

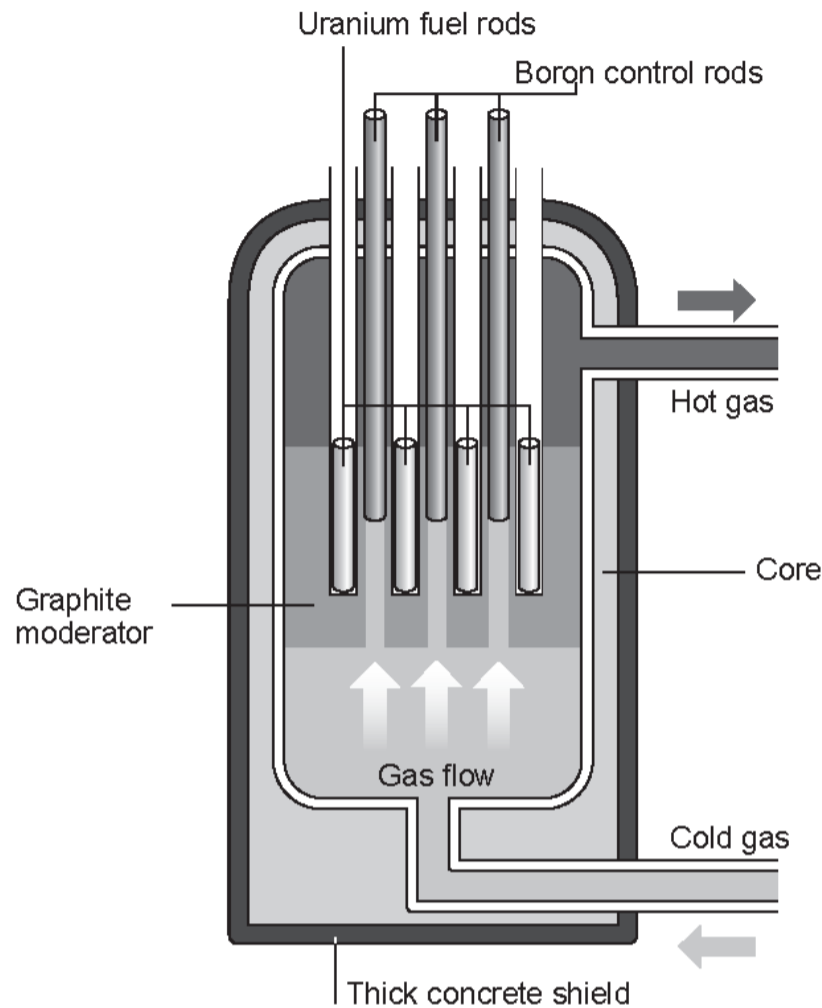
My Question Paper

1.

Read the information in the passage and study the diagram before answering the questions that follow.

In the reactor, energy is released by fission and is the result of a controlled chain reaction. Fuel rods are made of uranium. The graphite moderator surrounds the fuel rods. The boron control rods can be raised and lowered.

The diagram shows the important parts in the core of a gas-cooled nuclear reactor.



- (a) (i) Describe the process of fission of a single uranium nucleus in a gas-cooled reactor. [2]

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- (ii) Explain the purpose of the graphite moderator. [2]

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- (iii) Explain why raising the boron control rods increases the energy released in the reactor. [2]

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- (b) The table below shows different isotopes of uranium (U).

Isotope	Nuclear symbol
U-230	${}_{92}^{230}\text{U}$
U-234	${}_{92}^{234}\text{U}$
U-235	${}_{92}^{235}\text{U}$
U-238	${}_{92}^{238}\text{U}$

- (i) Tick (✓) the boxes next to **three** correct statements about the isotopes shown in the table. [3]

All the isotopes have nuclei which contain 92 neutrons

A nucleus of U-230 contains the least number of neutrons

A nucleus of U-235 contains 143 neutrons

A nucleus of U-234 contains 92 protons

A nucleus of U-238 contains 238 protons

- (ii) Complete the following nuclear equations which show the decay of two of the uranium isotopes listed in the table above. [2]



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2.

