

MARK SCHEME

GCSE

PHYSICS

AQA - TRIPLE SCIENCE

P4 - TEST 6

ATOMIC STRUCTURE

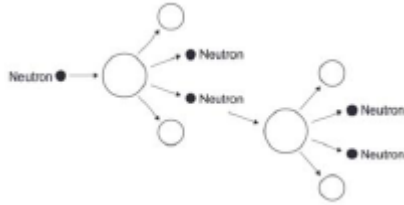
Advanced

Mark schemes

- 1.** (a) a uranium nucleus 1
- absorbs a neutron 1
- (uranium-236 nucleus) splits into two smaller nuclei
or
Kr and Ba nuclei
or
krypton and barium nuclei 1
- and releases 3 neutrons and energy 1
- (b) light nuclei 1
- join to form a heavier nucleus
allow hydrogen nuclei for light nuclei
allow helium nucleus for heavier nucleus 1
- (some of the) mass of the nuclei is converted to energy
allow particles for nuclei 1
- (c) any **two** from:
- easy to obtain / extract
 - available in (very) large amounts
 - releases more energy (per kg)
- do **not** accept figures **only***
naturally occurring is insufficient
seawater is renewable is insufficient
less cost is insufficient
allow produces little / no radioactive waste 2
- 2.** (a) Nucleus splitting into two fragments and releasing two or three neutrons 1
- (at least one) fission neutron shown to be absorbed by additional large nucleus and causing fission 1
- two or three additional neutrons released from fission reaction 1

[9]

This diagram would gain all **3** marks:



- (b) lowering the control rods increases the number of neutrons absorbed
accept converse description

1

(so) energy released decreases

1

allow changing the position of the control rods affects the number of neutrons absorbed for 1 mark

- (c) rate of increase between 240 and 276 (MW / min)

2

allow 1 mark for attempt to calculate gradient of line at 10 minutes

[7]

3.

- (a) (i) plutonium (239)
accept Pu / Thorium / MOX (mixed oxide)
*do **not** accept uranium-238 or hydrogen*

1

(ii) (energy) used to heat water and

1

produce (high pressure) steam

1

the steam drives a turbine (which turns a generator)

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

- (c) any **two** from:

- neutrons are absorbed (by boron / control rods)
- there are fewer neutrons
- chain reaction slows down / stops
accept fewer reactions occur

2

[8]

4.	(a) (i) splitting of a(n atomic) nucleus <i>do not accept splitting an atom</i>	1
	(ii) Neutron	1
	(b) (i) nuclei have the same charge or nuclei are positive <i>accept protons have the same charge</i>	1
	(ii) (main sequence) star <i>accept Sun or any correctly named star</i> <i>accept red (super) giant</i>	1
	(c) (i) any two from: <ul style="list-style-type: none"> • easy to obtain / extract • available in (very) large amounts • releases more energy (per kg) <i>do not accept figures only</i> • produces little / no radioactive waste. <i>naturally occurring is insufficient</i> <i>seawater is renewable is insufficient</i> <i>less cost is insufficient</i> 	2
	(ii) any one from: <ul style="list-style-type: none"> • makes another source of energy available • increases supply of electricity • able to meet global demand • less environmental damage • reduces amount of other fuels used. <i>accept any sensible suggestion</i> <i>accept a specific example</i> <i>accept a specific example</i> 	1
	(d) 12 <i>allow 1 mark for obtaining 3 half-lives</i>	2
		[9]
5.	(a) 78	1
	(b) atomic	1

- (c) (i) 131
correct order only 1
- 54 1
- (ii) 32 (days)
allow 1 mark for showing 4 half-lives provided no subsequent step 2
- (iii) limits amount of iodine-131 / radioactive iodine that can be absorbed
accept increases level of non-radioactive iodine in thyroid
*do **not** accept cancels out iodine-131* 1
- so reducing risk of cancer (of the thyroid)
accept stops risk of cancer (of the thyroid) 1
- [8]**
- 6.** (a) (i) 18 1
- (ii) the count rate for the source 1
- (iii) the alpha radiation would not cover such a distance 1
- (iv) plots correct to within $\frac{1}{2}$ small square
allow 1 mark for 4 correct points plotted 2
- correct curve through points as judged by eye 1
- (v) two attempts at finding 'half-distance' using the table
20 to 10 cpm $d = 0.4$ m
125 to 56 cpm $d = 0.2$ m
31 to 14 cpm $d = 0.4$ m
allow 1 mark for one attempted comparison 2
- obeyed or not obeyed
dependent on previous two marks 1
- (b) (i) there is no effect on the count rate in experiment 1 because the field is parallel
or beta particles are not deflected **or** there is no force 1
- count rate is reduced in experiment 2 because field is perpendicular **or** beta particles are deflected **or** there is a force 1

(ii) only background radiation (as beta do not travel as far)

1

slightly different values show the random nature of radioactive decay

1

[13]

7. (a) (same) number of protons
same atomic number is insufficient 1
- (b) (i) nuclei split
*do **not** accept atom for nuclei / nucleus* 1
- (ii) (nuclear) reactor 1
- (c) beta 1
- any **one** from:
- atomic / proton number increases (by 1)
accept atomic / proton number changes by 1
 - number of neutrons decreases / changes by 1
 - mass number does not change
(total) number of protons and neutrons does not change
 - a neutron becomes a proton 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
- (ii) radiation causes ionisation
allow radiation can be ionising 1
- that may then harm / kill healthy cells
accept specific examples of harm, eg alter DNA / cause cancer 1
- (iii) benefit (of diagnosis / treatment) greater than risk (of radiation)
accept may be the only procedure available 1

[11]

8.	<p>(a) most alpha particles pass straight through the atom</p> <p>which shows that the atom is mostly empty space</p> <p>very few alpha particles are deflected through a large angle</p> <p>which shows the atom contains a nucleus where the mass / charge of the atom is concentrated</p> <p>(b) electron may absorb electromagnetic radiation</p> <p style="padding-left: 40px;"><i>full credit may be scored for a description of an electron emitting electromagnetic radiation</i></p> <p>(and) move further from the nucleus</p> <p>to a higher energy level</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>[7]</p>
9.	<p>(a) cannot predict <u>which</u> dice / atom will 'decay'</p> <p style="padding-left: 40px;"><i>accept answers given in terms of 'roll a 6'</i></p> <p>cannot predict <u>when</u> a dice / atom will 'decay'</p> <p>(b) 3.6 to 3.7 (rolls)</p> <p style="padding-left: 40px;"><i>allow 1 mark for attempt to read graph when number of dice = 50</i></p> <p>(c) 90</p> <p>(d) uranium</p> <p>(e) beta</p> <p style="padding-left: 40px;">proton number has gone up (as neutron decays to proton and e⁻)</p> <p>(f) prevents contamination</p> <p style="padding-left: 20px;">or</p> <p style="padding-left: 20px;">prevents transfer of radioactive material to teacher's hands</p>	<p>1</p> <p>1</p> <p>1</p> <p>2</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>

which would cause damage / irradiation over a longer time period.

1
[10]