SCIENCE (PHYSICS) – Paper 2 Physics (set 2.9) – mark scheme

Use this to mark your own attempt. Accept any correct alternative that answers the question as set. Marks are for the ideas, not the exact words. Unless stated, ecf (error carried forward) applies in calculations. Chermistry practice paper – not an official examination paper.

Total marks: 65 (Section A: 55 marks; Section B: one question of 10 marks)

Textbook references are quoted word for word from *Discover Physics, 5th ed*.

Section A – Question 1 [3]

Part	Answer and mark points	Marks
1(a)	numerical magnitude = 540; unit = kilogram (kg) (both correct) (1) **Accept:** 540 and kg. NOT: "540 kg" given as the magnitude; NOT: mass as the unit **Textbook: Discover Physics, 5th ed., p. 3 (Ch 1 Physical Quantities, Units and Measurements, 1.2)** > *"A physical quantity is a quantity that can be measured. It consists of a numerical magnitude and a unit."*	1
1(b)(i)	a scalar has magnitude (size) only; a vector has both magnitude and direction (1) **Accept:** both halves are needed **Textbook: Discover Physics, 5th ed., p. 12 (Ch 1 Physical Quantities, Units and Measurements, 1.4)** > *"Scalar quantities are physical quantities that have only magnitude."* **Textbook: Discover Physics, 5th ed., p. 12 (Ch 1 Physical Quantities, Units and Measurements, 1.4)** > *"Vector quantities are physical quantities that have both magnitude and direction."*	1
1(b)(ii)	distance = 7.0 km (scalar); displacement = 3.0 km (due) east of the gate (direction needed); the vector is the displacement (all three correct) (1) **Accept:** NOT: displacement 7.0 km. NOT: displacement 3.0 km with no direction. NOT: displacement 5.0 km **Textbook: Discover Physics, 5th ed., p. 12 (Ch 1 Physical Quantities, Units and Measurements, 1.4)** > *"The total length covered by a moving object regardless of the direction of motion"* **Textbook: Discover Physics, 5th ed., p. 12 (Ch 1 Physical Quantities, Units and Measurements, 1.4)** > *"The distance measured in a straight line in a specified direction"*	1

Section A – Question 2 [3]

Part	Answer and mark points	Marks
2(a)(i)	speed = distance / time = 60 / 20 = **3.0 m/s** (1) **Accept:** 3 m/s. NOT: 60 m/s (a distance read as a speed) **Textbook: Discover Physics, 5th ed., p. 18 (Ch 2 Kinematics, 2.1)** > *"Speed is the distance travelled per unit time. Its SI unit is metre per second (m/s)."*	1
2(a)(ii)	velocity is the rate of change of displacement (displacement per unit time; speed in a stated direction) (1) **Accept:** velocity = displacement / time taken. NOT: "velocity is the speed" (no reference to direction or displacement) **Textbook: Discover Physics, 5th ed., p. 22 (Ch 2 Kinematics, 2.1)** > *"Velocity is the rate of change in displacement. Its SI unit is metre per second (m/s)."*	1

2(b)	the truck is moving with increasing speed (non-uniform speed) because the gradient of the graph keeps increasing (1) **Accept:** speeding up / accelerating together with the line curving upwards (gradient increasing); both the motion and the feature are needed. NOT: moving at constant speed **Textbook: Discover Physics, 5th ed., p. 27 (Ch 2 Kinematics, 2.2)** *"The gradient of a distance-time graph of an object gives the speed of the object."* **Textbook: Discover Physics, 5th ed., p. 28 (Ch 2 Kinematics, 2.2)** *"The graph has an increasing gradient. The speed of the car increases."*	1

Section A – Question 3 [4]

Part	Answer and mark points	Marks
3(a)	• PQ: uniform acceleration, the graph is a straight line sloping upwards (constant positive gradient) • QR: uniform speed (constant speed), the graph is a horizontal line (zero gradient) • RS: non-uniform acceleration (deceleration that changes), the graph is a curve (gradient changes and is negative) • two marks for all three motions correct; one mark for two correct (features may be omitted if motions are correct) **Accept:** RS: slowing down with non-uniform deceleration. NOT: uniform deceleration for RS **Textbook: Discover Physics, 5th ed., p. 28 (Ch 2 Kinematics, 2.2)** *"The gradient of a speed-time graph of an object gives the acceleration of the object."*	2
3(b)	• time for QR = 14 − 4 = 10 s (1) • $P = E / t = 1.2 \times 10^4 / 10 =$ **1200 W** (1.2×10^3 W) (1) **Accept:** allow 1.2 kW. Only the first mark if the time is read incorrectly (ecf for the power mark) **Textbook: Discover Physics, 5th ed., p. 115 (Ch 6 Energy, 6.2)** *"Power is defined as the work done or energy transferred per unit time."*	2