Complete the following paragraph about a nuclear reactor by underlining the correct word or words in each of the brackets. [5]

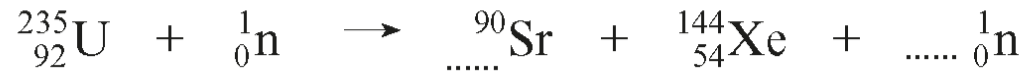
The absorption of (slow protons / slow neutrons / slow electrons) can cause a (fusion / fission / chemical) reaction in uranium nuclei. The particles are slowed down by (a moderator / control rods / concrete shielding). The emission of (protons / neutrons / electrons) in this reaction can cause a chain reaction. An uncontrolled chain reaction is prevented by using (a moderator / control rods / concrete shielding).

5

3.

Nuclear fission and nuclear fusion are examples of nuclear reactions. Typical nuclear fission and nuclear fusion reactions are shown below.

(a) (i) Complete the equation for the first reaction. [2]



(ii) Explain how the first reaction could lead to an uncontrolled chain reaction. [2]

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(b) ${}_1^2\text{H}$ and ${}_1^3\text{H}$ are both isotopes of hydrogen.

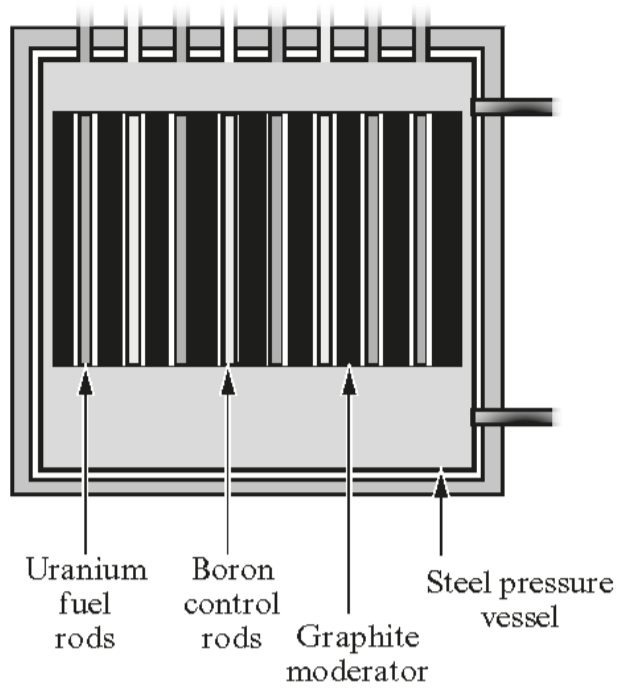
Compare the structure of the nuclei of these two isotopes. [2]

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4. The diagram shows a nuclear fission reactor.



(a) (i) State which labelled part of the reactor slows down neutrons. [1]

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(ii) Give a reason why the neutrons need to be slowed down. [1]

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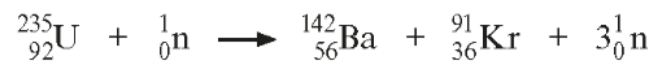
(b) (i) State which labelled part of the reactor absorbs neutrons. [1]

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(ii) Give a reason why neutrons need to be absorbed. [1]

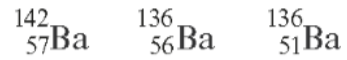
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(c) The reaction in this type of reactor is shown below.

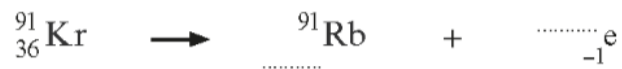


Use the information in the equation to answer the questions below.

