SCIENCE (PHYSICS) – Paper 2 Physics (set 2.6) – 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 [6]

Part	Answer and mark points	Marks
1(a)	• length: **metre**, **m** • time: **second**, **s** • thermodynamic temperature: **kelvin**, **K** **Accept:** 2 marks for 5 or 6 correct entries; 1 mark for 3 or 4 correct entries. NOT: degree Celsius or °C for temperature; NOT: minute or hour for time **Textbook: Discover Physics, 5th ed., p. 3 (Ch 1 Physical Quantities, Units and Measurements, 1.2)** *"Table 1.1 shows some base quantities and their corresponding SI units."*	2
1(b)	• P: the line is straight and sloping, so the trolley moves with uniform (constant) speed (1) • Q: the line is horizontal (gradient zero), so the trolley is at rest (stationary) (1) • R: the line is a curve with an increasing gradient, so the trolley moves with non-uniform speed (its speed is increasing) (1) **Accept:** 3 correct = 2 marks; 2 correct = 1 mark; 1 correct = 0. A correct reason without the conclusion does not score. NOT: Q: the trolley moves 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. 31 (Ch 2 Kinematics, 2.2 (Worked Example 2H))** *"For region A, as the line is horizontal from t = 0 s to t = 0.8 s, the gradient is zero. The speed of the car is zero so the car is at rest."*	2
1(c)	• at rest: **A** (speed is zero; horizontal line on the time axis) • uniform acceleration: **B** (straight line sloping upwards, constant gradient) • non-uniform acceleration: **C** (curve, the gradient is decreasing) • constant speed: **D** (horizontal line above the time axis, gradient zero) **Accept:** 4 correct = 2 marks; 2 or 3 correct = 1 mark; fewer than 2 correct = 0 **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."* **Textbook: Discover Physics, 5th ed., p. 28 (Ch 2 Kinematics, 2.2 (Figure 2.19, car at rest))** *"The speed of the car remains at 0 m/s for every second."* **Textbook: Discover Physics, 5th ed., p. 29 (Ch 2 Kinematics, 2.2 (Figure 2.21, uniform acceleration))** *"The graph has a positive and constant gradient, and the acceleration is constant."* **Textbook: Discover Physics, 5th ed., p. 29 (Ch 2 Kinematics, 2.2 (Figure 2.24, non-uniform acceleration))** *"The graph has a positive and decreasing gradient, and the acceleration decreases."*	2

Section A – Question 2 [5]

Part	Answer and mark points	Marks
2(a)	• tension (the pull of the cord on the bag): a contact force (1) • weight (the gravitational force of the Earth on the bag): a non-contact force (1) **Accept:** one mark for each correctly named force with the correct type. NOT: gravity is a contact force; NOT: normal force **Textbook: Discover Physics, 5th ed., p. 47 (Ch 3 Force and Pressure, 3.1)** *"The pull exerted by a stretched spring, string or rope on an object attached to it"* **Textbook: Discover Physics, 5th ed., p. 48 (Ch 3 Force and Pressure, 3.1)** *"Non-contact forces are those that do not require objects to be in contact to exist."*	2
2(b)	**10 m/s^2** (approximately) and it is constant (does not change) (1) **Accept:** accept 9.8 to 10 m/s^2. 10 N/kg is not accepted as the unit of acceleration here. Both the value and "constant" are needed **Textbook: Discover Physics, 5th ed., p. 41 (Ch 2 Kinematics, chapter summary (Let's Map It))** *"Acceleration of free fall for a body near Earth is constant and is approximately 10 m/s².*"	1
2(c)	• the bag is in the Earth's gravitational field, which is a region in which a mass experiences a force due to gravitational attraction (1) • this force (the weight) is now the only (unbalanced) force on the bag, so there is a resultant force downwards and it accelerates downwards (1) **Accept:** the force on the bag is a non-contact force. NOT: gravity pulls it (no reference to a field or region) **Textbook: Discover Physics, 5th ed., p. 50 (Ch 3 Force and Pressure, 3.2)** *"A gravitational field is a region in which a mass experiences a force due to gravitational attraction."*	2

Section A – Question 3 [5]

