Question			Expected Answers	Marks	
1	a		acceleration ∝ displacement/distance from a fixed point;	1	
			directed towards that point/indication acc. and displ. in opp. direction	1	
			for symbols without explanation ($a = -\omega^2 x$ or $a \propto -x$) max 1 mark		2
	b		arrow downwards through centre of bob, labelled weight/gravity/mg;	1	
			upward arrow on string, labelled tension	1	2
	c	i	reading T = 1.6 s ; *2 marks for correct f without working*	1	
			f = 1/T = 0.625 to 0.632 ; Hz or s^{-1}	2	3
		ii	tangent to graph at displacement = 0; gradient = 0.20 ± 0.03 ($m\ s^{-1}$)		
			or $v = 2\pi fA$; = 2 x 3.14 x 0.625 x 0.05 = 0.20 ($m\ s^{-1}$)		2
	d	i	none ; as period independent of amplitude		2
		ii	doubled; as twice the distance covered in the same time/ from c(ii) *or*	1	
			$v \propto -A/AW$ *possible ecf from d(i)*	1	
			increased because the gradient is steeper/greater distance in same time worth 1 mark only		2
			Total		13
2	a	i	Arrows of equal length towards; and directed through centre of orbit		2
		ii	For circular orbit centripetal force required; force of attraction is along line joining stars which must therefore be diameter of circle/AW		2
	b		F : force (of attraction) between M's/stars		
			G : gravitational constant/AW		
			M : mass of a star		
			R : radius of orbit (of star system) *1 mark for 2 correct; 2 marks for all 4*		2
	c	i	v = distance/time or circumference of circle/period = $2\pi R/T$;		1
		ii	$F = mv^2/r$ or Mv^2/R; so $F = 4\pi^2 MR/T^2$		2
		iii	$F = GM^2/4R^2 = 4\pi^2 MR/T^2$; suitable algebra to show $M = 16\pi^2 R^3/GT^2$		2
	d		$M = 16 \times 9.87 \times (5 \times 10^{10})^3 / 6.67 \times 10^{-11} \times (8.64 \times 10^6)^2$	1	
			giving $M = 4.0 \times 10^{30}$ (kg) *possible ecf from b(i)*	1	2
			Total		13
3	a		C = Q/V with symbols explained or charge per unit potential difference/voltage		1
	b	i 1	$Q = CV$; = 4.7 x 10^{-7} x 11 = 5.2 x 10^{-6} (C) or 5.2 (μC)		2
		2	$E = ½ QV$ or $½ CV^2$; = 2.8(4) x 10^{-5} (J) or 28.4 μ(J) *possible ecf from b(i)*		2
		ii 1	V = IR ; I = 11/2200 = 5 (mA) or 0.005 (A)		2
		2	T = RC ; = 2200 x 4.7 x 10^{-7} = 1.0 x 10^{-3} (s)		2
	c	i	attempt constant ratio for equal time intervals or other suitable method;	1	
			achieved successfully	1	2
		ii	$\Delta Q = I \times \Delta t$; estimates area under graph between t = 1 ms and t = 2 ms;	2	
			$\Delta Q = 1.20 \pm 0.1 \times 10^{-6}$ (C) *accept analytical answer using exp. function*	1	3
			Total		14