- (i) State the nucleon number of uranium (U). [1]
- (ii) State the proton number of krypton (Kr). [1]
- (iii) Calculate the number of neutrons in an atom of krypton. [1]
- (d) One of the products, barium (Ba), has other isotopes.
Circle the correct symbol of an isotope of barium in the following list. [1]



- (e) The other product krypton, decays into rubidium (Rb) by emitting beta particles.
Complete the decay equation shown below. [2]



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5.

The table below gives information about some elements.

Element	Symbol	Nucleon number (A)	Proton number (Z)	Number of neutrons in a nucleus
Hydrogen	H	1	1	0
Helium	He	4	2
Iron	Fe	26	30
Lead	Pb	207	82	125
Krypton	Kr	90	36	54
Barium	Ba	144	56	88
Uranium	U	235	92	143

(a) Complete the table. [2]

(b) Tritium has a proton number of 1 and a nucleon number of 3. Tritium is an isotope of one of the elements in the table above. Which one? [1]

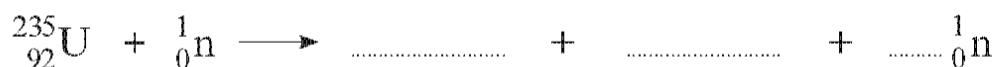
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(c) The nuclear symbol for uranium is written as ${}_{92}^{235}\text{U}$. Use information in the table above to answer the following questions.

(i) Complete the nuclear symbol for lead. ${}_{\dots\dots\dots}^{\dots\dots}\text{Pb}$ [1]

(ii) In a nuclear reactor, uranium undergoes fission by absorbing a neutron (${}^1_0\text{n}$). The products of this reaction are krypton, barium and two neutrons.

Complete the equation below for this reaction. [2]



(d) Complete the sentences below by underlining the correct word(s) in the brackets. [2]

(i) In a nuclear reactor the moderator (slows down / speeds up / absorbs) neutrons.

(ii) In a nuclear reactor the control rods (slow down / speed up / absorb) neutrons.

6. (a) Draw a line from **each** of the four boxes on the left to a **box on the right**.

[3]

