SCIENCE (PHYSICS) – Paper 2 Physics (set 2.1) – 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)	measuring cylinder B (1), with both reasons: its range (0 to 50 cm^3) includes 35 cm^3 (cylinder A, 0 to 25 cm^3, is too small) and its smallest division is 1 cm^3, smaller than the beaker (50 cm^3) or the jug (100 cm^3), so it is the most precise (the mark is given only for B with the range reason and the division reason; cylinder B with only one reason scores no mark) **Accept:** the smallest unit it can measure is 1 cm^3 **Textbook: Discover Physics, 5th ed., p. 8 (Ch 1 Physical Quantities, Units and Measurements, 1.3)** *"The smallest unit an instrument can measure is known as its precision."*	1
1(b)	• mass of oil = 116.2 − 84.0 = 32.2 g; density = mass / volume = 32.2 / 35 = 0.92 g/cm^3 (1) • 1 g/cm^3 = 1000 kg/m^3, so **920 kg/m^3** (1); 0.92 g/cm^3 without conversion scores the first mark only **Accept:** 32.2 g = 0.0322 kg and 35 cm^3 = 3.5 × 10^{-5} m^3, giving 920 kg/m^3 (2)	2

Section A – Question 2 [5]

Part	Answer and mark points	Marks
2(a)	a constant rate of change of velocity **Accept:** velocity / speed increases by the same amount every second (for motion in a straight line) **Textbook: Discover Physics, 5th ed., p. 24 (Ch 2 Kinematics, 2.1)** *"Uniform acceleration is a constant rate of change of velocity."*	1
2(b)	• distance = area under the graph (1) = ½ × (24 + 16) × 0.40 • **8.0 m** (1) **Accept:** 0.8 + 6.4 + 0.8 (areas of triangle, rectangle, triangle)	2
2(c)	• average speed = total distance / total time = 8.0 / 24 = 0.33 m/s (1) • the speed of the second robot (0.40 m/s) is greater than 0.33 m/s for the same distance, so it takes less time and finishes first / before the first robot (1) **Accept:** time for the second robot = 8.0 / 0.40 = 20 s, which is less than 24 s (1); ecf from (b) for the distance	2

Section A – Question 3 [3]

Part	Answer and mark points	Marks
3(a)	total mass = 64 + 8.0 = 72 kg; weight = mass × gravitational field strength = 72 × 10 = **720 N** (1); 640 N (the empty fridge only) scores no mark	1

3(b)	• area of one foot = 2.0 × 2.5 = 5.0 cm^2; total area = 4 × 5.0 = 20 cm^2 = 2.0 × 10^{-3} m^2; pressure = force / area = 720 / (2.0 × 10^{-3}) (1) • **3.6 × 10^5 Pa** (1); 7.2 × 10^5 Pa (area of two feet only), 1.4 × 10^6 Pa (area of one foot only) or 36 N/cm^2 (area left in cm^2) scores the first mark only **Accept:** 360 000 N/m^2; ecf from (a)	2

Section A – Question 4 [4]

Part	Answer and mark points	Marks
4(a)	• the washing machine is moving at constant velocity, so its acceleration is zero / the resultant force is zero (the forces are balanced) (1) • so the push (forwards) must be equal and opposite to the friction (backwards), 150 N (1); do not accept "the push is greater than friction" (the machine would accelerate) **Textbook: Discover Physics, 5th ed., p. 65 (Ch 4 Dynamics, 4.1)** > *"The two forces acting on the book are equal but act in opposite directions. Thus, the resultant force is zero and the book continues moving at a constant velocity."*	2
4(b)	• resultant force = 210 − 150 = 60 N; $a = F / m$ = 60 / 60 (1) • **1.0 m/s^2** (1)	2

Section A – Question 5 [3]

