

**Eduqas Physics GCSE**  
**Topic 9.4: Nuclear fission and fusion**  
**Mark Schemes for Questions by topic**

1.

- (a) (i) (two) nuclei (of light elements) join  
*accept hydrogen atoms for nuclei*

1

forming a larger / heavier nucleus / one  
*accept comparative term equivalent to larger*  
*accept forms a helium (nucleus / atom) this mark only scores*  
*if fusion is in terms of hydrogen atoms*

1

- (ii) stars  
*accept a named star*  
*e.g. the Sun*  
*accept nebula*  
*mention of planets negates answer*

1

- (b) (i) any **one** from:

- (currently) only experimental
- reaction does not last long enough
- use more energy than they produce  
*allow difficult to control*  
*do **not** allow inefficient on its own*

1

- (ii) any **one** from:

- will give another source of energy
- unlimited fuel supplies / energy  
*accept unlimited hydrogen*
- would not produce any radioactive waste  
*accept less radioactive waste*  
*accept nuclear for radioactive*  
*do **not** accept toxic waste*

- want to show that it can be done  
*accept any sensible suggestion*  
*do **not** accept answers only in terms of fossil fuels or carbon dioxide*

1  
**[5]**

2.

- (a) (i) (nuclear) fission is the splitting of a (large atomic) nucleus  
*do **not** accept particle/atom for nucleus*

1

(nuclear) fusion is the joining of (two atomic) nuclei (to form a larger one)  
*do not accept particles/atoms for nuclei*

1

- (ii) energy  
*accept heat/radiation/nuclear energy*  
*accept gamma (radiation)*  
*do not accept neutrons/neutrinos*

1

- (b) (i) uranium (–235)  
*accept U (–235)*  
*ignore any numbers given with uranium*  
*accept thorium*  
*accept MOX (mixed oxide)*  
*do **not** accept hydrogen*

1

- (ii) (same) number of protons  
*accept (same) atomic number*  
*accept (same) positive charge*  
*ignore reference to number of electrons*

1  
**[5]**

3.

(a) (i) plutonium (239)

*accept Pu / Thorium / MOX (mixed oxide)*

*do not accept uranium-238 or hydrogen*

1

(b) Neutron(s) shown 'hitting' other U-235 nuclei

*one uranium nucleus is sufficient*

1

U-235 nuclei (splitting) producing 2 or more neutrons

1

4.

Question Number	Answer	Acceptable answers	Mark
<b>2(ai)</b>	<b>B</b> 1 proton only <b>(1)</b>		<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>2(aii)</b>	Same number of protons (as hydrogen) or same atomic number( as hydrogen) <b>(1)</b>	Same proton number( as hydrogen) / (they all) have one proton / (their) proton number is 1  accept bottom number is 1/the same  NOT same mass / nucleon number NOT same atomic mass  ignore references to electrons / neutrons	<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>2(b)(i)</b>	Helium (nucleus has) positive/+ (charge) <b>(1)</b>  Neutron has no/zero/0 (charge) <b>(1)</b>	helium is +(any number >0 and <5) helium has a larger/bigger charge  neutron is neutral /neutrally charged/uncharged  ignore references to nuclear fusion or masses	<b>(2)</b>

Question Number	Indicative Content	Mark
<b>QWC *2(c)</b>	<p>A description including some of the following points</p> <p>Stages involved in a chain reaction:</p> <ul style="list-style-type: none"> <li>○ (neutrons released go on to) collide with other nuclei</li> <li>○ causes nuclei to become unstable</li> <li>○ (nuclei) split/fission (into daughter nuclei)</li> <li>○ releases <b>more</b> neutrons</li> <li>○ releases energy</li> </ul> <p>Control:</p> <p>-Action of the moderator</p> <ul style="list-style-type: none"> <li>○ neutrons need to be slowed down/turned into thermal neutrons</li> <li>○ to increase chance of collision</li> <li>○ this is achieved with a moderator</li> <li>○ carbon/graphite/water/heavy water can be used</li> </ul> <p>-Action of control rods</p> <ul style="list-style-type: none"> <li>○ number of neutrons available for collision needs to be controlled</li> <li>○ so that reaction proceeds at a steady rate / does not increase</li> <li>○ this is achieved by control rods absorbing neutrons</li> <li>○ boron / silver/indium/cadmium can be used.</li> </ul> <p>Many candidates repeat parts of the question Do NOT give credit for these statements eg neutrons are released during fission</p>	<b>(6)</b>

