Question		Expected Answers	Marks	
1	(a)	Same speed (mandatory) as energy transfer is the same / some further qualification, e.g. (increase in) k.e = (loss in) p.e./car falls through same height	2	[2]
	(b)	**(i)** $h = 1.2 \sin 45 = 0.85$ m	1	
		mgh; $= 0.05 \times 9.8 \times 0.85 = 0.42$ (J) accept g=10ms^{-2}	2	
		(ii) $1/2mv^2 = 0.42$ ecf or $v^2 = 2gh$	1	
		$v = 4.1$ (m s^{-1})	1	[5]
	(c)	**(i)** $m(v + 2v/3)$; $= 5m = 0.25$; kg m s^{-1}/N s	3	
		(ii) $F = m\,\Delta v/\Delta t$; = 1.25 (N) ecf c(I)	2	[5]
		Total		12
2	(a)	$C = Q/V$ with symbols explained or charge per unit potential difference/voltage	1	[1]
	(b)	**(i)** (Electrons/negative) charge are/is moved from one plate of C to other plate (by the action of the battery) or battery sets up instantaneous current in circuit	1	
		(ii) $Q = CV = 500 \times 12 = 6000$ (μC)	1	[2]
	(c)	**(i)** Initial current = 6 mA; $R = V/I = 2 \times 10^3$ (Ω) or finding RC = 1.0 s; value of R	2	
		(ii) RC = 1.0 (s) ecf	1	
		(iii) $I = 6 \times (10^{-3})\, e^{-t}$ ecf	1	
		(iv) Area under curve (is the integral of current against time/sum of $I \times \Delta t$ at all t); charge = current x time / a mathematical link	2	
		(v) Initial current = 12 mA; curve with time constant = 0.5 s	2	[8]
		Total		11
3	(a)	Internal energy is the sum of the (random) kinetic and potential energies; of the molecules/atoms/particles in the system/body	2	
		s.h.c. is the change in (internal) energy per unit mass/energy required to heat unit mass/kg per unit rise in temperature/^{o}C/K	1	[3]
	(b)	$Q = mc\theta$	1	
		$= 600 \times 1.1 \times 10^3 \times 40$	1	
		$= 2.6 \times 10^7/26$ M(J)	1	[3]
	(c)	Combine $pV = nRT$ and $U = 3/2nRT$; to give $U = 3/2\,pV$	2	
		$= 3/2 \times 1.0 \times 10^5 \times 24$; $= 3.6 \times 10^6/3.6$ M(J)	2	
		or $n = m/M$ where $m = \rho V$; $n = 1.3 \times 24/0.03 = 1040$	2	
		$U = 3/2nRT = 3/2 \times 1040 \times 8.31 \times 293$; $= 3.8 \times 10^6/3.8$ M(J)	2	
		or using $pV = nRT$ to find n gives $n = 986$ with $U = 3.7 \times 10^6/3.7$ M(J)		[4]
		Total		10

