PHYSICS – Paper 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: 80 (Section A: 70 marks; Section B: one question of 10 marks)

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

Section A – Question 1 [6]

Part	Answer and mark points	Marks
1(a)	gradient = 24 / 12 = **2.0 m/s** (1) **Textbook: Physics Matters, 5th ed., p. 25 (Ch 2 Kinematics, 2.2 Displacement–Time Graphs)** > *"The gradient of a displacement–time graph of an object gives the velocity of the object."*	1
1(b)	• the robot moves back towards the charging point / displacement decreases to zero (1) • non-uniform velocity: its speed increases (gradient gets steeper) until about t = 25 s, then decreases (gradient gets less steep) until it stops at t = 30 s (1) **Accept:** the robot is accelerating then decelerating (both needed for the second mark) **Textbook: Physics Matters, 5th ed., p. 26 (Ch 2 Kinematics, 2.2 Displacement–Time Graphs)** > *"The graph has an increasing gradient. The velocity of the car increases."* **Textbook: Physics Matters, 5th ed., p. 26 (Ch 2 Kinematics, 2.2 Displacement–Time Graphs)** > *"The graph has a decreasing gradient. The velocity of the car decreases."*	2
1(c)	• total distance travelled = 24 + 24 = 48 m (1) • average speed = 48 / 30 = **1.6 m/s** (1) **Accept:** M1 for 48 m; 0 m / 30 s = 0 (using displacement) scores 0	2
1(d)	250 × 10^{-6} = **2.5 × 10^{-4} m** (1) **Accept:** 0.00025 m	1

Section A – Question 2 [6]

Part	Answer and mark points	Marks
2(a)	the weight *W* (gravitational force) (1) **Accept:** gravitational force **Textbook: Physics Matters, 5th ed., p. 44 (Ch 3 Dynamics I, 3.1 Types of Forces)** > *"Forces can be classified into two types: non-contact forces, which do not require objects to be in contact to exist; and contact forces, which exist between objects that are in contact."* **Textbook: Physics Matters, 5th ed., p. 44 (Ch 3 Dynamics I, 3.1 Types of Forces)** > *"Gravitational force The pull exerted by Earth's gravity on any object (i.e. weight)"*	1
2(b)	• the kite is at rest, so the three forces form a closed triangle: *W* drawn 2.0 cm vertically down and *T* drawn 5.0 cm at 50° below the horizontal (to the left), head to tail (1) • third side drawn from the head of the last arrow back to the tail of the first; this is *F*, direction marked (1) • *F* = **6.7 N** (accept 6.5 to 6.9 N) at **61°** above the horizontal (accept 59° to 63°), pointing up and to the right (the side away from the string) (1) **Textbook: Physics Matters, 5th ed., p. 63 (Ch 4 Dynamics II, Vector Diagrams)** > *"If arrows representing the forces result in a closed triangle, we say that the forces are in equilibrium (i.e. the resultant force is zero) (Figure 4.17)."*	3

2(c)	• resultant force = 5.0 N (equal in size to T, because $W + F$ balanced T before) (1) • $a = F / m = 5.0 / 0.20 =$ **25 m/s^2** (1) **Accept:** 24 to 26 m/s^2	2

Section A – Question 3 [7]

Part	Answer and mark points	Marks
3(a)	• clockwise moment = anticlockwise moment: $16 \times x = 40 \times 6.0$ (1) • $x =$ **15 m** (1)	2
3(b)	the heavy block lowers the centre of gravity of the crane (1) **Accept:** a large base area (the vertical line through the centre of gravity stays inside the base for a larger tilt) **Textbook: Physics Matters, 5th ed., p. 86 (Ch 5 Turning Effects of Forces, Stability)** *"The lower the centre of gravity of an object, the more stable it is."* **Textbook: Physics Matters, 5th ed., p. 86 (Ch 5 Turning Effects of Forces, Stability)** *"The stability of an object can be affected in two ways — the position of the centre of gravity and the area of the base of the object."*	1
3(c)	• volume = $5.0 \times 5.0 \times 1.2 = 30$ m^3 (1) • $\rho = m / V = 72\,000 / 30 =$ **2400 kg/m^3** (1)	2
3(d)	• weight = $72\,000 \times 10 = 7.2 \times 10^5$ N and area = $5.0 \times 5.0 = 25$ m^2 (1) • $p = F / A = 7.2 \times 10^5 / 25 =$ **2.9×10^4 Pa** (1) **Accept:** 28 800 Pa; N/m^2	2

Section A – Question 4 [7]