Level		No rewardable content
1	1 - 2	<ul style="list-style-type: none"> <li>A limited description which gives one relevant fact e.g. (neutrons) cause atoms to split. OR (during fission of uranium atom) neutrons collide with atoms OR (nuclear fission) releases energy OR (3) neutrons are released and two of them are absorbed/taken away</li> <li>the answer communicates ideas using simple language and uses limited scientific terminology</li> <li>spelling, punctuation and grammar are used with limited accuracy</li> </ul>
2	3 - 4	<ul style="list-style-type: none"> <li>A simple description, giving more than one fact, about a chain reaction or control OR at least one fact about both. e.g. a neutron collides with (uranium) atoms and causes them to split (into daughter nuclei) OR atoms split releasing <b>more</b> neutrons OR an atom splits and releases energy OR (neutrons) cause atoms to split and there are (control) rods to control the neutrons. OR control rods can be lowered into the reactor to absorb neutrons</li> <li>the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately</li> <li>spelling, punctuation and grammar are used with some accuracy</li> </ul>
3	5 - 6	<p>A detailed description involving:-</p> <ul style="list-style-type: none"> <li>more than two stages of the chain reaction</li> <li>OR a description involving more than one stage of the chain reaction AND at least one detail about control.</li> <li>OR a description involving more than one detail about control AND at least one detail about the chain reaction.</li> </ul> <p>e.g. Neutrons are slowed down by graphite/water. This makes them more likely to collide with other nuclei. OR neutrons collide with other nuclei and cause them to split releasing more neutrons AND these neutrons hit another nuclei causing it to split OR neutrons collide with other nuclei and cause them to split releasing more neutrons AND there are (control) rods to control the neutrons OR neutrons collide with uranium nuclei causing them to split and release more neutrons. Control rods of boron absorb some of the neutrons.</p> <ul style="list-style-type: none"> <li>the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately. uses nuclei split and not atoms split.</li> <li>spelling, punctuation and grammar are used with few errors.</li> </ul>

## 5.

Question Number	Answer	Acceptable answers	Mark
<b>4(a)(i)</b>	does not emit (ionising) radiation / no (radioactive) decay	it is not radioactive	<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>4(b)(i)</b>	beryllium (1)      helium (1) helium (1)	daughter in right hand boxes daughter	<b>(2)</b>

Question Number	Answer	Acceptable answers	Mark
<b>4(b)(ii)</b>	a comparison which describes any <b>three</b> of the following:  similarities: <ul style="list-style-type: none"> <li>• produce (more) neutrons (1)</li> <li>• produce 'daughter' (nuclei) (1)</li> <li>• release energy (1)</li> <li>• split a (bigger) nucleus (1)</li> <li>• (triggered by) a neutron coming in (1)</li> <li>• nucleus becomes unstable (before splitting) (1)</li> </ul> differences: <ul style="list-style-type: none"> <li>• uranium daughters are different from each other/ beryllium daughters are the same (1)</li> <li>• uranium daughters are heavier than beryllium daughters (1)</li> </ul>	different elements / smaller nuclei for daughters  do not accept split an atom  neutron is absorbed	<b>(3)</b>

Question Number	Answer	Acceptable answers	Mark
<b>4(b)(iii)</b>	a description including:  neutron(s) (from first fission) (1) (go on to) cause another fission (1)	collide with another nucleus /atom	<b>(2)</b>

6.

Question Number	Answer	Acceptable answers	Mark
<b>2(c)</b>	a description to include:  neutron(s) (from the fission) (1)  (neutrons from fission go on to collide with/be absorbed by another uranium(-235) nucleus (1)	2/3 neutrons references to the neutron on the diagram colliding with the uranium-235 nucleus do not score. The answer must imply neutrons from fission  cause more fissions/splitting alternative descriptions of collisions eg hit/bump into/smash into etc condone (go on to) collide with another uranium(-235 atom)  new neutrons {cause fission/repeat this process} scores both marks  ignore react/chain reaction	<b>2</b>

Question Number	Answer	Acceptable answers	Mark
<b>2(d)</b>	a description to include any <b>three</b> of the following:  (two light/small) nuclei (1)  fuse (together) (1)  (to produce a) heavier nucleus (1)  releasing energy (1)	condone atoms for nuclei throughout this item  named examples {eg hydrogen/deuterium/tritium} or identifiable symbols  {join/merge/bind/bond/combine} (together)  (to produce) helium/He (nuclei/atoms) condone bigger/larger  {make/create/produce} energy condone gives off energy accept any reasonable form of energy eg thermal/heat or light or KE	<b>3</b>

7.

The mass is converted into energy and released (1)



## 8.

Question			Marking details	Marks
2.	(a)	(i)	38 (1) 2 (1)	2
		(ii)	Neutrons produced [go on to] cause more reactions <b>or</b> collisions <b>or</b> 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. <b>To award both marks both statements must be linked.</b>	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. <b>Don't accept</b> nucleons / mass number / atomic number	2
	(c)		<b>Indicative content:</b>  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.  <b>5 – 6 marks</b> 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.  <b>3 – 4 marks</b> 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.  <b>1 – 2 marks</b> 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.  <b>0 marks</b> The candidate does not make any attempt or give a relevant answer worthy of credit.  <b>Question total</b>	6
				<b>[12]</b>

