

2025 RVHS JC2 H2 Physics Preliminary Examinations Paper 2 Mark Scheme

Questions			Answers	Marks
1	(a)	(i)	The gas molecules move randomly (and rapidly)	B1
		(ii)	The <u>volume</u> of their <u>molecules</u> is negligible compared to the volume of the containing vessel.	B1
	(b)	(i)	The gas molecules move in three dimensions (or x- , y- and z- direction.)	B1
		(ii)	Using $p = \frac{1}{3}\rho \langle c^2 \rangle$, we get $101\,000 = \frac{1}{3} \times 1.25 \times \sqrt{v}$	M1
			$v = 492 \text{ m s}^{-1}$	A1
	(iii)	Kinetic energy of ideal gas $\propto T$, and Kinetic energy of ideal gas $\propto v_{rms}^2$ so $v_{rms}^2 \propto T$	M1	
		$\frac{v}{492.34} = \sqrt{\frac{273.15 + 127}{273.15}}$ $v = 596 \text{ m s}^{-1}$ award M1 mark if temperature not given in thermodynamic temperature, but A0	A1	

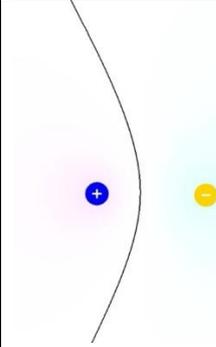
Questions			Answers	Marks
2	(a)		Its <u>acceleration</u> is directly proportional to its <u>displacement</u> from a fixed point (equilibrium position) and is always <u>directed towards that fixed point</u> .	B1
		(b)	gain in gPE = mgh	C1
			$(0.150)(9.81)(1.0 \times 10^{-3}) = 1.4715 \times 10^{-3} \sim 1.5 \times 10^{-3} \text{ J}$	A1

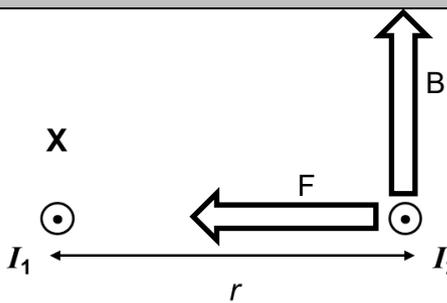
<p>(c)</p>	<p>(i) (ii)</p>		<p>B1 B2</p>
<p>(d)</p>		<p>From calculation in (b), total energy is 1.5×10^{-3} J So the horizontal displacement should be 40 mm</p>	<p>B1</p>
<p>(e)</p>		<p>Direction of displacement must be opposite to that of velocity, i.e. if line is in positive displacement, velocity must be in negative region</p> <p>Subsequent quarter of oscillation must decrease in amplitude and magnitude of velocity.</p>	<p>B2</p>

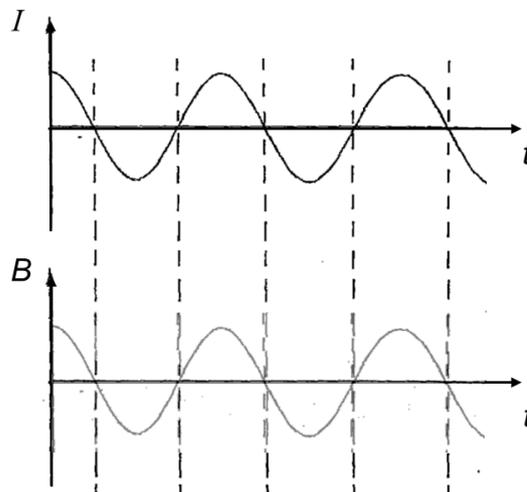
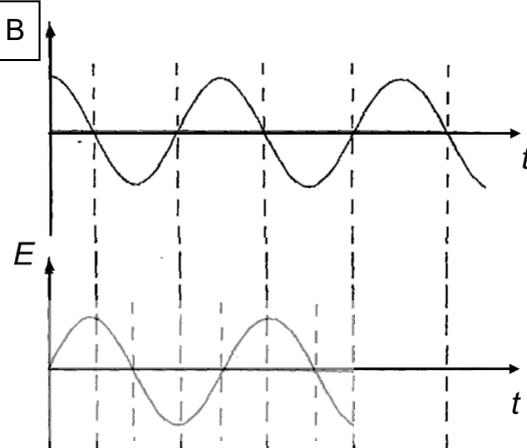
Questions		Answers	Marks
3	(a)	$\lambda = \frac{v}{f}$ $= \frac{330}{1780}$ $= 0.185\text{m}$	A1
	(b)	$S_1D = \sqrt{12^2 + 4^2}$ $= 12.649\text{ m}$ Path difference = 12.649 – 12 $= \frac{0.649}{0.18539} \lambda$ $= 3.5\lambda$	M1 A1
	(c)	Since the two sources are in antiphase, <u>the waves meet at D exactly in phase</u> (Phase difference is 0 rad) and there is <u>constructive interference</u> . Hence a <u>maximum intensity is detected</u> .	B1 A1
	(d)	Since path difference remains unchanged and there are two more changes in sound intensity, Path difference = (3.5 + 2) λ_{new} $= 5.5 \lambda_{\text{new}} \text{ (}\lambda_{\text{new}} \text{ is the new wavelength)}$ $5.5 \lambda_{\text{new}} = 3.5 \lambda$ $5.5\left(\frac{v}{f_{\text{new}}}\right) = 3.5(0.18539)$ $f_{\text{new}} = 2797\text{ Hz}$ $= 2800\text{ Hz (3s.f.)}$	B1 C1 A1

