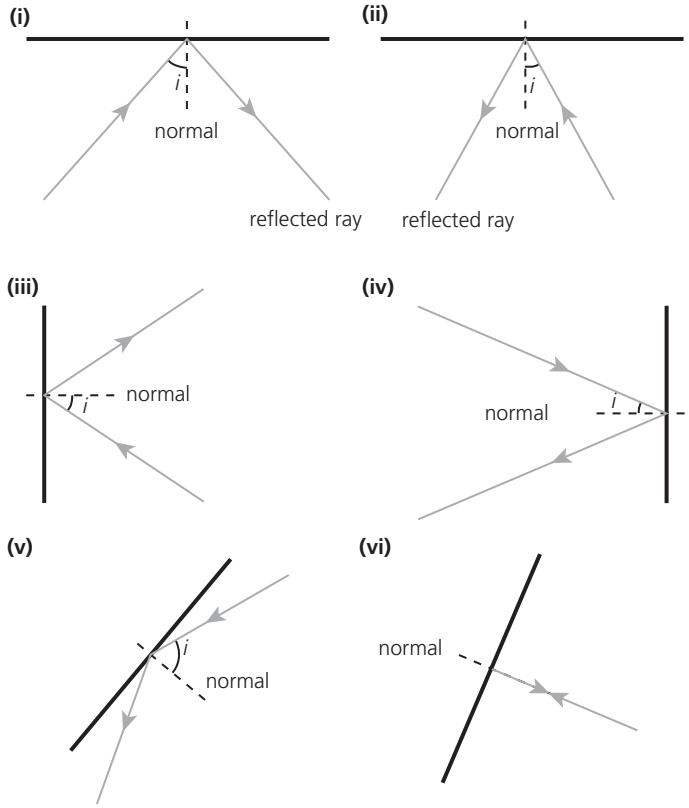
5 (a)



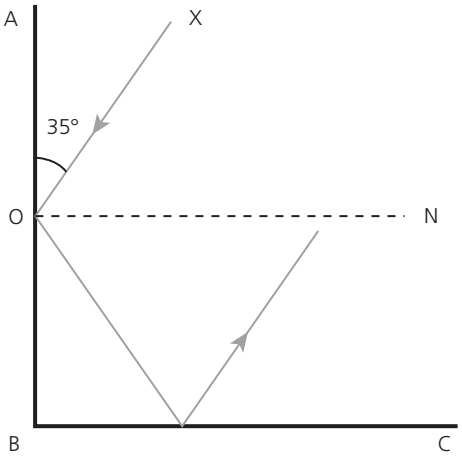
[3]

(b) (i) 40° [1] **(ii)** 40° [1]

6 (a) [3] **(b)** [3] **(c)** [3]



7 (a)

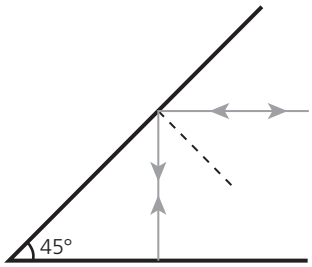


[2]

(b) (i) 55° [1] **(ii)** 55° [1] **(iii)** 35° [1] **(iv)** 35° [1]

(c) turned through 180° from incident ray [1]

8 (a) [2]

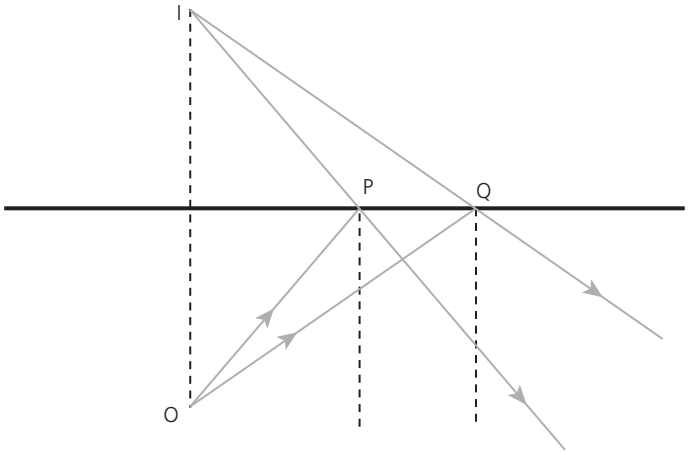


(b) (i) 45° [1] **(ii)** 0° [1]

9 B, C [2]

10 A real image can be formed on a screen and the light rays pass through the image. [2]

11 (a) [4]



(b) virtual [1]

(c) same distance behind mirror as the object is in front [1]

12 (a) 1 m [1] **(b)** 1 m [1]

13 Left and right are interchanged in the image, compared with the object. [2]

14 11:01 [2]

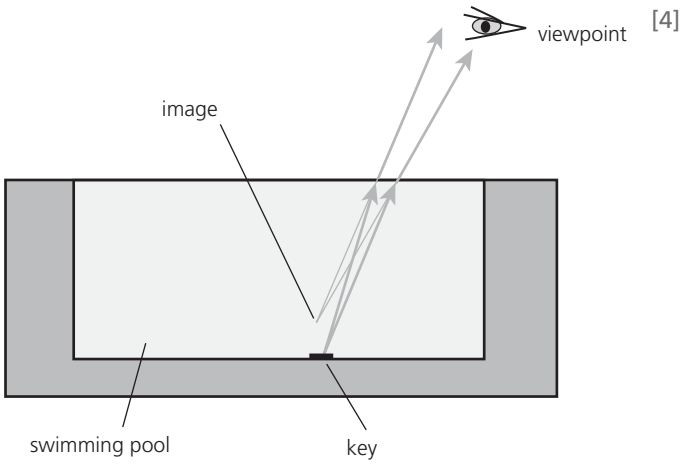
15 И [2]

16 The ray is refracted towards the normal. [2]

17 towards, denser, away from, normal, optically, normally [3]

18 B [1]

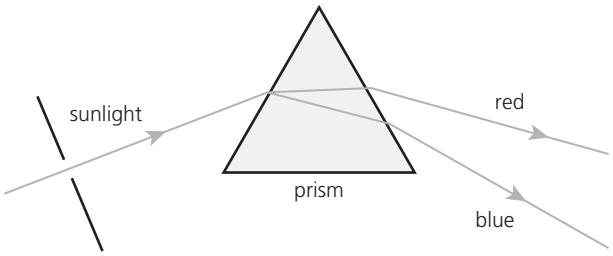
19 (a) [4]



(b) below [1]

20 (a) 2×10^8 m/s [3] **(b)** 2.25×10^8 m/s [3]

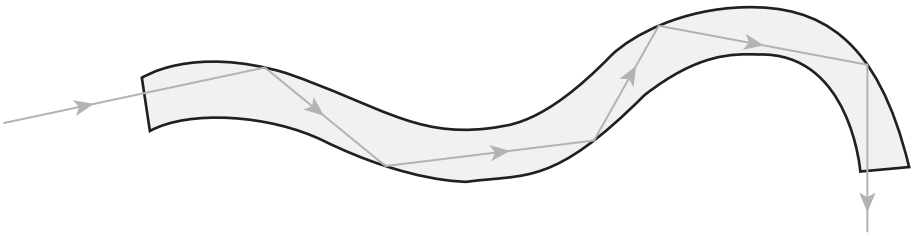
21 **(a)** Dispersion occurs because the prism has different refractive indices for different colours of light. [2]
(b) red, orange, yellow, green, blue, indigo, violet [3]
(c) [3]



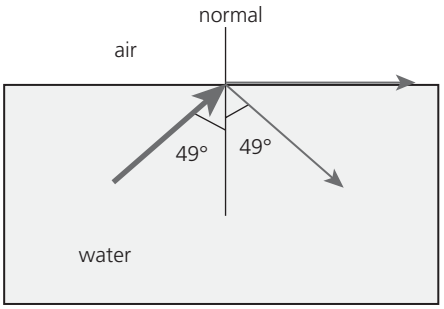
(d) blue [1]
(e) light of one colour (or frequency) [1]

22 When light is incident on a boundary of lesser optical density at an angle of incidence greater than a critical angle, *c*, all of the light is reflected inside the denser medium. [3]

23 [2]



24 [3]



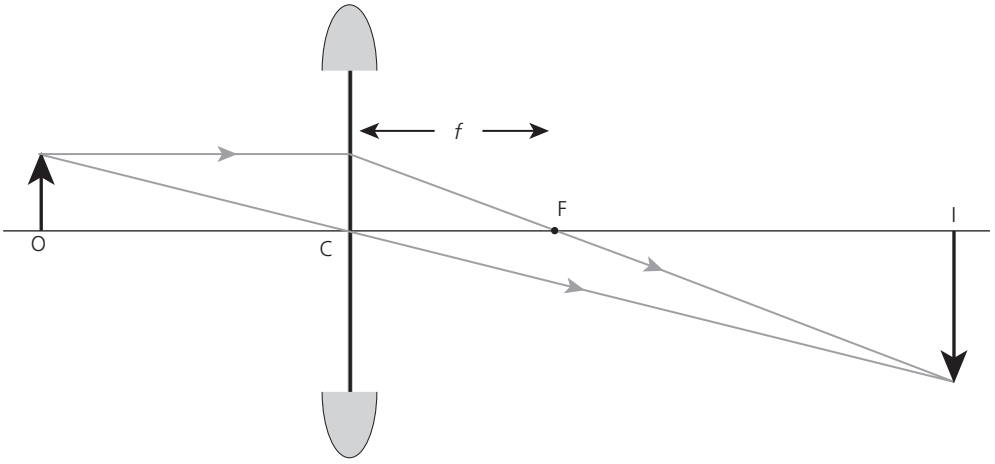
refractive index = $\frac{\sin 90°}{\sin 49°}$ = 1.32

