Question			Expected Answers	Marks	
1	(a)	(i)	Two vertical arrows of equal length (by eye) and opposite direction in the same vertical line passing through the ball;	1	
			weight/gravity/mg/0.49 N and (normal)reaction/string tension/0.49 N	1	2
		(ii)	gravity; acts on ball and Earth /AW	2	
			contact/reaction forces; between ball and strings/racket	2	4
		(iii)	(resultant force) = ma; = 0.05 x 2 = 0.1 (N)	2	2
	(b)	(i)	$v^2 = u^2 + 2gh$/ ½ $mv^2 = mgh$ to give $v^2 = 2gh$;	1	
			$v^2 = 2 \times 9.8 \times 0.8$ to give v = 4.0 (m s^{-1}) accept 3.96	1	2
		(ii)	mv = 0.20 (kg m s^{-1}) accept 0.198	1	1
		(iii)	2mv = 0.40 (kg m s^{-1}) accept 0.396	1	1
		(iv)	2mv/t = 8.0 (N) accept 7.92 *ecf b(iii)*	1	1
			[Total		**13]**
2	(a)	(i)	120 (mJ)	1	1
		(ii)	120 - 70 ; = 50 (mJ) *give 2 marks for correct answer without working*	2	2
	(b)	(i)	k.e. = ½ mv^2 = 50 x 10^{-3} = 0.2 v^2 ecf from a(ii)	1	
			v^2 = 0.25; v = 0.5 (m s^{-1})	1	2
		(ii)	Reasoning, e.g. max energy = ½ mv_m^2 = ½ kA^2 so A ∝ v_m/AW;	1	
			or max ke = 12.5 mJ so total energy = 82.5 mJ, read x from graph;		
			giving A = 0.025 (m)	1	2
	(c)	(i)	$a = -4\pi^2 f^2 x$;	1	
			$f^2 = 110/4\pi^2 = 2.786$ / $f = 10.5/2\pi = 1.67$ so f = 1/T = 0.6 (s)	1	2
		(ii)	sinusoidal wave with correct period; correct amplitude	2	
			correct phase accept A or –A at 0.15 s	1	3
			[Total		**12]**
3	(a)	(i)	(Gravitational) force on/per unit mass (at that point)	1	1
		(ii)	$g = (-) GM/R^2$ *accept lower case m and r in formula*	1	1
		(iii)	$g = 9.8 = 6.67 \times 10^{-11} M/(6.4 \times 10^6)^2$ giving $M = 6.0 \times 10^{24}$ (kg)	1	1
	(b)	(i)	$g_m = M_m/M_e . R_e^2/R_m^2 . g_e$ or gR^2/M = constant or AW;	1	
			$g_m = 3.7^2/81 \times 9.8 = 1.66$ (N kg^{-1})	1	2
		(ii)	athlete lifts centre of mass 1 m on Earth/AW;	1	
			assume same energy transfer/ same mgΔh/same velocity;	1	
			$\Delta h_m/\Delta h_e = g_e/g_m$ giving $\Delta h_m = 5.8\ \Delta h_e$ (hence h = 7 m)	1	3
			allow 1 mark for g less/force less/force in ratio 1:6		
			allow up to 2 marks for 2 x 9.8/1.7 = 11.5 m		
	(c)		$a = v^2/r$; $= GM/r^2$ or $F = mv^2/r$; $= GMm/r^2$	2	
			use $a = 4\pi^2 r/T^2$ to give $T^2 = 4\pi^2 r^3/GM$;	1	
			correct substitution; = 27 (days)	2	5
			[Total		**13]**

Question			Expected Answers	Marks	
4	(a)	(i)	$E = V/d = 2000/4 \times 10^{-3} = 5 \times 10^5$; $N\,C^{-1}/V\,m^{-1}$	2	2
		(ii)	$Q = CV$;= $200 \times 10^{-12} \times 2000$; = $4 \times 10^{-7} = 0.40$ (μC) *taking p as 10^{-9} -1 mark/ correct conversion of any answer to μC gets final mark*	3	3
		(iii)	$W = \frac{1}{2} CV^2$ ecf possible = $\frac{1}{2}$ QV;	1	
			= $0.5 \times 200 \times 10^{-12} \times 4 \times 10^6$;= 400 (μJ)	2	3
	(b)	(i)	4000 (V)	1	1
		(ii)	100 (pF) *ecf from (b)(i)*	1	1
		(iii)	800 (μJ) *ecf from (b)(i),(ii) also accept twice (a)(iii)*	1	1
	(c)		the mechanism pulling the plates apart/force working against attraction between charged plates/opposite charges/work done in separating plates/AW	1	1
			[Total		**12]**
5	(a)	(i)	**1** 94 **2** 239 – 94 = 145	1	1
		(ii)	**1** 92; **2** 143 *ecf from a(i) 2*	2	2
	(b)		$\lambda = 0.693/T$ *on page 3* = $0.693/24000 \times 3.2 \times 10^7 = 9 \times 10^{-13}$ (s^{-1})	1	1
	(c)	(i)	$n = P/\varepsilon$;=$2.5/8.2 \times 10^{-13} = 3.0(48) \times 10^{12}$	2	2
		(ii)	$A = \lambda N$;	1	
			$N = 3 \times 10^{12}/9 \times 10^{-13} = 3.3 \times 10^{24}$ *ecf from b*	1	2
		(iii)	$m = N/N_A.M$ / = $(3.3 \times 10^{24}/6.02 \times 10^{23}) \times 0.239$; =1.3(4) (kg) *ecf (c)(ii) aliter* $m = AuN$ / = $239 \times 1.66 \times 10^{-27} \times 3.3 \times 10^{24}$	2	2
