SCIENCE (PHYSICS) – Paper 2 Physics (set 2.7) – 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 [2]

Part	Answer and mark points	Marks
1(a)	• the measuring tape (1) • its range (3.0 m) is long enough to measure the 1.20 m cable in one go, while the metre rule (1.00 m) and the calipers (15 cm) are too short; its precision (1 mm) is good enough for a length of 1.20 m (1) **Accept:** the calipers (0.1 mm) are more precise than needed for a length of about 1.2 m. NOT: it is the most accurate / it is the biggest / it is the most modern **Textbook: Discover Physics, 5th ed., p. 8 (Ch 1 Physical Quantities, 1.3)** > *"Table 1.3 shows the measuring range, smallest division as well as the common usage of the measuring instruments."* **Textbook: Discover Physics, 5th ed., p. 8 (Ch 1 Physical Quantities, 1.3)** > *"The smallest unit an instrument can measure is known as its precision."*	2

Section A – Question 2 [4]

Part	Answer and mark points	Marks
2(a)	• time = 21 min = 1260 s; distance = 12 600 m; average speed = distance / time = 12 600 / 1260 (1) • **10 m/s** (1) **Accept:** 36 km/h scores 1 mark (units not converted). 12.6 / 21 = 0.60 km/min scores 1 mark	2
2(b)	• 0 to 4 s: (6 − 0) / 4 = 1.5 m/s^2; 8 s to 12 s: (11 − 9) / 4 = 0.5 m/s^2; so the acceleration decreases, because the gradient of the speed-time graph decreases (the graph gets less steep) (non-uniform acceleration) (1) • the acceleration becomes zero at **16 s**, where the graph becomes horizontal (constant speed) (1) **Accept:** accept 15 s to 17 s. Both accelerations correct (1.5 and 0.5 m/s^2) with a statement that the acceleration decreases for the first mark; ecf if one value is wrong but the conclusion is consistent. The speed still increases, but by less and less each second. NOT: the bus slows down **Textbook: Discover Physics, 5th ed., p. 26 (Ch 2 Kinematics, 2.1)** > *"An object undergoes non-uniform acceleration if the change in its velocity for every unit of time is not the same (Table 2.4)."*	2

Section A – Question 3 [6]

Part	Answer and mark points	Marks
3(a)(i)	a measure of the amount of matter in the object (body) (1) **Accept:** NOT: how heavy it is; NOT: the force of gravity on it **Textbook: Discover Physics, 5th ed., p. 49 (Ch 3 Force and Pressure, 3.2)** > *"Mass is a measure of the amount of matter in a body."*	1

3(a)(ii)	each casing contains the same amount of matter (the same kind and number of atoms), so 300 casings contain three times as much matter (as 100 casings) and therefore have three times the mass (1) **Accept:** mass depends on the number (and composition) of atoms. NOT: because they weigh three times as much (weight is not the reason); NOT: because there are more of them (with no reference to the amount of matter) **Textbook: Discover Physics, 5th ed., p. 49 (Ch 3 Force and Pressure, 3.2)** *"Mass of a body depends on the number and composition of atoms and molecules."*	1
3(b)(i)	the gravitational force (the weight) acting per unit mass placed at that point (in the field) (1) **Accept:** gravitational force per unit mass; force per kilogram. NOT: the acceleration of the body unless the answer says it is the gravitational force per kilogram **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
3(b)(ii)	$g = W / m$ = 150 / 15 = **10 N/kg** (1) **Accept:** 10 N/kg only (1). Accept m/s^2	1
3(c)	• total weight = 150 + 40 = 190 N (1) • $m = W / g$ = 190 / 10 = **19 kg** (1) **Accept:** 15 kg + 4 kg = 19 kg. Award 1 mark for 15 kg or 4.0 kg found separately. ecf from a wrong value of g in (b)(ii)	2

Section A – Question 4 [3]