Part	Answer and mark points	Marks
5(a)	distance = 60 − 20 = 40 cm = 0.40 m; moment = force × perpendicular distance from the pivot = 3.0 × 0.40 = **1.2 N m** (1); a distance of 60 cm (the scale reading, not the distance from the pivot) scores no mark **Accept:** 120 N cm	1
5(b)	• clockwise moment = anticlockwise moment: W × (20 − 10) cm = W × 0.10 m = 1.2 (1) • **12 N** (1) **Accept:** W × 10 = 3.0 × 40 (distances in cm); ecf from (a) for the moment	2

Section A – Question 6 [5]

Part	Answer and mark points	Marks
6(a)	• $E_p = mgh$ = 8.0 × 10 × 4.5 (1) • **360 J** (1)	2
6(b)	power = energy transferred / time taken = 360 / 12 = **30 W** (1) **Accept:** ecf from (a)	1
6(c)	energy cannot be created or destroyed, it can only be transferred from one store to another (the total energy of an isolated system is constant) **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. The total energy of an isolated system is constant."*	1
6(d)	480 − 360 = **120 J** (1) **Accept:** ecf from (a)	1

Section A – Question 7 [5]

Part	Answer and mark points	Marks
7(a)	any one: a gas has no fixed volume (fills its container) but a liquid has a fixed volume; a gas can be compressed but a liquid cannot (easily); a gas has a much lower density than a liquid **Accept:** gas takes up the volume and shape of its container; the liquid has a fixed volume and no fixed shape (do not accept "a gas is hotter" or "gas particles move faster") **Textbook: Discover Physics, 5th ed., p. 125 (Ch 7 Kinetic Particle Model of Matter, 7.1)** > *"Gases have no fixed volume (compressible) and no fixed shape. A gas takes up the volume and shape of its container."* **Textbook: Discover Physics, 5th ed., p. 125 (Ch 7 Kinetic Particle Model of Matter, 7.1)** > *"Liquids have a fixed volume and no fixed shape."*	1
7(b)	• energy is transferred to the water, so the kinetic energy of the molecules increases / the molecules move faster (1) • temperature rises with the (average) kinetic energy of the molecules (1); do not accept "the molecules expand" or "the molecules get hotter" without reference to kinetic energy / speed **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."* **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(c)	• the total kinetic energy associated with the random motion of the molecules (1) • and the total potential energy between the molecules (due to the forces between them) (1) **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 8 [4]

Part	Answer and mark points	Marks
8(a)	• conduction and convection need a medium / particles to transfer the energy (1) • there are no particles in a vacuum, so energy cannot be transferred across the gap by conduction or convection (1) **Textbook: Discover Physics, 5th ed., p. 140 (Ch 8 Thermal Processes, 8.2)** > *"In both conduction and convection, a physical medium is needed for energy transfer to occur."*	2
8(b)(i)	by radiation (infra-red / electromagnetic waves), which does not need a medium **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
8(b)(ii)	a shiny (silver) surface is a poor emitter of radiation, so it emits radiation at a slow rate **Accept:** it reflects the radiation back towards the soup **Textbook: Discover Physics, 5th ed., p. 142 (Ch 8 Thermal Processes, 8.2, surface colour and texture)** > *"The shiny, smooth and light-coloured surface of an object absorbs incoming radiation at a slower rate. The same surface also emits radiation at a slow rate."*	1

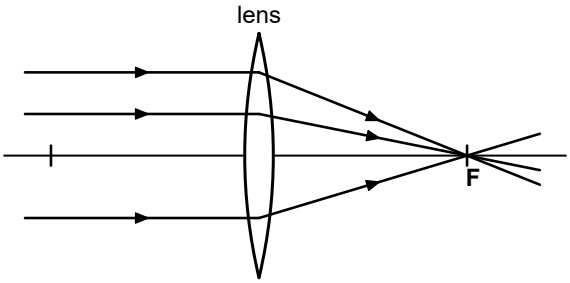
Section A – Question 9 [1]