Question			Expected Answers		Marks
4	a	i	Flux = B x A (normal to B) with symbols explained		1
		ii	Linkage = N x flux; $A = x^2$ so linkage = NBx^2		2
	b	i	Statement of Faraday's law or indication e.g.$V = d(NBx^2)/dt$ from a(ii);	1	
			$V = NBxdx/dt$ or $V = NBxv$ / argue area swept out per second as xv /AW;		
			giving $V = 1250 \times 0.032 \times 0.02 \times 0.1 = 0.08$ V or 80 mV	2	3
		ii	equal positive and negative regions	1	
			equal positive and negative values of 'maxima' labelled on y-axis	1	
			value changes within correct time zones, t = 0.2 to 0.4, 0.6 to 0.8 s	1	
			'square pulse' shape	1	4
			sinusoidal graphs score zero marks		
			Total		10
5	a		the splitting of a nucleus into (roughly two equal) parts (spontaneously or by absorption of a neutron)		1
	b	i	136 ; 38		2
		ii	$\Delta E = c^2\Delta m$; $\Delta m = 0.213$ u ; $\Delta E = 9 \times 10^{16} \times 0.213 \times 1.66 \times 10^{-27}$	3	
			$= 3.2 \times 10^{-11}$ (J)		3
	c	i	$E = N_A/235 \times \Delta E$;$= 6.02 \times 10^{23}/235 \times 3.2 \times 10^{-11} = 8.2 \times 10^{10}$ (J)		2
			or $E = 0.001/235 \times 1.66 \times 10^{-27} \times \Delta E$ etc.		
		ii	$Q = mc\theta$;	1	
			$m = 8.2 \times 10^{10}/4200 \times 80$;	1	
			$= 2.4 \times 10^5$ (kg)	1	3
			Total		11
6	a		α : +2e $4m_p$	1	
			β : -e m_e or $1/1836\ m_p$	1	
			γ : 0 0	1	3
	b	i	35 ± 1 (mm)		1
		ii	$E = \frac{1}{2} mv^2$; *possible ecf from (a)*	1	
			$5 \times 1.6 \times 10^{-13} = 0.5 \times 4 \times 1.67 \times 10^{-27} \times v^2$;	1	
			$v = 1.55 \times 10^7$ (m s^{-1})	1	3
		iii	collision with air molecules; alpha particles ionise air/ collision is inelastic/	1	
			mechanism of energy transfer during collision	1	2
	c		α radiation cannot penetrate air/paper/plastic;	1	
			so the film is not exposed to α radiation/so α radiation is not detected	1	
			β will penetrate thin plastic/window/AW; gives benchmark for comparison	1	
			with other parts of film/AW	1	
			γ radiation is much more penetrating than β/ only γ passes through (metal/thicker/denser) filters/AW	1	
			different thicknesses of plastic (for β)/(metal, etc. for γ) filter will discriminate strength/AW;	1	
			other sensible statement *max 4 marks*	1	4
			Total		13

Question		Expected Answers	Marks
7	a	Momentum of a particle = mass x velocity,	1
		linear momentum is constant in the collision; always/ in every collision;	2
		because there are no external forces	1
		total energy is constant in every collision;	1
		k.e. is (only) conserved in elastic collisions;	1
		otherwise some k.e. is lost/dissipated/randomised/turned to heat,etc	1
		max 6 marks	6
	b	*Neatest and possibly shortest answer is in terms of constant steady motion of the centre of mass of the system*	
		there are several ways of approaching a satisfactory answer with many marking points; use 1 mark per valid point and 1 mark per valid reason.	
		here is a selection of likely marking points:	
		small particle incident on large one	
		Analogy with ball bouncing off wall;	1
		energy transfer to massive particle is very small;	1
		as v of massive particle is so small; because momentum conserved;	2
		large particle incident on small one	
		massive particle can only transfer a small fraction of its momentum;	1
		so keeps most of its k.e.; small particle hardly needs any k.e.;	2
		alternative wording such as:	
		small particle moves off at roughly twice velocity of massive particle;	1
		massive particle hardly slowed	1
		common features which can be expressed in many alternative ways	
		(constant/steady) motion of c.of mass of system (towards right)	1
		incident momentum very small in first case compared to second	1
		ratio of masses to inverse ratio of velocities/distances moved	1
		k.e depends on v^2, so v ratio has more effect than mass ratio on energy transfer	1
		any other valid points *for each*	1
		mathematical expositions acceptable as long as they reach meaningful conclusions	
		max 6 marks	6
		Quality of written communication	4
		Total	16

Criteria for assessment of written communication

4 marks

- The candidate expresses ideas extremely clearly and fluently. Sentences and paragraphs follow on from one another smoothly and logically.
- Arguments are consistently relevant, based on sound knowledge of Physics, and are well structured.
- There are few, if any, errors in grammar, punctuation and spelling.

3 marks

- The candidate expresses moderately complex ideas clearly and reasonably fluently through well-linked sentences and paragraphs.
- Arguments are generally relevant being based on a good knowledge of physics, and are well structured.
- There are occasional errors in grammar, punctuation and spelling.

2 marks

- The candidate expresses straightforward ideas clearly and accurately, if not always fluently. Sentences and paragraphs are not always well connected.
- Arguments may sometimes stray from the point or be weakly presented.
- There are some errors in grammar, punctuation and spelling, but not to suggest a serious weakness in these areas.

1 mark

- The candidate expresses simple ideas clearly, but is imprecise and awkward in dealing with complex or subtle concepts.
- Arguments are of doubtful relevance or obscurely presented.
- Errors in grammar, punctuation and spelling and noticeable and intrusive, suggesting weaknesses in these areas.

0 marks

- Even simple ideas are not expressed clearly.
- Arguments are irrelevant or poorly stated.
- There are gross errors in grammar, punctuation and spelling.