Section A – Question 4 [6]

Part	Answer and mark points	Marks
4(a)	• volume = $0.50 \times 0.20 \times 0.10 = 0.010$ m^3 (1) • density = mass / volume = 27 / 0.010 = **2700 kg m^{-3}** (1) **Accept:** 2.7×10^3 kg/m^3; 2.7 g/cm^3. Second mark is ecf from the volume	2
4(b)(i)	the gravitational force per unit mass placed at that point (1) **Accept:** g = W / m; force per kg of mass **Textbook: Discover Physics, 5th ed., p. 51 (Ch 3 Force and Pressure, 3.2)** *"Gravitational field strength g is defined as the gravitational force per unit mass placed at that point."*	1
4(b)(ii)	g = W / m = 270 / 27 = **10 N/kg** (1) **Accept:** 10 m/s^2	1
4(c)(i)	pressure is the force acting per unit area (force acting normally / perpendicular to a surface divided by the area) (1) **Accept:** pressure = force / area **Textbook: Discover Physics, 5th ed., p. 57 (Ch 3 Force and Pressure, 3.4)** *"Pressure is the force acting per unit area."*	1

4(c)(ii)	the greatest pressure is on the smallest face: area = 0.20 × 0.10 = 0.020 m^2; $p = F / A$ = 270 / 0.020 = **13 500 Pa** (1.35 × 10^4 Pa) (1) **Accept:** 13.5 kPa; 13 500 N/m^2. NOT: 2700 Pa or 5400 Pa (the largest or the middle face used: 270 / 0.10, 270 / 0.050) **Textbook: Discover Physics, 5th ed., p. 59 (Ch 3 Force and Pressure, 3.4)** *"The pressure is maximum when the contact area is minimum."*	1

Section A – Question 5 [5]

Part	Answer and mark points	Marks
5(a)(i)	15 000 N because the speed is constant, so the forces are balanced (resultant force is zero) (1) **Accept:** NOT: 15 000 N with no reason **Textbook: Discover Physics, 5th ed., p. 66 (Ch 4 Dynamics, 4.1)** *"Newton's First Law of Motion states that every object will continue in its state of rest or uniform motion in a straight line unless a resultant force acts on it."*	1
5(a)(ii)	the (friction) force of the ground on the tracks, pushing the bulldozer forwards; it acts on the tracks (bulldozer) (1) **Accept:** an equal and opposite force of the ground on the bulldozer. NOT: the weight of the bulldozer **Textbook: Discover Physics, 5th ed., p. 69 (Ch 4 Dynamics, 4.1)** *"Thus, for every action, there is an equal and opposite reaction."* **Textbook: Discover Physics, 5th ed., p. 70 (Ch 4 Dynamics, 4.1)** *"Action and reaction forces act on different bodies."*	1
5(b)	$a = F / m$ = 6000 / 8000 = **0.75 m/s^2** (1)	1
5(c)	• distance = 1.5 × 8.0 = 12 m (1) • $W = F s$ = 15 000 × 12 = **1.8 × 10^5 J** (180 000 J) (1) **Accept:** allow 180 kJ. 1 mark for 15 000 × 1.5 × 8.0 set up with an arithmetic slip	2

Section A – Question 6 [3]