Part	Answer and mark points	Marks
3(a)	• pressure is the force acting per unit area (pressure = force / area) (1) • the weight (force) is spread over a large area, so the pressure on the skin is small (1) **Accept:** pressure = force / area. The second mark needs a link between large area and small pressure. NOT: the mattress reduces the weight of the patient **Textbook: Discover Physics, 5th ed., p. 57 (Ch 3 Force and Pressure, 3.4)** *"Pressure is the force acting per unit area."* **Textbook: Discover Physics, 5th ed., p. 58 (Ch 3 Force and Pressure, 3.4)** *"the smaller the contact area, the larger the pressure."*	2
3(b)	• resultant force = ma = 130 × 1.2 = 156 N (1) • friction = 200 − 156 = **44 N** (1) **Accept:** ecf from a wrong resultant force for the second mark. 156 N alone scores 1 mark. NOT: 200 + 156 = 356 N	2
3(c)	friction (which opposes motion) is now the only horizontal force, so the resultant force is backwards and the bed decelerates (slows down) and comes to rest (1) **Accept:** NOT: the bed stops immediately; NOT: the bed continues at constant speed **Textbook: Discover Physics, 5th ed., p. 74 (Ch 4 Dynamics, 4.3)** *"If the applied force is removed, friction will cause the book to slow down and come to a stop eventually."*	1

Section A – Question 4 [5]

Part	Answer and mark points	Marks
4(a)	• moment = force × perpendicular distance = 14 × 0.30 = **4.2 N m** (1) **Accept:** 420 N cm; 4.2 N m anticlockwise **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."*	1
4(b)	• sum of clockwise moments = sum of anticlockwise moments: F × 0.70 + 7.0 × 0.20 = 14 × 0.30 (weight of the beam acts at its centre, 0.20 m from the pivot) (1) • F = (4.2 − 1.4) / 0.70 = **4.0 N** (1) **Accept:** any consistent unit (cm and N cm). 6.0 N (beam weight omitted) scores 0 for the first mark; ecf for the answer **Textbook: Discover Physics, 5th ed., p. 85 (Ch 5 Turning Effects of Forces, 5.2)** > *"The principle of moments states that when a body is in equilibrium, the sum of clockwise moments about a pivot is equal to the sum of anticlockwise moments about the same pivot."*	2
4(c)	• E_k = ½ m v^2 = ½ × 2.0 × 6.0^2 = 36 J and E_p = m g h = 2.0 × 10 × 1.5 = 30 J (1) • total = 36 + 30 = **66 J** (1) **Accept:** first mark needs both stores correct; second mark for the sum of the candidate's two values (ecf). 30 J + 36 J in either order. NOT: only one of the two stores calculated for the second mark	2

Section A – Question 5 [4]

Part	Answer and mark points	Marks
5(a)(i)	**50 °C** (1) **Accept:** 49 to 51 °C	1
5(a)(ii)	energy continues to be transferred to the wax (it is used to melt it, increasing the potential energy of the particles), without a change in temperature (the average kinetic energy of the particles stays constant) (1) **Accept:** energy is used to break the bonds between particles / do work against the attractive forces. NOT: the wax does not absorb energy; NOT: the heater is switched off **Textbook: Discover Physics, 5th ed., p. 129 (Ch 7 Kinetic Particle Model of Matter, 7.2)** > *"During melting and boiling, energy transferred to the substance results in work done against the attractive intermolecular forces."* **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."*	1

5(b)	• solid wax has a fixed shape; the vapour has no fixed shape (takes the shape of its container) (1) • solid wax has a fixed volume and cannot be compressed; the vapour has no fixed volume and can be compressed (1) **Accept:** any two correct differences from: shape (fixed / no fixed), volume (fixed / no fixed), compressibility (cannot / can), density (higher / lower). NOT: the vapour is lighter / hotter (unqualified) **Textbook: Discover Physics, 5th ed., p. 122 (Ch 7 Kinetic Particle Model of Matter, 7.1 (Figure 7.1, solid))** *"Fixed shape"* **Textbook: Discover Physics, 5th ed., p. 122 (Ch 7 Kinetic Particle Model of Matter, 7.1 (Figure 7.1, gas))** *"No fixed shape"* **Textbook: Discover Physics, 5th ed., p. 122 (Ch 7 Kinetic Particle Model of Matter, 7.1 (Figure 7.1, solid))** *"Cannot be compressed"* **Textbook: Discover Physics, 5th ed., p. 122 (Ch 7 Kinetic Particle Model of Matter, 7.1 (Figure 7.1, gas))** *"Can be compressed"*	2