25 thin, two, parallel, focus, undeviated, centre, top, F, refracted, principal [5]

26 D [1]

27 Use the lens to focus an image of a distant object onto a piece of paper; the lens–image distance is equal to the focal length. [2]

28



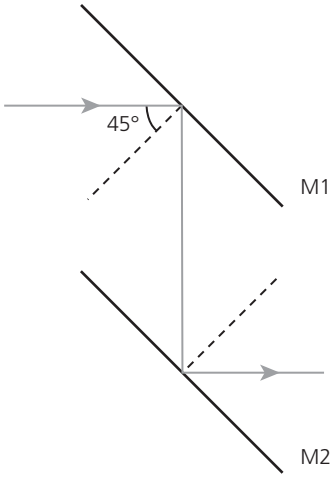
2.7 cm [4]

29 the one of focal length 5 cm [1]

30 parallel beam [1]

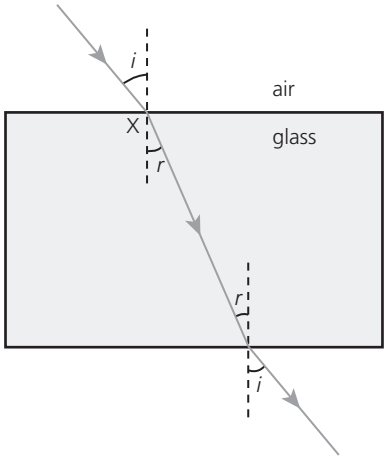
Stretch and challenge

31 (a) [2]



(b) (i) 45° [1] **(ii)** periscope [1] **(iii)** can be used to see over higher obstacles [1]
(c) A, D [2]

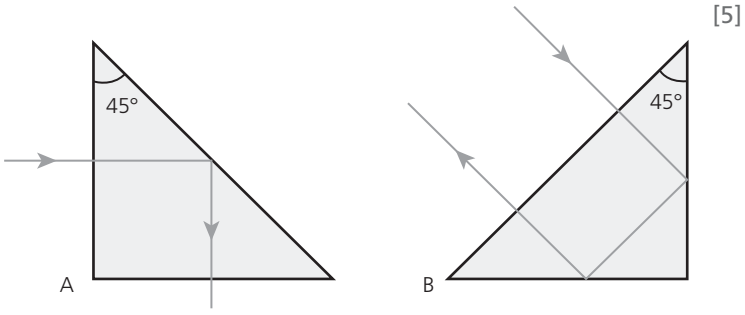
32 (a) [3]



(b) Exit ray is parallel to the ray entering the block but is displaced sideways. [2]
(c) 19° [4]

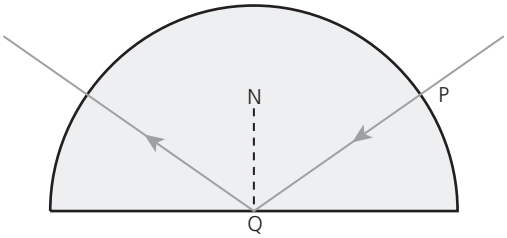
Exam focus

1 (a) [5]



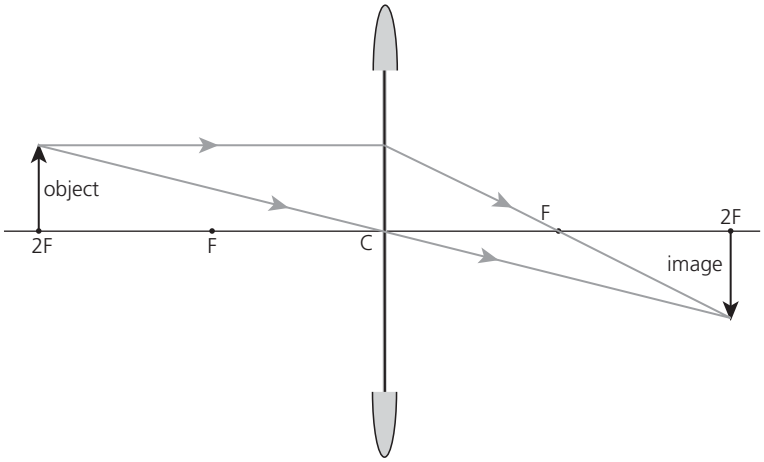
(b) (i) periscope [1] **(ii)** binoculars [2]

2 (a) The beam strikes the glass normally. [1]
(b) 55° [2]



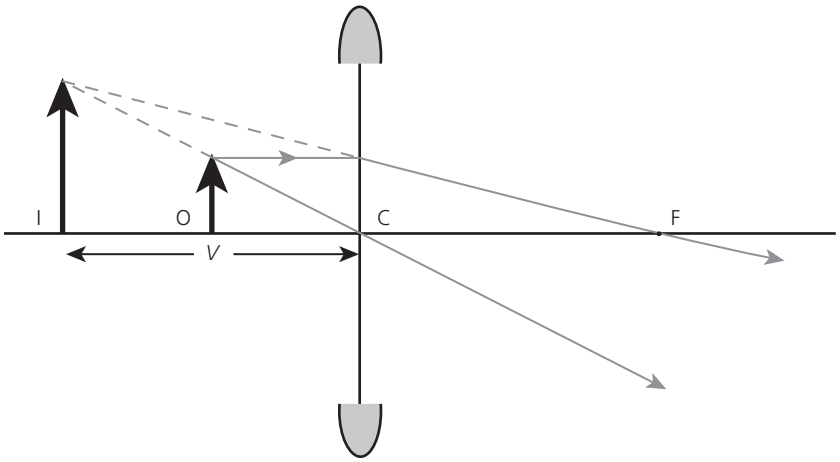
(c) 42° [2]

3 (a) [4]



(b) 10 cm [1] **(c)** The same [1]

4 (a) [3]

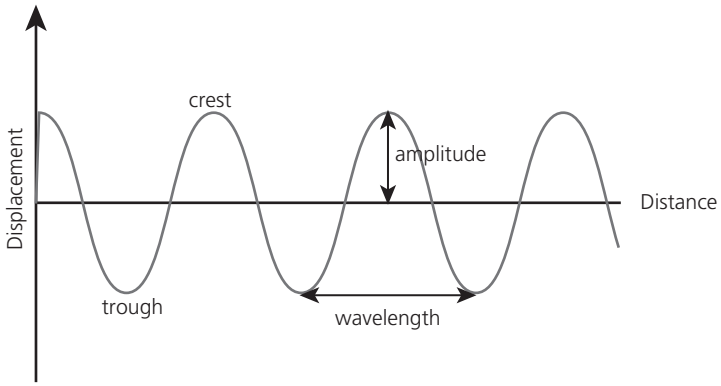


(b) 4 cm [1] **(c)** virtual [1]

2 Waves and sound

1 Vibrations are perpendicular to direction of travel for transverse wave, in line with direction of travel for longitudinal wave. [4]

2 [4]



3 10 Hz [1]

4 1.2 Hz [2]

5 (a) 6 cm [1] **(b)** 5 Hz [1] **(c)** 30 cm/s [2] **(d)** 3.2 s [2]

6 (a) no change [1] **(b)** halved [1]
(c) The direction of travel bends towards normal to boundary. [1]

7 P down [1] Q up [1] R up [1]

8 (a) longitudinal [1] **(b)** transverse [1] **(c)** transverse [1]
(d) transverse [1] **(e)** transverse [1] **(f)** longitudinal [1]

9 (a) four from: obey wave equation $v = f\lambda$, transverse, undergo reflection, refraction, diffraction, travel at 3×10^8 m/s in a vacuum [4]
(b) (i) infrared [1] **(ii)** microwaves or infrared [1] **(iii)** X-rays [1]
(iv) infrared [1] **(v)** X-rays [1] **(vi)** microwaves [1]

10 3.3 m [3]

11 (a) radio [1] **(b)** X-rays [1] **(c)** X-rays [1]

12 (a) Microwaves may harm living cells; use hands-free devices. [2]
(b) X-rays can kill or damage living cells and cause cancer; protect by use of lead shielding. [2]

