

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	Gold Level
Booklet	Mark Scheme 1

Time Allowed: 60 minutes

Score: /57

Percentage: /100

Grade Boundaries:

- M1.(a)** electromagnetic radiation from the nucleus
'electromagnetic radiation' is insufficient 1
- (b) (Gamma is the most penetrating) so a large proportion of the emitted radiation will leave the body 1
- more easily detected outside the body 1
- (c) (average) time it takes for the number of nuclei of the isotope in a sample to halve
or
(average) time it takes for the count rate from a sample containing the isotope to fall to half its initial level 1
- (d) initially there is a high level of hazard. 1
- level of hazard drops to a low level quickly 1
- answer must imply short period of time*
(activity initially high) due to short half-life
or
(drops to safe level quickly) due to short half-life 1

- (e) it is exposed to ionising radiation 1
- (f) does not become radioactive 1
- [9]

M2.(a) 10 000 1

(b) **Increase**
absorb electromagnetic radiation 1

Decrease
emit electromagnetic radiation 1

(c) atomic number is the number of protons 1

mass number is the number of protons and neutrons 1

- (d) **Level 2 (3–4 marks):**
A clear comparison, with logical structure.
- Level 1 (1–2 marks):**
Fragmented points, with no logical structure.
- 0 marks:**
No relevant content

Indicative content

Beta decay

- Atomic number increases by one
- When a neutron decays into a proton

Alpha decay

- Atomic number decreases by two
- When an alpha particle is emitted

Comparison

Both change number of protons (hence new element / transmutation)

Beta decay increases atomic number and alpha decay decreases (explicit)

NB No credit is given for different number of protons = new element.

4

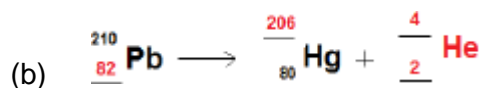
[9]

M3.(a) half-life read from graph = 2 hours

1

time to fall to 1.56 is six half lives = $6 \times 2 = 12$ (hours)

1



one mark for each correct element in the equation

3

(c) ionising radiation turns atoms into ions

1

which can break up molecules

1

this can change DNA

1

causing mutations to genes

1

which can cause cancer

1

[10]

M4.(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]

- M5.** (a) (i) (total) number of protons plus neutrons
accept number of nucleons
accept amount for number
do not accept number of particles in the nucleus 1
- (ii) number of neutrons decreases by one 1
- number of protons increases by one
accept for both marks a neutron changes into a proton 1
- (b) (i) $^{208}_{81}\text{Th}$ 1
- correct order only* 1
- (ii) the number of protons determines the element
accept atomic number for number of protons 1
- alpha and beta decay produce different changes to the number of protons
there must be a comparison between alpha and beta which is more than a description of alpha and beta decay alone
 or alpha and beta decay produce different atomic numbers
ignore correct reference to mass number 1

[7]

M6. (a) beta

1

alpha: would not pass through (the aluminium / foil)

1

gamma: no change in count rate when thickness changes

*must be a connection between detection / count rate /
passing through and change in thickness*

1

(b) foil thickness increases then decreases (then back to normal / correct thickness)
a description of count rate changes is insufficient

1

gap between rollers decreases, then increases (then back to correct size) or pressure
from rollers increases then decreases

accept tightness for pressure

*answers may link change in thickness and gap width for full
credit ie:*

foil thickness increases so gap between rollers decreases (1)

foil thickness decreases so gap between rollers increases (1)

1

(c) 56 (years)

accept any value between 55-57 inclusive

*allow 1 mark for correct calculation of mass remaining as 1.5
(micrograms)*

*allow 1 mark for a mass of 4.5 micrograms plus correct use
of graph with an answer of 12*

maximum of 1 compensation mark can be awarded

2

[7]

- M7.** (a) (i) number of protons are the same
accept atomic number / number of electrons for number of protons
1
- number of neutrons are different
accept mass numbers are different – only if the first mark is awarded
1
- (ii) an electron from the nucleus
both parts needed
1
- (b) decays at the same rate as it is made
accept decays as fast as it is made
accept absorbed / used by plants (in CO₂) at same rate as it is being made
1
- (c) (i) 3500
no tolerance
1
- (ii) adjusted age correctly obtained from the graph
accept values between 3700–3800 inclusive
accept their (c)(i) used correctly to obtain an adjusted age from the graph
1
- adjusted age +50
second mark can only be scored if first mark awarded
if no working shown an answer between 3750–3850

inclusive scores both marks

note: any line or mark made on the graph counts as working out

1

[7]