Section A – Question 6 [6]

Part	Answer and mark points	Marks
6(a)	• the energy is transferred electrically (by an electric current) from the mains supply to the heating element (1) • the energy is then transferred by radiation (propagation of electromagnetic waves, infrared) from the element to the baby, increasing the energy in the internal (thermal) store of the baby (1) **Accept:** the first mark needs "electrically / electric current"; the second needs "radiation / electromagnetic (infrared) waves". NOT: the energy is used up; NOT: by conduction **Textbook: Discover Physics, 5th ed., p. 100 (Ch 6 Energy, 6.1)** *"electrically (by an electric current)."* **Textbook: Discover Physics, 5th ed., p. 100 (Ch 6 Energy, 6.1)** *"by propagation of waves (both electromagnetic and mechanical); and"*	2
6(b)	the energy is transferred by (infrared) radiation, which is electromagnetic waves, and these do not need a medium (material) to travel (1) **Accept:** infrared waves can travel through a vacuum. NOT: the heater heats the air by conduction **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."*	1
6(c)	a shiny (polished) surface is a good reflector (poor absorber) of infrared radiation, so the radiation travelling away from the baby is reflected towards the baby instead of being absorbed by the sheet (1) **Accept:** the sheet reflects the infrared radiation towards the baby. NOT: shiny surfaces are good emitters; NOT: the sheet conducts the heat to the baby **Textbook: Discover Physics, 5th ed., p. 142 (Ch 8 Thermal Processes, 8.2)** *"a surface that reflects red light is often a good reflector for infrared radiation."* **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."*	1

6(d)	• the air near the heater is warmed, expands and becomes less dense, so it rises (1) • cooler, denser air sinks to take its place; this sets up a convection current that carries the energy through the incubator (1) **Accept:** convection currents with a reference to density. NOT: heat rises; NOT: the air is warmed by conduction through the whole of the incubator **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. This difference in density results in convection currents (Figure 8.9)."*	2

Section A – Question 7 [5]

Part	Answer and mark points	Marks
7(a)	• normal drawn (dashed) at O so that it bisects the angle between the incident ray and the reflected ray (angle of incidence = angle of reflection = 40°) (1) • mirror drawn as a straight line through O at 90° to the normal (1) **Accept:** normal within ±2° of the bisector; mirror within ±2° of 90° to the candidate's normal (ecf for the second mark); angles of incidence and reflection may be marked as 40° but this is not required. NOT: mirror drawn along the bisector **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."*	2
7(b)	• refractive index = speed of light in a vacuum / speed of light in the medium (the ratio) (1) • so light travels 1.38 times more slowly in the cornea than in a vacuum (speed in cornea = c / 1.38) (1) **Accept:** $n = c / v$. NOT: the ratio of the angles **Textbook: Discover Physics, 5th ed., p. 210 (Ch 12 Light, 12.2)** > *"The refractive index n of a medium is defined as the ratio of the speed of light in a vacuum to the speed of light in the medium."*	2
7(c)	sunburn (damage to the skin cells, or to the cells of the eye) or a higher risk of skin cancer (1) **Accept:** premature skin ageing; damage to the cells of the eye. NOT: UV makes the person radioactive; NOT: UV makes the body feel hot **Textbook: Discover Physics, 5th ed., p. 195 (Ch 11 Electromagnetic Waves, 11.2)** > *"Sun burn is the most common effect of over-exposure to electromagnetic radiation, specifically caused by too much ultraviolet radiation. Frequent sunburns can cause premature skin aging and higher risk of skin cancer."*	1

Section A – Question 8 [5]