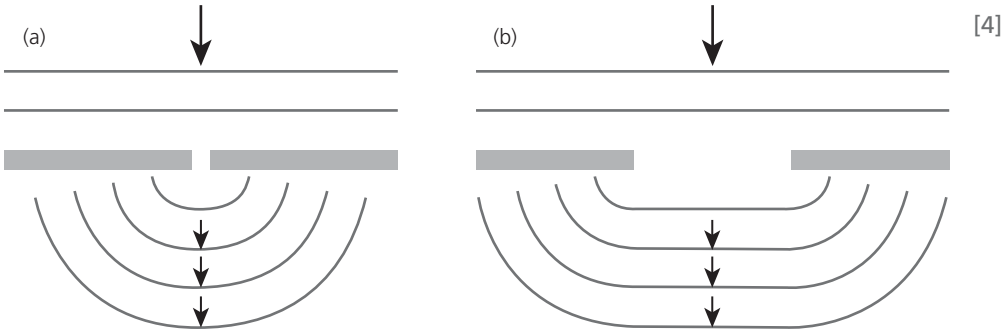
13 (a) 0.4 µm [2] **(b)** 0.7 µm [2] **(c)** B [1]

14 (a) 1650 Hz [2]
(b) (i) 20–20 000 Hz [1] **(ii)** greater than 20 kHz [1]

15 2.64 [3]

Stretch and challenge

16 (a) (b) [4]



17 (a) 495 m [2] **(b)** 2 s [2]

Exam focus

1 (a) (i) Y [1] **(ii)** X [1] **(iii)** Y [1]
(b) Molecules in the air vibrate to and fro in the direction of travel of the sound wave; when the molecules are moving towards each other a compression (region of higher pressure) results; when they are moving apart a rarefaction (region of lower pressure) occurs. [3]
(c) (i) 0.85 m [1] **(ii)** 400 Hz [2]

2 (a) 28 mm [4] **(b)** speed = frequency × wavelength [1]
(c) 1.4 mm [2]

3 (a) 0.99 m [2] **(b)** 6000 m/s [2]
(c) Use a digital timer to measure the time, *t*, that a sharp sound (e.g. a hammer blow on a metal plate) takes to travel between a 'start' and a 'stop' microphone. Measure the distance between the microphones, *d*. Repeat measurements of *t* several times and work out an average value. Speed of sound = *d*/*t*. [4]

3 Matter and measurements

1 (a) kilogram [1] **(b)** metre [1] **(c)** second [1]

2 (a) 20 [1] **(b)** 4 [1] **(c)** 120 [1] **(d)** 500 [1] **(e)** 1400 [1]

3 (a) 15.00 m [1] **(b)** 1.50 m [1] **(c)** 0.15 m [1] **(d)** 0.015 m [1]

4 (a) 1×10^3 [1] **(b)** 2.25×10^5 [1] **(c)** 6.5×10^2 [1] **(d)** 1.5×10^4 [1]

5 (a) 10 000 [1] **(b)** 250 [1] **(c)** 1 500 000 [1] **(d)** 350 000 000 [1]

6 (a) 1×10^{-3} [1] **(b)** 2×10^{-2} [1] **(c)** 1.2×10^{-3} [1] **(d)** 1.02×10^{-2} [1]

7 (a) (i) 1×10^{-2} [1] **(ii)** 0.01 [1]
(b) (i) 2×10^{-3} [1] **(ii)** 0.002 [1]
(c) (i) 3×10^{-4} [1] **(ii)** 0.0003 [1]
(d) (i) 8×10^{-4} [1] **(ii)** 0.0008 [1]

8 (a) 5×10^{-3} m [1] **(b)** 5×10^{-1} m [1] **(c)** 5×10^3 m [1] **(d)** 5 m [1]
(e) 5×10^{-6} m [1] **(f)** 5×10^{-9} m [1]

9 (a) 3 [1] **(b)** 3 [1] **(c)** 2 [1] **(d)** 1 [1]
(e) 2 [1] **(f)** 3 [1]

10 (a) 1 m [1] **(b)** 1.3 m [1] **(c)** 1.26 m [1]

11 yes [1]

12 27 cm^2 (do not accept 27.0 cm^2) [1]

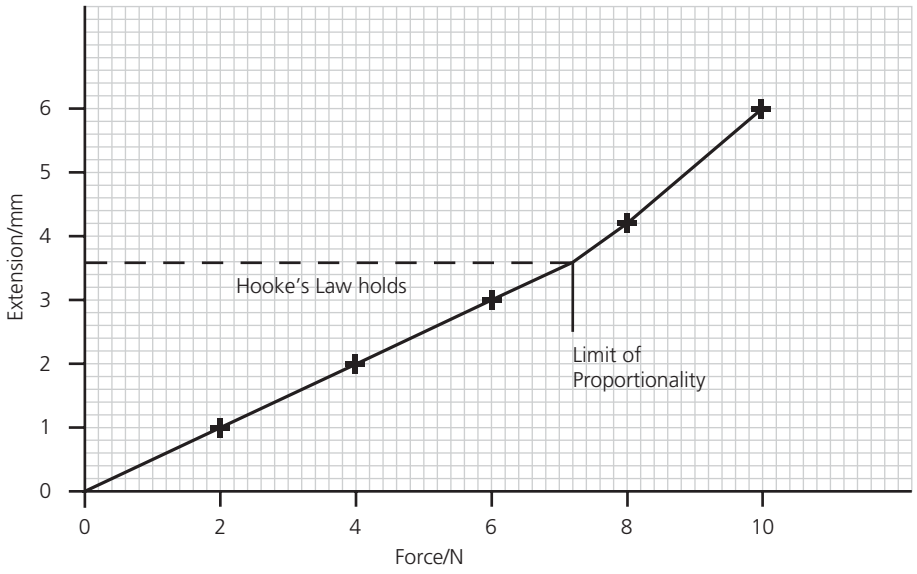
13 600 cm² [2]
14 75 [2]
15 1.6 s [1]
16 **(a)** 0.16 mm [1] **(b)** 2 g [1]
17 C [1]
18 0.92 g/cm³ or 920 kg/m³ [2]
19 **(a)** 40 cm³ [2] **(b)** 270 g [1]
20 **(a)** 25 cm³ [1] **(b)** 8×10^3 kg/m³ [2]
21 39 kg [2]
22 **(a)** 0.15 N [1] **(b)** 0.50 N [1] **(c)** 3 N [1] **(d)** 30 N [1]
23 **(a)** 80 kg [1] **(b)** 128 N [1]
24 0.75 kg [1]
25 D [1]

Stretch and challenge

26 C [1]
27 **(a)** B [2] **(b)** A [2]

Exam focus

1 **(a)** 200 N/m [2] **(b)** 1000 N/m [2]
2 **(a)** 5 N/m [2]
(b) **(i)** 20 cm [1] **(ii)** 1 N [2]
3 **(a)** **(b)** [6]

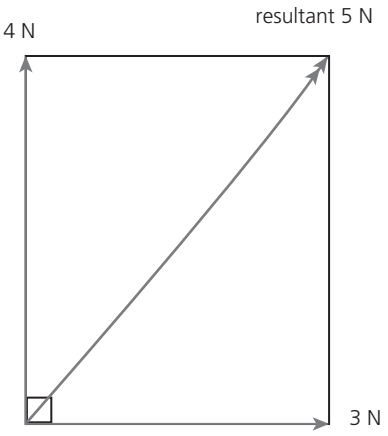


(c) 2×10^3 N/m [2]

4 Forces and resources

1 **(a)** **(i)** 25 cm [1] **(ii)** 10 cm [1] **(iii)** 5 cm [1]
(b) **(i)** 40 cm [1] **(ii)** 16 cm [1]
2 forces, equilibrium, sum, equals, direction, clockwise, point, moments, no, resultant [5]
3 **(a)** 3 N [3] **(b)** 3 N [2]
4 Suspend card from one corner and use a plumb line to draw the vertical line through the card from the point of suspension; repeat with a different point of suspension. The centre of gravity is located where the two lines intersect. [3]
5 **(a)** Until the vertical line from its centre of gravity falls outside its base. [2]
(b) lower its centre of mass; increase the area of its base [2]
6 Scalars have magnitude only, e.g. mass; vectors have magnitude and direction, e.g. force. Direction must be taken into account when adding vectors. [4]
7 **(a)** 13 N [1] **(b)** 3 N [1]

8



5 N [3]

9 **(a)** 5 N downwards [2] **(b)** 5 N upwards [2]

10 60 kJ [2]

11 **(a)** 1.8×10^5 J [2] **(b)** 12 kW [2]

12 **(a)** 72 J [2] **(b)** 9.6 W [3]

13 **(a)** 15 J [2] **(b)** 2 cm [3]

14 **(a)** gravitational potential energy → kinetic energy and heat [2]
(b) electrical energy → electromagnetic energy → heat [2]
(c) electrical energy → kinetic energy, sound, heat and light [2]
(d) gravitational potential energy → kinetic energy → electrical energy and heat [2]

15 **(a)** 70% [3] **(b)** becomes heat [1]

16 **(a)** Cannot be used up [1]. Two from: solar, wind, hydroelectric, tidal, geothermal [2].
(b) Cannot be replaced once used [1]. Two from: coal, oil, gas, nuclear [2].