Part	Answer and mark points	Marks
4(a)(i)	0.40 N, because the mouse moves at constant velocity, so the forces on it are balanced (resultant force is zero) (1) **Accept:** friction equals the push. NOT: 0.40 N with no reason **Textbook: Discover Physics, 5th ed., p. 65 (Ch 4 Dynamics, 4.1)** *"Forces on an object at rest or moving at a constant velocity are balanced."*	1
4(a)(ii)	0.40 N, in the opposite direction to the push (backwards, towards the hand) (1) **Accept:** equal and opposite to the force of the hand on the mouse. NOT: friction (this acts on the mouse). NOT: 0.40 N with no direction **Textbook: Discover Physics, 5th ed., p. 69 (Ch 4 Dynamics, 4.1)** *"Thus, for every action, there is an equal and opposite reaction."*	1
4(b)	$a = F / m$ = 0.40 / 0.10 = **4.0 m/s^2** (opposite to the motion) (1) **Accept:** −4.0 m/s^2. 4 m/s^2. 0 marks for 0.25 m/s^2 (mass divided by force) and for an answer of zero (resultant force wrongly taken as zero)	1

Section A – Question 5 [3]

Part	Answer and mark points	Marks
5(a)	• the moment (turning effect) of a force = force × perpendicular distance from the pivot (hinge) (1) • the front edge is further from the hinge, so the same moment (needed to lift the lid) is obtained with a smaller force (1) **Accept:** turning effect is proportional to both the force and the distance from the pivot **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)** > *"That is why it is easier to lift the lid with a longer spoon."*	2
5(b)	X at the centre of the rectangle (where the diagonals cross) (1) **Accept:** X within 3 mm of the intersection of the diagonals **Textbook: Discover Physics, 5th ed., p. 88 (Ch 5 Turning Effects of Forces, 5.3)** > *"The centre of gravity for an object that has a regular shape and uniform density is at the centroid or centre of the object."*	1

Section A – Question 6 [4]

Part	Answer and mark points	Marks
6(a)	• work done per key = force × distance moved = 0.60 × 0.0030 = 1.8×10^{-3} J (1) • total = 450 × 1.8 × 10^{-3} = **0.81 J** (1) **Accept:** 0.60 × 3.0 = 1.8 (mm not converted) scores 1 mark at most	2
6(b)	• elastic (potential) store (of the spring) (1) • transferred mechanically, by a force acting over a distance (by work done by the typist) (1) **Accept:** NOT: kinetic store (the spring is not moving at the end of the press); NOT: by heating **Textbook: Discover Physics, 5th ed., p. 98 (Ch 6 Energy, 6.1)** > *"A stretched rubber band or a compressed spring has energy in the elastic potential store (elastic potential energy)."* **Textbook: Discover Physics, 5th ed., p. 100 (Ch 6 Energy, 6.1)** > *"mechanically (by a force acting over a distance);"*	2

Section A – Question 7 [7]

Part	Answer and mark points	Marks
7(a)	• the average kinetic energy of the particles increases (1) • so the particles vibrate faster (on average) (1) **Accept:** temperature rises with the average kinetic energy of the particles. NOT: the particles expand / get hotter **Textbook: Discover Physics, 5th ed., p. 127 (Ch 7 Kinetic Particle Model of Matter, 7.2)** > *"Temperature rises with the average kinetic energy of the particles in a body and vice versa."*	2

