Question Number	Answer	Acceptable answers	Mark
1(a)(i)	**B** magnetic		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(a)(ii)	(high frequency alternating) voltage	electric field / electrostatic force electrodes + and – (not just 'electrodes') potential difference (p.d.)	**(1)**

Question Number	Answer	Acceptable answers	Mark
1(a)(iii)	A description using the following:- (charged) particles bombard (1) atoms/molecules/nuclei / (stable) elements (1)	 (charged) particles {hit / shoot into / fired into / collide with} generally accept 'it' / 'they' as alternatives to 'charged particles' target (material) / nucleus / **stable** isotope 'neutrons hitting a target' would get second mark only (neutrons not charged) 2nd mark needs idea of hitting target nuclei / atoms, not (charged) particles hitting other particles.	**(2)**

Question Number	Answer	Acceptable answers	Mark
1(b)(i)	**C** 		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(b)(ii)	An explanation linking any three of the following:- positron has a positive (charge) (1) electron has a {negative (charge) / opposite charge(s) } (1) these charges cancel out (1) gamma rays /waves have no charge (1)	 positron has +1 / +e (charge) positron charge is + electron has -1 / -e (charge) electron charge is – neutralise / overall charge is zero Accept for three marks: electron and positron have equal and opposite charges which cancel out.	**(3)**

Question Number	Answer	Acceptable answers	Mark
1 (b)(iii)	An explanation linking : positron and electron have mass(before the annihilation) (1) gamma (rays produced by annihilation) have energy (1) (the equation shows)	 mass (of particles) becomes energy of gamma (rays) (2) all the mass before the collision becomes the energy of the gamma (rays) after the particles have been annihilated (2) $E=mc^2$ reference (1) explained will get the other (1)	**(2)**

Total for Question 4 = 10 marks

Question Number	Answer	Acceptable answers	Mark
2(a)(i)	60 (kW h/ units) (1) 60 x 20 (= 1200) (p) (1)	15459 - 15399 £12 ecf Award full marks for correct answer with no working £12 scores 2 Power of Ten error scores maximum 1 60 in answer space with no working scores 1	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(a)(ii)	60 / 15 (1) 4 (kW) (1)	Allow ecf from 6(a)(i) marking point 1 Award full marks for correct answer with no working	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(b)	An explanation linking any two of: • increase voltage (1) • decrease current (1) • reduce {loss / waste} of {energy / heat} (1)	Increase efficiency (of energy transmission) Ignore "more efficient" by itself Accept power instead of energy Accept no energy loss	**(2)**

Question Number		Indicative content	Mark
QWC	***2(c)**	A description to include some of the following points • speed of movement • stronger / more powerful (ORA) magnet • more turns / coils (ORA) • iron core • reversing movement • turning the magnet round • effect of any / each change • more conducting / less resistant wire • allow stronger current • allow ammeter reading / recording / voltage for current • allow moving coil Correct ideas but using inaccurate scientific terminology • larger / bigger magnet • more / longer movement Ignore • irrelevant information • speeds up current or more electricity	**(6)**
Level	**0**	no rewardable material	
1	**1-2**	• a limited description of any one change e.g. use more coils **OR** a stronger magnet. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3-4**	• a simple description of any two different changes **OR** one change and its effect e.g. use more coils and a weaker magnet **OR** more coils more current • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed description of a change linked to its effect and a second different change e.g. using more turns of wire makes a bigger current. Moving the magnet out. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

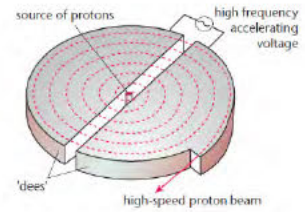
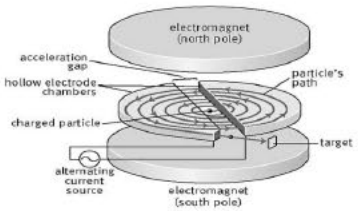
(Total for Question 6 = 12 marks)

Question Number	Answer	Acceptable answers	Mark
3(a)(i)	D towards the centre of the circle		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(a)(ii)	centripetal (force)	reject centrifugal force accept misspellings where meaning is clear e.g. centripedal	**(1)**

