

MARK SCHEME

GCSE

PHYSICS

AQA - TRIPLE SCIENCE

P4 - TEST 5

ATOMIC STRUCTURE

Intermediate

Mark schemes

1.

(a)

Particle	Relative Mass	Relative charge
Proton	1	
Neutron		0

*accept one, accept +1
do **not** accept -1*

1

accept zero

*do **not** accept no charge/ nothing/neutral unless given with 0*

1

(b) equal numbers/amounts of protons and electrons

1

protons and electrons have equal but opposite charge

accept protons charge +1 and electron charge -1

accept (charge) on proton

cancels/balances (charge) on electron

accept positive (charges) cancel out the negative(charges)

neutrons have no charge is neutral

*do **not** accept total charge of protons, electrons (and neutrons) is 0
unless qualified*

1

(c) (i) (3) fewer neutrons

accept lower/ smaller mass number

*do **not** accept different numbers of neutrons*

any mention of fewer/more protons/electrons negates mark

*accept answers in terms of U-238 providing U-238 is specifically
stated i.e. U-238 has (3) more neutrons*

1

(ii) neutron

1

(iii) (nuclear) fission

accept fision

*do **not** accept any spelling that may be taken as fusion*

1

[7]

2.

(a) (i) nuclear reactor

1

star

1

(ii) nuclei are joined (not split)

accept converse in reference to nuclear fission

*do **not** accept atoms are joined*

1

(b) (i) any **four** from:

- neutron
- (neutron) absorbed by U (nucleus)
ignore atom
*do **not** accept reacts*
*do **not** accept added to*
- forms a larger nucleus
- (this larger nucleus is) unstable
- (larger nucleus) splits into two (smaller) nuclei / into Ba and Kr
- releasing three neutrons and energy
accept fast-moving for energy

4

(ii) 56 (Ba)

1

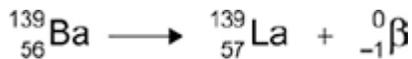
57 (La)

if proton number of Ba is incorrect allow 1 mark if that of La is 1 greater

1



accept e for β



scores 3 marks

1

[10]

3.

(a) (an equal amount of) positive charge

*do **not** accept charge on the atom / nucleus is positive*

1

- (b) (i) a (significant) number of alpha particles were scattered by more than 4°
or
alpha particles deflected backwards
accept (some) measurements / results were unexpected

1

measurements / results could not be explained by 'plum pudding' model
or
measurements / results did not support predictions
can be explained by the nuclear model is insufficient
accept measurements / results did not support hypothesis

1

- (ii) many / (over)100 000 measurements / results taken
accept Rutherford(and Marsden) were respected scientists
or
scientists were respected
accept measurements / results taken over several months
the experiment was repeated many times is insufficient

1

- (c) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

0 marks

no relevant content

Level 1 (1–2 marks)

A brief description is given with some particles correctly named

Level 2 (3–4 marks)

A description is given with all three particles named

plus either

the polarity of charge associated with the three particles

or

the relative mass of the three particles

or

the relative mass for one particle and the relative charge for one particle given

Level 3 (5–6 marks)

A more detailed description is given, naming the particles and polarity of charge

and either

the relative mass is given for at least two particles

or

the relative charge is given for at least two particles

Examples of the points made in the response

brief description

contains protons, neutrons and electrons

protons are positive
electrons are negative
neutrons are uncharged

has a nucleus

relative charge

proton +1
electron - 1
neutron 0

relative mass

proton 1
neutron 1
electron (about) 1 / 2000

accept protons and neutrons have the same mass
accept electrons have tiny / negligible mass
zero mass is neutral

more detailed description

protons and neutrons make up the nucleus
electrons orbit the nucleus
electrons are in shells
most of the atom is empty space
nucleus occupies a very small fraction of the volume of the atom
electrons orbit at a relatively large distance from the nucleus
most of the mass of the atom is contained in the nucleus
the nucleus as a whole is positively charged total number of protons in the nucleus equals the total number of electrons orbiting it in an atom

6
[10]

4. (a) (both graphs show an initial) increase in count rate
accept both show an increase

1

(b) only the right kidney is working correctly

1

any **two** from:

*if incorrect box chosen maximum of 1 mark can be awarded
reference to named kidney can be inferred from the tick box*

- count-rate / level / line for right kidney decreases (rapidly)
it decreases is insufficient
- count-rate / level / line for left kidney does not change
it does not change is insufficient
- radiation is being passed out into urine – if referring to right kidney
- radiation is not being passed out – if referring to the left kidney
- left kidney does not initially absorb as much technetium-99

2

[4]

5.