17 **(a)** 10 Pa [1] **(b)** 80 Pa [1] **(c)** 400 Pa [1] **(d)** 1.0×10^5 Pa [2]

18 **(a)** 40 N [1] **(b)** 20 N [1] **(c)** 2×10^{-3} N [2] **(d)** 2×10^{-4} N [2]

19 B [2]

20 A [2]

21 **(a)** 2.5×10^5 Pa [2]
(b) **(i)** 500 N [2] **(ii)** 500 N [1]

22 3×10^4 Pa [3]

Stretch and challenge

23 **(a)** **(i)** renewable, clean [2]
(ii) sun does not always shine, panels are expensive to manufacture [2]
(b) **(i)** high energy density, readily available [2]
(ii) radiation risks, safe disposal of radioactive waste required [2]
(c) **(i)** renewable, clean [2]
(ii) wind not always available, environmental objections [2]
(d) **(i)** high energy density, readily available [2]
(ii) non-renewable, release carbon dioxide and sulfur dioxide into atmosphere [2]

Exam focus

1 **(a)** 48 N [2] **(b)** 32 N [2]

2 **(a)** 300 N [2] **(b)** 900 J [2] **(c)** 300 W [2]

3 **(a)** potential energy transferred to kinetic energy and heat (resulting from resistive forces) [3]
(b) 60 J [2]
(c) **(i)** 60 W [1] **(ii)** 8 m/s [2]

5 Motion and energy

1 3 m/s [2]

2 **(a)** 12.5 m/s [2] **(b)** 7.5 km [2]

3 **(a)** B [1] **(b)** C [1] **(c)** 5 m/s [2]

4 **(a)** 4 m/s [2] **(b)** friction [1]

5 **(a)** $0.8\ m/s^2$ [2] **(b)** 4 s [2]

6 12 m/s [2]

7 **(a)** 14 m/s [1] **(b)** 840 m [2] **(c)** 0.2 m/s^2 [2]

8 **(a)** **(i)** 270 m [1] **(ii)** no distance [1] **(iii)** 270 m [1]
(b) 1.5 m/s [2]

9 **(a)** 3.0 m/s [1] **(b)** 0.15 m/s^2 [1] **(c)** 48 m [2] **(d)** 21 m [3]

10 **(a)** **(i)** 20 m/s [1] **(ii)** 20 m [2]
(b) linear, with slope = 10 m/s^2 [2]

11 force, rest, constant, straight [2]

12 **(a)** 800 N [1] **(b)** 800 N [1] **(c)** 500 N [1] **(d)** 800 N [1]

13 **(a)** 9000 N [1] **(b)** 3600 N [1]

14 **(a)** **(i)** 20 N to right [2] **(ii)** 0.4 m/s^2 [2]
(b) **(i)** 0 N [1] **(ii)** 0 m/s^2 [1]

15 60 N [1]

16 2 m/s^2 [2]

17 energy, motion, $mv^2/2$, potential, mgh, conserved [3]

18 **(a)** 90 [3] **(b)** 360 [3]

19 **(a)** 500 [2] **(b)** 1250 [2]

20 3 m/s [3]

21 **(a)** **(i)** 150 J [2] **(ii)** 150 J [1] **(iii)** 10 m/s [3]
(b) transferred to heat and sound [2]

22 1.8×10^5 W [3]

23 **(a)** Speed is a scalar and has magnitude only; velocity is a vector and has magnitude and direction. [1]
(b) centripetal force keeping ball moving in a circle [1]
(c) along the tangent to the circle at its lowest point, in the direction the ball is moving [1]

24 **(a)** 15 [1] **(b)** 200 [1]

Stretch and challenge

25 **(a)** **(i)** increasing [1] **(ii)** constant [1]
(b) **(i)** constant [1] **(ii)** zero [1]
(c) **(i)** increasing [1] **(ii)** constant [1]
(d) OA [1]

26 **(a)** B [1]
(b) **(i)** towards the centre of the circle [1]
(ii) causes acceleration towards the centre of the circle [2]
(iii) friction between the tyres of the car and the road [1]
(iv) smaller [1]

Exam focus

1 **(a)** 27 J [3] **(b)** 0 J [1] **(c)** 27 J [1] **(d)** 45 m [2]

2 **(a)** **(i)** increasing [1] **(ii)** constant [1]
(b) **(i)** constant [1] **(ii)** zero [1]
(c) **(i)** decreasing [1] **(ii)** constant [1]
(d) 4.5 km [2]
(e) AB [1]

3 **(a)** 30000 m/s^2 [2]
(b) 30 m/s [2]
(c) follow through longer to extend collision time, strike harder [2]

6 Heat and energy

1 **(a)** gas [1] **(b)** solid [1] **(c)** gas [1] **(d)** liquid [1] **(e)** solid [1]

2 **(a)** gas [1] **(b)** solid [1] **(c)** liquid [1]

3 **(a)** Fast-moving air molecules collide with the smoke particles. A smoke particle is much more massive than an air molecule, but when there are more high-speed molecules striking one side of it than the other at a particular instant, a net force results and the smoke particle will move in the direction of the force. The imbalance and the resulting force cause the smoke particles to change direction rapidly in a random manner. [3]
(b) They will move faster. [1]

4 Very large numbers of fast-moving molecules rebounding from the walls of the container produce a force and hence a pressure on the walls. [2]

5 **(a)** It increases. [1]
(b) The air molecules move faster and so have more frequent and more violent collisions with the walls: the average force on the walls increases. [3]

6 **(a)** 0 °C [1] **(b)** 100 °C [1]

7 **(a)** Two from: expansion of a liquid, thermoelectric effect, gas pressure, electrical resistance. [2]
(b) It should vary continuously [1]; it should vary in a similar way to other physical properties [1].
(c) thermocouple [1]

8 **(a)** They vibrate faster and the separation increases. [2]
(b) A gas [1]

9 When the temperature rises the two metals expand by different amounts; this causes the strip to bend and break the contacts to the heating circuit. On cooling, the strip straightens and reconnects the heating circuit. [4]

10 **(a)** 400 cm^3 [1] **(b)** 100 cm^3 [1]

11 B, D [2]

12 **(a)** 1×10^5 Pa [1] **(b)** 4×10^5 Pa [1]

13 B, C [2]

14 16 800 [3]

15 **(a)** A [1] **(b)** 900 J/°C [1]

16 Brick and concrete have a high specific heat capacity and are used to store energy. [2]

17 4200 J/(kg °C) [4]

18 B [1]

19 **(a)** The temperature at which the substance changes from a solid to a liquid. [2]
(b) The temperature at which the substance changes from a liquid to a vapour. [2]

20 **(a)** B [1] **(b)** A [1]

21 17 000 J [2]

22 21 000 J [2]

23 115 000 J [2]

24 153 000 J [2]

25 340 J/g [2]

26 **(a)** 51 000 J [2] **(b)** 170 W [2]

27 2300 J/g [2]

28 **(a)** Faster-moving molecules escape from the surface of the liquid. This results in the average speed, and therefore the average kinetic energy of the remaining molecules being lowered, so that the temperature of the liquid falls. [4]
(b) Two from: large surface area, high temperature, draught/vacuum above liquid. [2]
(c) Evaporation can take place at any temperature and occurs at the surface of the liquid; boiling only occurs at the boiling point with bubbles forming throughout the liquid. [4]

29 B [1]

30 thermal, higher, lower, energy, temperature, fluid, radiation, electromagnetic [4]

31 **(a)** C [1] **(b)** A [1] **(c)** E [1] **(d)** D [1]

32 Wrap paper around a metal/wood rod and pass it through a flame at the junction of the two materials a few times. The paper chars where it is wrapped over the wood but not over the metal. Heat is transferred quickly along the metal which is a good conductor. Wood is a poor conductor of heat and transfers thermal energy very slowly. [4]

33 Metal transfers heat faster than plastic away from the hand, because it is a better conductor. [2]

34 **(a)** Three from: double-glazed windows, cavity walls, fur or fleece jackets, string vests, fibreglass roof insulation. [3]
(b) Transfer of heat by convection is restricted. [1]

35 C [1]

36 At the bottom; convection can occur if tank heated at the bottom so more of the water in the tank will be heated. [3]

37 D [1]

38 D [1]

39 **(a)** A [1]. A black surface is a better emitter of radiation than a shiny one [1].
(b) **(i)** The shiny foil reflects the radiation back into the room. [1]
(ii) The white colour reflects radiation. [1]

40 **(a)** B [1] **(b)** C [1]

41 Long-wavelength infrared [1]

Stretch and challenge

42 (a) (i) Place in pure melting ice. [2]
(ii) Place in the steam above boiling water at normal atmospheric pressure. [2]
(b) 25 °C [2]
(c) (i) smaller [1] **(ii)** less [1]

43 Insert an immersion heater of power P into the centre of a cylinder of metal and place a thermometer into another hole in the cylinder. Switch on the heater for a measured time, t; work out the energy supplied by heater, $P \times t$. Record the temperature of the metal before the heater is switched on and the highest temperature reached by the metal just after the heater is switched off; work out the temperature rise of the metal, ΔT. Measure the mass of the metal, m. Equate energy supplied by heater to energy gained by metal, $P \times t = mc\Delta T$. Hence evaluate specific heat capacity, c. Error in value obtained is due to loss of heat to the environment. [8]