Part	Answer and mark points	Marks
4(a)	mechanically (by a force, the weight, acting over a distance) (1) **Textbook: Physics Matters, 5th ed., p. 132 (Ch 7 Energy, Energy Resources: Hydropower)** *"By releasing the water and letting it flow downwards, energy in the gravitational potential store is transferred mechanically to the kinetic store of the water."* **Textbook: Physics Matters, 5th ed., p. 114 (Ch 7 Energy, 7.1 Energy Stores)** *"Energy can be transferred from one store to another in four different pathways."*	1
4(b)	• $E = mgh = 3.0 \times 10^6 \times 10 \times 250$ (1) • **7.5×10^9 J** (1)	2
4(c)	• efficiency = useful energy output / total energy input = $5.4 \times 10^9 / 7.5 \times 10^9$ (1) • **72 %** (0.72) (1) **Textbook: Physics Matters, 5th ed., p. 127 (Ch 7 Energy, Concept of Efficiency)** *"Total energy input = useful energy output + non-useful energy"*	2
4(d)	$P = E / t = 5.4 \times 10^9 / 600 =$ **9.0×10^6 W** (1) **Accept:** 9.0 MW **Textbook: Physics Matters, 5th ed., p. 126 (Ch 7 Energy, Power)** *"Power is defined as the work done or energy transferred per unit time."*	1
4(e)	possible damage to the environment (habitat, land flooded) surrounding the river caused by damming the river (1) **Accept:** loss of habitats / flooding of land / change to the river ecosystem **Textbook: Physics Matters, 5th ed., p. 132 (Ch 7 Energy, Energy Resources: Hydropower (disadvantages))** *"Possible damage to the environment surrounding the river caused by damming of river for hydroelectric power station"*	1

Section A – Question 5 [9]

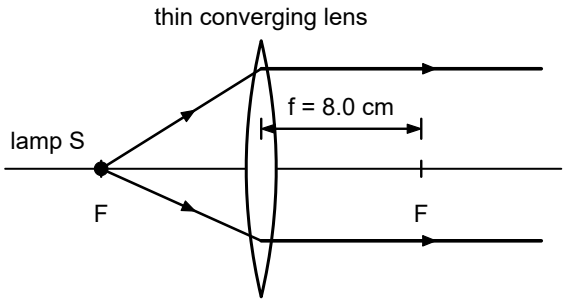
Part	Answer and mark points	Marks
5(a)	• particles (atoms) at the heated end vibrate more vigorously and pass energy on to neighbouring particles by collisions (1) • free electrons at the hot end gain energy, move quickly through the metal to the cooler end and transfer energy to the particles there (1) **Textbook: Physics Matters, 5th ed., p. 151 (Ch 9 Thermal Processes, Conduction in Solids)** > *"Thus, through collisions, energy is transferred from the more energetic particles to the less energetic particles towards the right."* **Textbook: Physics Matters, 5th ed., p. 151 (Ch 9 Thermal Processes, Conduction in Solids)** > *"In addition to the same process in non-metals, the free electrons at this heated end gain energy from interacting with the particles. The small size and high speed of the electrons allow them to move easily and quickly to the cooler end and transfer energy to the particles there."*	2
5(b)	it increases (1) **Textbook: Physics Matters, 5th ed., p. 143 (Ch 8 Kinetic Particle Model of Matter, Temperature)** > *"Temperature rises with the average kinetic energy of the particles in a body and vice versa."*	1
5(c)	• $E = mc\Delta T = 0.80 \times 4200 \times (100 - 25)$ (1) • **2.5×10^5 J** (252 000 J) (1)	2
5(d)	• the energy supplied is used to overcome / weaken the forces of attraction between the molecules (so they move far apart as steam), not to speed them up (1) • the average kinetic energy of the molecules stays the same, so the temperature stays constant (1) **Accept:** the energy increases the potential energy of the molecules; NOT: the energy is lost to the surroundings **Textbook: Physics Matters, 5th ed., p. 181 (Ch 10 Thermal Properties of Matter, Heating and Cooling (Disciplinary Idea))** > *"When a body changes state at a constant temperature, latent heat is absorbed or released. This is linked to changes in the forces of attraction between the particles. Kinetic energy of the particles remains the same."*	2
5(e)	• the steam particles move randomly and collide with the lid (and the walls) (1) • each collision exerts a force on the lid; many collisions per second add up, and the total force per unit area is the pressure that lifts the lid (1) **Textbook: Physics Matters, 5th ed., p. 144 (Ch 8 Kinetic Particle Model of Matter, Pressure)** > *"When there are many gas particles colliding with the inner wall of the container, the forces add up. The total force exerted by the gas per unit area is the pressure."* **Textbook: Physics Matters, 5th ed., p. 144 (Ch 8 Kinetic Particle Model of Matter, Pressure)** > *"At the particle level, pressure is the average force exerted by the particles per unit area."*	2

