SCIENCE (PHYSICS) – Paper 2 Physics (set 2.2) – 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 [5]

Part	Answer and mark points	Marks
1(a)	1 cm = 10^{-2} m so 1 cm^3 = 10^{-6} m^3; volume = **5.0×10^{-4} m^3** (1) **Accept:** 0.00050 m^3. NOT: 5.0×10^{-2} m^3 (the factor 10^{-2} was not cubed)	1
1(b)(i)	a measure of the amount of matter in the ball (in the body) (1) **Accept:** how many atoms / particles of matter it contains. NOT: how heavy it is; NOT: the pull of the Earth 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
1(b)(ii)	**2.0 kg**, because each half contains half the amount of matter (half the number of atoms) of the whole ball (1) **Accept:** mass is a measure of the amount of matter in the body, so halving the matter halves the mass. Both the value and the reason are needed. NOT: 4.0 kg (mass unchanged); NOT: 2.0 kg with no reason (e.g. 'because it is smaller') **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."* **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
1(c)	• density = mass / volume = 4.0 / (5.0×10^{-4}) = 8000 kg m^{-3} (1) • mass = density × volume = 8000 × 6.5 × 10^{-4} = **5.2 kg** (1) **Accept:** proportion: 4.0 × (6.5 / 5.0) = 5.2 kg scores both marks. ecf from a wrong density	2

Section A – Question 2 [4]

Part	Answer and mark points	Marks
2(a)	• speed is the distance travelled per unit time, and velocity is the rate of change of displacement (speed in a stated direction); speed = 400 / 100 = 4.0 m/s (1) • she finishes where she started, so her displacement is zero, therefore her velocity (displacement / time) is zero (1) **Accept:** speed = distance / time taken; velocity = displacement / time taken; velocity is speed in a stated direction. The first mark needs both definitions. NOT: velocity is zero because she is not moving / has stopped at the end **Textbook: Discover Physics, 5th ed., p. 18 (Ch 2 Kinematics, 2.1)** > *"Speed is the distance travelled per unit time."* **Textbook: Discover Physics, 5th ed., p. 22 (Ch 2 Kinematics, 2.1)** > *"Velocity is the rate of change in displacement."*	2

2(b)	• first 30 s: speed = gradient = 120 / 30 = 4.0 m/s; last 40 s: speed = (320 − 120) / (90 − 50) = 5.0 m/s (1) • the jogger ran faster during the last 40 s (5.0 m/s > 4.0 m/s; the line is steeper) (1) **Accept:** any correct pair of readings from each straight line; 5 m s^{-1}. The conclusion must follow from the two speeds (ecf). NOT: the last 40 s because the distance is greater (200 m > 120 m) without the times being compared; NOT: the 30 s to 50 s section (the jogger is at rest)	2

Section A – Question 3 [4]

Part	Answer and mark points	Marks
3(a)(i)	**R**, the line is horizontal (the speed does not change; the gradient is zero) (1) **Accept:** NOT R without the feature of the graph; NOT S (S is a decrease in speed)	1
3(a)(ii)	**Q**, the graph is curved (the gradient changes, so the acceleration is not constant) (1) **Accept:** NOT P (P is a straight sloping line, which is uniform acceleration)	1
3(b)	• total area = 2 × 1.5 = 3.0 cm^2 = 3.0 × 10^{-4} m^2, $p = F / A$ = 720 / (3.0 × 10^{-4}) (1) • **2.4 × 10^6 N/m^2** (2.4 × 10^6 Pa) (1) **Accept:** 240 N/cm^2 (area left in cm^2) if the unit is stated; one wheel: 360 N over 1.5 × 10^{-4} m^2 gives the same pressure. 1.2 × 10^6 N/m^2 (all four wheels used) scores 0 for the answer mark	2

Section A – Question 4 [4]