7(b)	• at the same temperature the particles in both have the same average kinetic energy, but the heat sink has many more particles, so the total kinetic energy of its particles (their random motion) is greater (1) • internal energy is the total kinetic energy of the particles plus the total potential energy between them, so the heat sink, with more particles, has the greater internal energy (1) **Accept:** NOT: the heat sink has more internal energy because it is hotter (the temperatures are the same); NOT: internal energy depends on temperature only. Award 1 mark if only the total kinetic energy idea is given **Textbook: Discover Physics, 5th ed., p. 124 (Ch 7 Kinetic Particle Model of Matter, 7.1)** *"Internal energy is an energy store that is made up of the total kinetic energy associated with the random motion of the particles and the total potential energy between the particles in the system."*	2
7(c)	free electrons in the copper move through the metal and transfer energy (by collisions) (1) **Accept:** movement (diffusion) of electrons. NOT: movement of atoms along the metal **Textbook: Discover Physics, 5th ed., p. 137 (Ch 8 Thermal Processes, 8.2)** *"Due to their small size and high speed, the free electrons move very fast through the metal and transfer energy easily."*	1
7(d)	• air heated by the servers expands, becomes less dense than the surrounding cooler air and rises to the ceiling vents (1) • cooler, denser air from the floor vents sinks and flows in to replace it, setting up a convection current (1) **Accept:** NOT: heat rises / cold air sinks (without a reference to density) **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 8 [3]

Part	Answer and mark points	Marks
8(a)	neither: they arrive at the same time, because all electromagnetic waves travel at the same speed (3×10^8 m/s) in a vacuum (1) **Accept:** NOT: radio waves arrive first because they have a longer wavelength; NOT: X-rays arrive first because they have a higher frequency **Textbook: Discover Physics, 5th ed., p. 185 (Ch 11 Electromagnetic Waves, 11.1)** *"All electromagnetic waves can travel without a medium and they all travel at the same speed of 3×10^8 m/s in a vacuum."*	1

8(b)	• mobile phone call: **microwaves**; thermal-imaging camera: **infra-red**; X-rays: **one use, e.g. scanning luggage at an airport / imaging fractures in bones (medical imaging) / checking manufactured goods for cracks**; radio waves: **one use, e.g. radio (and television) broadcasting / communication with satellites or police** • 4 correct = 2 marks; 2 or 3 correct = 1 mark; 0 or 1 correct = 0 marks **Accept:** infrared; IR; x rays; X-ray photography; CT scan; security scanning; radio astronomy; RFID. NOT: cooking (microwaves); NOT: sun tanning or sterilising (not X-rays) **Textbook: Discover Physics, 5th ed., p. 189 (Ch 11 Electromagnetic Waves, 11.2)** *"A mobile phone converts sound waves to microwave signals."* **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."* **Textbook: Discover Physics, 5th ed., p. 193 (Ch 11 Electromagnetic Waves, 11.2)** *"At airports, X-rays are used to scan luggages for hazardous materials."* **Textbook: Discover Physics, 5th ed., p. 188 (Ch 11 Electromagnetic Waves, 11.2)** *"When you tune in to a radio station, sound is encoded and transmitted through the air to your radio set via radio waves (Figure 11.5)."*	2

Section A – Question 9 [5]

Part	Answer and mark points	Marks
9(a)	normal drawn at 90° to the mirror through the point of incidence (it bisects the 76° angle) AND angle of reflection = 76° / 2 = **38°** (1) **Accept:** dashed or solid normal; normal within 2° of the perpendicular. NOT: 76°; NOT: 52° (angle to the mirror) **Textbook: Discover Physics, 5th ed., p. 201 (Ch 12 Light, 12.1)** *"The perpendicular line (90 °) to the surface at the point of incidence is called the normal."* **Textbook: Discover Physics, 5th ed., p. 201 (Ch 12 Light, 12.1)** *"The angle between the reflected ray and the normal is called the angle of reflection"*	1
9(b)	• angle of incidence = 90 − 32 = **58°** (1) • angle of refraction = 90 − 56 = **34°** (1) **Accept:** 32° and 56° score 0 (not measured from the normal) **Textbook: Discover Physics, 5th ed., p. 209 (Ch 12 Light, 12.2)** *"The angle of refraction is the angle between the refracted ray and the normal at the point of incidence."*	2
9(c)	• all three rays bent towards the principal axis on leaving the lens (rays converge) (1) • all three rays meet at one point, the principal focus F on the right-hand side of the lens, on the axis (the central ray undeviated) (1) **Accept:** arrows on the rays not required. Rays must meet at F (within 2 mm); rays which cross the axis beyond F: 1 mark **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

