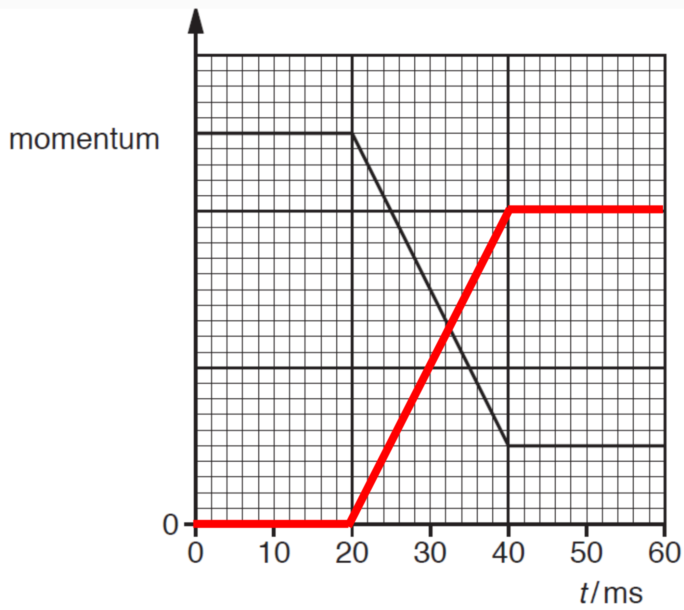
Paper 2 – Structured

Qns	Answer	Marks
1ai	(vernier/ digital) callipers Examiner's comment: Common mistakes: micrometre screw gauge	**B1**
1aii	percentage uncertainty = $\frac{0.0004}{0.0420}\times 100\%$ $=0.95\%$ Examiner's comment: Common mistakes: A lot of students did not leave the answer in the correct number of significant figures 2 s.f. For THIS MYE ONLY, they are awarded full mark despite wrong s.f. due to leniency in marking.	**B1**
1bi	kg m^{-3} = kg × m^n/m $-3 = n-1$ $n=-2$ Examiner's comment: Common mistakes: Cambridge does NOT recognise [ ] as a short cut symbol for "unit of". Please write "unit of" in the future examinations where applicable. "Show" questions must show ALL steps. Do NOT skip steps.	**M1** **A1**
1bii	$\frac{\Delta\rho}{\rho}=\frac{\Delta M}{M}+2\frac{\Delta r}{r}+\frac{\Delta L}{L}$ percentage uncertainty = $\left(\frac{0.001}{1.072}+2\frac{0.0004}{0.0420}+\frac{0.0001}{0.1242}\right)\times 100\%$ $=2.1\%$	**C1** **C1** **A1**
1biii	$\rho=\frac{1.072\times 0.0420^{-2}}{2.094\times 0.1242}=2337\text{ (kg m}^{-3})$ $\Delta\rho=0.021\times 2337=49\text{ (kg m}^{-3})$ $\rho=(2340\pm 50)\text{ kg m}^{-3}$	**C1** **C1** **A1**

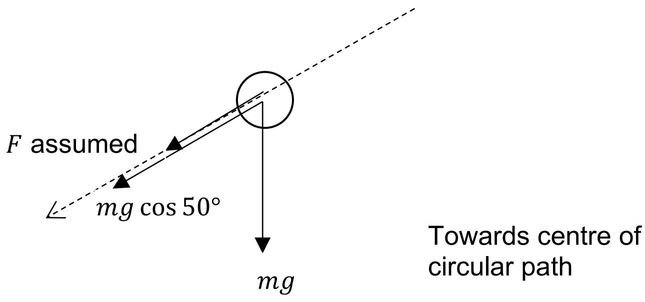
Qns	Answer	Marks
2ai	By conservation of linear momentum, $5p + 0 = p + m_Y v$ $5m_X v = m_X v + m_Y v$ $\frac{m_X}{m_X + m_Y} = \frac{1}{5}$ $\frac{\text{total kinetic energy of X and Y after collision}}{\text{total kinetic energy of X and Y before collision}}$ $= \frac{\frac{1}{2}}{\frac{1}{2}} \frac{(m_X + m_Y)}{m_X} \frac{v^2}{(5v)^2}$ $= \frac{5}{1} \frac{v^2}{(5v)^2}$ $= 0.20$	C1 C1 A1
2aii	ratio = 1	B1
2b	horizontal line from (0 ms, 0 squares) ending at (20 ms, 0 squares) and horizontal line from (40 ms, 4.0 squares) ending at (60 ms, 4.0 squares) straight line from (20 ms, 0 squares) ending at (40 ms, 4.0 squares [= 4.0 cm vertically])  Examiner's comment: Note: From t = 0 to t = 20 ms, the line needs to be visible too despite on the axis.	B1 B1