Questions		Answers	Marks
4	(a)	Resistivity (ρ) is the <u>proportionality constant between the dimensions of a specimen</u> of a material and its <u>resistance</u> (that is constant at constant temperature) such that $R = \frac{\rho L}{A}$	B1
	(b) (i)	N.B. If the soil is acidic, it reacts with copper and this produces an e.m.f. This occurs due to a galvanic reaction, where two dissimilar metals (in this case, copper plates) in an electrolyte (the acidic soil) create a voltage. $V = 1.398 - 0.281 = 1.117\text{ V}$ $I = 0.31 \times 10^{-3}\text{ A}$ $R = V/I = 3603$ $\sim 3600\ \Omega$	M1
	(ii)	$R = \rho/LA, \text{ thus}$ $\rho = RA/I = 3600 \times 0.800 \times 0.210 / 0.900$ $= 670\ \Omega\text{ m (2 s.f.)}$	M1 A1
	(iii)	Any one of these:	

		<ul style="list-style-type: none"> Among all the readings given, the least significant or most imprecise is the current reading (only 2 s.f.). The current reading will be subject to significant random errors. <p>EITHER: Increase the area of the copper plates in the soil OR decrease the distance between copper plates. This will decrease the resistance of the sample of soil to be measured and increase the current readings for the same voltage applied.</p> <p>Main point is to increase measured current, so that it will be more than 2 s.f., as given in the question.</p>	M1 A1
(c)	(i)	$\text{Power} = \frac{V^2}{R} = \frac{12^2}{6.0} = 24 \text{ W}$	A1
	(ii)	<p>1 mark for correct graph (at least two periods) for ac supply 1 mark for labelling of values on axes</p>	B2
	(iii)	<p>Power input = Power output</p> $0.7V_1 I_1 = V_2 I_2$ $0.7(230) I_1 = 24$ $I_1 = 0.15 \text{ A}$	M1 A1
	(iv)	<p>Voltage can be easily <u>stepped up or down</u> using a transformer in order to reduce power loss in transmission wires.</p>	B1

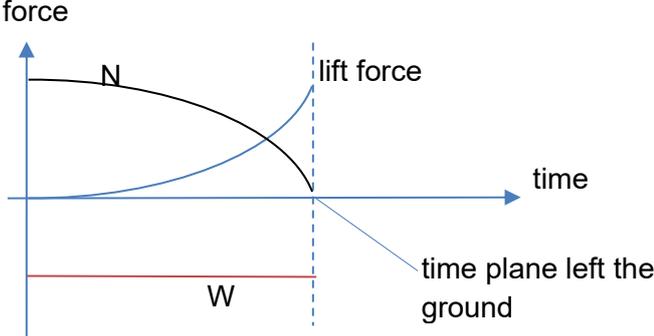
Qn	Answer		Mark
5	(a)	<ul style="list-style-type: none"> electric field due to point charges are radial. 	B1
		<ul style="list-style-type: none"> So vectors can only cancel away completely if they are collinear / parallel. Hence ... 	
		Alternative	
		<ul style="list-style-type: none"> electric field due to point charges are radial. 	
		<ul style="list-style-type: none"> So vertical components of vectors can only cancels away completely along the line joining the two charges. 	B1
	(b)	Show understanding that electric field for point charges $\propto \frac{1}{r^2}$	B1
		Deduce that P is at left of A	B1
		$\frac{1}{4\pi\epsilon_0} \frac{2.4}{x^2} = \frac{1}{4\pi\epsilon_0} \frac{2.9}{(0.15 + x)^2}$	M1
		<ul style="list-style-type: none"> $x = 1.51 \text{ m}$ 	A1
		Example of alternatives	
		define P distance x to be right of B	
		$\frac{1}{4\pi\epsilon_0} \frac{2.4}{(0.15 + x)^2} = \frac{1}{4\pi\epsilon_0} \frac{2.9}{x^2}$	C1
		$x = -1.66 \text{ m}$ <u>and</u> left of B	B1, M1 A1
	(c)	 <p>B1: line cuts AB nearer to lesser charge B1: line curves towards lesser charge.</p>	B1 ; B1