Question		Expected Answers	Marks	
4	(a)	(i) Labelled horizontal arrows outwards	1	
		(ii) $F_e = Q^2/4\pi\varepsilon_0 r^2$; $= 9 \times 10^{-16} \times 9 \times 10^9/36 \times 10^{-4} = 2.25 \times 10^{-3}$(N)	2	[3]
	(b)	Labelled arrows for weight (down) and tension (along string)	1	[1]
	(c)	(moments about suspension) $mgl \sin\theta = F_e l \cos\theta$	1	
		or (resolution) $T\sin\theta = F_e$, $T\cos\theta = mg$		
		$\text{Tan}\theta = F_e/mg$; $= 2.25 \times 10^{-3}/8.0 \times 9.8 \times 10^{-4}$ giving $\theta = 16^o$	2	
		$2\theta = 32^o$	1	[4]
	(d)	$F_g = Gm^2/r^2$; calculation to give 1.2×10^{-14} N or $F_g/F_e = Gm^2 4\pi\varepsilon_0/Q^2$	2	
		$Fg/Fe = 1.2 \times 10^{-14}/2.25 \times 10^{-3} = 5.3 \times 10^{-12}$	2	[4]
		Total		**12**
5	(a)	He nucleus, a few cm/3 to 10 cm About 1 m / 0.3-2 m /several m, 1 to 10 mm Al / 1 mm Pb (high energy) e-m radiation, 1-10 cm of Pb/several m of concrete *2 correct 1 mark, 4 correct 2 marks*	3	[3]
	(b)	Source, absorbers placed in front of detector on diagram	1	
		How results identify source)	2	
		Allowance for background) to max 2	1	
		Allow for distance expt to max 2		[3]
	(c)	(i) ^{235}U decays to $N/2^6$; ^{238}U decays to N/2	2	
		$= 1/2^5 = 0.03$	1	
		(ii) Ratio will have reached 0.0075 in a little over two half lives of ^{235}U, another 1.5×10^9 years; ^{238}U will have not halved again so ratio reaches 0.0072 soon after 6×10^9 years / calc for both isotopes / calc based on 235 varying and 238 constant /	2	
		basis of suggestion unreliable max 1		[5]
		Total		**11**
6	(a)	(i) Radial towards centre	1	
		(ii) Anticlockwise	1	
		(iii) $F = BIl$	1	
		(iv) $F = 0.40 \times 80 \times 10^{-3} \times 15$; $= 0.48$ (N)	2	[5]
	(b)	(i) Sine/cosine curve; amplitude correct; 2 cycles in 40 ms	3	
		(ii) $a = (-)\ 4\pi^2 f^2 A$; $= 4 \times 9.87 \times 25 \times 10^2 \times 2 \times 10^{-3}$; $= 197$ (m s^{-2})	3	
		(iii) 1 $F = ma = 0.02 \times 200 = 4$ (N)	1	
		2 I/0.08 = 4/0.48; $I = 0.67$ or $I = F/Bl = 4/(0.4 \times 15) = 0.67$ (A) ecf	2	[9]
	(c)	(i) Resonance	1	
		(ii) 122 (Hz) range118-126	1	
		(iii) Amplitude at peak will increase; curve will become narrower /sharper; amplitude increases thoughout; more pronounced at peak; resonant frequency increased slightly max 2	2	[4]
		Total		**18**

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.

Question		Expected Answers	Marks	
7	(a)	α-particle scattering	1	
		suitable diagram with source, foil, moveable detector	1	
		2 or more trajectories shown	1	
		vacuum (to remove absorption)	1	
		most particles have little if any deflection	1	
		large deflection of very few	1	
		reference to Coulomb's law /elastic scattering	1	
		alphas repelled by nucleus (positive charges)	1	
		monoenergetic;	1	
		.....max 6 marks		
		OR electron scattering	1	
		high energy	1	
		diagram with source sample, moveable detector/film	1	
		vacuum	1	
		electron accelerator or other detail	1	
		electrons diffracted by nucleus (as obstacle not slit)	1	
		most have zero deflection	1	
		characteristic angular distribution with minimum	1	
		minimum not zero	1	
		de Broglie wavelength	1	
		wavelength comparable to nuclear size hence high energy	1	
		..... *max 6 marks*		[6]
	(b)	(i) splitting of nuclei, fusing of nuclei/massive, light nuclei/large (200 MeV), small (30 MeV) energy release per reaction	1	
		release of energy/total mass decrease/'increase' in binding energy/ release radiation eg neutrons	1	
		(ii) neutron is absorbed by the nucleus;	1	
		which then splits into two (major) fragments;	1	
		and several/two/three neutrons	1	
		charges on/Coulomb repulsion pushes major fragments apart;	1	
		loss of mass/increased binding energy accounts for k.e. of fragments/release of energy	1	
		reference to $\Delta E = c^2 \Delta m$	1	[6]
		..... *max 4 marks* **Total**		**12**
		Quality of Written Communication		[4]