Part	Answer and mark points	Marks
6(a)	the perpendicular distance from P to the line of action of the force is greater, so the moment (turning effect) of his force about P is greater (1) **Accept:** moment = force × perpendicular distance. NOT: the force is bigger **Textbook: Discover Physics, 5th ed., p. 83 (Ch 5 Turning Effects of Forces, 5.1)** *"The turning effect of the force is proportional to: the perpendicular distance from the pivot where the force is applied; and the magnitude of the force applied."* **Textbook: Discover Physics, 5th ed., p. 83 (Ch 5 Turning Effects of Forces, 5.1)** *"Thus, using a longer spoon creates a greater turning effect."*	1
6(b)	• perpendicular distance from P to the line of action of the force (vertical) = 1.00 m (not 1.15 m) (1) • moment = $F d$ = 150 × 1.00 = **150 N m** (1) **Accept:** 15 000 N cm. Using 1.15 m gives 172.5 N m: neither mark is awarded (wrong distance, no ecf); the unit N m is required for the second mark **Textbook: Discover Physics, 5th ed., p. 83 (Ch 5 Turning Effects of Forces, 5.1)** *"The moment of a force M, or torque about a pivot is the product of the force F and the perpendicular distance d from the pivot to the line of action of the force."*	2

Section A – Question 7 [5]

Part	Answer and mark points	Marks
7(a)	• the aluminium solidifies (freezes) at a constant temperature of 660 °C (1) • energy is transferred out of the aluminium to the surroundings, but this reduces the potential energy of the particles (they come closer together); the average kinetic energy of the particles stays constant, so the temperature does not change (1) **Accept:** NOT: no energy is transferred; NOT: the aluminium is too hot to cool **Textbook: Discover Physics, 5th ed., p. 129 (Ch 7 Kinetic Particle Model of Matter, 7.2)** > *"During condensation and solidification, energy is transferred out of the substance. The average separation of the particles decreases and so the potential energy of the particles decreases."* **Textbook: Discover Physics, 5th ed., p. 129 (Ch 7 Kinetic Particle Model of Matter, 7.2)** > *"However, during these processes of changing states, the average kinetic energy of the particles remains constant. Hence, the temperature stays constant."*	2
7(b)	the water next to the heater expands and becomes less dense, so it rises; the cooler, denser water from the top sinks to take its place; these convection currents carry energy through the whole tank (1) **Accept:** warm water is less dense than the water around it and rises; cold water is denser and sinks. NOT: hot water rises (no reference to density or to the sinking cooler water) **Textbook: Discover Physics, 5th ed., p. 139 (Ch 8 Thermal Processes, 8.2)** > *"The warm liquid, being less dense than its surroundings, will rise. The cold liquid, being denser, will sink."* **Textbook: Discover Physics, 5th ed., p. 139 (Ch 8 Thermal Processes, 8.2)** > *"The liquid at the bottom of the pot expands due to heating via conduction through the bottom of the pot."*	1
7(c)	• the furnace emits infrared (electromagnetic) radiation, which needs no medium and travels through the air to the worker (1) • a shiny surface is a poor absorber (good reflector) of radiation, so it absorbs energy at a slower rate (1) **Accept:** NOT: the shiny suit conducts the heat away; NOT: heat is carried by convection currents only **Textbook: Discover Physics, 5th ed., p. 140 (Ch 8 Thermal Processes, 8.2)** > *"Radiation is the process of energy transfer by electromagnetic waves. It does not require a medium."* **Textbook: Discover Physics, 5th ed., p. 142 (Ch 8 Thermal Processes, 8.2)** > *"The shiny, smooth and light-coloured surface of an object absorbs incoming radiation at a slower rate."*	2

Section A – Question 8 [5]

Part	Answer and mark points	Marks
8(a)	energy is transferred; matter (the rock particles themselves) is not transferred (1) **Accept:** both halves needed **Textbook: Discover Physics, 5th ed., p. 156 (Ch 9 General Wave Properties I, 9.1)** > *"A wave is a disturbance that propagates through space, transferring energy with it but not matter."*	1