(a) (i) **K and L**

both answers required either order

1

(ii) (1) same number of protons

accept same number of electrons

accept same atomic number

1

(2) different numbers of neutrons

1

(b) (i) 90

1

(ii) 140

1

(c) alpha (particle)

reason may score even if beta or gamma is chosen

1

mass number goes down by 4

or

number of protons and neutrons goes down by 4

or

number of neutrons goes down by 2

*candidates that answer correctly in terms of why gamma
and beta decay are not possible gain full credit*

1

atomic / proton number goes down by 2

or

number of protons goes down by 2

accept an alpha particle consists of 2 neutrons and 2 protons for 1 mark

accept alpha equals ${}^4_2\text{He}$ or ${}^4_2\alpha$ for 1 mark

an alpha particle is a helium nucleus is insufficient for this mark

1

[8]

6.

(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]

7.

(a) (i) cannot penetrate aluminium

allow can only pass through air / paper too weak is neutral

1

(ii) gamma rays not affected (by aluminium)

allow all / most (gamma rays) to pass through

too strong is neutral

danger is neutral

1

- (b) (i) (nuclei) unstable 1
- (ii) causes harm / damage to body / cells
allow radiation sickness 1
- detail e.g., causes mutations / causes cancer / damages DNA /
damages chromosomes
allow two effects for 2 marks 1

[5]

8.

- (a) (i) alpha particles cannot penetrate covering
do not credit any answer not relating to film badge or its case 1
- (ii) film gets fogged **or** blackened
accept film gets exposed
*do not credit film changes colour **or** goes white **or** blotchy* 1
- (b) (i) any **one** from

may cause cancer may damage cells **or** cell nucleii causes mutations
changes DNA
*accept (causes) burns **or** kills cells* 1
- (ii) any **two** from

treating cancers
tracers in body
sterilising instruments **or** bandages
*accept two descriptions of named treatments, eg thyroid check and
circulation monitoring*
*accept is a source of X-rays, eg for dentistry **or** taking X-rays of
bones* 2
- (c) calculation that 1000 is 3 half lives on
 $8000 \rightarrow 4000 \rightarrow 2000 \rightarrow 1000$ 1
- time elapsed is $3 \times \text{half life} = 31.8 \text{ hr}$

award both marks for 31.8 hr or 1 day 7.8 hr with no working shown 1

[7]

- 9.** (a) (i) and (ii) in any order 1
- (i) alpha 1
accept Greek symbol (α)
- He^{2+} or ${}^4_2\text{He}$ 1
- (ii) beta 1
accept Greek symbol (β) or electron
- e^- or ${}^0_{-1}e$ 1
mass and automatic numbers are not required
accept e
- (b) (i) alpha 1
accept symbol
- (ii) decreases 1
 then stops (entirely) or after a few cm
accept stops because α can only travel a few cm in air
- (c) it's gamma 1
accept its not ionising or it is not charged or it's not α or β because
a spark counter only measures α or β

[8]

- 10.** (a) at least 6 points correctly plotted 2
gains 1 mark
- (to better than half a square) **but all** points correctly plotted 2
gains 2 marks
- any **line** graph related to plotted points;
 point (3,29) discounted;
 best fit smooth curve 3
each for 1 mark

(b) radiation decreases with time

gains 1 mark

but decreases quickly at first then more slowly

gains 2 marks

but *idea that* it (about) halves every 2 weeks **or** half-life is (about) 2 weeks

gains 3 marks

3

[8]

11.

(a) γ /gamma

- because more penetrating
- so can reach/damage cells from outside body/through skin

but

α /alpha

- does more damage/more likely to cause cancer
- can only do this if inside the body/cells
each • for 1 mark
[credit same ideas expressed conversely]

4

(b) • must emit alpha / α radiation

- *idea that* half-life must be just long enough to kill cancer cells
each for 1 mark
[do not credit simply short half-life]
(allow 'must be liquid / in solution)

2

(c) *evidence of repeated halving then*

n \times 3.6

gains 1 mark

but

answer in range

22 – 25.2 days

(ie >6 and up to 7 half lives)

gains 2 marks

2

[8]