Part	Answer and mark points	Marks
4(a)	• weight (W) drawn vertically downwards from the dot (1) • normal (contact) force perpendicular to the slide, away from the surface, AND friction along the slope, up the slope, both labelled and drawn from the dot (1) **Accept:** allow R / N / normal reaction for the contact force and F / f for friction. All three arrows must start at the dot for the second mark. The weight arrow should be the longest (the forces are balanced)	2
4(b)(i)	the normal (contact) force of the girl on the slide, which acts on the slide (1) **Accept:** the girl presses on the slide with an equal force, perpendicular to the slide. Both the force and the body are needed. NOT: the weight of the girl (that is paired with the pull of the girl on the Earth); NOT: friction on the girl; NOT: the force on the girl **Textbook: Discover Physics, 5th ed., p. 70 (Ch 4 Dynamics, 4.1)** > *"The normal force FTB by the table on the book, and the normal force FBT by the book on the table (Figure 4.12(b))."* **Textbook: Discover Physics, 5th ed., p. 70 (Ch 4 Dynamics, 4.1)** > *"Action and reaction forces act on different bodies."*	1
4(b)(ii)	resultant force = 120 − 20 = **100 N** down the slope; the forces are unbalanced so she accelerates (speeds up) down the slope (1) **Accept:** both the 100 N (direction down the slope) and the effect (acceleration / speeds up) are needed. NOT: she moves faster at constant speed; NOT: 140 N (the forces added) **Textbook: Discover Physics, 5th ed., p. 66 (Ch 4 Dynamics, 4.1)** > *"When there is a resultant force acting on an object, the object will accelerate in the direction of the resultant force."*	1

Section A – Question 5 [2]

Part	Answer and mark points	Marks
5(a)	the product of the force and the perpendicular distance from the pivot to the line of action of the force (1) **Accept:** moment = force × perpendicular distance from the pivot; the turning effect of a force about a pivot **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
5(b)	the line of action of the force passes through the axle (pivot), so the perpendicular distance from the pivot to the line of action is zero, and moment = 25 × 0 = **0 N m** (no turning effect) (1) **Accept:** the force acts along a line through the pivot so it has no turning effect. The value 0 N m AND the reason (zero perpendicular distance) are needed. NOT: 25 × 0.80 = 20 N m (the distance along the line of action used); NOT: the force is too small; NOT: friction at the axle stops it **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."* **Textbook: Discover Physics, 5th ed., p. 83 (Ch 5 Turning Effects of Forces, 5.1)** *"When the line of action of the force passes through the pivot, the perpendicular distance is zero (Figure 5.4(b)). Thus, no moment is produced."*	1

Section A – Question 6 [3]

Part	Answer and mark points	Marks
6(a)	the (imaginary) point where the entire weight of the body seems to act (1) **Accept:** the single point at which the weight of the body may be taken to act **Textbook: Discover Physics, 5th ed., p. 88 (Ch 5 Turning Effects of Forces, 5.3)** *"The centre of gravity of an object is an imaginary point where the entire weight of the object seems to act."*	1
6(b)	• $E_p = m\,g\,h$ = 65 × 10 × 1.10 = 715 J, which is about 7.2 × 10^2 J (the unrounded value or the substitution must be shown) (1) • $h = E_p / m\,g$ = 715 / (55 × 10) = **1.3 m** (1.30 m) (1) **Accept:** 7.15 × 10^2 J. ecf from 715 J (or from a wrong energy) for the second mark; 1.3 m (2 s.f.). Proportion method: 1.10 × 65 / 55 = 1.30 m is accepted for the second mark. NOT: 7.2 × 10^2 J on its own with no substitution	2

Section A – Question 7 [4]

Part	Answer and mark points	Marks
7(a)	• the barbell moves at constant speed, so the upward force = the weight = 140 × 10 = 1400 N (1) • work done = force × distance moved = 1400 × 0.55 = **770 J** (7.7 × 10^2 J) (1) **Accept:** *mgh* = 140 × 10 × 0.55 = 770 J scores both marks. 0.77 kJ. NOT: 140 × 0.55 = 77 (mass used as the force) scores 0 for the first mark and the second mark is lost	2