Section A – Question 10 [4]

Part	Answer and mark points	Marks
10(a)	the coulomb (C); positive and negative (all three needed) (1) **Accept:** C **Textbook: Discover Physics, 5th ed., p. 226 (Ch 13 Electric Charge and Current of Electricity, 13.1)** > *"An electron is negatively charged while a proton is positively charged. The SI unit of electric charge is the coulomb (C)."*	1
10(b)	series branch: 20 + 40 = 60 Ω; 1/*R* = 1/60 + 1/60 so **R = 30 Ω** (1) **Accept:** 30 ohm. 0 marks for 120 Ω (all three added)	1
10(c)	• the p.d. across each branch is 6.0 V, so the current in the series branch = 6.0 / 60 = 0.10 A (1) • *V* = *IR* = 0.10 × 20 = **2.0 V** (1) **Accept:** the 20 Ω resistor takes one third of the p.d. across the series branch (20 : 40) = 2.0 V (2 marks). Using the total current from (b): 0 marks (that current divides between two branches)	2

Section A – Question 11 [5]

Part	Answer and mark points	Marks
11(a)(i)	the cable (adaptor and socket) overheats because of the large current, which can cause a fire (1) **Accept:** overheating of the cable. NOT: the adaptor will stop working; NOT: the servers will be damaged **Textbook: Discover Physics, 5th ed., p. 275 (Ch 15 Practical Electricity, 15.2)** > *"Overheated circuits can cause fire and even explosions."* **Textbook: Discover Physics, 5th ed., p. 275 (Ch 15 Practical Electricity, 15.2)** > *"Too many plugs connected to a socket"*	1
11(a)(ii)	a person who touches the exposed live wire (conductor) can get an electric shock (1) **Accept:** the exposed wires may touch and cause a short circuit and a fire. NOT: the cable will not work **Textbook: Discover Physics, 5th ed., p. 274 (Ch 15 Practical Electricity, 15.2)** > *"Exposed wires are hazardous as they can cause electric shocks when touched accidentally."*	1
11(b)	• P: **live**; Q: **neutral**; R: **earth** • 3 correct = 2 marks; 1 or 2 correct = 1 mark **Accept:** the names are required: colours alone (brown, blue, yellow and green) are not enough **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 neutral wire is blue and is kept at zero voltage. It completes the path for current to flow through appliances in the electrical circuit."* **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."*	2

11(c)	when the breaker trips it opens the live wire, so the server and its metal case are disconnected from the live (230 V) supply; the case is no longer live and a person touching it cannot get an electric shock (1) **Accept:** the breaker in the live wire cuts off the supply from the mains to the server. NOT: because the live wire carries a bigger current; NOT: because the neutral wire is not dangerous; NOT: only that the breaker stops the current, with no reference to the live (high-voltage) supply or to the case being safe **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."* **Textbook: Discover Physics, 5th ed., p. 281 (Ch 15 Practical Electricity, 15.2)** > *"The switch disconnects the live wire from the metal casing"*	1

Section A – Question 12 [5]