Exam focus

1 (a) 16 800 J [2] **(b)** 340m J [2] **(c)** 63m J [2]
(d) 403m J [1] **(e)** water [1] **(f)** 42 g [3]

2 (a) Atoms in hot regions pass on their vigorous vibrations to neighbouring atoms in colder regions. Also, in metals, 'free' electrons move faster and further in the hot regions and can transfer that energy to atoms in cooler regions very quickly. [4]
(b) There are no 'free' electrons available to move rapidly through the material, transferring energy. [1]

7 Electricity

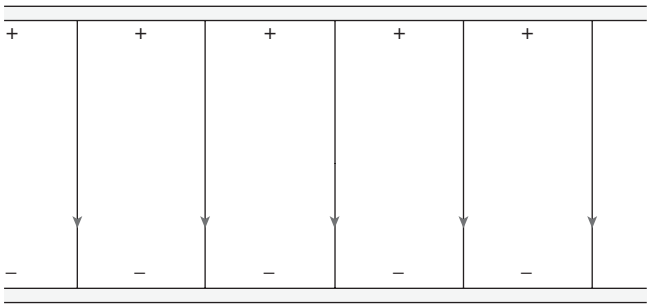
1 (a) repel [1] **(b)** repel [1] **(c)** attract [1]

2 Electrons are transferred from the perspex to the cloth [1], leaving the perspex positively charged [1].

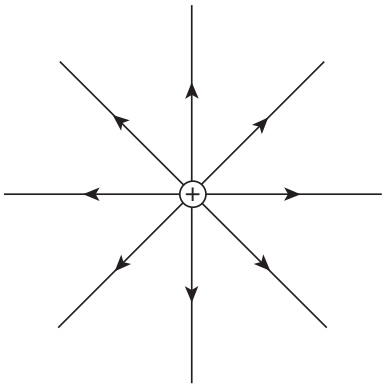
3 (a) Some electrons can move easily from atom to atom [1] and can be considered to be 'free' electrons [1].
(b) All electrons are firmly bound to atoms [1] and there are no 'free' electrons available to produce a current [1].

4 D [1]

5 (a) [3]



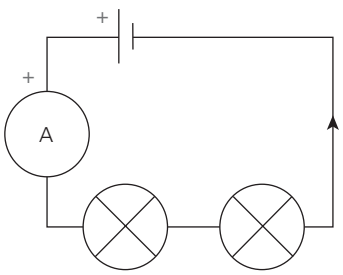
(b) [3]



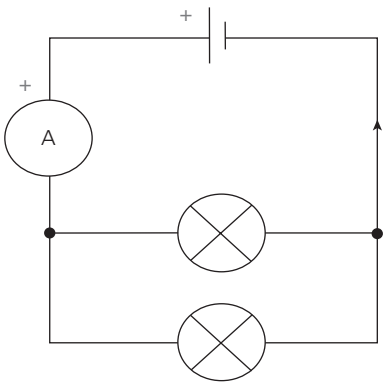
6 (a) 20 C [2] **(b)** 600 C [2]

7 (a) 2 A [2] **(b)** 1 A [2]

8 (a) [4]



(b) [4]



9 (a) coulomb C [1] **(b)** ampere A [1] **(c)** volt V [1] **(d)** volt V [1]
(e) ohm Ω [1]

10 (a) 3 J [2] **(b)** 360 J [3]

11 (a) 4 C [2] **(b)** 0.4 A [2]

12 (a) Connect four cells in series. [2]
(b) 12 J [2]

13 (a) It's dimmer. [1] **(b)** Same (full) brightness [1]
(c) It's dimmer. [1]

14 (a) potential difference = current × resistance [2]
(b) Connect a battery, ammeter, variable resistor and the wire whose resistance is to be measured, in series. Connect a voltmeter across the wire. Measure *V* and *I* with different settings of the variable resistor. Evaluate $R = V/I$ for each setting. [4]

15 1.2 V [1]

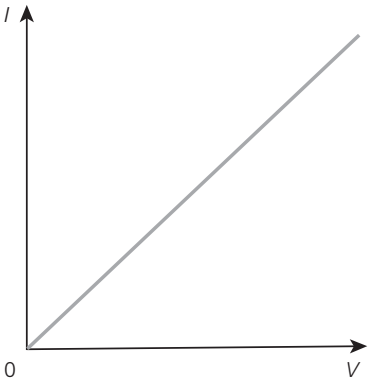
16 6 Ω [2]

17 0.3 A [2]

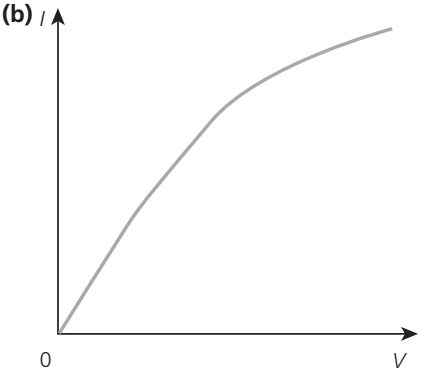
18 (a) 15 Ω [2] **(b)** 0.1 A [2] **(c)** 0.6 V [2] **(d)** 0.9 V [2]

19 (a) 3 Ω [4] **(b)** 2 A [2] **(c)** 1.5 A [2] **(d)** 0.5 A [2]

20 (a) [3]



(b) [3]



21 **(a)** It is constant. [1] **(b)** It increases as lamp heats up. [1]

22 **(a)** doubled [1] **(b)** halved [1] **(c)** doubled [1] **(d)** halved [1]

23 C [1]

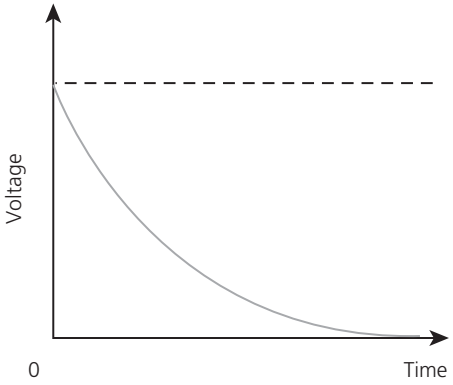
24 B [1]

25 C [1]

26 **(a)** [1]

(b) farad, F [1] **(c)** It stores electrical energy. [1]

(d) [3]



27 **(a)** 2.4 kW [2] **(b)** 5760 kJ or 1.6 kWh [2]

28 **(a)** 14400 kJ [2] **(b)** 8 A [2]

29 **(a)** 200 J/s [2] **(b)** 60 kJ [2]

30 3 A [2]

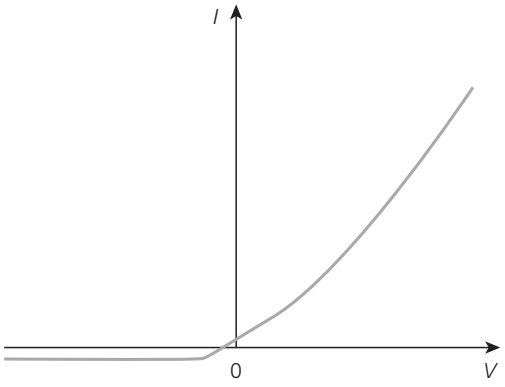
31 C [3]

32 C [1]

33 **(a)** B [1]

(b) **(i)** 2.5 V [2] **(ii)** 7.5 V [2]

34 [3]



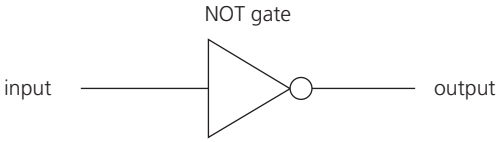
35 It only allows current to flow in one direction, so converts a.c. to d.c. [3]

36 **(a)** **(i)** increases [1] **(ii)** switches on [1] **(iii)** rings [1]
(b) as a light-operated intruder alarm [1]

37 Analogue voltages vary continuously [1]; digital voltages have discrete values, for example, high or low [1].

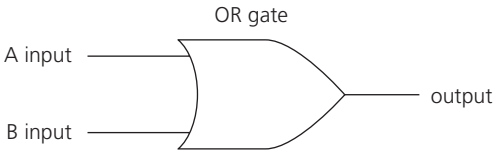
38 **(a)** analogue [1] **(b)** digital [1] **(c)** digital [1] **(d)** analogue [1]

39 **(a)** [1]

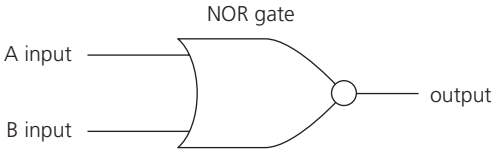


(b) It gives a high output if input low, and vice versa. [2]

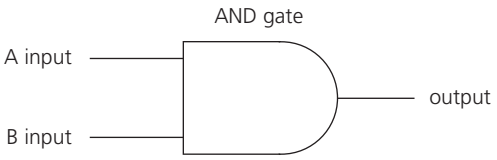
40 **(a)** [1]



