

Markscheme

November 2021

Physics

Standard level

Paper 2

9 pages

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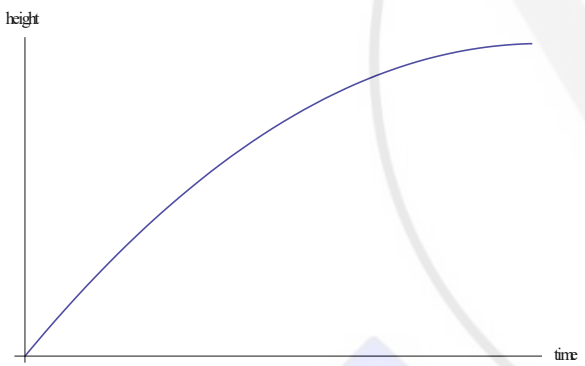
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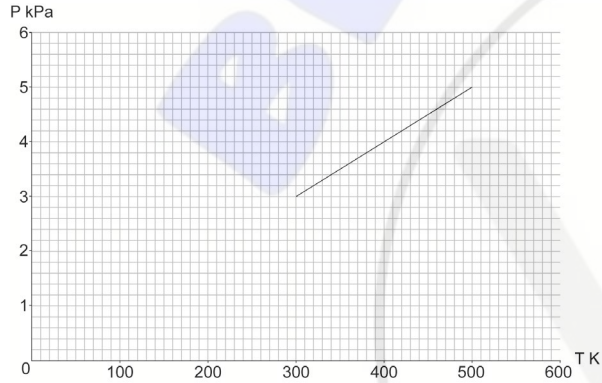
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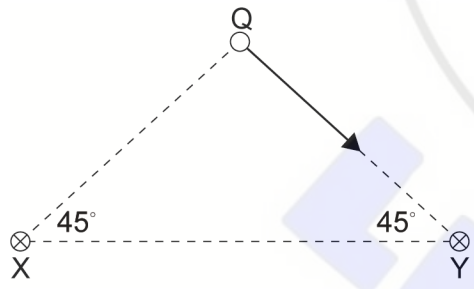
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Question			Answers	Notes	Total
1.	a		$H = \ll \frac{1}{2}gt^2 \Rightarrow 4.9 \ll \text{m} \gg \checkmark$	<p>Accept other methods as area from graph, alternative kinematics equations or conservation of mechanical energy.</p> <p>Award [1] for a bald 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		$\ll \text{loss of KE is } \frac{1}{2} \times 0.25 \times (9.8^2 - 5^2) \Rightarrow 8.9 \ll \text{J} \gg \checkmark$	<p>Award [1] mark for an answer in the range 8.7 - 9.5</p>	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 <i>impulse</i> instead of <i>force</i> . Do not award references to <i>energy</i> .	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>	<p>Award [1 max] for a bald statement that kinetic energy is the same.</p>	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	$\llcorner \pm \gg \frac{\pi}{2} / 90^\circ$ 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	$L = \llcorner \frac{3}{4} \lambda \gg 0.90 \text{ «m»}$ ✓		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		$\ll V = \frac{4.5}{0.25} = 18 \ll V \gg \checkmark$		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 $15.7 \approx 16 \text{ «W m}^{-2}\text{»}$ ✓	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 $3.07 \text{ «W m}^{-2}\text{»}$ ✓	Allow 3.06 from rounding and 3.12 if they use 16 Wm^{-2}	3
	a	iii	$\sigma T^4 = 3.07$ OR $T = 86 \text{ «K»}$ ✓		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	$T = 15.9 \times 24 \times 3600 \text{ «s»}$ ✓ $M = \frac{4\pi^2(1.2 \times 10^9)^3}{6.67 \times 10^{-11} \times (15.9 \times 24 \times 3600)^2} = 5.4 \times 10^{26} \text{ «kg»}$ ✓	Award [2] marks for a bald correct answer. Allow ECF from MP1	2