Question Number	Answer	Acceptable answers	Mark
1(a)(i)	☒ **A** electron		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(a)(ii)	suggestion to include **two** of • the ionisation is different (1) • correct difference in ionisation (1) • the <u>masses</u> are different (1) • alpha is bigger than beta (1) • alpha hits more (air) particles (1) • alpha loses its energy in shorter distance (1)	alpha more ionising (than beta) scores 2 marks RA (heavier for bigger) RA RA IGNORE references to penetration	**(2)**

Question Number	Answer	Acceptable answers	Mark
1(b)	☒ **A** gamma radiation		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(c)(i)	A description linking the following: • neutron decays / changes / becomes (1) • (neutron) into proton (1) • (plus an) electron (1)	quark changes (quark changes) from down to up / d to u e^- (do not accept β^-) accept n and p for neutron and proton $n > p + e^-$ scores 3 marks IGNORE references to atomic and mass numbers; unstable nuclei; too many neutrons; gamma emitted	**(3)**

Question Number	Answer	Acceptable answers	Mark
1(c)(ii)	An explanation linking **three** of the following: • mass number doesn't change (1) • (because) same number of nucleons / quarks (1) • atomic number goes up by one (1) • (because) there is an extra proton (1)	emitted electron mass is negligible proton and neutron have same mass a neutron has (decayed in)to a proton	**(3)**

Question Number	Answer	Acceptable answers	Mark
2(a)	A description including the following points • steam {drives/turns} turbine (1) • (which) {drives/turns/powers} generator (1)	transfers ke to electrical energy rotates a magnet in coils or coils in magnet accept dynamo for generator	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(b)	A description including the following points • neutron {hits / splits / is absorbed by} uranium (nucleus) (1) • producing more neutrons (1) • at least one neutron can {hit / split / be absorbed by} other uranium (nuclei) (1)	full marks may be scored on a labelled diagram fired at other U (nuclei) or "process repeats"	**(3)**

Question Number	Answer	Acceptable answers	Mark
2(c)	krypton-91		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(d)	An explanation linking the following points • removes electrons (1) • from atoms (1)	collides with atoms ignore references to β decay process (nucleus losing an electron)	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(e)	An explanation linking the following points • nuclei are positively charged (1) • need enough energy to overcome repulsion (1)	ignore references to high temp and pressure accept same charge accept protons for nuclei accept atoms and will repel each other	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(a)(i)	A 92		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(a)(ii)	neutron(s) (1)	allow phonetic spelling nutron, newtron, nuetron	**(1)**

Question Number	Answer	Acceptable answers	Mark
3(b)	An explanation linking any two of the following points • a neutron(s)(1) • hits nucleus/nuclei (1) • uranium/nucleus splits (1) • (producing) neutrons /daughter nuclei/ energy / Kr and Ba (1)	 collides/is absorbed breaks/divides accept chain reaction for 1 mark if no other mark awarded accept a correctly labelled diagram	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(c)	An explanation linking two of the following points • absorb (1) • neutrons (1) • (influences) chain reaction / rate of reaction (1)	Accept reverse arguments collects/removes/takes away slows down/changes	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(d)	An explanation linking any two of the following points • heats/boils water (1) • to produce steam (1) • to run/turn/spin turbines (1) • to turn/power generators (1)	 labelled diagram that indicates process (not just parts). heats boiler turns a coil in a magnet	**(2)**

Total marks for question 2 = 8

Question Number	Answer	Acceptable answers	Mark
4(a)(i)	Neutron(s)	Accept phonetic spellings eg newtron(s) or neutron(s) Reject newtons	**(1)**

Question Number	Answer	Acceptable answers	Mark
4(a)(ii)	D 9 Be 4		**(1)**

Question Number	Answer	Acceptable answers	Mark
4(a)(iii)	A explanation linking the following points • Charge/electron transfer (1) • Correct transfer detail (1)	Gains/loses charge Gains an electron = 1mark Loses (an) electron(s) gains both marks Award 1 mark for gaining a proton as idea of gains charge	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(b)	A description including any two of the following points • Two (light) / (small) <u>nuclei</u> (1) • Fuse together (1) • To produce a large(r)/heavier nucleus/atom /particle (1)	Ignore references to releasing energy as this is in the Q. two hydrogen (and or helium) <u>nuclei</u> / two protons join /combine/merge/come / forced together helium/lithium (nucleus/atom/particle)	**(2)**

Question Number		Indicative Content	Mark
QWC	*)	A description including some of the following points • Nucleus absorbs a neutron • Nucleus becomes unstable • nucleus fissions/ splits • (2 or) more neutrons released • daughter products • chain reaction • use of moderator • to control kinetic energy of neutrons/slow down neutrons • increases chance of further/more (fission) reactions • use of control rods • control rods absorb neutrons • reducing number of neutrons available for fission/to control (fission) reaction • containment of radioactive materials • little/no radiation enters environment Ignore references to the release of energy as this is given in Q Marks can be scored by a suitably labelled diagram	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description that contains one or two points and possibly has a number of inaccuracies e.g. Uranium atom splits .....control rods are used (to moderate the reaction) OR Uranium atom absorbs a neutron ....there is a chain reaction OR (In the nuclear reactor) .....chain reaction starts • 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 that links two points e.g. A uranium nucleus absorbs a neutron and splits. OR A uranium atom splits and releases more neutrons. • 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 that gives a linked statement about fission plus some detail about control or containment OR A detailed description that gives two pairs of linked statements about fission e.g Uranium nucleus absorbs a neutron and splits/fissions AND 2 or more neutrons are released and are slowed by a moderator/ produce a chain reaction. OR Control rods absorb (some) neutrons to control the reaction. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

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

Question Number	Answer	Acceptable answers	Mark
5(a) (ii)	(equivalent to a) helium nucleus	Two protons and two neutrons for 2 marks helium/mass of 4 for 1 mark charge of +2 for 1 mark correct statement of any property for 1 mark	**(2)**

Question Number	Answer	Acceptable answers	Mark
5 (b)	A description to include any four of the following • neutron • is captured by a U-235 nucleus • nucleus (is) unstable • nucleus splits • into 2 daughter nuclei (of similar size) • (2 or more) neutrons are released • energy is released	• collides with /absorbed by (U-235) nucleus • metastable • named isotopes	**(4)**

Question Number	Answer	Acceptable answers	Mark
5 (c)	An explanation linking • moderator slows down (absorbs energy from) neutrons • more likely to be captured /cause fission (if it collides with a U-235 nuclei)	Reverse argument	**(2)**