Part of nuclear reactor

Its function

Control rods

Provides atoms for fission to occur

Moderator

Absorb neutrons

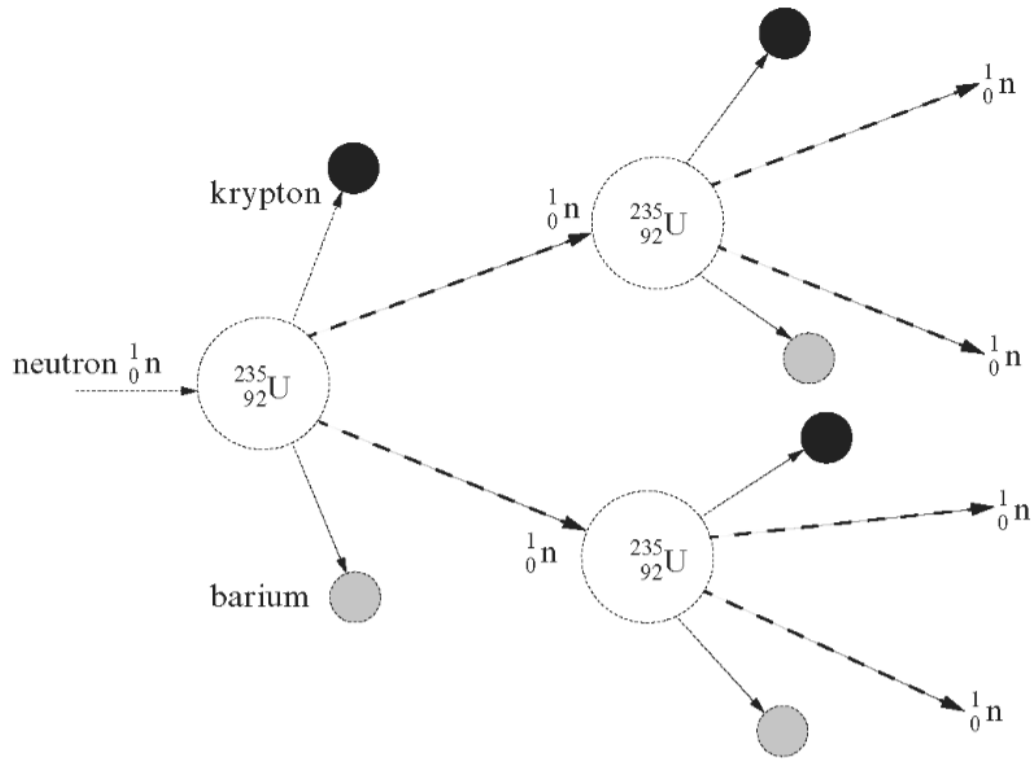
Steel and concrete container

Slow down neutrons

Uranium

Absorb radiation

(b) A nuclear reaction that takes place in a nuclear reactor is shown below. Use the diagram to help you answer the questions that follow.



- (i) Write down the name of this type of reaction. [1]
- (ii) Name **one** waste product of this reaction. [1]

(c) State **two** reasons why waste radioactive materials from nuclear reactors need to be stored **safely** for a **long period** of time. [2]

1.

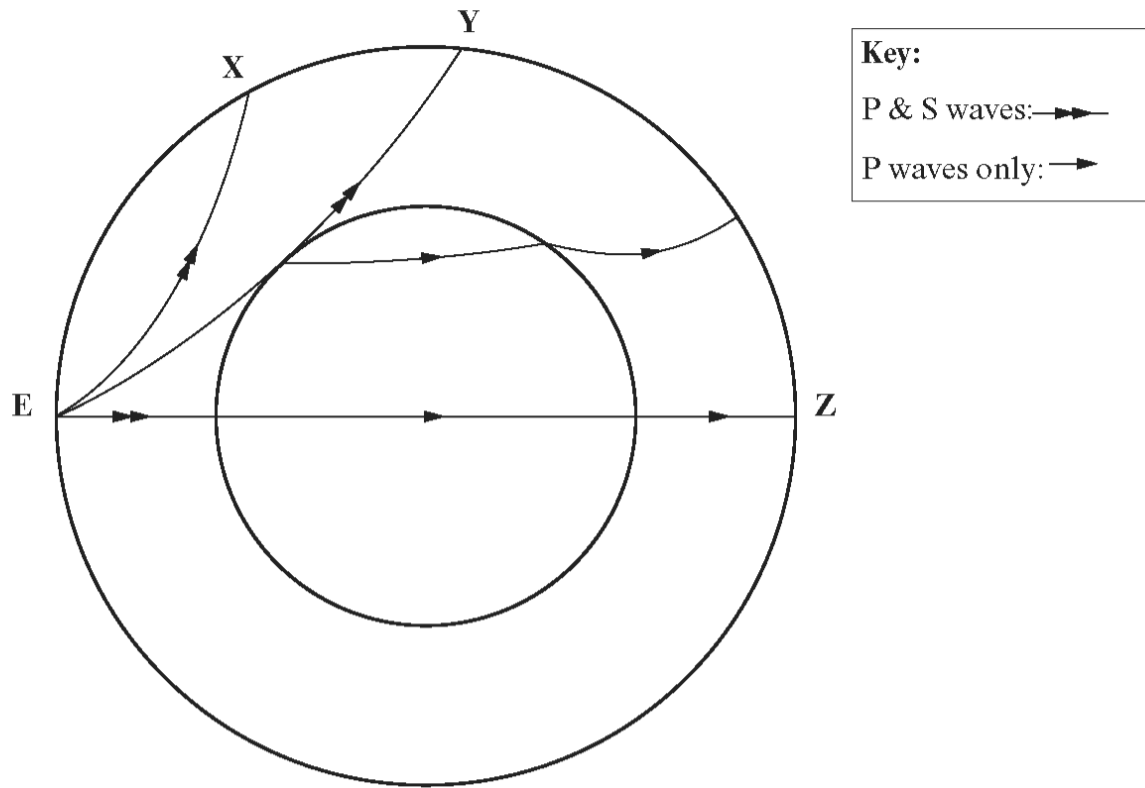
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2.