Qns	Answer	Marks
3a	<u>Rate</u> of change of momentum is proportional to the <u>resultant</u> force Takes place in the direction of the <u>resultant</u> force	B1 B1
3b	Apply N2L to each of the masses. For 8kg mass, F=ma 150 +8(9.81)sin30° – T = 8a [1] For 4kg mass, F=ma T = 4a [2] Solving the equations, T = 63 N a = 15.8 m s^{-2} *Accept if students solving a using the whole system for this case.*	M1 M1 A2

Qns	Answer	Marks

4a

Let force in rod be F.



Resultant of force in rod and component of weight towards the centre provides centripetal force

Acceptable: "Component of resultant force towards centre"
Not acceptable: "resultant force provides centripetal force"

Assuming F points towards the centre of the circle,

B1

$$mg\cos 50° + F = m\frac{v^2}{R}$$

M1

$$(1.5)(9.81)\cos 50° + F = (1.5)\left(\frac{9.5^2}{2.0}\right)$$

$$F = 58\ \text{N}$$

Since $F_{\text{centripetal}} > mg\cos 50°$, F points towards the centre of the circle.

Rod is in <u>tension</u>. **A1**

4b

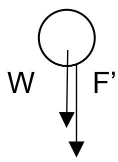
minimum magnitude of force occurs at the top of the circle. **B1**

Gain in $E_{P(G)}$ = Loss in E_K

$mgh = \frac{1}{2}mv_{\text{initial}}^2 - \frac{1}{2}mv_{\text{top}}^2$

$v_{\text{top}}^2 = v_{\text{initial}}^2 - 2gh$

$v_{\text{top}}^2 = 9.5^2 - 2 \times 9.81 \times 2.0(1 - \cos 50°) = 76.2$ m^2 s^{-2} **M1**



Resultant of force in rod and weight provides centripetal force.

$$F' + W = m\frac{v_{\text{top}}^2}{R}$$

M1

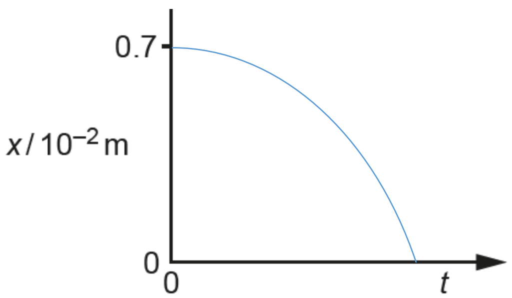
$$F' + (1.5)(9.81) = (1.5)\left(\frac{76.2}{2.0}\right)$$

A1

$$F' = 42.4\ \text{N}$$

Qns	Answer	Marks
5a	$I = 3.6 - 2.1 = 1.5$ A $V = 4.4$ V $R = \frac{V}{I} = \frac{4.4}{1.5} = 2.9\ \Omega$	C1 C1 A1
5b	$E = V + Ir$ $12.0 = 4.4 + 3.6r$ $r = 2.1\ \Omega$	 C1 A1
5c	Energy loss = IVt $(470 - 240) \times 10^3 = (3.6)(12.0)t$ $t = 5320$ s	 C1 A1
6a	anticlockwise	B1
6b	towards P	
6c	Newton's third law forces are equal in magnitude and opposite in direction.	B1 B1
6di	$R = \frac{mv\sin\theta}{Bq}$ $= \frac{(9.11\times10^{-31})(7.0\times10^{6})\sin 36.9^o}{(3.14\times10^{-5})(1.6\times10^{-19})}$ = 0.76 m	M1 M1 A1
6dii	$T = \frac{2\pi m}{Bq}$ $= \frac{2\pi(9.11\times10^{-31})}{(3.14\times10^{-5})(1.6\times10^{-19})}$ = 1.14 x 10^{-6} s	M1 M1 A1
6diii	Pitch = $T(v\cos\theta)$ = (1.14 x 10^{-6})(7.0 x 10^{6}) cos 36.9^o = 6.4 m	 M1 A1
6div	Pitch = $T(v\cos\theta)$ = (1.14 x 10^{-6})(7.0 x 10^{6}) cos 0^o = 8.0 m	 M1 A1
7(a)	In a fission reaction, the daughter nuclides should be of approximately the same mass, whereas in an alpha-decay, the alpha particle is typically much less massive than the other nuclide produced.	B1
7(b)(i)	From conservation of nucleon number, 235 + 1 = 144 + 89 + $x \Rightarrow x$ = 3 From conservation of charge, 92 = y + 36 $\Rightarrow y$ = 56 Hence, ${}^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{144}_{56}\text{Ba} + {}^{89}_{36}\text{Kr} + 3\,{}^{1}_{0}\text{n}$	B1

