



Markscheme

November 2021

Physics

Standard level

Paper 2

9 pages

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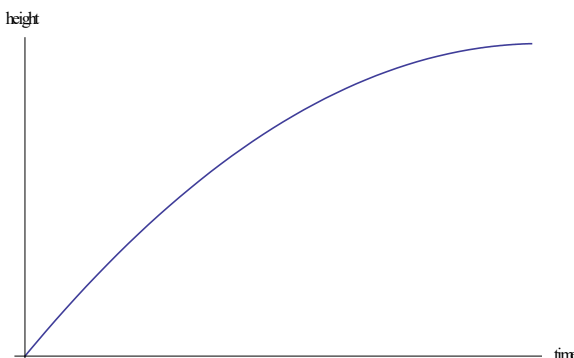
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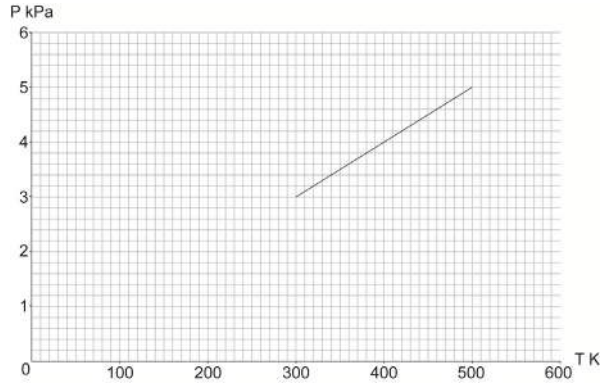
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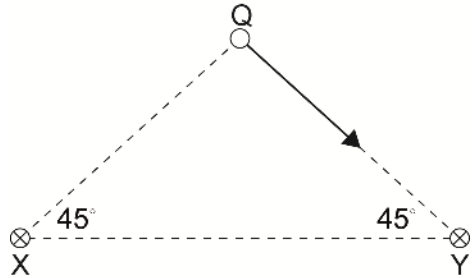
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Question			Answers	Notes	Total
1.	a		$H = \ll \frac{1}{2}gt^2 \Rightarrow 4.9 \ll \text{m} \gg \checkmark$	<p>Accept other methods as area from graph, alternative kinematics equations or conservation of mechanical energy.</p> <p>Award [1] for a bald correct answer in the range 4.9 - 5.1</p> <p>Award [0] if time used is different than 1.0 s</p>	1
	b	i	M at 1.6 s \checkmark		1
	b	ii	$\ll g = \gg 9.80 \ll \text{ms}^{-2} \gg \checkmark$	<p>Accept 9.81, 10 or a plain "g"</p> <p>Ignore sign if provided.</p>	1
	b	iii	 <p>height</p> <p>time</p> <p>concave down parabola as shown «with non-zero initial slope and zero final slope» \checkmark</p>	<p>Award [1] mark if curve starts from a positive time value.</p> <p>Award [0] if the final slope is negative.</p>	1
	c		$\ll \text{loss of KE is } \frac{1}{2} \times 0.25 \times (9.8^2 - 5^2) \Rightarrow 8.9 \ll \text{J} \gg \checkmark$	Award [1] mark for an answer in the range 8.7 - 9.5	1

Question		Answers	Notes	Total
d	i	$\Delta p = 0.250 \times (9.8 + 5.0) \checkmark$ $F_{\text{net}} = \ll \frac{\Delta p}{\Delta t} = \frac{3.7}{0.1} = \gg 37 \ll \text{N} \gg \checkmark$ $N = 37 + 0.250 \times 9.8 = 39.5 \ll \text{N} \gg \checkmark$	Allow ECF for MP2 and MP3	3
d	ii	there is an external force acting on the ball OR some momentum is transferred to the floor \checkmark	Allow references to impulse instead of force. Do not award references to energy.	1

Question			Answers	Notes	Total
2.	a		the total «random» kinetic energy of the molecules/atoms/particles ✓		1
	b	i	$p = \frac{nRT}{V} = \frac{0.24 \times 8.31 \times 300}{0.20} \Rightarrow 3.0 \times 10^3 \text{ «Pa»} \checkmark$		1
	b	ii	 <p>straight line joining (300, 3) and (500, 5) ✓ drawn only in the range from 300 to 500 K ✓</p>	<p>Allow ECF from (b)(i) for incorrect initial pressure.</p> <p>Allow tolerance of \pm one grid square for the endpoints.</p>	2
	c		<p>temperature is the same for both gases ✓</p> <p>«average» kinetic energy is the same «because $E_k = \frac{3}{2}kT$ OR E_k depends on T only» ✓</p>	Award [1 max] for a bald statement that kinetic energy is the same.	2