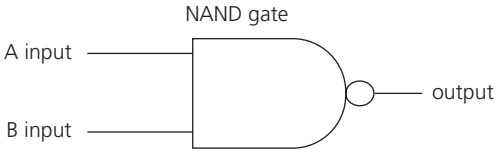
(b) [1]



(c) [1]



(d) [1]



41 **(a)** low [1] **(b)** high [1]

42 **(a)** Two from: LDR, thermistor, microphone, pressure switch. [2]
(b) Two from: lamp, LED, loudspeaker, relay, motor, heater. [2]

43 AND [2]

Stretch and challenge

44 **(a)** All at same brightness because they have the same voltage across them; if one lamp fails, the rest remain lit. [2]
(b) **(i)** 0.3 A [2] **(ii)** 6 A [2] **(iii)** 5.7 A [2]

45 **(a)** No damaged insulation, exposed wires, loose connections or short circuits [1]; plug correctly wired [1].
(b) Water lowers the resistance of the path to earth so the current increases. [2]
(c) Current through wire is too high. [2]

Exam focus

1 **(a)** **(i)** 0.3 A [2] **(ii)** 5.4 V [2] **(iii)** 3.6 V [2]
(b) **(i)** 0.2 A [2] **(ii)** 6.6 V [2] **(iii)** 2.4 V [2]
(c) increases [1]

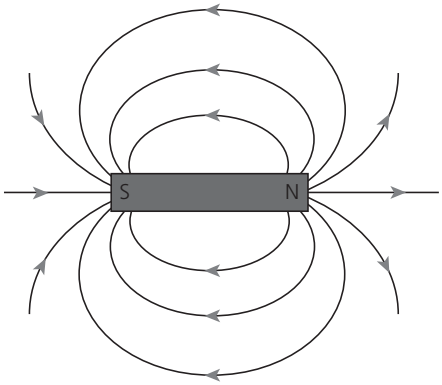
2 **(a)** **(i)** increases [1] **(ii)** increases [1] **(iii)** decreases [1]
(b) 14 Ω [4]

8 Electromagnetic effects

1 pole, south, repel, attract, demagnetised, soft, steel, permanent [4]

2 (a) Place a piece of paper on top of the magnet and sprinkle some iron filings thinly and evenly onto the paper. Tap the paper gently so that the filings settle into the field lines. Alternatively use a plotting compass: lay bar magnet on a piece of paper and place plotting compass near the N pole. Mark the position of the N and S poles of the compass on the paper; then move the compass so that the S pole is at the point where the N pole was previously and mark the new position of the N pole. Continue until compass is near S pole then join up the points to give a field line. Plot other field lines by repeating the process with the compass at different starting points. [3]

(b) [3]



3 B, D [2]

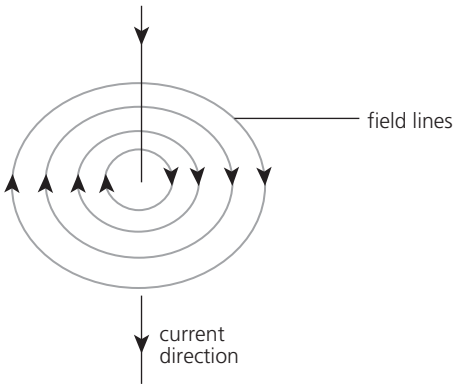
4 Two from: stroking with another magnet; hammering in a magnetic field; inserting in a solenoid and increasing d.c. through the solenoid. [2]

5 Dropping, hammering or heating in the absence of a magnetic field [1]; inserting in a solenoid and decreasing a.c. through the solenoid [1].

6 (a) (i) B [1] **(ii)** reverse current direction [1] **(iii)** left [1]
(b) (i) inside solenoid [1] **(ii)** outside solenoid [1]

7 Larger current [1], more turns on solenoid [1].

8 [3]



9 (a) downwards [1]
(b) (i) upwards [1] **(ii)** upwards [1]

10 B [1]

11 (a) does not move [1] **(b)** swings to right [1]
(c) swings further to left [2] **(d)** swings to right [2]

12 Current flows to the right. [2]

13 (a) N [1] **(b)** S [1] **(c)** N [1]

14 B [1]

15 In a.c. the direction in which current flows reverses regularly; in d.c. the current flows in one direction only. [4]

16 a.c. voltages can be stepped up and down easily using transformers. [2]

17 (a) 0.2 A [2] **(b)** 0.6 J/s [2]

18 C [1]

19 (a) 12 V [3] **(b)** step-down [1]

20 (a) 3.0 A [3] **(b)** 2.7 A [2]

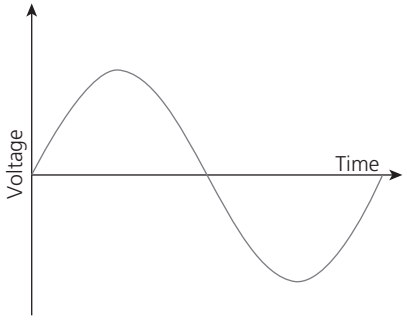
Stretch and challenge

21 **(a)** The current through the coil reaching the 'pull-on' value. [1]
(b) It becomes magnetized by current in coil and attracts the iron armature. [2]
(c) Contact is made in circuit PQ. [2]
(d) It is used to control power in a second circuit; especially useful if second circuit requires a larger current. [2]

22 **(a)** It causes the coil to turn. [1]
(b) Increase current in coil [1], increase number of turns on coil [1], increase strength of magnet [1].
(c) The coil would turn faster. [1]
(d) It causes a change of direction of the current in the coil every half-turn [1] so that the direction of the couple on the coil stays constant [1].

Exam focus

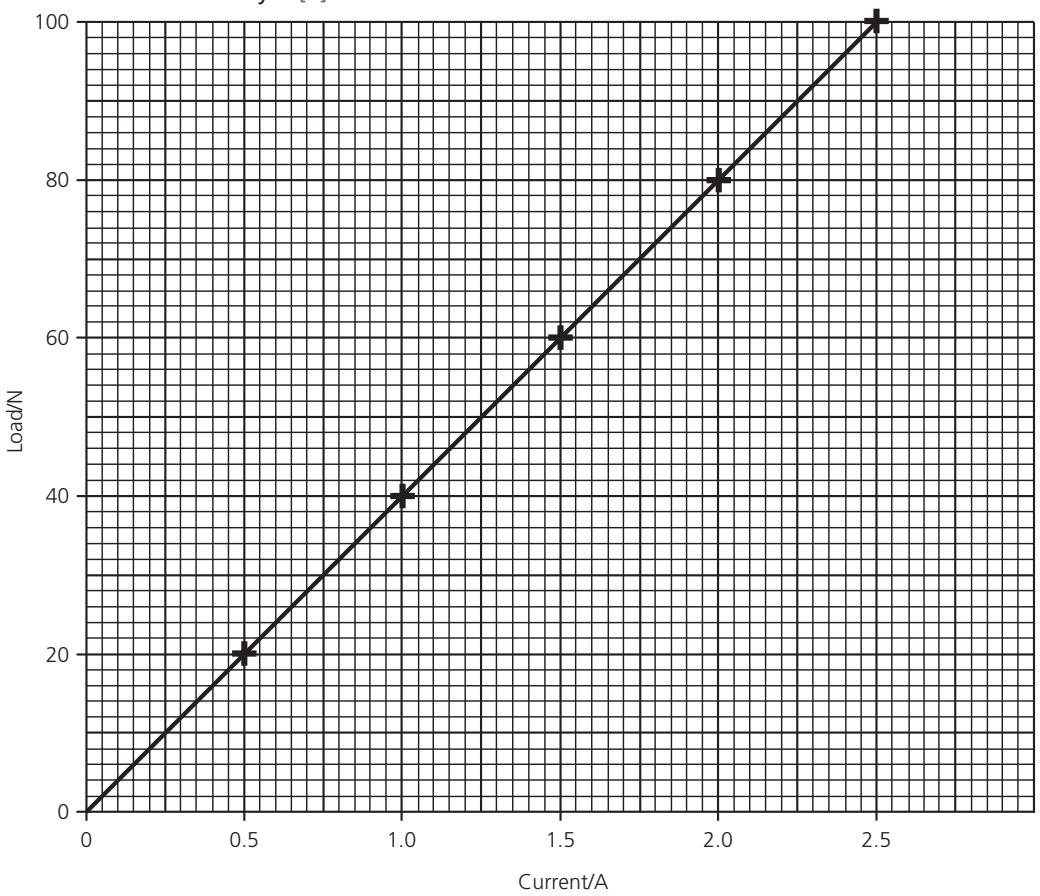
1 **(a)** They maintain contact with the brushes as the coil rotates. [1]
(b) [3]



(c) horizontal [1] **(d)** a.c. [1]

2 **(a)** 400 [3] **(b)** 200 W [2] **(c)** 0.2 A [3]
(d) It reduces the efficiency. [1]

3 **(a)** [4]



(b) yes [1] **(c)** 0.75 A [1] **(d)** 50 N [1]
(e) Q could lift a heavier load with a given current. [1]

9 Electrons and atoms

1 B [1]

2 Emission of electrons from a metal surface when the metal is heated in a vacuum. [4]

3 Travel at high speed in straight lines in a vacuum [1], cause emission of light when they strike a fluorescent screen [1], deflected by an electric field [1], deflected by a magnetic field [1].