8(b)	• transverse: vibration perpendicular to the direction of wave travel; longitudinal: vibration parallel to the direction of wave travel (1) • one correct example of each (not seismic waves): transverse, e.g. light (any electromagnetic wave), waves on a plucked guitar string; longitudinal, e.g. sound waves (1) **Accept:** the second mark needs BOTH examples. NOT: sound as a transverse wave **Textbook: Discover Physics, 5th ed., p. 158 (Ch 9 General Wave Properties I, 9.2)** > *"A transverse wave has a direction of vibration that is perpendicular to the direction of wave travel (Figure 9.9)."* **Textbook: Discover Physics, 5th ed., p. 158 (Ch 9 General Wave Properties I, 9.2)** > *"A longitudinal wave has a direction of vibration that is parallel to the direction of wave travel (Figure 9.10)."*	2
8(c)(i)	the end of the girder (the steel) vibrates when it is struck: it is the vibrating source (1) **Accept:** the girder / hammer blow makes the steel vibrate. NOT: the hammer is loud; NOT: the air **Textbook: Discover Physics, 5th ed., p. 172 (Ch 10 General Wave Properties II - Sound, 10.1)** > *"Sound is a longitudinal wave created by a vibrating source."*	1
8(c)(ii)	the vibrating end makes the neighbouring steel particles (atoms) vibrate and the vibrations are passed on from particle to particle along the girder (the steel is the medium needed to transmit the sound) (1) **Accept:** the particles of the medium pass the vibration on to their neighbours. NOT: sound travels through a vacuum; NOT: the steel particles themselves travel along the girder **Textbook: Discover Physics, 5th ed., p. 173 (Ch 10 General Wave Properties II - Sound, 10.1)** > *"Sound travels when the vibrations of atoms are passed on to neighbouring atoms."*	1

Section A – Question 9 [7]

Part	Answer and mark points	Marks
9(a)	• (i) **infrared** (1) • (ii) **X-rays** (1) **Accept:** infra-red; IR. gamma rays for (ii) (gamma-ray radiography). NOT: ultraviolet; NOT: visible light **Textbook: Discover Physics, 5th ed., p. 190 (Ch 11 Electromagnetic Waves, 11.2)** > *"Infrared thermometers detect the characteristics of the infrared emitted by a person to determine the body temperature. The same technology can detect and construct the temperature map of a subject of object."* **Textbook: Discover Physics, 5th ed., p. 193 (Ch 11 Electromagnetic Waves, 11.2)** > *"X-rays are used to scan manufactured goods for hidden defects and cracks."*	2
9(b)	a dashed line drawn at 90° to the mirror at P (normal) AND *i* marked between the incident ray and the normal AND *r* marked between the reflected ray and the normal AND r = 90 − 40 = **50°** (all four needed) (1) **Accept:** angles measured from the mirror surface score 0 (r = 40° is wrong); the normal need not be dashed **Textbook: Discover Physics, 5th ed., p. 202 (Ch 12 Light, 12.1)** > *"The second law of reflection states that the angle of incidence θi is equal to the angle of reflection θr."*	1

9(c)	• the lens refracts (bends) the rays of the beam towards the principal axis (the rays converge) (1) • the rays meet (are brought to a focus) at a point on the principal axis, the principal focus (focal point) F (1) **Accept:** NOT: the lens spreads the rays out **Textbook: Discover Physics, 5th ed., p. 215 (Ch 12 Light, 12.3)** > *"A device made of glass or other transparent material that is able to concentrate light rays is called a converging lens (Figure 12.33)."* **Textbook: Discover Physics, 5th ed., p. 216 (Ch 12 Light, 12.3)** > *"The point on the principal axis where all rays parallel to the principal axis meet after passing through the lens"*	2
9(d)	• virtual (the image is formed on the same side of the lens as the object; rays appear to come from it, dashed lines) (1) • magnified and upright (all three characteristics correct for 2 marks; two correct for 1 mark) (1) **Accept:** NOT: real; NOT: diminished; NOT: inverted **Textbook: Discover Physics, 5th ed., p. 217 (Ch 12 Light, 12.3)** > *"In this arrangement, the lens will function as a magnifying glass. Hence the viewer will see an enlarged image of the object."* **Textbook: Discover Physics, 5th ed., p. 217 (Ch 12 Light, 12.3)** > *"A virtual image cannot be formed on a screen placed at its image plane."*	2

Section A – Question 10 [4]

Part	Answer and mark points	Marks
10(a)(i)	**0.30 A** (1) **Accept:** NOT: a smaller reading **Textbook: Discover Physics, 5th ed., p. 250 (Ch 14 D.C. Circuits, 14.1)** > *"In a series circuit, the current at every point is the same."*	1
10(a)(ii)	the current at every point in a series circuit is the same; the lamps transfer energy (the charge carrying it is not used up) (1) **Accept:** charge / current is not used up, it is conserved. NOT: the lamps are identical **Textbook: Discover Physics, 5th ed., p. 250 (Ch 14 D.C. Circuits, 14.1)** > *"In a series circuit, the current at every point is the same."*	1
10(b)	• the two branches are in parallel, so each has 12 V across it; resistance of the branch with the 20 Ω resistor = 10 + 20 = 30 Ω, so its current = 12 / 30 = 0.40 A (1) • p.d. across the 20 Ω resistor = 0.40 × 20 = **8.0 V** (1) **Accept:** 12 × 20 / (10 + 20) = 8.0 V (potential divider). The second mark is ecf from the branch current. NOT: 12 V; NOT: 6.0 V (12 V shared equally between the two resistors)	2