7(b)	• gravitational potential (energy) store, which gains 770 J (the work done in (a)) (1) • the remaining 2400 − 770 = 1630 J is transferred by heating to the internal store of the lifter (her body) and the surroundings (1) **Accept:** ecf from the work done in (a). 1.6×10^3 J. NOT: kinetic store (the barbell moves at constant speed and is at rest at the end); NOT: the remaining energy is lost / destroyed (energy is conserved) **Textbook: Discover Physics, 5th ed., p. 99 (Ch 6 Energy, 6.1)** > *"An object such as a book above the ground has energy in the gravitational potential store (gravitational potential energy)."* **Textbook: Discover Physics, 5th ed., p. 108 (Ch 6 Energy, 6.1)** > *"The energy in the chemical potential store of the match head is transferred by heating to the internal store of the surroundings."*	2

Section A – Question 8 [4]

Part	Answer and mark points	Marks
8(a)	• the average kinetic energy of the particles increases as the temperature rises, so the particles move (vibrate) faster / with higher average speed (1) • the average kinetic energy of the particles in B is the same as in A (equal), because the temperature is the same (1) **Accept:** temperature rises with the average kinetic energy of the particles. NOT: the particles expand / get bigger; NOT: B is greater because there is more liquid (that is the total, not the average, kinetic energy) **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."* **Textbook: Discover Physics, 5th ed., p. 127 (Ch 7 Kinetic Particle Model of Matter, 7.2)** > *"When a substance such as water is heated, the kinetic energy of the particles increases and the particles vibrate or move faster."*	2
8(b)	• internal energy is the total kinetic energy associated with the random motion of the particles and the total potential energy between the particles (1) • pack B has twice as many particles, so its total kinetic energy and total potential energy (its internal energy) are greater (1) **Accept:** both parts (kinetic AND potential) are needed for the first mark. NOT: B has greater internal energy because its temperature is higher (the temperatures are equal); NOT: the heat in the liquid **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

Section A – Question 9 [4]

Part	Answer and mark points	Marks
9(a)	• in both materials, the particles (atoms) at the hot side vibrate more and pass on their vibrational energy to neighbouring particles by collisions (1) • aluminium (a metal) also has free electrons, which move very fast through the metal and transfer energy to the cooler particles; glass (a non-metal) has no free electrons, so conduction is faster in aluminium (1) **Accept:** the vibration of the particles AND the free electrons in the metal are both required. NOT: the heat / atoms move along the metal; NOT: aluminium is a better conductor (no reference to free electrons) **Textbook: Discover Physics, 5th ed., p. 136 (Ch 8 Thermal Processes, 8.2)** *"Conduction is a process of energy transfer where energy is transferred through the passing on of vibrational motion from one particle to another."* **Textbook: Discover Physics, 5th ed., p. 137 (Ch 8 Thermal Processes, 8.2)** *"However, metals consist of tiny particles called free electrons that are absent in most non-metals."* **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."*	2
9(b)	• ice at the top: air next to the ice is cooled, contracts and becomes denser than the warmer air, so it sinks past the cans; the warmer, less dense air rises to take its place, so a convection current carries energy from the cans to the ice (1) • ice at the bottom: the air cooled by the ice is denser and stays at the bottom, below the warmer air, so no convection current forms and the air around the cans stays warm (1) **Accept:** first mark: cold air sinks and warm air rises, with a reference to a change in density; second mark: the comparison, that with the ice at the bottom the cold air stays at the bottom so no convection current forms. NOT: cold air sinks (no reference to density); NOT: heat rises **Textbook: Discover Physics, 5th ed., p. 139 (Ch 8 Thermal Processes, 8.2)** *"When a liquid is heated, it expands and increases in volume. As volume increases, density decreases. 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 10 [5]