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7.

The diagram shows the path of P and S waves from an earthquake at **E**. Surface waves are not shown on this diagram. **X**, **Y** and **Z** are stations that detect seismic waves.

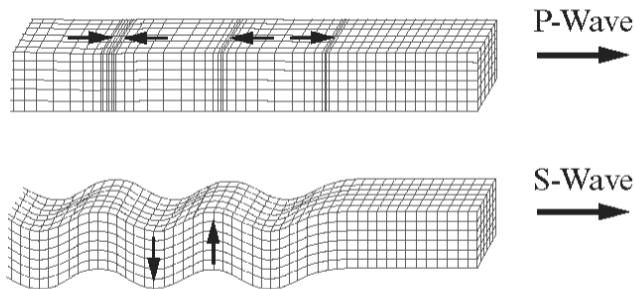


(a) (i) State the difference between surface waves and P and S waves. [1]

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(ii) Use the diagram below to help you explain the difference between how the particles move in P and S waves. [2]

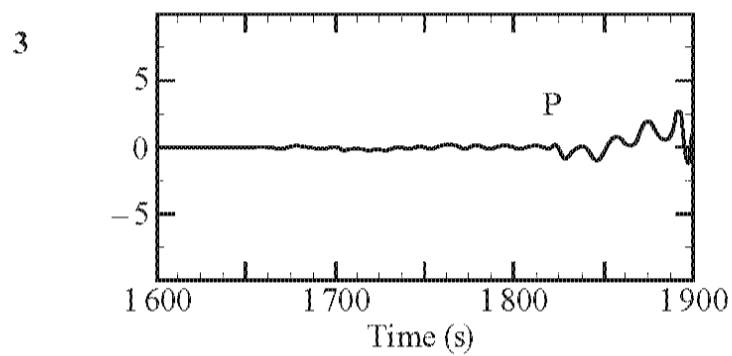
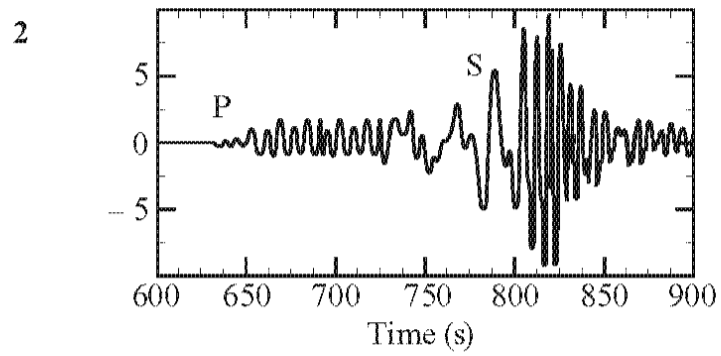
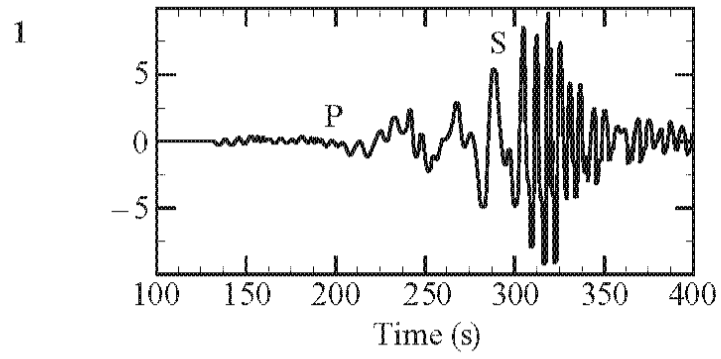


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(b) The signals 1, 2 and 3 below were detected at either stations X, Y or Z.