Part	Answer and mark points	Marks
12(a)	• the strong magnet induces magnetism in the steel: the end of the screw nearest the magnet becomes a pole opposite to the pole of the magnet (induced magnetism) (1) • unlike poles attract, so the screw is attracted to the magnet (1) **Accept:** the magnetic field of the magnet aligns the tiny magnets (domains) in the steel **Textbook: Discover Physics, 5th ed., p. 291 (Ch 16 Magnetism and Electromagnetism, 16.1)** > *"Proximity induced magnetism can take place when a magnetic material is in close proximity or in contact with a strong magnet (Figures 16.10 and 16.11)."*	2
12(b)	at least three lines from the N pole of the left magnet to the S pole of the right magnet, nearly straight and parallel in the gap, bulging outwards at the edges, each with an arrow pointing from N to S (to the right) (1) **Accept:** lines must not cross or touch; field lines leaving the outer ends of the magnets are not required. NOT: arrows from S to N **Textbook: Discover Physics, 5th ed., p. 300 (Ch 16 Magnetism and Electromagnetism, 16.2)** > *"When two unlike poles are placed next to each other, field lines go from the north pole of one magnet to the south pole of the other magnet (Figure 16.32)."*	1
12(c)	• concentric circles centred on the wire, getting further apart away from the wire, with arrows clockwise (1) • the magnetic field becomes stronger (the field lines are closer together) (1) **Accept:** at least two circles. Direction: clockwise for current into the paper (right-hand grip rule) **Textbook: Discover Physics, 5th ed., p. 304 (Ch 16 Magnetism and Electromagnetism, 16.3)** > *"If we grip the conductor with our thumb pointing in the direction of the conventional current, the curl of the fingers shows the direction of the magnetic field (Figure 16.41)."* **Textbook: Discover Physics, 5th ed., p. 305 (Ch 16 Magnetism and Electromagnetism, 16.3)** > *"The strength of magnetic field increases when the current is increased (Figure 16.42)."*	2

Section A – Question 13 [4]

Part	Answer and mark points	Marks
13(a)(i)	lead-208 has the same proton number, 82, so neutrons = A − Z = 208 − 82 = **126** (1) **Accept:** NOT: 208 or 82 **Textbook: Discover Physics, 5th ed., p. 321 (Ch 17 Radioactivity, 17.1)** > *"Number of neutrons = nucleon number A - proton number Z in a nucleus"*	1

13(a)(ii)	they have the same number of protons (proton number 82, so the same element) but different numbers of neutrons (124 and 126) (different nucleon numbers) (1) **Accept:** NOT: they have different numbers of electrons **Textbook: Discover Physics, 5th ed., p. 322 (Ch 17 Radioactivity, 17.1)** > *"Isotopes are atoms of the same element that have the same numbers of protons but different numbers of neutrons."*	1
13(b)(i)	nuclear radiation present in an environment where no radioactive source has been deliberately introduced (1) **Accept:** radiation that is all around us from natural and man-made sources **Textbook: Discover Physics, 5th ed., p. 326 (Ch 17 Radioactivity, 17.3)** > *"Background radiation refers to nuclear radiation in an environment where no radioactive source has been deliberately introduced."*	1
13(b)(ii)	most of it is natural (about 80%), e.g. radon gas from the ground, cosmic rays, rocks, food; the man-made part, such as medical X-rays, is small (1) **Accept:** any one natural source named with the statement that natural sources are the main part. NOT: there is no background radiation from devices **Textbook: Discover Physics, 5th ed., p. 326 (Ch 17 Radioactivity, 17.3)** > *"Natural background radiation accounts for about 80% of the radiation that we are exposed to."*	1

Section B – Question 14 [10]

Part	Answer and mark points	Marks
14(a)(i)	• current is the rate of flow of charge (1) • measured in amperes (A) (1) **Accept:** charge flowing per unit time (per second). NOT: the flow of charged particles / electrons without a reference to rate **Textbook: Discover Physics, 5th ed., p. 228 (Ch 13 Electric Charge and Current of Electricity, 13.2)** > *"Electric current is the rate of flow of charge and not charged particles."* **Textbook: Discover Physics, 5th ed., p. 228 (Ch 13 Electric Charge and Current of Electricity, 13.2)** > *"The SI unit for current is ampere (A) or coulomb (C) per second (s)."*	2
14(a)(ii)	1.5 A means 1.5 C of charge per second, so time = 5400 / 1.5 = 3600 s = **60 minutes** (1) **Accept:** 1.0 hour. 3600 s only scores 0 (the answer was asked in minutes)	1
14(b)	• volt (V) (1) • the battery does 3.7 J of work (transfers 3.7 J of energy) in driving each coulomb of charge around a complete circuit (1) **Accept:** 3.7 V is the work done per unit charge by the battery in driving charge round the circuit. NOT: the p.d. across the phone **Textbook: Discover Physics, 5th ed., p. 232 (Ch 13 Electric Charge and Current of Electricity, 13.3)** > *"The electromotive force (e.m.f) of an electrical source is the work done by the source in driving a unit charge around a complete circuit."*	2
14(c)(i)	the wave transfers energy (the cork gains energy) but does not transfer matter (the water / cork is not carried along with the wave) (1) **Accept:** NOT: the wave transfers nothing **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