Questions	Answers		Marks
6	(a)	(i) (ii)	B1 B1
			

		(iii)	$F = BIL = \frac{\mu_0 I_1 I_2 L}{2\pi r}$	M1
			$= \frac{\mu_0(5.0)(7.0)}{2\pi(3.0)} = 2.333 \times 10^{-6} \sim 2.3 \times 10^{-6} \text{ N m}^{-1}$	A1
		(b)	Faraday's law of electromagnetic induction states that the e.m.f. induced in a conductor is directly proportional to the rate of change of magnetic flux linkage (or the rate of cutting of magnetic flux)	B1
		(i)	 <p>For solenoid $B = \mu_0 n I \rightarrow B \propto I$</p>	B1
		(ii)	 <p>From Faraday's Law</p> $E = -\frac{d(N\Phi)}{dt} = -\frac{d(NBA \cos \theta)}{dt} \rightarrow E \propto -\frac{dB}{dt}$	B1
		(iii)	$B = \mu_0 n I = (4\pi \times 10^{-7})(10 \times 100)(I) = 1.0 \times 10^{-3}$	M1
			$\rightarrow I = 0.7958 \text{ A} \sim 796 \text{ mA}$	A1

7	(a)	A photon is defined as a <u>quantum of electromagnetic energy</u> .
	(b)	(i) 1.0 V By C.O.E, EPE = KE_max EPE = (1.0)(1.6 × 10 ⁻¹⁹) = 1.6 × 10 ⁻¹⁹ J
		(ii) From principle of conservation of energy, hf = Φ + KE_max KE_max = eVs = ½ mv ² [M1] $v = \sqrt{\frac{(2(1.6 \times 10^{-19})(1))}{(9.11 \times 10^{-31})}} = 592673 \sim 590 \text{ km s}^{-1} \text{ [A1]}$
		(iii) For Φ, $E = hc/\lambda = \frac{(6.63 \times 10^{-34})(3.00 \times 10^8)}{365 \times 10^{-9}} = 5.4493 \times 10^{-19} \text{ [M1]}$ = 3.4058 ~ 3.4 eV Φ = 3.4058 – 1.0 eV ~ 2.4 eV [A1]

Questions		Answers	Marks
8	(a)	After fission, products have smaller nucleons with <u>higher binding energy per nucleon</u> (more stable) , so energy will be released. Accept other equivalent statement.	B1
	(b)	<ul style="list-style-type: none"> $\Delta mass = 235.123 + 1.009 - (94.945 + 138.955 + 2 \times 1.009) = 0.214u$ 	B1
		<ul style="list-style-type: none"> $E = mc^2 = 0.214 \times 1.66 \times 10^{-27} \times (3.0 \times 10^8)^2 = 3.197 \times 10^{-11} \text{J}$ 	M1
		<ul style="list-style-type: none"> $E = \frac{3.197 \times 10^{-11}}{10^6 \times 1.6 \times 10^{-19}} = 199.8 \text{ MeV} = 200 \text{ MeV}$ 	A1
	(c)	<ul style="list-style-type: none"> number of reactions = $\frac{6.02 \times 10^{23} \text{ mol}^{-1}}{235 \text{ g mol}^{-1}} \times 1.0 \text{ g} = 2.56 \times 10^{21}$ reactions or number of reactions = $\frac{1 \times 10^{-3} \text{ kg}}{235.123 \times 1.66 \times 10^{-27} \text{ kg}} = 2.56 \times 10^{21}$ reactions 	M1
		<ul style="list-style-type: none"> $E = 2.56 \times 10^{21} \times 3.197 \times 10^{-11} = 8.19 \times 10^{10} \text{ J}$ 	A1
	(d)	<ul style="list-style-type: none"> energy required from nuclear reactions $\frac{500 \times 10^6 \times 60 \times 60}{0.3} = 6.0 \times 10^{12} \text{ J}$	M1
		<ul style="list-style-type: none"> $\frac{6.0 \times 10^{12} \text{ J}}{8.19 \times 10^{10} \text{ J g}^{-1}} = 73.3 \text{ g}$ 	A1