(i) State which signal 1, 2 or 3 was detected at station Z. [1]
 Give a reason for your answer. [1]

(ii) State which signal 1, 2 or 3 was detected at station Y. [1]
 Explain your choice. [2]

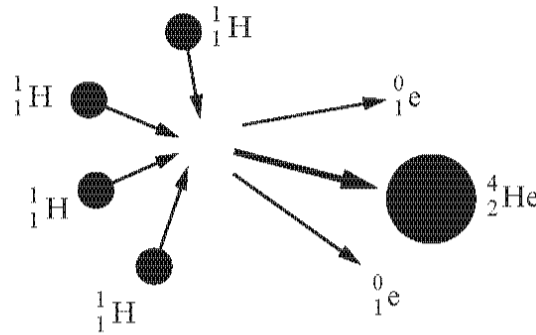
8.

The Sun is in a stable state in the main sequence stage of its "life".

(a) (i) Name the forces acting on the Sun. [1]

(ii) State why the Sun is in a stable state at present. [1]

(b) The Sun generates most of its energy by the nuclear reaction shown in the diagram.



(i) Write the nuclear equation for this reaction. [1]



(ii) Describe this reaction, naming the particles involved. [3]

(c) State what happens when a particle ${}^0_1\text{e}$ collides with a particle ${}^0_{-1}\text{e}$. [1]

7

Marking Scheme

1.

Question Number		Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT							
5		(a)	(i)	2	Uranium [nucleus] / it absorbs neutron[s] (1) splits into 2 [smaller] nuclei <u>and</u> neutrons [are released] (1)	Atoms Neutron capture Named elements		Force of impact shatters nucleus. Don't accept collides.
			(ii)	2	Slows down the neutrons (1) so they can be absorbed / captured <u>by uranium</u> [nuclei] (1) The 2 nd mark can only be awarded if it is linked to the 1 st mark.	For 2 nd mark: Split <u>uranium</u> nuclei or they cause fission of <u>uranium</u> or the reaction of uranium		
			(iii)	2	Fewer or no neutrons absorbed (1) so increase [in rate of] fission [of uranium nuclei] (1) The 2 nd mark can only be awarded if it is linked to the 1 st mark.	For 1 st mark: So more neutrons available for fission		Taken out / removed / more energy released
		(b)	(i)	3	Ticks in the 2 nd , 3 rd and 4 th boxes A nucleus of U-230 least number of neutrons (1) <input checked="" type="checkbox"/> A nucleus of U-235 contains 143 neutrons (1) <input checked="" type="checkbox"/> A nucleus of U-234 contains 92 protons (1) <input checked="" type="checkbox"/>			Extra tick attracts -1
			(ii)	2	$^{234}_{92}\text{U}$ (1) as shown here			
Total Mark				11				

2.

Question	Marking details	Marks
2.	slow neutrons (1) fission (1) moderator (1) neutrons (1) control rods (1)	5
	Question total	[5]

3.

Question			Marking details	Marks
7.	(a)	(i)	38 (1) 2 (1)	2
		(ii)	Neutrons produced [go on to] cause more reactions or collisions or bombards (1), number of neutrons doubles (accept increase / multiply / triple) [each time] (1) Treat reference to fast neutrons as neutral. N.B. reference to 3 neutrons could arise from the equation above. To award both marks both statements must be linked.	2
	(b)	They contain same number of protons / 1 proton (1) but different number of neutrons / 1 neutron and the other has 2 neutrons (1) Reference to electrons loses 1 mark. Don't accept nucleons / mass number / atomic number	2	
	(c)	<p>Indicative content:</p> <p>In fission a heavy element such as [U 235] absorbs a neutron and splits into lighter nuclei [releasing energy]. In fusion, light elements [such as hydrogen isotopes] collide [in high energy collisions and join together] to produce a heavier element, [also releasing energy]. The main problem with nuclear fission is that it produces waste products which are highly radioactive for a long time. The main problem with nuclear fusion is that it requires very high temperatures and pressures which need lots of energy so it is not yet easily contained.</p> <p>5 – 6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p>3 – 4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.</p> <p>Question total</p>	6	
			Question total	[12]
			Foundation tier paper total	[60]

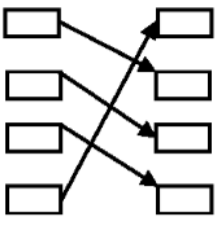
4.