Part	Answer and mark points	Marks
9(a)	wavelength = **80 cm** (110 − 30) and amplitude = **3 cm** (both values needed for the mark) (1) **Accept:** any reading of the distance between two successive crests (or troughs), e.g. 190 − 110; twice the distance between a crest and the next trough; amplitude = maximum displacement from the undisturbed position (do not accept 6 cm, the crest-to-trough height, or 30 cm, the position of the first crest)	1

Section A – Question 10 [2]

Part	Answer and mark points	Marks
10(a)	• oven heating the soup: microwaves; remote controller: infra-red (waves / radiation); baby-bottle cupboard: ultraviolet (UV); kitchen set tuned to a station: radio waves • all four correct (2); any two or three correct (1) **Accept:** infrared; UV light **Textbook: Discover Physics, 5th ed., p. 189 (Ch 11 Electromagnetic Waves, 11.2, microwaves)** > *"The frequency of the waves in microwave ovens is specially chosen to enhance the transfer of energy to the water molecules as water is a major component in food."* **Textbook: Discover Physics, 5th ed., p. 190 (Ch 11 Electromagnetic Waves, 11.2, infrared)** > *"Devices such as the television and air conditioners can be remotely turned on or off using an infrared remote controller."* **Textbook: Discover Physics, 5th ed., p. 192 (Ch 11 Electromagnetic Waves, 11.2, ultraviolet)** > *"In Singapore's water treatment plants, UV light plays an important role in disinfection and sterilisation by killing bacteria and viruses."* **Textbook: Discover Physics, 5th ed., p. 188 (Ch 11 Electromagnetic Waves, 11.2, radio waves)** > *"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 11 [5]

Part	Answer and mark points	Marks
11(a)	• all three rays drawn bending towards the principal axis (converging) at the lens (1) • the rays meet at one point on the principal axis, at the mark to the right of the lens, labelled F (1)  model answer for Fig. 11.1 **Accept:** the emergent rays need not be extended beyond F; rays drawn with a ruler, straight, with the arrow direction shown (arrows are not required for the mark) **Textbook: Discover Physics, 5th ed., p. 214 (Ch 12 Light, 12.3)** *"Its shape allows a beam of parallel rays passing through it to be brought to a single focal point."* **Textbook: Discover Physics, 5th ed., p. 216 (Ch 12 Light, 12.3, principal focal point F)** *"The point on the principal axis where all rays parallel to the principal axis meet after passing through the lens"*	2
11(b)	• real, inverted, diminished • all three correct (2); any two correct (1) **Accept:** the image is on the opposite side of the lens from the object, formed where the rays actually meet (real); it is below the axis (inverted); it is smaller than the object (diminished) **Textbook: Discover Physics, 5th ed., p. 221 (Ch 12 Light, 12.3, forming image in a camera)** *"A converging lens is used to form an inverted, real and diminished image on the sensor of a film camera."*	2
11(c)	sin r = sin 48° / 1.5 = 0.743 / 1.5 = **0.50** (1) **Accept:** 0.495	1

Section A – Question 12 [4]

Part	Answer and mark points	Marks
12(a)	• $Q = It$ = 5.0 × (6.0 × 60) (1) • **1800 C** (1); 30 C (time not converted to seconds) scores the first mark only	2
12(b)	• $R = V / I$ = 230 / 5.0 (1) • **46 Ω** (1)	2

Section A – Question 13 [4]

Part	Answer and mark points	Marks
13(a)	• 4.0 + 8.0 = 12 Ω in series; 1 / R = 1 / 12 + 1 / 6.0 (1) • **4.0 Ω** (1)	2

13(b)	• current in the 4.0 Ω and 8.0 Ω branch = 12 / (4.0 + 8.0) = 1.0 A (1) • p.d. = IR = 1.0 × 8.0 = **8.0 V** (1) **Accept:** the p.d. across the 4.0 Ω resistor is 4.0 V, so 12 − 4.0 = 8.0 V (1 mark each step)	2

Section A – Question 14 [4]