Qns	Answer	Marks
7(b)(ii)	energy released $=$ total binding energy of products $-$ total binding energy of reactants $= 8.27 \times 144 + 8.62 \times 89 - 7.59 \times 235$ $= 174.41\ \text{MeV}$ $= 174.41 \times 1.6 \times 10^{-19} \times 10^{6}$ $= 2.79 \times 10^{-11}\ \text{J}$	M1 M1 A1
7(b)(iii)	kinetic energy of the products, gamma photons **Note**: Heat or sound is not accepted.	B1 B1
7(b)(iv)	Energy released = (total mass of reactants – total mass of products) c^2 total mass of reactants = total mass of products + energy released/c^2 $235.043923u + 1.008665u =$ $88.917633u$ + mass of ^{144}Ba + $3 \times 1.008665u$ + energy released/c^2 mass of ^{144}Ba = $(235.043923 - 88.917633 - 2 \times 1.008665)u$ $- 2.79 \times 10^{-11}/(3.0 \times 10^{8})^2$ $= 144.108960 \times 1.66 \times 10^{-27} - 2.79 \times 10^{-11}/(3.0 \times 10^{8})^2$ $= 2.3891 \times 10^{-25}$ kg	C1 M1 A1
8(a)(i)	electric force per unit <u>positive</u> charge on a small stationary test charge at that point	B2
8(b)(ii)	field strength $= \dfrac{\text{force}}{\text{charge}}$ work done = force × d $V = \dfrac{\text{work done}}{\text{charge}}$ field strength $= \dfrac{\text{work done}}{d \times charge} = \dfrac{1}{d}\left(\dfrac{\text{work done}}{charge}\right)$ field strength $= \dfrac{V}{d}$ <u>Examiner's comment:</u> "Show" questions must define all terms that yet to be defined in the question. For example. A lot of students just write "W" without defining "W" as Work done. This is not acceptable for "show" question because "W" can also mean Weight, Watt etc,	M1 M1 M1 A0
8(b)(i)	$E = \dfrac{1340}{1.4 \times 10^{-2}}$ $= 9.6 \times 10^{4}\ \text{V m}^{-1}$	C1 A1

Qns	Answer	Marks
8(b)(ii)	$q = 4.6 \times 10^{-14} / 9.6 \times 10^{4}$ $= 4.8 \times 10^{-19}$ C sign of charge: negative	**C1** **A1** **A1**
8(b)(iii) 1.	2 adjacent field lines have same separation (or both patterns direction of lines changes from downwards to upwards	**B1** **B1**
8(b)(iii) 2.	resultant force $= 4.6 \times 10^{-14} + (9.6 \times 10^{4} \times 4.8 \times 10^{-19})$ $= 4.6 \times 10^{-14} + 4.6 \times 10^{-14}$ $= 9.2 \times 10^{-14}$ N	 **C1** **A1**
8(b)(iii) 3.	a = F / m or 2W / m or 2g $a = 9.2 \times 10^{-14} / (4.6 \times 10^{-14} / 9.81) = 20$ m s^{-2} or $a = 2 \times 9.81 = 20$ m s^{-2}	**M1** **M1** **A0**
8(b)(iii) 4.	$s = ut + ½at^2$ $(1.4 \times 10^{-2} / 2) = ½ \times 20 \times t^2$ $t = 2.6 \times 10^{-2}$ s	 **C1** **A1**
8(b)(iii) 5.	line from $(0, 0.7 \times 10^{-2})$ to a non-zero point on the t-axis magnitude of gradient of line increases  <u>Examiner's comment:</u> A lot of students did not answer the question to context where *x* is the distance from the bottom plate. Leniency in marking allows them to get partial mark despite wrong answer.	**M1** **A1**