Section A – Question 6 [9]

Part	Answer and mark points	Marks
6(a)(i)	**4 µm** (1) **Accept:** 4.0 µm	1
6(a)(ii)	**0.80 m** (1) **Accept:** 80 cm	1
6(b)	$v = f\lambda = 425 \times 0.80$ (1) **340 m/s** (1) ecf from (a)(ii)	2

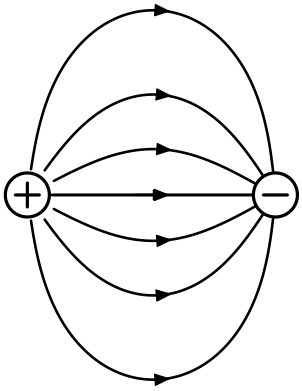
6(c)	• the sound is quieter / less loud because the amplitude of the wave is smaller (1) • the pitch is higher because the frequency of the wave is higher (1) **Accept:** each change must be linked to the correct wave property **Textbook: Physics Matters, 5th ed., p. 209 (Ch 12 General Wave Properties II: Sound)** *"Loudness is generally related to the amplitude of a sound wave. The larger the amplitude, the louder the sound."* **Textbook: Physics Matters, 5th ed., p. 209 (Ch 12 General Wave Properties II: Sound)** *"The higher the frequency, the higher the pitch."*	2
6(d)	they arrive together because all electromagnetic waves travel with the same speed in a vacuum (3×10^8 m/s) (1) **Accept:** the one mark needs both the outcome and the reason **Textbook: Physics Matters, 5th ed., p. 221 (Ch 13 Electromagnetic Waves)** *"All electromagnetic waves can travel without a medium, with the same speed of 3×10^8 m/s in a vacuum."*	1
6(e)	mobile (cell) phone communication / microwave oven (cooking) (1) **Accept:** radar; Wi-Fi; GPS **Textbook: Physics Matters, 5th ed., p. 225 (Ch 13 Electromagnetic Waves)** *"Microwaves are used very extensively for communication. The best known example is in mobile phone communication where many transmitters and receivers relay information across the whole network."*	1
6(f)	heating of body cells / tissue (1) [which can damage or kill cells / cause burns] **Accept:** absorption of the microwaves causes heating; damage to living cells and tissue **Textbook: Physics Matters, 5th ed., p. 230 (Ch 13 Electromagnetic Waves)** *"Absorption of electromagnetic waves may cause heating (e.g. microwave oven for cooking), ionisation and damage to living cells and tissues."*	1

Section A – Question 7 [7]

Part	Answer and mark points	Marks
7(a)	each ray drawn after the lens parallel to the principal axis (1 + 1)  Fig. 7.1 (answer) **Textbook: Physics Matters, 5th ed., p. 257 (Ch 14 Light)** *"An incident ray passing through the principal focal point F before passing through the lens will emerge parallel to the principal axis (principal of reversibility)."*	2
7(b)	• virtual, upright and magnified: all three correct = 2 marks; any two correct = 1 mark (the three characteristics are virtual, upright, magnified) **Textbook: Physics Matters, 5th ed., p. 260 (Ch 14 Light)** *"If the object distance is less than the focal length, the image is magnified and not inverted."* **Textbook: Physics Matters, 5th ed., p. 258 (Ch 14 Light)** *"The image is virtual just like the image in a mirror."*	2

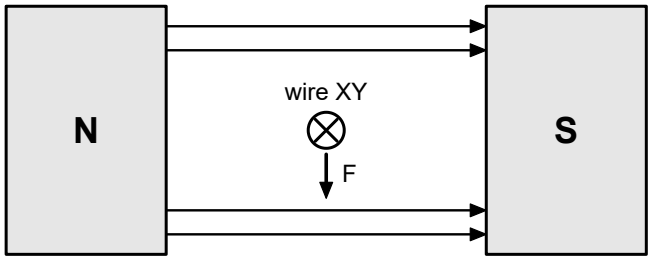
7(c)(i)	the ratio of the speed of light in a vacuum to the speed of light in the medium (1) **Textbook: Physics Matters, 5th ed., p. 244 (Ch 14 Light)** *"The refractive index n of a medium is defined as the ratio of the speed of light in a vacuum to the speed of light in that medium."*	1
7(c)(ii)	$v = c / n = 3.0 \times 10^8 / 1.5 =$ **2.0×10^8 m/s** (1)	1
7(d)	angle of incidence = 90° − 35° (angles are measured from the normal) = 55°, so the angle of reflection = **55°** (1) **Accept:** NOT 35° (the common wrong answer: the angle was taken from the mirror, not from the normal) **Textbook: Physics Matters, 5th ed., p. 236 (Ch 14 Light)** *"The second law of reflection states that the angle of incidence θi is equal to the angle of reflection θr."*	1

