

2024 4E Pure Physics Prelim Paper 2

Mark Scheme

Note:

1. All numerical answers can be expressed in 2 SF or 3 SF unless stated otherwise in question.
2. Units of physical quantities must be accurate.

Section A

No.	Ans	Marks	Remarks/Comments
1a	Rate of change for displacement / change in displacement per unit time	B1	
1bi	gravitational field strength = gradient of v-t graph = -1.6 Weight = mass x gravitational field strength = 7.5×1.6 = 12 N	M1 M1 A1	
1bii	max height = area under v-t graph during first 2.5 s = $\frac{1}{2} \times 2.5 \times 4 = 5.0$ m	A1	
1biii	Gradient of v-t graph is equal to the acceleration due to gravity. 1. Gradient of graph drawn = - 10 2. Graph must start from 4.0 m/s	B1 B1	
2a	pressure = height x density x gravitational field strength = $35 \times 1000 \times 10 = 3.5 \times 10^5$ Pa	A1	
2bi	Pressure calculated was only due to water, however the <u>actual pressure will need to include atmospheric pressure</u> which acts on the surface of the water.	B1	
2bii	Using $P = F/A$, $F = P \times A = 450 \times 10^3 \times 42 = 1.89 \times 10^7$ N	A1	
2c	A vector quantity has both magnitude and direction, while a scalar quantity has only magnitude.	B1	
2d	Pressure at P = atmospheric pressure = 1.0×10^5 Pa = 735 mm Hg Pressure at P = Pressure at Q + pressure due to mercury column Pressure of gas = Pressure at Q = $735 - 320 = 415$ mm Hg	M1 A1	
3a	Near surface of liquid nitrogen.	B1	
3b	Any of <u>two</u> of the following: - Boiling takes place at a fix temperature (boiling point) and evaporation takes place at any temperature. - Boiling needs a heat source where evaporation does not. - Rate of boiling is faster compared to evaporation. - During boiling, temperature of liquid remains constant but for evaporation, temperature of liquid drops.	B1 B1	

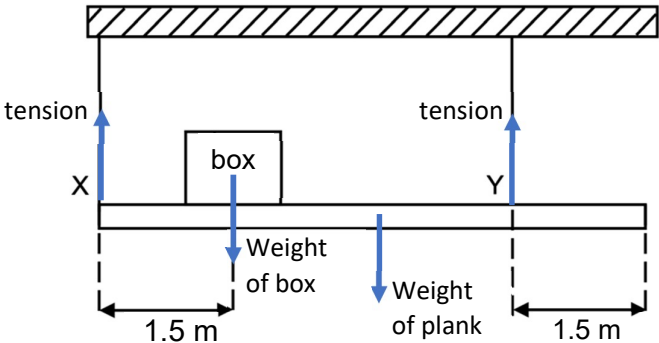
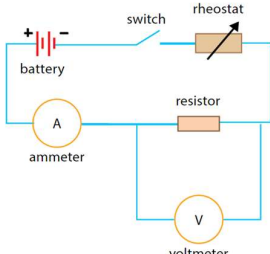
No.	Ans	Marks	Remarks/Comments
3c	Vacuum <u>reduces the amount of energy gain from surrounding</u> because <u>vacuum stop energy transfer via conduction and convection</u> from taking place due to lack of matter.	B1 B1	
3di	50 g = 0.050 kg energy lost from metal = mass of metal x specific heat capacity of metal x change in temperature = $0.050 \times 390 \times 10^3 \times (20 - (-196))$ = 4.2×10^6 J (2 SF)	M1 A1	
3dii	Assuming all energy used to boil nitrogen is from the piece of metal. energy used to boil = mass of nitrogen x latent heat of vaporisation of nitrogen mass of nitrogen = $4.2 \times 10^6 / 200 = 21000$ g (2SF) or 21 kg	 A1	
4a	Microwaves	B1	
4b	(i) X rays (ii) Microwaves (iii) Infra-red <i>Note: B2 for all correct or B1 for 2 of 3 correct</i>	B2	
4c	Ultrasound is <u>a type of sound (or longitudinal) wave</u> , thus it is not an electromagnetic wave.	B1	
4d	(i) Ultrasound: Both source and detector on the same side above the patient's body. (ii) X-ray: Source and detector opposite of each other of the patient's body.	B1 B1	
5a	<u>Plastic ruler loses electrons to the cloth</u> and becomes positively charged.	B1	
5b	Droplets are charged positively/negatively when they leave the sprayer. Like charges repel, this causes the droplets to spread out. As charged droplets approached the leaf, the charges on droplets are attracted to the opposite charge (or induced opposite charge) on the leaf. When droplets land on the leaf, they are discharged due to leaf being earthed. This helps to allow leaf to be covered with insecticide.	B1 B1 B1	
6a	(i) direction of current is from B to A (ii) Magnetic field drawn from N pole to S pole	B1 B1	