Section A – Question 11 [5]

Part	Answer and mark points	Marks
11(a)	the wire that carries the current (and the high voltage, 230 V, relative to earth) from the mains supply to the appliance (1) **Accept:** the wire at high potential. NOT: the wire that gives electric shocks only **Textbook: Discover Physics, 5th ed., p. 280 (Ch 15 Practical Electricity, 15.2)** > *"The live wire is usually brown. It carries both the high voltage and the current."*	1

11(b)	• the metal casing is connected to earth by the earth wire, which has a very low resistance, so a large current flows through the earth wire to the ground (instead of through the user) (1) • the large current melts the fuse (breaks the circuit) so the casing is no longer live (1) **Accept:** NOT: the earth wire stops the current flowing; NOT: the earth wire is plastic **Textbook: Discover Physics, 5th ed., p. 279 (Ch 15 Practical Electricity, 15.2)** > *"An earthed metal casing is a metal housing that encloses the electrical parts of an appliance and is connected to the earth, keeping the user safe in the event of an electrical fault. The live current passing through the earth metal casing flows to the ground. As Earth wire has very little resistance, it is likely that the fuse will be blown. This prevents further current flow."*	2
11(c)(i)	the brown (live) wire is connected to terminal N and the blue (neutral) wire to terminal L; they are swapped (1) **Accept:** live and neutral wires connected to the wrong terminals; the blue (neutral) wire is connected to the live terminal / through the fuse **Textbook: Discover Physics, 5th ed., p. 280 (Ch 15 Practical Electricity, 15.2)** > *"The neutral wire is blue and is kept at zero voltage. It completes the path for current to flow through appliances in the electrical circuit."*	1
11(c)(ii)	the live wire (brown) (1) **Accept:** NOT: the neutral wire; NOT: the earth wire **Textbook: Discover Physics, 5th ed., p. 281 (Ch 15 Practical Electricity, 15.2)** > *"Switches and safety features such as fuses and circuit breakers have to be connected to the live wire in order to break or complete a circuit."*	1

Section A – Question 12 [5]

Part	Answer and mark points	Marks
12(a)	• when freely suspended (e.g. on a thread) it comes to rest pointing north-south (1) • one end repels the pole of a known magnet (like poles repel, unlike poles attract) / only a magnet can be repelled by another magnet (1) **Accept:** NOT: it attracts iron (unmagnetised steel is also attracted); other valid property: the attraction is strongest at the ends (poles) of the bar **Textbook: Discover Physics, 5th ed., p. 288 (Ch 16 Magnetism and Electromagnetism, 16.1)** > *"When two pieces of magnets are placed together, the like poles of the magnet repel while the unlike poles attract (Figure 16.2)."* **Textbook: Discover Physics, 5th ed., p. 289 (Ch 16 Magnetism and Electromagnetism, 16.1)** > *"We can determine if an object is a magnet or not by whether it gets repelled by another magnet (Figure 16.7)."*	2
12(b)	at least four closed-loop lines leaving the N pole, curving round the outside of the magnet and entering the S pole, not crossing, closer together near the poles; each line has an arrow pointing out of N and into S (1) **Accept:** the arrows must point away from the N pole and towards the S pole; lines that cross, or that do not touch the poles, or have no arrows score 0 **Textbook: Discover Physics, 5th ed., p. 297 (Ch 16 Magnetism and Electromagnetism, 16.2)** > *"The magnetic field lines never cross one another."* **Textbook: Discover Physics, 5th ed., p. 297 (Ch 16 Magnetism and Electromagnetism, 16.2)** > *"By convention, the field lines have arrows that point out from the north pole of the magnet and point into the south pole."*	1
12(c)(i)	wires drawn so that terminal X, the cell, the switch and terminal Y form one complete circuit in series (cell and switch connected between X and Y; no short circuit across the cell) (1) **Accept:** either order of cell and switch; the cell may be connected either way round	1