Question			Answer / Explanatory Notes	Marks Available
4.	(a)	(i)	graphite / moderator	1
		(ii)	to cause [fission / chain] reactions / if too quick, reaction won't work	1
	(b)	(i)	boron / control rods	1
		(ii)	to prevent an <u>uncontrolled</u> chain reaction / <u>control</u> the chain reaction / prevent overheating or meltdown / Don't accept "to stop fission" only must be qualified.	1
	(c)	(i)	235	1
		(ii)	36	1
		(iii)	[91 - 36] = 55 (No ecf for 91 - (ii))	1
	(d)		$^{136}_{56}\text{Ba}$ circled	1
	(e)		37 (1) 0 (1)	2
				Question total

5.

Question			Marking details	Marks	
4.	(a)		[He] 2 (1) [Fe] 56 (1)	2	
	(b)		<u>H</u> or hydrogen	1	
	(c)	(i)	$^{207}_{82}\text{Pb}$	1	
		(ii)	$^{90}_{36}\text{Kr} + ^{144}_{56}\text{Ba}$ (1) ^1_0n (1)	2	
				Do not accept krypton and barium written in full	
				Do not accept Kr_{36}^{90} or Ba_{56}^{144}	
(d)	(i)		slows down	2	
	(ii)		absorb		
			Question total	[8]	

6.

Question		Marking details	Mark
1.	(a)	All correct - 3 marks 2 or 3 correct – 2 marks 1 correct – 1 mark 	3
	(b)	(i) fission OR chain [reaction]	1
		(ii) krypton or barium (accept Kr or Ba)	1
	(c)	Any 2 x (1): - they have <u>long half- lives</u> - <u>highly/very radioactive</u> - prevents leaks / getting into the environment or food chain or water supply - <u>harmful/poisonous/toxic/dangerous to living things</u> or <u>ionises cells / mutates cells</u> or <u>risk to health/cancer</u> - prevent theft/use as weapons/use by terrorists If 2 correct answers given on 1 line only then award 2 marks. If 2 correct answers given on 1 line and then on the 2 nd line an incorrect answer is given award 1 mark only. If 1 correct answer and 1 incorrect answer are given on the same line then no mark awarded.	2
Question total			[7]

7.

Question		Marking details	Mark
4.	(a)	1	1
	(b)	positron / antiparticle of electron / antielectron	1
	(c)	it is negative (accept different charge or opposite charge) don't accept it is positive	1
	(d)	annihilate / cancel each other out / destroy each other (1) don't accept fuse or neutralise and release energy / creates heat (1) any reference to 2 electrons don't award the 1 st mark	2
Question total			[5]

8.

Question Number		Sub-section		Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT							
6		(a)	(i)	1	Gravity and radiation / pressure			
			(ii)	1	Forces are balanced / they are balanced	Equal and opposite / forces cancel each other out		The same / equal / because it has a supply of hydrogen / its balanced
		(b)	(i)	1	$4\text{}^1_1\text{H} \rightarrow \text{}^4_2\text{He} + \text{}^0_{-1}\text{e} + \text{}^0_{+1}\text{e}$	$4\text{}^1_1\text{H} \rightarrow \text{}^4_2\text{He} + 2\text{}^0_{-1}\text{e}$		
			(ii)	3	Four hydrogen [nuclei] / protons <u>join</u> / <u>fuse</u> (1) to form a helium [nucleus] (1) and <u>two</u> positrons (1)	Antielectron instead of positron		Positive electron / react / bond / collide / alpha particle
		(c)		1	Energy / gamma is released	They annihilate / destroy each other / cancel each other out	An explosion takes place	They neutralise each other
		Total Mark				7		