Part	Answer and mark points	Marks
10(a)	• transverse waves (1) • the speeds are the same (equal) in a vacuum (3×10^8 m/s) (1) **Accept:** NOT: longitudinal; NOT: radio waves are faster / slower **Textbook: Discover Physics, 5th ed., p. 185 (Ch 11 Electromagnetic Waves, 11.1)** *"All electromagnetic waves are transverse waves."* **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."*	2
10(b)	• time = 2.5 hours = $2.5 \times 3600 = 9000$ s (1) • $I = Q / t = 2.25 \times 10^5 / 9000 =$ **25 A** (1) **Accept:** the first mark is for the time in seconds; ecf from a wrong time. NOT: $2.25 \times 10^5 / 2.5 = 9.0 \times 10^4$ (time not converted to seconds) scores 0 for the second mark	2

10(c)	0.30 × (150 / 60) ÷ 1.5 = **0.50 Ω** (1) **Accept:** 0.50 ohm; 0.5 Ω. Resistance is proportional to length and inversely proportional to cross-sectional area. NOT: 0.75 Ω (area ignored); NOT: 1.1 Ω (multiplied by 1.5)	1

Section A – Question 11 [5]

Part	Answer and mark points	Marks
11(a)	angle of incidence = 90 − 40 = 50° the angle of reflection is also 50°, so the angle between the rays = 50 + 50 = **100°** (1) **Accept:** angles are measured from the normal. NOT: 80° (2 × 40°, angles measured from the mirror); NOT: 50°	1
11(b)	• the distance between the optical centre of the lens and the principal focus (focal point) (1) • the principal focus is the point on the principal axis where rays parallel to the principal axis meet after passing through the lens (1) **Accept:** distance from the lens to where a parallel beam is brought to a focus **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"* **Textbook: Discover Physics, 5th ed., p. 216 (Ch 12 Light, 12.3)** *"The distance between the optical centre C and the principal focus point F"*	2
11(c)	• real (the rays meet / it can be formed on the sensor) (1) • inverted AND diminished (smaller than the runner) (1) **Accept:** three correct characteristics = 2 marks; two correct = 1 mark; one correct = 0. NOT: smaller (as the only answer) **Textbook: Discover Physics, 5th ed., p. 216 (Ch 12 Light, 12.3)** *"When an image is formed on a screen, it is called a real image. Notice that the image is inverted compared to the object."*	2

Section A – Question 12 [4]

Part	Answer and mark points	Marks
12(a)	• effective resistance = 4.0 + 1 / (1/6.0 + 1/3.0) = 4.0 + 2.0 = 6.0 Ω (1) • $I = V / R$ = 12 / 6.0 = **2.0 A** (1) **Accept:** 1 mark for the effective resistance of the circuit (6.0 Ω), 1 mark for the current; ecf from a wrong effective resistance	2
12(b)	• the p.d. across the parallel pair = the total p.d. minus that across the series resistor = 12 − 8.0 = 4.0 V (1) • $I = V / R$ = 4.0 / 6.0 = **0.67 A** (0.667 A) (1) **Accept:** the sum of the p.d.s in a series circuit equals the p.d. across the whole circuit (battery e.m.f.). Also accept 2.0 A × 2.0 Ω = 4.0 V for the first mark; 0.7 A. NOT: 8.0 / 6.0 = 1.3 A (the p.d. across the 4.0 Ω resistor used); ecf from a wrong p.d. **Textbook: Discover Physics, 5th ed., p. 253 (Ch 14 D.C. Circuits, 14.1)** *"The sum of the potential differences in a series circuit is equal to the potential difference across the whole circuit."*	2

Section A – Question 13 [4]