12(c)(ii)	the copper wire swings (moves) sideways, out of (or into) the gap between the poles, when the switch is closed; when the connections to the cell are reversed (current reversed) it swings in the opposite direction (both statements needed) (1) **Accept:** either direction of swing for the first statement, as it depends on which way round the cell was connected in (i); reversing the magnetic field (the poles) also reverses the swing, as a bonus point. NOT: the wire does not move **Textbook: Discover Physics, 5th ed., p. 309 (Ch 16 Magnetism and Electromagnetism, 16.4)** > *"When the switch is closed, the copper wire frame immediately swings outwards (Figure 16.51(a))."* **Textbook: Discover Physics, 5th ed., p. 309 (Ch 16 Magnetism and Electromagnetism, 16.4)** > *"If the connection of the terminals is reversed, the copper wire frame swings in the opposite direction."*	1

Section B – Question 13 [10]

Part	Answer and mark points	Marks
13(a)(i)	• protons and neutrons are in the nucleus at the centre of the atom; the electrons move around the nucleus (1) • protons are positively charged, neutrons carry no charge, electrons are negatively charged (1) **Accept:** relative charges +1, 0, −1. Both statements are needed for each mark **Textbook: Discover Physics, 5th ed., p. 319 (Ch 17 Radioactivity, 17.1)** > *"An atom consists of a positively charged nucleus (plural: nuclei) and negatively charged electrons moving around the nucleus (Figure 17.1)."* **Textbook: Discover Physics, 5th ed., p. 319 (Ch 17 Radioactivity, 17.1)** > *"The nucleus of an atom consists of two types of particles — protons and neutrons."*	2
13(a)(ii)	it has equal numbers of protons and electrons (13 each), so the total positive charge equals the total negative charge (1) **Accept:** NOT: neutrons make it neutral **Textbook: Discover Physics, 5th ed., p. 320 (Ch 17 Radioactivity, 17.1)** > *"In a neutral atom, the total positive charge equals the total negative charge. Therefore, in a neutral atom, the number of protons is the same as the number of electrons."*	1
13(b)(i)	the foil has become thicker, because the thicker foil absorbs more of the beta radiation so fewer beta particles reach the detector (1) **Accept:** less radiation reaches the detector so the foil must be thicker. NOT: thinner **Textbook: Discover Physics, 5th ed., p. 333 (Ch 17 Radioactivity, 17.3)** > *"A detector measures the amount of radiation passing through. If the material is too thick, the amount of radiation is low and vice versa."*	1
13(b)(ii)	the radiation can kill (damage) living cells, cause mutations or cancer (1) **Accept:** NOT: it makes the workers radioactive **Textbook: Discover Physics, 5th ed., p. 334 (Ch 17 Radioactivity, 17.3)** > *"The energy carried by the radiation can kill cells, and cause mutation and cancer."*	1
13(c)(i)	the droplets all carry the same (positive) charge and like charges repel each other (1) **Accept:** they repel one another. NOT: they are attracted to the air **Textbook: Discover Physics, 5th ed., p. 226 (Ch 13 Electric Charge and Current of Electricity, 13.1)** > *"Like charges repel each other while unlike charges attract each other."*	1
13(c)(ii)	the droplets are positive and the panel is negative; unlike charges attract (1) **Accept:** opposite charges attract. NOT: like charges attract **Textbook: Discover Physics, 5th ed., p. 226 (Ch 13 Electric Charge and Current of Electricity, 13.1)** > *"Like charges repel each other while unlike charges attract each other."*	1

13(c)(iii)	B is negative, because it repels the negative droplet A and like charges repel (1) **Accept:** both the sign and the reason are needed. NOT: B is positive **Textbook: Discover Physics, 5th ed., p. 226 (Ch 13 Electric Charge and Current of Electricity, 13.1)** *"Like charges repel each other while unlike charges attract each other."*	1
13(d)	• R is directly proportional to length and inversely proportional to area; the resistance and material are the same, so the length is proportional to the area: length of Q = 40 × (4.0 / 2.5) (1) • **64 m** (1) **Accept:** NOT: 40 × (2.5 / 4.0) = 25 m (ratio inverted): 1 mark at most, only if the proportionality is stated **Textbook: Discover Physics, 5th ed., p. 239 (Ch 13 Electric Charge and Current of Electricity, 13.4)** *"The longer the cylinder, the more collisions the electrons will make with its atom. Hence, the resistance R of the cylindrical resistor is directly proportional to the length of the cylinder l."* **Textbook: Discover Physics, 5th ed., p. 239 (Ch 13 Electric Charge and Current of Electricity, 13.4)** *"The larger the cross-sectional area A of the cylinder, the greater the number of electrons that can flow through it. Therefore, the resistance R of the cylindrical resistor is inversely proportional to the area of the cylinder A."*	2