Question			Answers	Notes	Total
3.	a		$T = 4 \times 10^{-3} \text{ «s»}$ or $f = 250 \text{ «Hz»}$ ✓ $\lambda = 340 \times 4.0 \times 10^{-3} = 1.36 \approx 1.4 \text{ «m»}$ ✓	Allow ECF from MP1 . Award [2] for a bald correct answer.	2
	b	i	$\ll\pm\gg \frac{\pi}{2} / 90^\circ$ OR $\frac{3\pi}{2} / 270^\circ$ ✓		1
	b	ii	1.5 «ms» ✓		1
	b	iii	8.0 OR 8.5 «μm» ✓	From the graph on the paper, value is 8.0. From the calculated correct trig functions, value is 8.49.	1
	c	i	$L = \ll\frac{3}{4}\gg \lambda \Rightarrow 0.90 \text{ «m»}$ ✓		1
	c	ii	to the right ✓ displacement is getting less negative OR change of displacement is positive ✓		2
	c	iii	horizontal line drawn at the equilibrium position ✓		1

Question			Answers	Notes	Total
4.	a		$\ll V = \frac{4.5}{0.25} \Rightarrow 18 \ll V \gg \checkmark$		1
	b	i	$F = \frac{8.99 \times 10^9 \times 68 \times 10^{-6} \times 0.25 \times 10^{-6}}{0.48^2} \checkmark$ $F = 0.66 \ll N \gg \checkmark$	<p>Award [2] marks for a bald correct answer.</p> <p>Allow symbolic k in substitutions for MP1.</p> <p>Do not allow ECF from incorrect or not squared distance.</p>	2
	b	ii	<p>Q moves to the right/away from P «along a straight line» OR Q is repelled from P ✓ with increasing speed/Q accelerates ✓ acceleration decreases ✓</p>		2 max
	c	i	 <p>arrow of any length as shown ✓</p>		1
	c	ii	<p>«using components or Pythagoras to get» $B = 21 \ll \text{mT} \gg \checkmark$ directed «horizontally» to the right ✓</p>	If no unit seen, assume mT.	2

Question			Answers	Notes	Total
5.	a	i	the energy needed to «completely» separate the nucleons of a nucleus OR the energy released when a nucleus is assembled from its constituent nucleons ✓	Accept reference to protons AND neutrons.	1
	a	ii	curve rising to a maximum between 50 and 100 ✓ curve continued and decreasing ✓	Ignore starting point. Ignore maximum at alpha particle	2
	a	iii	At a point on the peak of their graph ✓		1
	b	i	correct mass numbers for uranium (234) and alpha (4)✓ $234 \times 7.600 + 4 \times 7.074 - 238 \times 7.568$ «MeV» ✓ energy released 5.51 «MeV» ✓	Ignore any negative sign.	3
	b	ii	$\ll \frac{KE_\alpha}{KE_U} \Rightarrow \frac{\frac{p^2}{2m_\alpha}}{\frac{p^2}{2m_U}} \text{ OR } \frac{m_U}{m_\alpha} \gg$ ✓ $\ll \frac{234}{4} \Rightarrow 58.5 \gg$ ✓	Award [2] marks for a bald correct answer Accept $\frac{117}{2}$ for MP2 .	2

Question			Answers	Notes	Total
6.	a	i	incident intensity $\frac{1360}{9.3^2}$ OR $15.7 \approx 16$ «W m ⁻² » ✓	Allow the use of 1400 for the solar constant.	1
	a	ii	exposed surface is $\frac{1}{4}$ of the total surface ✓ absorbed intensity = $(1-0.22) \times$ incident intensity ✓ $0.78 \times 0.25 \times 15.7$ OR 3.07 «W m ⁻² » ✓	Allow 3.06 from rounding and 3.12 if they use 16 Wm^{-2}	3
	a	iii	$\sigma T^4 = 3.07$ OR $T = 86$ «K» ✓		1
	b	i	correct equating of gravitational force / acceleration to centripetal force / acceleration ✓ correct rearrangement to reach the expression given ✓	Allow use of $\sqrt{\frac{GM}{R}} = \frac{2\pi R}{T}$ for MP1	2
	b	ii	$T = 15.9 \times 24 \times 3600$ «s» ✓ $M = \frac{4\pi^2(1.2 \times 10^9)^3}{6.67 \times 10^{-11} \times (15.9 \times 24 \times 3600)^2} = 5.4 \times 10^{26}$ «kg» ✓	Award [2] marks for a bald correct answer. Allow ECF from MP1	2