14(c)(ii)	an (imaginary) line joining all adjacent points on the wave that are moving in step (in phase), e.g. a crest line (1) **Accept:** NOT: the front edge of the wave only **Textbook: Discover Physics, 5th ed., p. 157 (Ch 9 General Wave Properties I, 9.1)** > *"The imaginary line that joins all adjacent points on the wave that are moving in step is called a wavefront."*	1
14(d)	• frequency = 40 / 5.0 = 8.0 Hz (1) • six wavefronts have five wavelengths between them: wavelength = 10.0 / 5 = 2.0 cm (1) • $v = f\lambda$ = 8.0 × 2.0 = **16 cm/s** (0.16 m/s) (1) **Accept:** 0.16 m/s. Dividing by 6 (wavelength 1.7 cm) leads to 13 cm/s: 2 marks (ecf). Using 40 or 5.0 as the frequency: at most 1 mark	3

Section B – Question 15 [10]

Part	Answer and mark points	Marks
15(a)	• weight (W) drawn vertically downwards (1) • normal (contact) force perpendicular to the surface of the stand, pointing away from the stand (1) • friction up (along) the slope; all three arrows start on the phone and are labelled (1) **Accept:** allow R / N / reaction for the normal force and F / f for friction. Award 2 marks at most if there is an extra force (e.g. a force down the slope). The arrows need not be equal in length, but the weight is the longest **Textbook: Discover Physics, 5th ed., p. 71 (Ch 4 Dynamics, 4.2)** > *"In Section 4.1, we have been using arrows to represent forces acting on individual objects. These diagrams are called free-body diagrams."*	3
15(b)	• friction opposes the tendency of the phone to slide, acting up the slope, so the forces are balanced and the phone stays at rest (1) • oil reduces the friction, so the force pulling the phone down the slope is greater than friction: the forces are unbalanced and the phone accelerates down the slope (1) **Accept:** NOT: friction pushes the phone up the slope **Textbook: Discover Physics, 5th ed., p. 74 (Ch 4 Dynamics, 4.3)** > *"Friction is the contact force that opposes or tends to oppose motion between surfaces in contact."* **Textbook: Discover Physics, 5th ed., p. 47 (Ch 3 Force and Pressure, 3.1)** > *"The friction between the tyres and the slope prevents the vehicle from sliding down."*	2
15(c)(i)	energy cannot be created or destroyed (the total energy stays constant); it can only be transferred from one store to another (1) **Accept:** total energy before = total energy after **Textbook: Discover Physics, 5th ed., p. 108 (Ch 6 Energy, 6.1)** > *"The principle of conservation of energy states that energy cannot be created or destroyed. Energy can be transferred from one store to another."*	1
15(c)(ii)	• energy lost by the gravitational potential store = mgh = 0.20 × 10 × 8.0 = 16 J; kinetic energy gained = $\frac{1}{2}mv^2$ = ½ × 0.20 × 12^2 = 14.4 J (1) • energy transferred to the surroundings = 16 − 14.4 = **1.6 J** (1) **Accept:** 1.60 J. Award 1 mark for either 16 J or 14.4 J correctly calculated	2
15(d)	• time = 20 × 60 = 1200 s; $P = E / t$ = 12 000 / 1200 (1) • **10 W** (1) **Accept:** 0.010 kW; 10 J/s. Award 1 mark for 12 / 20 = 0.60 (units not converted)	2