Section B – Question 14 [10]

Part	Answer and mark points	Marks
14(a)(i)	• $I = P / V$ = 1800 / 230 = 7.8 A (1) • 10 A fuse: its rating is just above the normal current, so it does not blow in normal use, but it melts before a dangerously large current can flow (13 A is too high, 5 A would blow in normal use) (1) **Accept:** the answer 10 A with a reason that mentions the rating being above the normal current (7.8 A) **Textbook: Discover Physics, 5th ed., p. 277 (Ch 15 Practical Electricity, 15.2)** *"A fuse has to have a current rating greater than the current drawn. Otherwise the fuse will blow even before the kettle can work."*	2
14(a)(ii)	the fuse wire melts when the current exceeds its rating, breaking the circuit so the current stops and the wiring does not overheat (1) **Accept:** NOT: the fuse reduces the current **Textbook: Discover Physics, 5th ed., p. 276 (Ch 15 Practical Electricity, 15.2)** *"A fuse is a safety device added to an electric circuit to prevent excessive current flow. It consists of a strip of fusible wire that will melt when the current flowing through it exceeds a certain value (Figure 15.12(a))."*	1
14(b)	• energy used = 4951 − 4735 = 216 kW h (1) • cost = 216 × 0.26 = **$56.16** (1) **Accept:** $56; $56.2. ecf for the energy; using the 1.8 kW rating as the energy (1800 × 0.26) loses both marks **Textbook: Discover Physics, 5th ed., p. 271 (Ch 15 Practical Electricity, 15.1)** *"One kW h of electricity is the energy used by a 1 kW device in an hour."*	2
14(c)(i)	**up the page** (1) **Accept:** NOT: down the page **Textbook: Discover Physics, 5th ed., p. 310 (Ch 16 Magnetism and Electromagnetism, 16.4)** *"First, the left hand is held out with the forefinger, second finger and thumb perpendicular to each other (Figure 16.53). Next, the first finger is oriented in the direction of the magnetic field from north to south, and the second finger in the direction of conventional current. The resultant force that is induced by the current-carrying conductor will be given by the direction the thumb is pointing to."*	1

14(c)(ii)	**out of** the paper (the force is reversed with the same current, so the field must be reversed) (1) **Accept:** NOT: into the paper **Textbook: Discover Physics, 5th ed., p. 310 (Ch 16 Magnetism and Electromagnetism, 16.4)** *"Fleming's left-hand rule is used to find either the direction of the force, magnetic field or current when the directions of any two of these are known."*	1
14(c)(iii)	**up the page** (unchanged): reversing the current reverses the force and reversing the field reverses it again, so the force is back in its original direction (1) **Accept:** both the direction and the reason are needed. NOT: down the page **Textbook: Discover Physics, 5th ed., p. 309 (Ch 16 Magnetism and Electromagnetism, 16.4)** *"Reversing the direction of current induces a swing in the opposite direction."* **Textbook: Discover Physics, 5th ed., p. 309 (Ch 16 Magnetism and Electromagnetism, 16.4)** *"Reversing the polarity of the magnet also reverses the direction of the swing."*	1
14(d)	• force on P is upwards and force on Q is downwards (both directions correct) (1) • the forces are equal in size and opposite in direction and act on opposite sides of the axle, so their moments about the axle are in the same direction and the coil turns (turning effect) (1) **Accept:** NOT: the magnets rotate the coil without reference to forces on the two sides; NOT: P down and Q up **Textbook: Discover Physics, 5th ed., p. 312 (Ch 16 Magnetism and Electromagnetism, 16.4)** *"The current-carrying coil experiences an equal force on parts AB and CD of the coil. This force is created by the motor effect on each side of the coil."* **Textbook: Discover Physics, 5th ed., p. 312 (Ch 16 Magnetism and Electromagnetism, 16.4)** *"The forces produce a turning effect that is equal in magnitude on each wire."*	2