

Mark schemes

1	(a) (i) two protons	1	
	2 neutrons		
	<i>if neither point gained allow 1 mark for helium nucleus</i>	1	
	(ii) electron	1	
(b) neutron splits (to form proton and electron)	1		
			[4]

2	(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
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3

- (a) The nucleus will emit a neutron.

1

- (b) **Similarity**

same mass number

allow same number of nucleons (protons + neutrons)

1

difference

different atomic number

allow different number of protons

1

- (c) Radioactive decay is random.

1

- (d) 1.3 (billion years)

allow 1.2-1.4 (billion years)

2

allow 1 mark for horizontal line drawn from ~ 550

- (e) alpha

1

[7]

4

- (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

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- (a) alpha particles **cannot** pass through...
*do **not** accept gamma particles...*
or
alpha particles can pass through a very thin sheet of **paper / card**
credit answers where correct amendments are made to boxed statement

1

- (b) (i) horizontal and vertical line drawn at correct positions on the graph
accept a cross drawn at 4500 / 500 on the curve
or
two pairs of lines drawn, for example, at 600 and 300
accept a horizontal line drawn at 500 on its own
*do **not** accept vertical lines only* 1
- (ii) 4500 million years 1
- (iii) half-life too long
*do **not** accept simply its half-life is 4500 million years* 1
- no (measurable) change in count rate
*do **not** accept have not got the equipment*
*do **not** accept it's harmful (to children)*
if neither of the above points scored, accept not enough time to measure it for 1 mark 1

[5]

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- (a) (i) element with equal number of protons, different number neutrons
or
 same atomic/proton number different mass/nuclear number 1
- (ii) time taken for activity **or** count rate **or** number of nuclei to decrease to half
*accept parents atoms **or** radioactive isotope*
do not accept time taken for radioactivity/substance/ material to halve 1
- (iii) 12 (s) 1
- (b) (i) 22800 (years)
*allow 1 mark for iterative steps 80-40-20-10-5 **or** statement of 4 half-lives* 2
- (ii) decay (of carbon 14) over 150 years is insignificant
accept very little decay
accept change is too small 1

- (c) either argument gains full credit
accept any 3 valid points from for and/or against arguments

FOR

- massive dilution of waste
- reduces concentration (within a given volume) to insignificant levels
- distant from habitation

AGAINST

- pollution (of the sea/beach)
- mutation **or** harm caused to living things (animals/plants)
- effect on food chain
- long period of time necessary

3

[9]

7

- (a) **C**

1

- (b) beta

accept gamma

if answer alpha can still gain marks for saying why not beta or gamma

1

any **two** from:

must have at least one quantitative statement to get 2 marks

- range in air for beta is (at least) 50cm
- count-rate does not drop (much) in first 40cm
- count-rate does not fall much until distance is 60cm
- alphas cannot travel more than 5cm in air / alphas could not travel 100cm in air

accept alphas cannot travel that far

- alphas would not be detected
- gammas not absorbed by 100cm of air
accept gammas not stopped by air
accept gammas travel further than alphas and betas
strength of source is neutral
references to penetrating power is neutral

2

- (c) (i) increases 1
- (ii) Group **A** think that (even a very small level of exposure) gives some risk
accept there is always a risk, no matter how small the level of exposure 1
- Group **B** think that there is no risk (from a very low level of exposure)
accept below a certain level of exposure there is no risk
no marks for a simple graph description 1

[7]

- 8** (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

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- 9** (a) nucleus 1
*do **not** accept core / centre / middle*

(b) radiation damages our cells
accept radiation is dangerous / poisonous / harmful / toxic
accept radiation can cause cancer / kills cells / change DNA / cause mutations / harm health
accept so precautions can be taken
accept so they know they may be exposed to / harmed by radiation
it refers to radiation (source)
to stop people being harmed is insufficient

1

(c) **C**

1

(d) gamma

1

gamma will pass through the lead
reason only scores if gamma chosen
or
alpha and beta will not pass through lead
accept correct symbols for alpha, beta and gamma

1

(e) (i) range of alpha too short
accept alpha would not reach detector
or
alpha absorbed whether box is full or empty
accept alpha (always) absorbed by box / card
accept alpha will not pass through the box / card
alphas cannot pass through objects / solids is insufficient
alpha not strong enough is insufficient

1

(ii) **M**
*reason only scores if **M** chosen*

1

less radiation / beta (particles) absorbed
accept more radiation / beta particles pass through
or
more radiation absorbed by full boxes
accept reading is higher

1

[8]

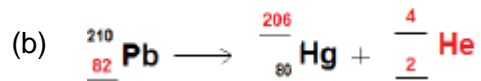
10

(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]

11

(a) gamma

allow 1 mark for 1 or 2 correct

beta

alpha

2

(b) any **two** from:

- do not point (radioactive) source at students
- keep (radioactive) source outside the box for minimum time necessary
- wear safety glasses **or** eye protection **or** do not look at source
- wear gloves
- hold (radioactive) source away from body
- hold (radioactive) source with tongs / forceps

2

(c) as time increases count rate decreases

1

count rate halves every 80 seconds

1

(d) half-life is 80 seconds

1

so after 200 seconds count rate = 113

1

(e) because a very small amount of radiation will be emitted **or** will be similar to / same as background radiation

1

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12

(a) (mass number) 231

1

(protons) 92

1

(neutrons) 141

1

(b) 2 / two (hours)

1

(because) count rate halves in that time

1

(c) A high-speed electron

1

(d) uncontrolled

1

benign

1

[8]