Part	Answer and mark points	Marks
14(a)	• steel is a hard magnetic material, so it is a permanent magnet: it keeps its magnetism (1) • iron is a soft magnetic material, it is easily demagnetised / loses its magnetism easily (a temporary magnet), so it would not hold the door shut for long (1) **Accept:** steel is difficult to magnetise and demagnetise; iron is easily magnetised and demagnetised **Textbook: Discover Physics, 5th ed., p. 294 (Ch 16 Magnetism and Electromagnetism, 16.1)** *"Permanent magnets do not require the presence of an electric current or a permanent magnetic field to retain their magnetism."* **Textbook: Discover Physics, 5th ed., p. 294 (Ch 16 Magnetism and Electromagnetism, 16.1)** *"Iron and steel are examples of soft and hard magnetic materials, respectively."*	2
14(b)	• place the (plotting) compass at P and wait for the needle to settle (1) • the direction in which the north pole (N end) of the needle points is the direction of the magnetic field at P (1) **Textbook: Discover Physics, 5th ed., p. 298 (Ch 16 Magnetism and Electromagnetism, 16.2)** *"The direction of the magnetic field lines is indicated by the direction of the plotting compass needle (Figure 16.28)."*	2

Section A – Question 15 [3]

Part	Answer and mark points	Marks
15(a)	241 − 95 = **146** (1)	1
15(b)	• $4.8 \times 10^4 \rightarrow 2.4 \times 10^4 \rightarrow 1.2 \times 10^4 \rightarrow 6.0 \times 10^3 \rightarrow 3.0 \times 10^3 \rightarrow 1.5 \times 10^3$: 5 half-lives (1) • 5 × 432 = **2160 years** (1) **Accept:** 2.2×10^3 years; 2200 years	2

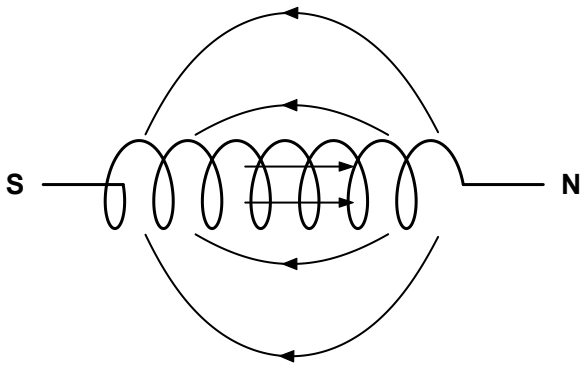
Section B – Question 16 [10]

Part	Answer and mark points	Marks
16(a)	• $P = VI$, so I = 1840 / 230 = 8.0 A (1) • $E = VIt$ (or Pt) = 230 × 8.0 × (15 × 60) (1) • **1.7×10^6 J** (1) **Accept:** 1 656 000 J; 1.66×10^6 J; ecf for the energy from the current	3

16(b)	• current in kettle = 2300 / 230 = 10 A, so the total current = 8.0 + 10 = 18 A, which is more than 13 A (1) • the fuse wire in the adaptor gets hot and melts, breaking the circuit, so the wiring does not overheat / cause a fire (1) **Accept:** total power 4140 W gives 18 A; ecf from (a) **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."* **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
16(c)	• speed of sound = distance / time = 10.2 / 0.030 = 340 m/s (1) • $\lambda = v / f$ = 340 / 2500, with 2.5 kHz = 2500 Hz (1) • **0.14 m** (1) **Accept:** 0.136 m	3
16(d)	• B is louder: its amplitude is 1 division × 2 V/div = 2.0 V, which is greater than the 2 × 0.5 = 1.0 V of A (1) • A has the higher pitch: period of A = 4 × 0.2 ms = 0.8 ms (1250 Hz), which is shorter than the 2 × 0.5 = 1.0 ms of B (1000 Hz), so A has the higher frequency (1) • an answer with no reading or calculation to support it scores no mark; the settings must be used, not only the look of the traces **Textbook: Discover Physics, 5th ed., p. 175 (Ch 10 General Wave Properties II - Sound, 10.2)** > *"Loudness is generally related to the amplitude of a sound wave. The larger the amplitude, the louder the sound."* **Textbook: Discover Physics, 5th ed., p. 175 (Ch 10 General Wave Properties II - Sound, 10.2)** > *"The higher the frequency, the higher the pitch."*	2