Part	Answer and mark points	Marks
8(a)	• conventional current: **clockwise**; it leaves the positive terminal of the battery (the end with the longer line of the cell symbol, at the top) and passes through the switch and the wire to the negative terminal (1) • electron flow after reversing: **clockwise**; the conventional current is now anticlockwise and the electron flow is opposite in direction to the conventional current (1) **Accept:** the second mark needs the direction and the reason. NOT: anticlockwise for the first mark (that is the direction of the electron flow in the original circuit). Electrons flow from the negative terminal of the battery to the positive terminal **Textbook: Discover Physics, 5th ed., p. 228 (Ch 13 Electric Charge and Current of Electricity, 13.2)** > *"The direction of flow of positive charges is described as the conventional current, which assumes that positive charges flow out of the positive terminal of a battery to the negative terminal (Figure 13.6)."* **Textbook: Discover Physics, 5th ed., p. 229 (Ch 13 Electric Charge and Current of Electricity, 13.2)** > *"Electron flow is opposite in direction to conventional current."* **Textbook: Discover Physics, 5th ed., p. 229 (Ch 13 Electric Charge and Current of Electricity, 13.2)** > *"The flow of electrons from the negative terminal of the battery to the positive terminal is opposite to the conventional current."*	2
8(b)	$R = V / I = 12 / 2.0 =$ **6.0 Ω** (1) **Accept:** 6 Ω **Textbook: Discover Physics, 5th ed., p. 237 (Ch 13 Electric Charge and Current of Electricity, 13.4)** > *"The resistance R of a component is the ratio of the potential difference V across it to the current I flowing through it."*	1
8(c)(i)	**R**: resistance is proportional to length and inversely proportional to cross-sectional area, so it is the ratio length / area that matters; this is greatest for R (10, compared with 5.0 for P and 6.0 for Q) (1) **Accept:** a comparison of length / area values, or a calculation of the three resistances (6.0 Ω, 7.2 Ω and 12 Ω). NOT: Q because it is the longest wire; NOT: R because it is the thinnest wire (without the length) **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."*	1
8(c)(ii)	$R = 6.0 \times (10 / 5.0) =$ **12 Ω** (1) [length / area: R is 1.0 / 0.10 = 10, P is 2.5 / 0.50 = 5.0] **Accept:** ecf for the resistance from (b) and for the wire chosen in (i) (Q: 7.2 Ω). NOT: a ratio inverted	1

Section A – Question 9 [4]

Part	Answer and mark points	Marks
9(a)	• a single series loop with correct symbols for the battery (cell), the switch, the lamp, the variable resistor and the ammeter connected in series (1) • the voltmeter connected in parallel across the lamp only (1) **Accept:** the order of the series components does not matter. NOT: voltmeter in series; NOT: ammeter in parallel with the lamp; NOT: a fixed resistor symbol for the variable resistor	2
9(b)	• row 1: A_2 = **0.30 A**; row 2: A_1 = **0.18 A** (1) • row 3: A_1 = **0 A** and A_2 = **0 A** (the circuit is broken, there is only one path for the current) (1) **Accept:** the first mark needs both entries correct. NOT: 0.30 A in row 3; NOT: different values on the two ammeters in a row **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."* **Textbook: Discover Physics, 5th ed., p. 250 (Ch 14 D.C. Circuits, 14.1)** > *"In a series circuit, there is only one single loop. The electric current has only one path to flow through."*	2

Section A – Question 10 [4]

Part	Answer and mark points	Marks
10(a)	• rod **Y** is a magnet, because one of its ends is repelled by the north pole of the bar magnet (1) • repulsion can occur only between two magnets; X and Z are attracted at both ends, which also happens with unmagnetised steel (a magnetic material), so they are not magnets (1) **Accept:** NOT: X and Z are magnets because they are attracted; NOT: Y because it is attracted at one end **Textbook: Discover Physics, 5th ed., p. 289 (Ch 16 Magnetism and Electromagnetism, 16.1)** > *"Repulsion can occur only between two magnets. We can determine if an object is a magnet or not by whether it gets repelled by another magnet (Figure 16.7)."*	2
10(b)	• a (copper) wire (or aluminium rod) is placed in the magnetic field between the poles of a magnet and connected to a battery and a switch; when the switch is closed the wire moves (swings out) (1) • reversing the connections to the battery (current) makes the wire move in the opposite direction, and reversing the magnet (poles) also makes the wire move in the opposite direction (1) **Accept:** both reversals must be described for the second mark. NOT: the wire moves only if the magnet is moved **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. The copper wire frame will also swing in the opposite direction if the polarity of the magnet is reversed."*	2

Section A – Question 11 [6]

Part	Answer and mark points	Marks
11(a)(i)	microwaves (between radio waves and infrared) and visible light (between infrared and ultraviolet) (1) **Accept:** both regions in the correct boxes. NOT: either box correct alone **Textbook: Discover Physics, 5th ed., p. 185 (Ch 11 Electromagnetic Waves, 11.1)** > *"In the electromagnetic spectrum, electromagnetic waves are arranged in order of their frequency or wavelength."*	1