4 **(a)** emits electrons [1] **(b)** accelerates electrons [1]
(c) allow electrons to pass down tube without colliding with gas atoms [1]
(d) control direction in which electrons move [1]
(e) produce spot of light on the screen where the electron beam strikes it [1]

5 upwards (towards the positive plate) [1]

6 upwards [1]

7 downwards [1]

8 **(a)** α-particles [1] **(b)** γ-rays [1] **(c)** γ-rays [1]
(d) α-particles [1] **(e)** β-particles [1] **(f)** α-particles [1]

9 **(a)** β-particles [1] **(b)** α-particles [1] **(c)** γ-rays [1]
(d) β-particles [1] **(e)** γ-rays [1] **(f)** α-particles [1]
(g) β-particles [1]

10 **(a)** Electrons are removed from atoms/molecules [1], leaving behind positive ions [1].
(b) by a Geiger counter/GM tube or a charged electroscope [1]

11 **(a)** **(i)** decreases [1] **(ii)** increases [1]
(b) β [1]; the radiation will pass easily through the paper and be readily detected by a Geiger counter [1].

12 B [1]

13 **(a)** time for activity of a radioactive sample to halve/average time for half the nuclei in a sample to decay [3]
(b) radiation from environment: cosmic rays, radioactive sources in the air and rocks around us [3]

14 one half-life: 5700 years [2]

15 40 minutes [1]

16 G [1]

17 Most of the incident α-particles pass straight through, while some are deflected through an appreciable angle and a few bounce back. [3]

18 **(a)** +1 [1] **(b)** 0 [1] **(c)** +2 [1]
(d) –1 [1] **(e)** 0 [1] **(f)** +2 [1]

19 **(a)** $A = Z + N$ [1] **(b)** Z [1]
(c) **(i)** $^{4}_{2}\mathrm{He}$ [1] **(ii)** $^{0}_{-1}e$ [1] **(iii)** $^{1}_{0}\mathrm{n}$ [1]

20 nuclides that have the same proton number (Z) but different nucleon numbers (A) [3]

21 **(a)** 14 [1]
(b) **(i)** 6 [1] **(ii)** 6 [1] **(iii)** 6 [1]
(c) yes [1]

22 **(a)** **(i)** 131 [1] **(ii)** 54 [1]
(b) 78 [1] **(c)** decreases to 77 [2]

Stretch and challenge

23 **(a)** the break-up of a large nucleus into two smaller nuclei of nearly equal size [2]
(b) **(i)** 144 [2] **(ii)** 36 [2]
(c) **(i)** k.e. of emitted particles [1]
(ii) heats water to produce steam which then drives a generator [1]

24 **(a)** the union of two light nuclei [1] into one heavier nucleus [1]
(b) **(i)** 4 [2] **(ii)** 1 [2]
(c) **(i)** He [1] **(ii)** H [1]
(d) electromagnetic radiation [1]

Exam focus

1 **(a)** 1.9×10^{-16} J [2] **(b)** 1.9×10^{-16} J [2] **(c)** $\sqrt{7400} = 86$ [5]

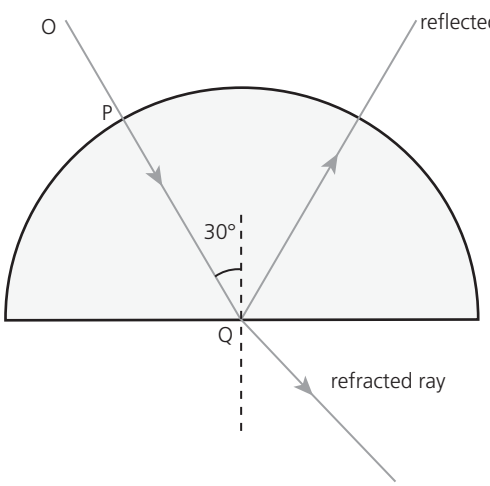
2 **(a)** Two from: damage living cells and tissues leading to cancer, eye cataracts, radiation burns/sickness, death, cause gene mutation. [2]
(b) Two from: radioactive tracers in medicine or agriculture, thickness testing and flaw detection in industry, dating of materials, sterilisation, radiotherapy, smoke detectors. [2]
(c) Two from: use lead or concrete shielding, handle sources with long forceps, keep away from the eyes, keep in lead boxes. [2]

3 (a) (i) 4 [1] **(ii)** 2 [1]
(b) α-particle [1]
(c) causes ionisation of the air [1]

PAST EXAM QUESTIONS

1 (a) 40° [1]
(b) (i) ray reflected at an angle > 40° to BC [1]
(ii) 60° [1] **(iii)** 20° [2]
(c) (i) 2 cm [1] **(ii)** 10 cm [2]

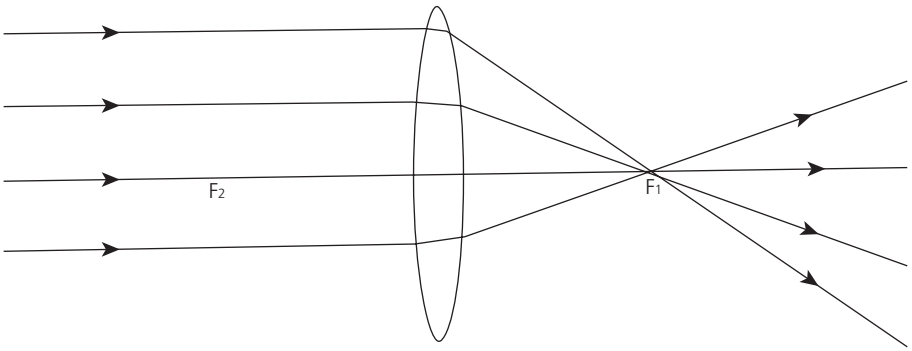
2 (a) at P the angle of incidence $i = 0$, so angle of reflection $r = 0$ [1]
(b) speed reduced, wavelength reduced, frequency unchanged [2]
(c)



[2]

(d) 48° [3]

3 (a) Ray is refracted at each surface of the lens and is bent towards F_1. This is because the refractive index of the lens is higher than that of air and so the light travels more slowly in the lens. [3]
(b) (i) (ii) [3]



(c) (i) X between F_1 and F_2 [1]
(ii) Three from: upright, virtual, larger, same side of lens as object, further from lens than object [3]

4 (a) (i) amplitude [1] **(ii)** wavelength [1]
(b) (i) The vibrating string causes the surrounding air molecules to vibrate backwards and forwards producing regions of high pressure, (compressions) and low pressure (rarefactions). When these pressure variations reach the eardrum, a sound is heard. [2]
(ii) It gets less loud. [1]

5 (a) (i) X-rays or gamma rays [1]
(ii) infra-red or radio waves [1]
(b) 3×10^{20} Hz [2]
(c) 3×10^{8} m/s [1]

6 (a) Displacement method: fill a beaker to overflowing with water then submerge the statue in the water and collect all the displaced liquid in a measuring cylinder – the measured volume equals the volume of the statue. Alternatively, partially fill a measuring cylinder with water and record the volume of water, V_1. Submerge the statue in the water and record the new volume V_2. Then the volume of the statue = V_2–V_1. [3]
(b) $\rho = M/V = 9.2\,g/cm^3$; no [3]

7 (a) micrometer screw gauge [1] **(b)** 2.73 mm [1]
(c) Check zero of gauge; close the instrument, not too tightly, on several sheets of paper; read both scales; divide reading by number of sheets. [3]

8 (a) (i) 120 N cm [1] **(ii)** 60 N cm [1] **(iii)** 3 N [3]
(b) 18 [3]

