

# Nuclear Fission and Nuclear Fusion Mark Schemes

## QUESTION 1

QUESTION	ANSWER	EXTRA INFORMATION	MARKS
a)i)	(nuclear) fission	accept fission providing clearly not fusion	1
a)ii)	(released) neutrons are absorbed by further (uranium) nuclei  more neutrons are released (when new nuclei split)	accept hit nuclei for absorbed / hit do not accept atom for nuclei  accept for both marks a correctly drawn diagram	1  1
a)iii)	increases by 1 or goes up to 236		1
b)	any two from: ☐ (more) neutrons are absorbed ☐ (chain) reaction slows down / stops  ☐ less energy released	accept there are fewer neutrons accept keeping the (chain) reaction controlled accept heat for energy accept gases (from reactor) are not as hot	2
Total marks			6

## QUESTION 2

QUESTION	ANSWER	EXTRA INFORMATION	MARKS
a)i)	(two) nuclei (of light elements) join forming a larger / heavier nucleus / one	accept hydrogen atoms for nuclei  accept comparative term equivalent to larger accept forms a helium (nucleus / atom) this mark only scores if	1 1

		fusion is in terms of hydrogen atoms	
a)ii)	stars	accept a named star e.g. the Sun accept nebula mention of planets negates answer	1
b)i)	any one from: <input type="checkbox"/> (currently) only experimental <input type="checkbox"/> reaction does not last long enough <input type="checkbox"/> use more energy than they produce	allow difficult to control do not allow inefficient on its own	1
b)ii)	any one from: <input type="checkbox"/> will give another source of energy <input type="checkbox"/> unlimited fuel supplies / energy <input type="checkbox"/> would not produce any radioactive waste <input type="checkbox"/> want to show that it can be done	accept unlimited hydrogen  accept less radioactive waste accept nuclear for radioactive do not accept toxic waste  accept any sensible suggestion	1
c)i)	any one from: <input type="checkbox"/> repeating did not produce the same results / data experiments were not / may not be reproducible <input type="checkbox"/> data / experiments were not valid	accept could not be repeated accept has not been repeated  do not accept answers in terms of scientists being biased	1
c)ii)	any one from: cannot trust journalists <input type="checkbox"/> newspaper journalist may not have a science background <input type="checkbox"/> newspaper may publish what people want to read <input type="checkbox"/> newspaper may simplify ideas people believe / trust the scientists	bias is insufficient on its own  accept any sensible suggestion, these are examples they do not constitute a full list	1

	writing the journal <input type="checkbox"/> people have heard of the scientists writing in the journal <input type="checkbox"/> scientists writing in the journal are famous <input type="checkbox"/> journal only publishes the work of respected / famous scientists <input type="checkbox"/> data is checked by other scientists before published in the journal		
Total marks			7

### QUESTION 3

QUESTION	ANSWER	EXTRA INFORMATION	MARKS
	<p><b>four lines correct</b></p> <p><b>List A</b></p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">the nuclei of two atoms joining together</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">the nucleus of an atom splitting into several pieces</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">an atom losing an electron</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">an electric charge moving through a metal</div>	<p>allow 1 mark for each correct line</p> <p>if more than 1 line is drawn from a box in List A, mark each line incorrect</p> <p><b>List B</b></p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">gamma emission</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">electric current</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">ionisation</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">nuclear fission</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;">nuclear fusion</div>	4
Total marks			4

**QUESTION 4**

QUESTION	ANSWER	EXTRA INFORMATION	MARKS
	<p><b>three lines correct</b></p> <p style="text-align: center;"><b>List A</b></p> <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 5px; width: 100px; text-align: center;">fusion</div> <div style="border: 1px solid black; padding: 5px; width: 100px; text-align: center;">chain reaction</div> <div style="border: 1px solid black; padding: 5px; width: 100px; text-align: center;">alpha decay</div> </div>	<p style="text-align: center;"><b>List B</b></p> <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 5px; width: 150px; text-align: center;">in a star</div> <div style="border: 1px solid black; padding: 5px; width: 150px; text-align: center;">in a nuclear reactor</div> <div style="border: 1px solid black; padding: 5px; width: 150px; text-align: center;">in a smoke precipitator</div> <div style="border: 1px solid black; padding: 5px; width: 150px; text-align: center;">in the nucleus of an atom</div> </div>	<p>allow 1 mark for each correct line</p> <p>if more than 1 line is drawn from a box in <b>List A</b>, mark each line incorrect</p> <p style="text-align: center;"><b>3</b></p>
			3

**QUESTION 5**

QUESTION	ANSWER	EXTRA INFORMATION	MARKS
a)	uranium-235	accept any correct indication	
b)	splits / breaks (into two smaller parts)	nucleus is separated is insufficient	1
	and (two / three) neutrons	do not accept atom splits – on its own	1
c)	steam turbine generator	correct order only	1 1 1
Total marks			6

**QUESTION 6**

QUESTION	ANSWER	EXTRA INFORMATION	MARKS
a)	(same) number of protons	same atomic number is insufficient	1
b)i)	nuclei split	do not accept atom for nuclei / nucleus	1

b)i)i)	(nuclear) reactor		1
c)	beta any one from: <ul style="list-style-type: none"> <li>• atomic / proton number increases (by 1)</li> <li>• number of neutrons decreases / changes by 1</li> <li>• mass number does not change</li> <li>• a neutron becomes a proton</li> </ul>	accept atomic / proton number  changes by 1  (total) number of protons and neutrons does not change	1 1
d)	(average) time taken for number of nuclei to halve or (average) time taken for count-rate / activity to halve		1
e)i)	6.2 (days)	Accept 6.2 to 6.3 inclusive allow 1 mark for correctly calculating number remaining as 20 000 or allow 1 mark for number of 80 000 plus correct use of the graph (gives an answer of 0.8 days)	2
e)ii)	radiation causes ionisation that may then harm / kill healthy cells	allow radiation can be ionising accept specific examples of harm, eg alter DNA / cause cancer	1 1
e)iii)	benefit (of diagnosis / treatment) greater than risk (of radiation)	accept may be the only procedure available	1
Total marks			11

### QUESTION 7

QUESTION	ANSWER	EXTRA INFORMATION	MARKS
a)i)	splitting of a(n atomic) nucleus	do not accept splitting an atom	1
a)ii)	neutrons		1
b)i)	nuclei have the same charge or nuclei are positive	accept protons have the same charge	1

b)ii)	(main sequence) star	accept Sun or any correctly named star  accept red (super) giant	1
c)i)	any two from: •easy to obtain / extract •available in (very) large amounts •releases more energy (per kg) •produces little/no radioactive waste	do not accept figures only naturally occurring is insufficient seawater is renewable is insufficient less cost is insufficient	2
c)ii)	any one from: • makes another source of energy available •increases supply of electricity • able to meet global demand •less environmental damage • reduces amount of other fuels used	accept any sensible suggestion  accept a specific example  accept a specific example	1
d)	12	allow 1 mark for obtaining 3 half-lives	2
Total marks			9

### QUESTION 8

QUESTION	ANSWER	EXTRA INFORMATION	MARKS
a)	inside the Sun		1
b)	fusion		1
c)	energy		1
Total marks			3