11(a)(ii)	the wavelength decreases (gets shorter) as the frequency increases (1) **Accept:** radio waves have the longest wavelength and gamma rays the shortest. NOT: the wavelength increases	1
11(b)	• random: it cannot be predicted when a particular nucleus will decay (or in which direction the radiation will be emitted) (1) • spontaneous: the unstable nucleus decays by itself, without any outside cause, and loses energy by emitting radiation (1) **Accept:** spontaneous: not affected by temperature, pressure or chemical changes. NOT: the decay is random because it happens quickly **Textbook: Discover Physics, 5th ed., p. 323 (Ch 17 Radioactivity, 17.2)** *"Nuclear decay is a random process by which an unstable atomic nucleus loses its energy by emission of electromagnetic radiation or particle(s)."* **Textbook: Discover Physics, 5th ed., p. 323 (Ch 17 Radioactivity, 17.2)** *"The direction of the emissions and the time between emissions cannot be predicted."* **Textbook: Discover Physics, 5th ed., p. 323 (Ch 17 Radioactivity, 17.2)** *"to make the radioactive nucleus emit radiation by heating, cooling, chemical means or any other method;"*	2
11(c)(i)	X is alpha, Y is beta, Z is gamma (all three correct) (1) **Textbook: Discover Physics, 5th ed., p. 324 (Ch 17 Radioactivity, 17.2 (Table 17.2, alpha))** *"They are easily absorbed by a piece of paper, a thin aluminium foil or human skin."* **Textbook: Discover Physics, 5th ed., p. 324 (Ch 17 Radioactivity, 17.2 (Table 17.2, beta))** *"They are absorbed by a piece of aluminium that is a few millimetres thick."* **Textbook: Discover Physics, 5th ed., p. 324 (Ch 17 Radioactivity, 17.2 (Table 17.2, gamma))** *"They pass through most materials easily. They are absorbed by lead that is a few centimetres thick or very thick concrete."*	1
11(c)(ii)	**Z** (gamma): it is the most penetrating, so it passes through the packaging to reach the syringes (1) **Accept:** gamma is ionising, so it kills bacteria (as the reason, with penetration through the packs). NOT: alpha, because it has the highest ionising effect (it is stopped by the paper) **Textbook: Discover Physics, 5th ed., p. 324 (Ch 17 Radioactivity, 17.2 (Table 17.2, gamma))** *"They pass through most materials easily. They are absorbed by lead that is a few centimetres thick or very thick concrete."*	1

Section B – Question 12 [10]

Part	Answer and mark points	Marks
12(a)	• the probe makes the particles of the tissue next to it vibrate (1) • each particle vibrates about a fixed position and passes the energy on to its neighbouring particles, so the energy travels along (1) • the particles return to their original positions, so energy is transferred without any net transfer of matter (1) **Accept:** NOT: the particles travel from the probe to the organ. Compressions and rarefactions may be used for the second mark **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."* **Textbook: Discover Physics, 5th ed., p. 156 (Ch 9 General Wave Properties I, 9.1)** *"Note that segments A, B and all subsequent segments do not move along the rope. There is no transfer of matter along the rope."*	3