Questions		Answers	Marks
9	(a)	$\frac{(18\,000 - 3\,000)\text{ kg}}{5\text{ kg km}^{-1}} = 3\,000\text{ km}$	B1
	(b)	$\frac{3\,000\text{ kg}}{5\text{ kg km}^{-1}} = 600\text{ km}$	B1
	(c)	42 000 + 18 000 + 15 000 = 75 000 kg total mass = mass of plane + mass of fuel (at full capacity) + mass of 150 passengers	B1
	(d)	 <p style="text-align: center;">Fig. 9.2</p> <p>vertical forces are balanced</p> <p>lift force + normal contact force + weight = 0</p>	B1; B1
	(e)	Using $v^2 = u^2 + 2as$, $u = 0$, gives $75^2 = 0 + 2(a)(1500)$ $a = 1.88\text{ m s}^{-2}$	M1 A1
	(f)	Using $F = ma$ gives $F = 1.875 \times 75\,000 = 140\,625 = 141\,000\text{ N}$	A1
	(g) (i)	Since $v^2 = u^2 + 2as$, $u = 0$ gives $a = \frac{v^2}{2s}$ and $F_{net} = ma$ So $\frac{F_{net}}{m} = \frac{v^2}{2s}$	M1
		Since F_{net}, v^2 are constants, $m \propto s$, $\frac{m}{75\,000} = \frac{1200}{1500}$, $m = 60\,000\text{ kg}$ alternative,	A0
		$75^2 = 0 + 2(a)(1200)$ gives $a = 2.3438\text{ m s}^{-2}$	M1
		$140\,625 = m \times 2.3438$ gives $m = 60\,000\text{ kg}$	A0

	(ii)	<table border="1"> <tr> <td>Length of take-off</td> <td>1500 m</td> <td>1200 m</td> <td>1200 m</td> <td>1200 m</td> </tr> <tr> <td>Number of passengers</td> <td>150</td> <td>130</td> <td>110</td> <td>90</td> </tr> <tr> <td>Mass of aeroplane / kg</td> <td colspan="4">42 000</td> </tr> <tr> <td>Mass of passengers / kg</td> <td>15 000</td> <td>13 000</td> <td>11 000</td> <td>9 000</td> </tr> <tr> <td>Total mass of fuel /kg</td> <td>18 000</td> <td>5 000</td> <td>7 000</td> <td>9 000</td> </tr> <tr> <td>Total mass / kg</td> <td>75 000</td> <td>60 000</td> <td>60 000</td> <td>60 000</td> </tr> <tr> <td>Mass of fuel in reserve / kg</td> <td colspan="4">3 000</td> </tr> <tr> <td>Usable mass of fuel /kg</td> <td>15 000</td> <td>2 000</td> <td>4 000</td> <td>6 000</td> </tr> <tr> <td>Maximum safe distance / km</td> <td>3000</td> <td>400</td> <td>800</td> <td>1 200</td> </tr> </table> <p>C1: Usable mass of Fuel A1: last row of column 2, 3, 4</p> <p>Total mass = mass of plane + mass of fuel + mass of passengers</p> <p>Eg column 2:</p> <ul style="list-style-type: none"> • $60\,000 = 42\,000 + (\text{mass of usable fuel} + 3000) + (130 \times 100)$ • max safe distance = mass of usable fuel / 5 kg per km 	Length of take-off	1500 m	1200 m	1200 m	1200 m	Number of passengers	150	130	110	90	Mass of aeroplane / kg	42 000				Mass of passengers / kg	15 000	13 000	11 000	9 000	Total mass of fuel /kg	18 000	5 000	7 000	9 000	Total mass / kg	75 000	60 000	60 000	60 000	Mass of fuel in reserve / kg	3 000				Usable mass of fuel /kg	15 000	2 000	4 000	6 000	Maximum safe distance / km	3000	400	800	1 200	C1 A1
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	(h)	<p>Any reasonable answer explained with sound physics concepts. Example</p> <p>Examples:</p> <p>B1: <u>Kinetic energy increases with mass</u> ($E_k = \frac{1}{2}mv^2$) B1: So more energy is needed to be dissipated / more stress force on landing gear.</p>	B1 B1																																													
		<p>or</p> <p>B1: With <u>large mass, more reaction force</u> by ground on plane / and by plane on ground. (Newton's third law)</p> <p>B1: More impact load at landing, increases probability of damage on landing gear (force by ground on plane) / increase probability of damage on runway (force by plane on ground)</p>	B1 B1																																													