Section A – Question 8 [10]

Part	Answer and mark points	Marks
8(a)	alpha particles are strongly ionising: they knock electrons out of air molecules / atoms to form (positive and negative) ions which carry charge (1) **Textbook: Physics Matters, 5th ed., p. 402 (Ch 22 Radioactivity)** *"Ionisation refers to the ability to eject electrons from atoms to form ions."*	1
8(b)	1290 / 430 = 3 half-lives (1) 36 → 18 → 9 → **4.5 kBq** (1)	2
8(c)	plate Q, because unlike charges attract / Q is negative (1; both needed) **Textbook: Physics Matters, 5th ed., p. 268 (Ch 15 Static Electricity)** *"Like charges repel each other while unlike charges attract each other."*	1
8(d)	there is an electric field (a region in which a charge experiences a force) between the plates, so each ion experiences a force (1) **Textbook: Physics Matters, 5th ed., p. 269 (Ch 15 Static Electricity)** *"Electric field is a region in which an electric charge experiences an electric force."*	1
8(e)	• at least four smooth field lines between X and Y, symmetrical, not crossing, starting and ending on the ions (1) • arrows on every line pointing from the positive ion X towards the negative ion Y (1)  Fig. 8.2 (answer) **Textbook: Physics Matters, 5th ed., p. 270 (Ch 15 Static Electricity)** *"The arrows always point towards a negative charge and away from a positive charge."*	2

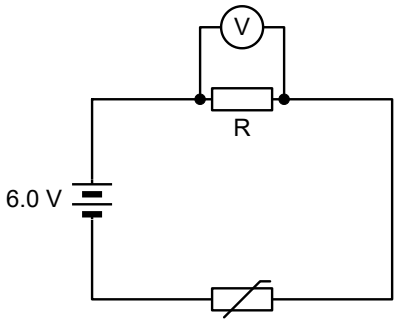
8(f)	less charge reaches the plates each second, and current is the rate of flow of charge (1) **Textbook: Physics Matters, 5th ed., p. 287 (Ch 16 Current of Electricity)** *"Electric current is the rate of flow of electric charge."*	1
8(g)	$Q = It = 0.80 \times 10^{-6} \times 30$ (1) **2.4×10^{-5} C** (1) **Accept:** 24 μC	2

Section A – Question 9 [9]

Part	Answer and mark points	Marks
9(a)	four straight parallel lines between N and S, with arrows from N to S (1)  Fig. 9.1 (answer) **Textbook: Physics Matters, 5th ed., p. 353 (Ch 19 Magnetism)** *"By convention, the field lines have arrows that point out from the north pole of the magnet and point into the south pole."*	1
9(b)	down the page (towards the bottom of the page) (1) **Textbook: Physics Matters, 5th ed., p. 370 (Ch 20 Electromagnetism)** *"The direction of the force can be determined using Fleming's left-hand rule. First, the left hand is held out with the forefinger, second finger and thumb perpendicular to each other (Figure 20.18)."*	1
9(c)	• reversing the current reverses the direction of the force on the coil (1) • the current alternates, so the force keeps changing direction and the coil and cone move backwards and forwards (1) **Textbook: Physics Matters, 5th ed., p. 370 (Ch 20 Electromagnetism)** *"Reversing the direction of current induces a swing in the opposite direction."*	2
9(d)	$I = P / V = 6.0 / 4.0 =$ **1.5 A** (1)	1
9(e)	the coil cuts the magnetic field lines / the magnetic field through the coil changes, which induces an e.m.f. (1) **Textbook: Physics Matters, 5th ed., p. 380 (Ch 21 Electromagnetic Induction)** *"He concluded that a changing magnetic field produces an induced current."*	1
9(f)	• more turns on the coil (1) • stronger magnet (1) **Accept:** any two correct; faster movement of the coil is not accepted because the same sound is used **Textbook: Physics Matters, 5th ed., p. 383 (Ch 21 Electromagnetic Induction)** *"the number of turns of the coil is increased; or"* **Textbook: Physics Matters, 5th ed., p. 383 (Ch 21 Electromagnetic Induction)** *"the strength of the magnet is increased."*	2

