

Atoms and Nuclear Radiation

Mark Scheme 1

Level	GCSE (9-1)
Subject	Combined Science: Trilogy - Physics
Exam Board	AQA
Topic	6.4 Atomic Structure
Sub-Topic	Atoms and Nuclear Radiation
Difficulty Level	Silver Level
Booklet	Mark Scheme 1

Time Allowed: 57 minutes

Score: /57

Percentage: /100

Grade Boundaries:

- M1.**
- (a) (i) 200 to 50
accept either order 1
- (ii) 5.3
accept values between 5.2 and 5.4 inclusive 1
- (iii) 5.3
accept values between 5.2 and 5.4 inclusive
or their (a)(ii) 1
- (b) (i) Make the conveyor belt move more slowly 1
- (ii) lead 1
- (c) Exposure increased the content of some types of vitamin. 1

[6]

- M2.**
- (a) (i) **K and L**
both answers required either order 1
- (ii) (1) same number of protons
accept same number of electrons

	<i>accept same atomic number</i>	1
	(2) different numbers of neutrons	1
(b)	(i) 90	1
	(ii) 140	1
(c)	alpha (particle) <i>reason may score even if beta or gamma is chosen</i>	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 <i>candidates that answer correctly in terms of why gamma and beta decay are not possible gain full credit</i>	1
	atomic / proton number goes down by 2 or number of protons goes down by 2 <i>accept an alpha particle consists of 2 neutrons and 2 protons for 1 mark</i> <i>accept alpha equals ${}^4_2\text{He}$ or ${}^4_2\alpha$ for 1 mark</i> <i>an alpha particle is a helium nucleus is insufficient for this mark</i>	1

[8]

M3. (i) 50 ± 5

1

(ii) 50 ± 5

accept their (b)(i)

1

(iii) less

accept any way of indicating the correct answer

1

[3]

M4. *answers must be comparative*
accept converse answers throughout

alpha: the count rate is (greatly) reduced
by the card **or** the card absorbs alphas but not betas
accept paper for the card

1

beta: the count rate is (greatly) reduced by the metal **or** the thin metal absorbs
alphas and betas **or** the thin metal absorbs all of the radiation (from the source)
accept aluminium for the metal

1

gamma: would pass through the thin
accept aluminium for the metal

metal but count rate is background **or** no radiation passing through **or** a higher
reading would be recorded **or** to reduce the count to 2 would require much
more than 3 mm of metal
accept lead / aluminium for the metal

1

[3]

- M5.** (a) suitable arrangement of source and GM tube ie fixed distance apart
accept 'detector' for GM tube and counter 1
- suitable test
*eg introduce absorbing material **or** increase distance between source and GM tube* 1
- suitable conclusion
*alpha that which gives a greatly reduced count with a paper absorber **or** alpha if count decreases rapidly when distance between source and GM tube exceeds 5 cm (approx)*
the first two marks could be scored from a labelled diagram 1
- (b) (i) (changes to) background radiation
*do **not** accept the source is decaying if it is their only answer*
or
(beta) decay is random
accept decay is not constant 1
- (ii) thickness decreasing
accept it is thin 1
- increased count rate 1
- (means) less (beta) radiation absorbed
accept more (beta) radiation passes through 1
- (iii) changing thickness will not change count rate (significantly)
accept insufficient absorption of gamma radiation irrespective of thickness
*do **not** accept gamma rays too penetrating*
*do **not** accept answers in terms of speed* 1

M6. (a) two half lives
gains 1 mark

but
20 minutes
gains 2 marks

2

(b) alphas will be stopped by skin / air **or** do not penetrate betas and gammas
can reach / damage organs / cells
for 1 mark each

2

[4]

M7. beta

1

alpha absorbed by paper
allow beta and alpha
second mark is linked to first

1

or beta absorbed by aluminium allow beta can penetrate paper
or gamma would affect all of film
i.e. cannot obtain second mark unless first mark is correct

[2]

- M8.**
- (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]

- M9.** 2 weeks
- if answer is incorrect 2 gains two marks weeks gains one mark*
half of 68 or 34 gains one mark / allow working shown on graph

[3]

- M10.**
- (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]

- M11.** (a) (i) and (ii) in any order

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

[8]