12(b)(i)	• time for the pulse to reach the front surface and return = (5.0 − 1.0) × 10^{-5} = 4.0 × 10^{-5} s; distance = ½ × 1500 × 4.0 × 10^{-5} = **0.030 m** (3.0 cm) (1) **Accept:** 0.060 m scores 0 (distance not halved). The delay must be measured from the pulse at 1.0 × 10^{-5} s; 0.0375 m scores 0 **Textbook: Discover Physics, 5th ed., p. 176 (Ch 10 General Wave Properties II - Sound, 10.3)** *"The reflected sound is called an echo."*	1
12(b)(ii)	• distance to the back surface = ½ × 1500 × (11.0 − 1.0) × 10^{-5} = 0.075 m; thickness = 0.075 − 0.030 = **0.045 m** (4.5 cm) (1) **Accept:** ecf from (i). The same answer from (11.0 − 5.0) × 10^{-5} = 6.0 × 10^{-5} s is also correct. 0.090 m scores 0 (not halved)	1
12(c)(i)	$I = V / R$ = 230 / 0.10 = **2300 A** (1) **Accept:** 2.3 × 10^{3} A. NOT: 240 V used for the supply	1
12(c)(ii)	the very large current (2300 A, much more than 13 A) flows through the low-resistance earth wire and melts the fuse, which disconnects the live wire (cuts off the supply), so the casing is no longer live (1) **Accept:** circuit breaker trips. NOT: the earth wire stops the live wire from touching the casing **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."* **Textbook: Discover Physics, 5th ed., p. 279 (Ch 15 Practical Electricity, 15.2)** *"As Earth wire has very little resistance, it is likely that the fuse will be blown. This prevents further current flow."*	1
12(c)(iii)	two layers of insulation enclose all the exposed metalwork and live parts (so the user cannot touch a live part) (1) **Accept:** NOT: a plastic casing only **Textbook: Discover Physics, 5th ed., p. 280 (Ch 15 Practical Electricity, 15.2)** *"Double insulation, as the name suggests, has two layers of insulation to enclose all exposed metalwork and "live" parts."*	1
12(d)	• live wire: brown insulation; connected to the live pin through the fuse (1) • earth wire: green and yellow (yellow and green) insulation; connected to the earth pin (1) **Accept:** the fuse must be in the live wire. NOT: blue for either wire; neutral wire details are not required **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."* **Textbook: Discover Physics, 5th ed., p. 280 (Ch 15 Practical Electricity, 15.2)** *"The earth wire is yellow and green. It is a safety wire that is needed to earth appliances with a metal case."* **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."*	2

Section B – Question 13 [10]

Part	Answer and mark points	Marks
13(a)(i)	**12 V** across each, because the branches are in parallel, so the p.d. across each branch is the same as the p.d. across the battery (1) **Accept:** the potential difference across the separate branches of a parallel circuit is the same. Both the value and the reason are needed **Textbook: Discover Physics, 5th ed., p. 256 (Ch 14 D.C. Circuits, 14.2)** *"The potential difference across each branch must be the same as the electromotive force of the cell."*	1

13(a)(ii)	**12 V** (unchanged), because the lamp is still connected directly across the battery (the p.d. across a branch of a parallel circuit does not depend on the other branches) (1) **Accept:** NOT: 0 V; NOT: 6.0 V **Textbook: Discover Physics, 5th ed., p. 256 (Ch 14 D.C. Circuits, 14.2)** > *"The potential difference across each branch must be the same as the electromotive force of the cell."*	1
13(b)(i)	the current from the source (battery) is equal to the sum of the currents in the separate branches (1) **Textbook: Discover Physics, 5th ed., p. 255 (Ch 14 D.C. Circuits, 14.2)** > *"In a parallel circuit, the total current flowing into or out of the parallel branches is equal to the sum of the individual currents in each parallel branch."*	1
13(b)(ii)	• current in lamp = 12 / 6.0 = 2.0 A and current in heater = 12 / 4.0 = 3.0 A (1) • reading on A = 2.0 + 3.0 = **5.0 A** (1) **Accept:** ecf for the second mark. 12 / 10 = 1.2 A (resistances added as if in series) scores 0	2
13(c)(i)	12 J of work is done (energy transferred) for each coulomb (unit charge) of charge driven through the heater (1) **Accept:** work done per unit charge = 12 J/C. NOT: the heater has 12 V of current **Textbook: Discover Physics, 5th ed., p. 233 (Ch 13 Electric Charge and Current of Electricity, 13.3)** > *"The potential difference (p.d.) across a component in a circuit is the work done per unit charge in driving charges through the component."*	1
13(c)(ii)	• charge = current × time = 3.0 × (5.0 × 60) = 900 C (1) • work done = p.d. × charge = 12 × 900 = **10 800 J** (1.1×10^4 J) (1) **Accept:** 1.08×10^4 J. ecf for the heater current from (b)(ii). 12 × 3.0 × 5.0 = 180 scores 0 (time not in seconds)	2
13(d)	• the droplets all carry the same (negative) charge and like charges repel, so the droplets push each other apart and spread out (1) • the droplets are negative and the frame is positive; unlike charges attract (1) **Accept:** one mark for each of (i) and (ii). NOT: negative charges attract positive charges only (without a statement of repulsion for (i)) **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."*	2