Section B – Question 17 [10]

Part	Answer and mark points	Marks
17(a)	• in steam (a gas) the particles are very far apart, with large spaces between them (1) • the attractive forces between the particles are weak, so they can be pushed closer together (compressed) (1) • in liquid water the particles are already close together / touching, with no space to be pushed closer, so it cannot be compressed (1) **Accept:** particles in a gas move freely and fill the container; particles in a liquid slide over each other but stay in contact **Textbook: Discover Physics, 5th ed., p. 125 (Ch 7 Kinetic Particle Model of Matter, 7.1, gas)** > *"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, gas)** > *"Gases have no fixed volume (compressible) and no fixed shape. A gas takes up the volume and shape of its container."* **Textbook: Discover Physics, 5th ed., p. 125 (Ch 7 Kinetic Particle Model of Matter, 7.1, liquid)** > *"The particles slide over each other throughout the liquid without fixed positions. The forces holding the particles together are weaker than in a solid."*	3
17(b)(i)	0 °C and 20 minutes (the temperature was constant at 0 °C from 10 min to 30 min, so 30 − 10 = 20 min) (both needed) **Accept:** any value from 20 to 30 minutes (the readings are 5 minutes apart)	1

17(b)(ii)	the energy removed comes from the potential energy of the particles (they move closer together as ice forms), while the average kinetic energy of the particles stays the same, so the temperature stays constant **Accept:** energy removed does not change the (average) kinetic energy of the particles **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."*	1
17(c)(i)	• iron is a magnetic material and the plunger is placed in / close to the field of the current-carrying solenoid (1) • the magnetic field of the solenoid magnetises the iron, so it becomes an induced magnet (1) **Accept:** the tiny (atomic) magnets in the iron line up in the direction of the field of the solenoid **Textbook: Discover Physics, 5th ed., p. 291 (Ch 16 Magnetism and Electromagnetism, 16.1)** *"Induction, or induced magnetism, can take place when a magnetic material is placed close to a strong magnet or within a current-carrying solenoid."*	2
17(c)(ii)	south pole; unlike poles attract (both needed for the mark) **Accept:** an induced pole is opposite to the pole of the magnet that is close to it **Textbook: Discover Physics, 5th ed., p. 288 (Ch 16 Magnetism and Electromagnetism, 16.1, properties of magnets)** *"When two pieces of magnets are placed together, the like poles of the magnet repel while the unlike poles attract (Figure 16.2)."*	1
17(d)(i)	• closed loops outside the solenoid from the N end round to the S end, straight parallel lines inside; arrows pointing out of the N end and into the S end (both the shape and the arrow directions are needed; lines must not cross) (1)  model answer for Fig. 17.2 **Accept:** the pattern is like that of a bar magnet **Textbook: Discover Physics, 5th ed., p. 306 (Ch 16 Magnetism and Electromagnetism, 16.3)** *"A current-carrying solenoid is an electromagnet. When a current is passed through a solenoid, a resultant magnetic field similar to a bar magnet is generated."*	1

17(d)(ii)	the field is stronger and its direction is reversed (the N and S poles swap) (both effects needed) **Textbook: Discover Physics, 5th ed., p. 306 (Ch 16 Magnetism and Electromagnetism, 16.3)** *"In addition, if the current flowing in the solenoid is increased, the strength of magnetic field of each individual turn would increase. This increases the resultant strength of magnetic field."* **Textbook: Discover Physics, 5th ed., p. 305 (Ch 16 Magnetism and Electromagnetism, 16.3)** *"Changing the direction of the current changes the direction of the magnetic field."*	1