No.	Ans	Marks	Remarks/Comments
6b	When switch is on, <u>current flowing through metal rod AB produces a magnetic field</u> around the rod. This <u>magnetic field interacts with the external magnetic field by the magnet and produces a magnetic force</u> to act on the metal rod. This magnetic force will <u>cause the metal rod to move upwards</u>. <i>Note: student must state the correct direction of movement to be given credit.</i>	B1 B1 B1	
6c	D.C. Motor	B1	
7ai	As tape passes the recording head, the <u>magnetic field produced by the head induced magnetism</u> on the tape.	B1	
7aii	By <u>changing direction of the current in the coil, the direction of magnetic field changes</u> . This allow the sections of the tape to be magnetized in opposite directions.	B1	
7aiii	For the same length of tape, there will be <u>lesser alternate sections and each section will be longer</u> .	B1	
7b	Advantage: It can be easily demagnetized and reuse for new recording Disadvantage: The recorded data can be loss easily over time as it can be easily demagnetized. <i>Accept other logical and suitable answers</i>	B1 B1	
8a	Power input is equal to power output OR Energy is conserved	B1	
8b	The alternating current flowing in the primary coil produces changing magnetic flux. This changing magnetic flux is directed towards the secondary coil through the iron core. With the changing magnetic flux in the secondary coil, it induces an output voltage in the secondary coil.	B1 B1 B1	
8c	$N_p/N_s = V_p/V_s = 25\ 000 / 400\ 000 = 1:16$ or $1/16$	A1	
8d	Input power = output power $400\ 000 \times I_s = 25\ 000 \times 12\ 000$ $I_s = 750\text{ A}$	A1	
8e	$P = IV = 750 \times 400\ 000 = 3.0 \times 10^8\text{ W}$	A1	
8f	<u>Reduce loss of power during transmission of electricity</u> due to lower current used for transmission.	B1	
9ai	Ratio of speed of light in vacuum to speed of light in medium. Or Speed of light in vacuum is 1.3 times the speed of light in medium.	B1	
9aii	Total internal reflection	B1	

No.	Ans	Marks	Remarks/Comments
9aiii	<u>Cladding has lower refractive index compared to core.</u> For total internal reflection to take place, <u>light must travel from optically denser to optically less dense medium.</u>	B1 B1	
9aiv	<u>Distance travelled is longer due to the path that was taken.</u> <u>Speed of light in optical fibre is slower than in air.</u>	B1 B1	
9bi	Total internal reflection occurs. <u>When angle of incidence is 50°, the corresponding angle of refraction is 90°. Therefore, 50° is the critical angle of light in water.</u> <u>When angle of incidence exceeds 50°, total internal reflection takes place.</u> Note: Student must explain why 50° is the critical angle in water and then relate to angle of incidence exceeding critical angle which result in T.I.R.	B1 B1	
9bii	$\sin c = 1/n$ $n = 1/\sin 40^\circ$ $c = 1.6$ (2 SF)	M1 A1	
10a	Spontaneous decay mean that it is <u>not possible to predict when a radioactive nucleus will emit radiation.</u>	B1	
10b	${}_{88}^{226}\text{Ra} \rightarrow {}_{86}^{222}\text{Rn} + {}_2^4\alpha$	B1 B1	
10ci	Accept one of these 19 or 20 or 21	B1	
10cii	count rate = count at 3.0 cm – background count = 429 – 19 = 410 The background count used must be the one answer by student in 10ci	A1	
10ciii	5.0 cm. Count rate per minute decreases to background count from 6.0 cm, thus 5.0 cm is the maximum distance.	B1 B1	
10di	4 days	B1	
10dii	After 20 days, the isotope has less than 5 % of radioactivity. However, after 5 day, the isotope has 42.5 % of radioactivity.	B1 B1	

Section B Answer **one** question.

11ai	Force drawn is furthest from the hinge.	B1	
11aai	Matchbox <u>topple and fall over</u> eventually.	B1	
	As cardboard is raised, <u>line of action of the weight of the matchbox will eventually fall out of the base.</u>	B1	
	The <u>weight of the matchbox then produces a clockwise moment</u> to topple the matchbox.	B1	

11bi	 - Any two correct forces to be awarded B1 - All four correct forces to be awarded B2	B2	
11bii	Weight of box = $2.5 \times 10 = 25 \text{ N}$ Taking moment about point X, $25 \times 1.5 + 400 \times 3.0 = T_y \times 4.5$ $T_y = \underline{275 \text{ N}}$ $T_x + T_y = 400 + 25$ $T_x = 400 + 25 - 275 = \underline{150 \text{ N}}$	M1 M1 M1 A1	
12a	<u>Resistance of X decreases</u> as p.d. increases from 0 V to 2.0 V.	B1	
12b	From <u>2.2 V to 3.8 V</u>. <u>Gradient of the I against V graph is constant, thus resistance is constant</u> like an ohmic conductor.	B1 B1	
12c	 - Setup circuit as shown in diagram drawn. - Record the readings of the ammeter and voltmeter for different position of the rheostat. - Plot a graph of voltmeter reading against ammeter reading. The resistance of the resistor is equal to gradient of the graph plotted.	B1 B1 B1	
12di	Resistance of 7.5Ω meant that a potential difference of 7.5 V is required to produce a current of 1.0 A.	B1	

12dii		B1	
12diii	$I = 0.80 + 1.2$ (current are obtained from Fig. 12.1) $= 2.0 \text{ A}$	M1 A1	