	(d)		advantage: (higher energy per particle/shorter half-life) so smaller mass required/AW	1	
			disadv.: power does not remain 'constant' for long period/AW	1	
			safety alternatives: short half-life means fewer disposal/storage problems; higher energy per particle needs more shielding *max 2 marks*	2	2
			[Total		**12]**
6	(a)	(i)	Closed loops linking primary coil	1	
			quality mark, e.g. lines not touching/crossing,passing through iron core	1	2
		(ii)	magnetic flux = BA	1	
			meanings of B and A, i.e. flux density or field strength and area ($\perp$ to it) *give max 1 mark for answer in terms of induced emf, i.e. Faraday's law*	1	2
		(iii)	magnetic flux linkage refers to the flux linking/passing through a coil;	1	
			and equals N x flux where N is the number of turns of the coil	1	2
		(iv)	alternating current has alternating/varying(magnetic) flux associated;	1	
			Faraday's law: voltage across coil is proportional to rate of change of flux linkage through it /correct mathematical formulation/AW	2	
			changing flux linking secondary coil induces voltage *allow current max 3 marks*	1	3
	(b)	(i)	T = 20 ms hence f = 1000/20 = 50 Hz	1	1
		(ii)	($V_p/V_s = n_p/n_s = \frac{1}{2}$ so as V_s = 10 V then) V_p = 5 V	2	2
			[Total		**12]**

Question			Expected Answers	Marks
7	(a)		Nucleus contains most/almost all of mass of atom/detail such as $m_p = m_n$ = 2000 m_e /atom volume almost all empty space/AW;	1
			nucleus consists of protons and neutrons;	1
			p positively charged, n neutral, e negatively charged;	1
			surrounded by cloud of electrons;	1
			equal numbers of protons and electrons (to make atom neutral);	1
			ratio of p to n; idea of isotope/element; p & n made of quarks, etc.	1
			maximum 4 marks	4
	(b)	(i)	X-ray diffraction/ (lower-energy) electron scattering (diffraction)/atomic stacking argument involving molar volume, mass and N_A;	1
			credit should be given for any sensible valid point/method three valid descriptive points for 3 marks, e.g.	
			diagram of apparatus/diffraction pattern	1
			(atoms in) crystal/polycrystals/ regular arrays	1
			diffraction observed because wavelength of order of atom plane spacing	1
			measurement of dot/ring pattern spacing and knowing wavelength enables atomic spacing to be found/AW	1 4
		(ii)	α-particle or high-energy electron scattering/diffraction	1
			credit should be given for any sensible valid point/method three valid descriptive points for 3 marks, e.g.	
			for α-particle	
			diagram of apparatus/scattering paths of particles by nucleus	1
			bouncing back of few particles from head-on collisions/few particles undergo significant deflections/AW	1
			in head-on assume all k.e. goes to p.e. enabling distance of closest approach to be estimated	1
			giving upper limit of nuclear size	1
			for electron scattering	
			high-energy electrons have short wavelength; as $\lambda = h/mv$;	2
			particle accelerators can produce high enough momentum for λ to be of order of nuclear size;	1
			measurement of diffraction pattern,etc. enables nuclear size to be found	1 4
			Neutron scattering can be stated in place of electron scattering. Mark scheme is the same. For b(i) the neutrons are thermal neutrons and for b(ii) MeV neutron from deuterium, for example, to give the correct λ.	
			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 reasonable 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.