9(g)	the force is opposite to the motion / opposes the movement of the coil (Lenz's law) (1) **Textbook: Physics Matters, 5th ed., p. 382 (Ch 21 Electromagnetic Induction)** *"Lenz's Law states that the direction of the induced e.m.f., and hence the induced current in a closed circuit, is always such that its magnetic effect opposes the motion or change producing it."*	1

Section B – Question 10 [10]

Part	Answer and mark points	Marks
10(a)(i)	• battery (cell), R and thermistor symbols in series in a closed circuit (1) • voltmeter connected in parallel with R (1)  answer	2
10(a)(ii)	• the resistance of an NTC thermistor falls as temperature rises, so the total resistance falls and the current rises (1) • p.d. across R = *IR* with R fixed, so it rises (the thermistor gets a smaller share of the 6.0 V) (1) **Textbook: Physics Matters, 5th ed., p. 318 (Ch 17 D.C. Circuits)** *"A negative temperature coefficient (NTC) thermistor is one where its resistance decreases with temperature."*	2
10(a)(iii)	resistance of thermistor at 20 °C = 8.0 kΩ (1) V_R = 6.0 × 4.0 / (8.0 + 4.0) = **2.0 V** (1) **Accept:** or current = 6.0 / 12 000 = 5.0 × 10^{-4} A, then 5.0 × 10^{-4} × 4000 = 2.0 V	2
10(b)(i)	1/*R* = 1/1150 + 1/1150 = 2/1150, so *R* = 575 Ω (1)	1
10(b)(ii)	energy = 0.092 kW × (12 × 30) h = 33 kW h (33.12) (1) cost = 33.12 × 25 = **830 cents** (828 cents, $8.28) (1) **Accept:** ecf from the energy; 825 cents if the energy is rounded to 33 kW h **Textbook: Physics Matters, 5th ed., p. 330 (Ch 18 Practical Electricity)** *"One kW h of electricity is the energy used by a 1 kW device in an hour."*	2
10(c)	water conducts electricity, so a person could get an electric shock (if water reaches live parts / damaged insulation) (1) **Accept:** short circuit / fire from water on live parts **Textbook: Physics Matters, 5th ed., p. 334 (Ch 18 Practical Electricity)** *"Many electrical accidents occur in damp environments."*	1

Section B – Question 11 [10]

Part	Answer and mark points	Marks
11(a)	background radiation (1) [from natural sources such as rocks, cosmic rays, radon, or man-made sources] **Textbook: Physics Matters, 5th ed., p. 404 (Ch 22 Radioactivity)** > *"Background radiation refers to nuclear radiation in an environment where no radioactive source has been deliberately introduced."*	1
11(b)	count rate falls from 640 to 320 in **6.0 hours** (1) **Accept:** any correct pair of values one half-life apart **Textbook: Physics Matters, 5th ed., p. 406 (Ch 22 Radioactivity)** > *"The half-life of a radioactive nuclide is the time taken for half the nuclei of that nuclide in any sample to decay."*	1
11(c)	30 h = 5 half-lives, 640 ÷ 2^5 = 20 counts per minute (corrected) (1) add background 20: **40 counts per minute** (1) **Accept:** 20 counts per minute (corrected rate, background not added) scores 1 mark	2
11(d)	• gamma rays are very penetrating, so they pass out of the body to the camera (1) • short half-life, so the activity falls quickly and the patient is not exposed for long (1) **Accept:** any two; also accept: gamma rays are weakly ionising (compared with alpha and beta), so less harm to cells **Textbook: Physics Matters, 5th ed., p. 402 (Ch 22 Radioactivity)** > *"Gamma rays can penetrate deep into the body more easily than other EM waves of lower frequencies."*	2
11(e)	$^{99}_{42}Mo \rightarrow {}^{99}_{43}Tc + {}^{0}_{-1}e$ (1 for the Tc numbers, 1 for the beta particle) **Accept:** β or β^- for the beta particle symbol	2
11(f)	• the nucleus of an atom splits (usually into two parts) (1) • energy is released from the nuclear store of the nucleus / a huge amount of energy is released (1) **Textbook: Physics Matters, 5th ed., p. 410 (Ch 22 Radioactivity)** > *"Nuclear fission is a process in which the nucleus of an atom splits (usually into two parts) and releases a huge amount of energy."*	2