Part	Answer and mark points	Marks
13(a)(i)	**downwards** (towards the bottom of the page) (1) **Textbook: Discover Physics, 5th ed., p. 310 (Ch 16 Magnetism and Electromagnetism, 16.3)** *"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
13(a)(ii)	**downwards** (unchanged): reversing the field reverses the force and reversing the current also reverses the force, so the two reversals cancel (1) **Accept:** both the direction and the reason are needed. NOT: upwards (only one of the two reversals applied) **Textbook: Discover Physics, 5th ed., p. 309 (Ch 16 Magnetism and Electromagnetism, 16.3)** *"Reversing the direction of current induces a swing in the opposite direction."* **Textbook: Discover Physics, 5th ed., p. 309 (Ch 16 Magnetism and Electromagnetism, 16.3)** *"Reversing the polarity of the magnet also reverses the direction of the swing."*	1
13(b)	• the current in the two sides is in opposite directions, so the forces on the two sides are in opposite directions (one side is pushed up, the other down) (1) • the two forces act on opposite sides of the axle, at a distance from it, so both produce a turning effect (moment) in the same direction and the coil turns (1) **Accept:** the forces form a couple; equal and opposite forces on the two sides. NOT: the coil is attracted by the magnet **Textbook: Discover Physics, 5th ed., p. 312 (Ch 16 Magnetism and Electromagnetism, 16.3)** *"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, 16.3)** *"The forces produce a turning effect that is equal in magnitude on each wire."*	2

Section A – Question 14 [3]

Part	Answer and mark points	Marks
14(a)	• a positively charged nucleus which contains the 11 protons and 13 neutrons, with negatively charged electrons moving around the nucleus; there are 11 electrons (1) • the number of protons (positive charge) is equal to the number of electrons (negative charge), so the charges cancel (1) **Accept:** protons are positive, neutrons are neutral, electrons are negative; the second mark may be given as the total positive charge equals the total negative charge. NOT: the nucleus contains electrons; NOT: 13 electrons; NOT: the neutrons cancel the charge of the protons **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."* **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."*	2
14(b)	the radiation can kill (damage) living cells / cause mutation / cause cancer (1) **Accept:** radiation burns; damage to healthy cells. NOT: it makes the athlete 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

Section B – Question 15 [10]

Part	Answer and mark points	Marks
15(a)	• X is a compression: the air particles are closer together (at higher pressure); Y is a rarefaction, where the particles are further apart (1) • the air particles vibrate back and forth, parallel to the direction in which the wave travels (longitudinal wave) (1) • the compressions and rarefactions move outwards, away from the whistle (to the spectators), but the air particles only vibrate about fixed positions and do not travel with the wave (1) **Accept:** the reason for X needs a reference to the particles being closer together. NOT: Y as the compression; NOT: the air particles travel from the whistle to the spectators **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."* **Textbook: Discover Physics, 5th ed., p. 172 (Ch 10 General Wave Properties II - Sound, 10.1)** > *"This causes alternate regions of the air particles to be compressed and extended. The compressed regions are called compressions and the extended regions are called rarefactions (Figure 10.1)."*	3
15(b)	• transverse: each person moves up and down (vertically), perpendicular to the direction (sideways, along the row) in which the wave travels (1) • in a longitudinal wave the vibration is parallel to the direction of wave travel; example: sound waves (certain waves of an earthquake) (1) **Accept:** the second mark needs both the difference and a correct example of a longitudinal wave. NOT: longitudinal for the Mexican wave; NOT: light as an example of a longitudinal 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)."* **Textbook: Discover Physics, 5th ed., p. 158 (Ch 9 General Wave Properties I, 9.2)** > *"Some examples of longitudinal waves are sound waves and certain waves of an earthquake."*	2
15(c)	• $P = V I$ = 230 × 1.5 = 345 W (1) • 2.0 hours = 2.0 × 3600 = 7200 s (1) • $E = P t$ = 345 × 7200 = **2.5×10^6 J** (2 484 000 J) (1) **Accept:** E = V I t = 230 × 1.5 × 7200 as one line scores the first and third marks if the time is in seconds. If the time is not converted to seconds (690 J) the last two marks are lost	3
15(d)	• old scoreboard: 1.15 kW × (4.0 × 30) h = 138 kW h, cost = 138 × 0.30 = $41.40; LED scoreboard: 0.345 kW × 120 h = 41.4 kW h, cost = 41.4 × 0.30 = $12.42 (1) • the LED scoreboard is cheaper, by 41.40 − 12.42 = **$29** ($28.98) (1) **Accept:** ecf from the power of the LED scoreboard in (c) (345 W); $28.98; $29.0. The conclusion must follow from the two costs	2