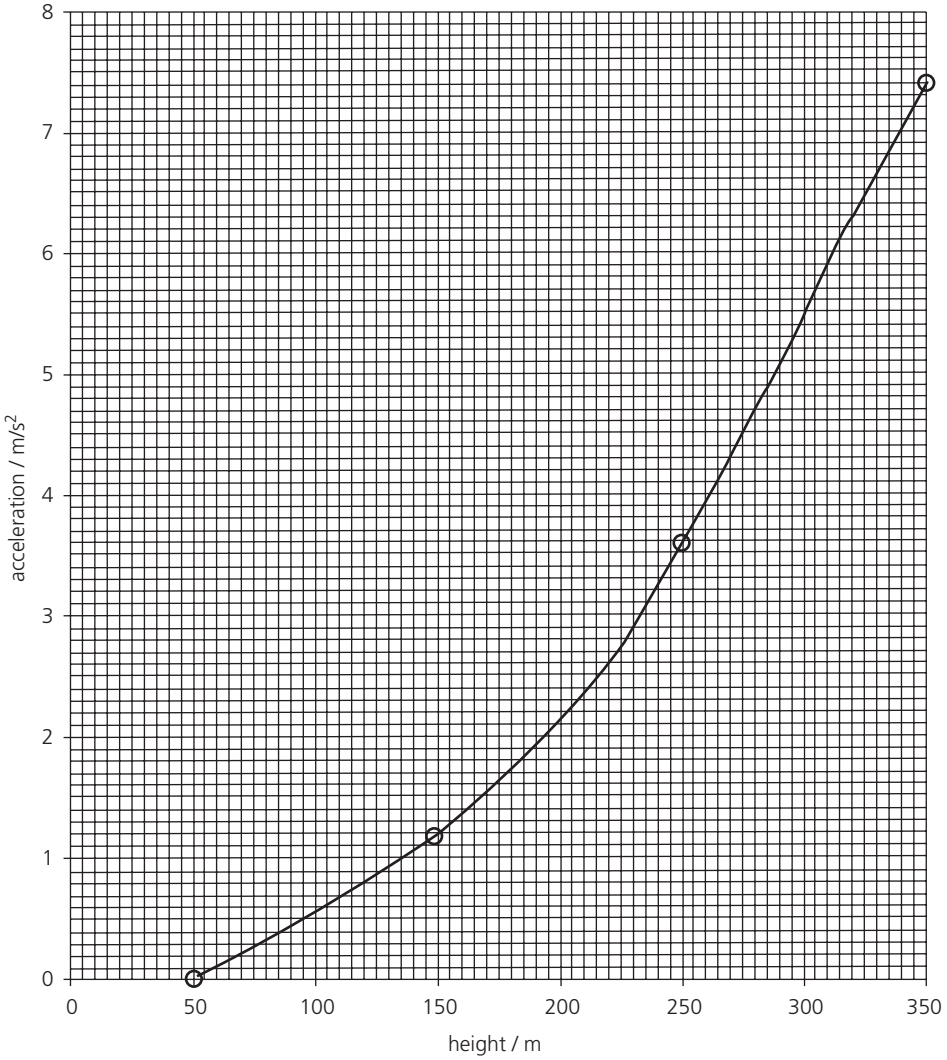
9 (a) Racing car [1]; wide base [1] and low centre of mass [1].
(b) It has wider tyres. [1] **(c)** 2×10^5 Pa [2]

10 (a) kinetic [1] **(b)** strain [1] **(c)** gravitational potential [1]
(d) weight of athlete [1], height of bar [1]

11 work, potential, kinetic, constant/conserved, joules [5]

12 (a) (i) air friction, engine thrust [1]
(ii) upward force (upthrust) [1]
(b) (i) 800 [3]
(ii) tailwind (or headwind on outward journey)/shorter route/less weight/less air friction [1]

13 (a) [2]



(b) (i) decreasing [1] **(ii)** increasing [1]
(c) Resultant force becomes zero because the force down the slope due to gravity and resistive force up the slope become equal. [1]
(d) decreasing [1] **(e)** 216 N [3]

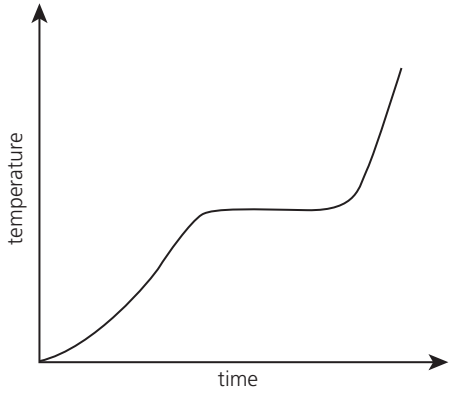
14 (a) in the direction of the force [1]
(b) accelerates object towards centre of the circle [1]
(c) (i) 600 N [1]; 600 N [1] **(ii)** 150 N [2]
(iii) 750 N [1] **(iv)** 600 N [1]

15 (a) 360 J [3] **(b)** 6 W [3]

16 (a) (i) same with piston at A or B [1]
(ii) greater with piston at B [1] **(iii)** greater with piston at B [1]
(b) A and C [2]

17 (a) (i) increases [1] **(ii)** 1.40×10^5 Pa [3] **(iii)** 175 N [4]
(b) (i) increases [1] **(ii)** no change [1] **(iii)** add extra weight [1]
(iv) increases [1]

18 (a) (i) A and B: cooling [1]; B and C: solidifying [1]; C and D: cooling [1]
(ii) all ticked [2] **(iii)** solid [1]
(b) [2]

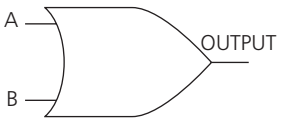


19 (a) (i) Copper is a good conductor of heat. [1]
(ii) Black surfaces are good absorbers of thermal radiation. [1]
(iii) This reduces heat loss from the water pipes to the roof. [1]
(iv) This traps long-wavelength infrared radiated from the water pipes. [1]
(b) 9.24×10^7 J [4]

20 (a) (i) series **(ii)** parallel [1]
(b) (i) 480 [2] **(ii)** 0.025 A [4] **(iii)** 5 V [2]
(iv) Connect a voltmeter between A and B. [2]

21 (a) diode [1] **(b) (i)** 2 Ω [1] **(ii)** 6 Ω [3]
(c) Current = zero/very small. Diode is reversed/wrong way round.
(d) B [3]

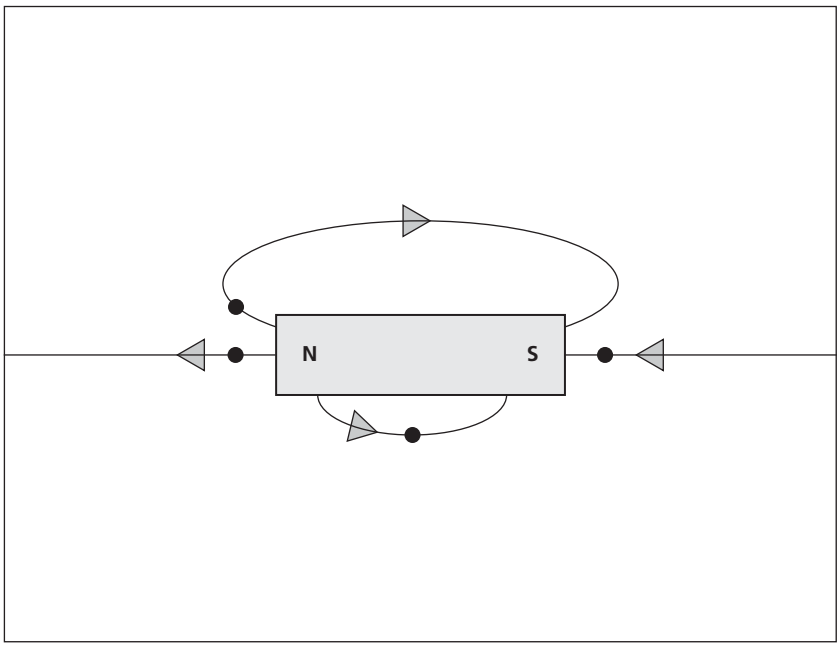
22 (a) [1]



(b) Output is low/zero if both inputs are low/zero. Output is high/on if one or both input is high/on. [2]
(c) Switches in doors are on if doors are open, or vice versa. Switches in doors provide inputs to gate. Output of gate controls the alarm; it switches the alarm on if the output is high. [3]

23 (a) A: NOT [1]; B: AND [1]
(b) (i) A: high; B: low [1] **(ii)** A; high; B: high [1]
(iii) A: low; B: low [1]
(c) (i) Output of B cannot provide enough power for the lamp. [1]
(ii) dark and warm [1]
(iii) high temperature warning light in a refrigerator/freezer [1]

24 (a) and **(b)** [6]



25 (a) (i) magnet which operates when there is a current, or a coil wrapped around an iron bar [1]
(ii) can be switched on/off [1]
(b) There is a changing magnetic field around the iron bar. Flux linkage changes/field lines are cut. An emf is induced. [3]
(c) (i) is magnetised [1]
(ii) is attracted towards the core [1]
(iii) the contacts close together [1]
(d) Any two from: the armature becomes permanently magnetised; the armature wouldn't release from the core; the contacts would be permanently closed. [2]

26 (a) Alternating voltage across primary gives a.c. in primary coil, which causes a changing magnetic field in the core. This leads to a changing magnetic field, cutting through the secondary coil as it grows and collapses, and hence to an induced p.d. across the secondary coil. **[3]**
(b) larger number of turns on secondary coil than on primary coil **[1]**
(c) 720 A **[2]**
(d) lower current so less power loss in transmission lines; cables can be thinner **[2]**

27 (a) electrons [3]
(b) A [1]
(c) (i) D [1]
(ii) to detect electrons/make the spot visible [1]
(d) deflects them [1]
(e) So there is no air/particles; to stop/slow down the electrons/cathode rays. [2]

28 (a) (i) proton [1] **(ii)** proton and neutron [1]
(b) number of protons = 47; number of neutrons = 60 [2]
(c) (i) 8 hours [1]
(ii) possible points on graph include:
16 hours, 80 counts/s
24 hours, 40 counts/s
13.5 hours, 100 counts/s
21.5 hours, 50 counts/s
16.5 hours, 75 counts/s [2]