Question Number	Answer	Acceptable answers	Mark
3(a)(iii)	Any two of the following :- ball slows down (1) ball / it drops (down) / circles at a lower height (1) go in smaller circles (1)	 less **kinetic** energy / momentum any lowering / less **potential** energy stops going in circles the ball/it would not make complete circles (not just 'stops')	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(a)(iv)	An explanation linking: • the idea that momentum (of the closed system) would stay the same (1) • the idea that kinetic energy would not be conserved (1)	 momentum **of the ball** decreases / changes (direction) / passed to wall must specify which momentum; do not credit 'momentum decreases' by itself kinetic energy → heat/sound/wall ignore 'KE decreases / is lost' without qualification allow 'KE is lost because it's not elastic' (i.e. qualified)	**(2)**

Question Number		Indicative Content	Mark
QWC	**3(b)**	A description including some of the following points :- Cyclotron • two D-shaped halves • gap between the Dees • (alternating) voltage across the gap • magnetic field (at right angles to the moving particles) • vacuum enables free movement of particles Particle movement • accelerate • start at the centre • move in a circular path • spiral outwards • exit in a straight line Examples of labelled diagrams which would give Level 3 by themselves (not all labels / details needed)   Level 2 if no labels but Dees AND particle path shown. Level 1 if no labels but either Dees OR spiral of particle shown Ignore uses of cyclotron	**(6)**

Level		No rewardable content
1	**1 - 2**	• a limited description of either particle movement OR cyclotron e.g. The particles move in a circle OR Cyclotrons have two Dees OR Cyclotrons are particle accelerators OR there's a vacuum • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	**3 - 4**	• a simple description of particle movement AND cyclotron OR a more detailed description of one e.g. A cyclotron has two D-shaped halves and the particles inside accelerate OR A cyclotron has a magnetic field and a voltage across the gap OR Charged particles increase in speed as they spiral outwards OR vacuum allows free movement of particles • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	**5 - 6**	• a description of particle movement AND cyclotron with a detailed description of one of them e.g. the charged particles get faster as they accelerate across the gap in the Dees **OR** the magnetic field (of the cyclotron) causes the particles to move in a circle • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

(Total for Question 5 = 12 marks)

Question Number	Answ		Mark
4(a)(i)	Circular/spiral/circle		**(1)**

Question Number	Answer	Acceptable answers	Mark
4 (a)(ii)	An explanation linking three of the following. • (fast moving) <u>protons</u> (1) • absorbed by (1) • nuclei (1) • (produces)unstable nuclei (1)	bombard / hit /strike / collide with stable atoms / stable element	**(3)**

Question Number	Answer	Acceptable answers	Mark
4 (b)(i)	B momentum		**(1)**

Question Number	Answer	Acceptable answers	Mark
4 (b)(ii)	(Momentum/it)equals mass x <u>velocity</u>	p = m x v kilograms / kg is the mass and metres per second / m/s is the <u>velocity</u> Accept "times" for x	**(1)**

Question Number		Indicative Content	Mark
QWC	***4(b)(iii)**	An explanation including some of the following points Diagram 1 • Moving in opposite directions before collision • inelastic collision • stationary after collision • momentum zero after collision • (therefore) total momentum must have been zero before collision • (therefore) cars were moving at the same speed in opposite directions (assuming cars have equal mass) • both cars had kinetic energy before the collision • KE zero after collision • KE converted into heat, sound, elastic potential energy etc. Diagram 2 • Elastic collision / almost elastic collision • Momentum conserved • Momentum transferred from first to last sphere • KE conserved / almost conserved • (because)last sphere reaches same height as first sphere • Three spheres always have zero momentum • Small amount of energy transferred to sound/heat	**(6)**

Level		No rewardable content
1	**1 - 2**	• A limited analysis of ONE collision which is given by a correct statement e.g. In collision 1, kinetic energy has been lost OR In collision 2 momentum is transferred from the first to the last sphere. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	**3 - 4**	• a simple analysis of BOTH collisions considering BOTH momentum AND kinetic energy correctly for each one e.g. In collision 1, momentum is conserved and the kinetic energy of the cars changes. In collision 2, momentum and the kinetic energy is conserved. • answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	**5 - 6**	• a detailed analysis of BOTH collisions considering momentum AND kinetic energy for each collision correctly for each AND detailed reference to EITHER diagram. e.g. In collision 1, the momentum before and after the collision is zero because momentum is always conserved, but the KE is lost. In collision 2, all the momentum and KE is transferred to the last sphere because it gets to the same height as the first one. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

(Total marks for question 6 = 12 marks)