Section B – Question 16 [10]

Part	Answer and mark points	Marks
16(a)	• Q is negatively charged, because P and Q repel each other (like charges repel) (1) • R is positively charged, because it is attracted to the negative balloon P (unlike charges attract), so R and Q **attract** each other (1) **Accept:** both charges and the final statement (R and Q attract) are needed for the second mark. NOT: they repel; NOT: R is neutral **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
16(b)(i)	the work done (energy transferred) per unit charge in driving charges through the lamp (1) **Accept:** p.d. = work done / charge. NOT: the difference in 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
16(b)(ii)	• lamp P: $V = W / Q$ = 27 / 6.0 = 4.5 V; lamp Q: 36 / 9.0 = 4.0 V (both with the unit volt, V) (1) • the student is not correct: the p.d. is the energy per unit charge, so lamp P (4.5 V) has the greater p.d. than lamp Q (4.0 V) (1) **Accept:** the unit mark is part of the first mark: V or volt, not J/C alone unless also given as volt. Conclusion must follow from the two values (ecf). NOT: yes, the student is correct **Textbook: Discover Physics, 5th ed., p. 233 (Ch 13 Electric Charge and Current of Electricity, 13.3)** *"The SI unit of potential difference is volt (V)."* **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."*	2
16(c)	• ice keeps its shape: the particles are closely packed in a regular pattern and are held in fixed positions by strong attractive forces (they only vibrate about fixed positions) (1) • drink takes the shape of the cup: the particles are not in fixed positions, they slide over each other (move around freely), so the liquid flows to fill the shape of the container (1) • vapour can be squashed: the particles are very far apart (there is a lot of empty space between them), so they can be pushed closer together (1) **Accept:** One mark per row. Each explanation needs the arrangement or the motion of the particles (and the forces or spacing where the row needs them). NOT: the particles of ice are solid / cold; NOT: the particles of the gas get smaller **Textbook: Discover Physics, 5th ed., p. 125 (Ch 7 Kinetic Particle Model of Matter, 7.1)** *"Particles are closely packed and arranged in a regular pattern."* **Textbook: Discover Physics, 5th ed., p. 125 (Ch 7 Kinetic Particle Model of Matter, 7.1)** *"Particles vibrate about fixed positions. They are held in position by strong attractive forces between the particles."* **Textbook: Discover Physics, 5th ed., p. 125 (Ch 7 Kinetic Particle Model of Matter, 7.1)** *"The particles slide over each other throughout the liquid without fixed positions."* **Textbook: Discover Physics, 5th ed., p. 125 (Ch 7 Kinetic Particle Model of Matter, 7.1)** *"Particles are very far apart from one another in an irregular pattern."* **Textbook: Discover Physics, 5th ed., p. 125 (Ch 7 Kinetic Particle Model of Matter, 7.1)** *"The particles can move freely in any direction."*	3

16(d)	• the student is not correct: the temperature stays at 0 °C for 10 minutes (4 to 14 min) because the ice is melting; the energy transferred is used to do work against the attractive forces between the particles (increasing their separation and potential energy) (1) • the average kinetic energy of the particles does not change, so the temperature stays constant (1) **Accept:** the first mark needs the idea that the energy is still being transferred (and is used to separate the particles / increase their potential energy). NOT: the ice absorbs the energy and the temperature cannot rise; NOT: the student is correct **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. The average separation of the particles increases and so the potential energy of the particles increases."* **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