

MARK SCHEME

GCSE

PHYSICS

AQA - TRIPLE SCIENCE

P4 - TEST 7

ATOMIC STRUCTURE

Advanced

Mark schemes

1.

- (a) smoke absorbs / stops alpha radiation

allow alpha particles for alpha radiation

alpha radiation does not reach the detector is insufficient

1

- (b) alpha radiation is not very penetrating

allow alpha particles for alpha radiation

or

alpha radiation does not penetrate skin

allow alpha radiation does not travel very far (in air)

1

- (c) beta and gamma radiation will penetrate smoke

allow beta and gamma radiation will not be stopped by smoke

1

no change (in the count rate) would be detected

allow the change detected (in the count rate) would be too small

1

- (d) (a long half-life means) the count rate is (approximately) constant

allow activity of source is (approximately) constant

or

a short half-life means the count rate decreases quickly

1

until 1.3 half-lives the count rate is above 80 per second

allow after 1.3 half-lives the count rate is below 80 per second

or

until 1.3 half-lives the count rate is above the threshold for the smoke alarm to be activated

or

after 1.3 half-lives the smoke alarm will be activated all the time

so don't have to replace source or smoke detector is insufficient

1

- (e) **Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

3-4

Level 1: Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.

1-2

No relevant content

0

Indicative content

- short half-life or half-life of a few hours
- (short half-life means) less damage to cells / tissues / organs / body
- low ionising power
- (low ionising power means) less damage to cells / tissues / organs / body
- highly penetrating
- (highly penetrating means) it can be detected outside the body
- emits gamma radiation

[10]

2.

- (a) (i) (atoms with the) same number of protons
allow same atomic number
or same proton number

1

(atoms with) different number of neutrons
allow different mass number

1

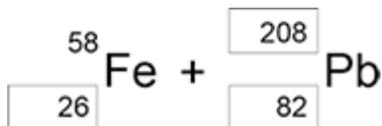
- (ii) 82

1

- (iii) 124

1

- (b) (i)



1 mark for each correct box

3

- (ii) (a) neutron

1

- (iii) 4.0×10^{-4} (s)

or

0.0004

$$3.00 \times 10^8 \times 0.1 = 12\,000 / t$$

gains 1 mark

2

- (iv) particles need to travel a large distance

1

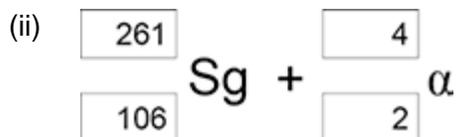
equipment would have to be very long

1

with circular paths long distances can be accommodated in a smaller space

1

- (c) (i) the average time for the number of nuclei to halve 1
 the time for count rate to halve 1



*1 mark if top boxes total = 265
 and bottom boxes total = 108
 1 mark for 4 and 2 for alpha*

2

- (d) (i) 3 plotted points 1
 $\pm \frac{1}{2}$ small square
 best line through points 1

- (ii) 190–205 (pm) 1
or correct from student's line

[20]

3.

- (a) any **three** from: 3
- no carbon dioxide emitted (to produce electricity)
no greenhouse gases is insufficient
 - doesn't cause global warming
allow climate change or greenhouse effect for global warming
 - nuclear power doesn't cause earthquakes
 - more energy released per kg of fuel (compared to shale gas)

- (b) uranium
 or
 plutonium 1
ignore any numbers given

(c) a neutron is absorbed by a (large) nucleus
a description in terms of only atoms negates first two marking points

1

the nucleus splits into two (smaller) nuclei

1

releasing energy (and gamma rays)

1

and (two / three) neutrons

1

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4.

(a) (i) any **one** from:

- nuclear power (stations)
accept nuclear waste
accept coal power stations
- nuclear weapons (testing)
accept nuclear bombs / fallout
- nuclear accidents
accept named accident, eg Chernobyl or Fukushima
accept named medical procedure which involves a radioactive source
accept radiotherapy
accept X-rays
accept specific industrial examples that involve a radioactive source
nuclear activity / radiation is insufficient
smoke detectors is insufficient

1

(ii) (radioactive decay) is a random process

accept an answer in terms of background / radiation varies (from one point in time to another)

1

(b) any **one** from:

- (maybe) other factors involved
accept a named 'sensible' factor, eg smoking
- evidence may not be valid
accept not enough data
- may not have (a complete) understanding of the process (involved)

1

(c) (i) 2

1

2

1

(ii) 218

correct order only

1

84

1

(d) 3.8 (days)

*allow 1 mark for showing correct method using the graph provided
no subsequent steps*

*correct answers obtained using numbers other than 800 and 400
gain 2 marks provided the method is shown*

2

[9]

5.

(a) *answers must be in terms of nuclear fuels*

concentrated source of energy

idea of a small mass of fuel able to generate a lot of electricity

1

that is able to generate continuously

accept it is reliable

or can control / increase / decrease electricity generation

idea of available all of the time / not dependent on the weather

ignore reference to pollutant gases

1

the energy from (nuclear) fission

1

is used to heat water to steam to turn turbine linked to a generator

1

(b) carbon dioxide is not released (into the atmosphere)

1

but is (caught and) stored (in huge natural containers)

1

[6]

6.

(a) **B E G**

all 3 required and no other

any order

1

same number of / 88 protons (and different numbers of neutrons)

same number of electrons is insufficient

1

- (b) (i) 222 1
- 86 1
- (ii) 4800 2
- allow 1 mark for obtaining 3 half-lives*
- (c) ethical 1
- deceived / lied to (about safety of working conditions)
- accept (women) not warned of the dangers*
- given no protection is insufficient*
- or**
- value own / scientists' lives more than women
- or**
- did not treat women humanely 1
- (d) accept any sensible suggestion
- eg
- too many interests in continued use of radium
- evidence may cause public unrest
- do **not** accept not enough evidence*
- doctors not want to be blamed for illnesses (caused by radium)
- accept doctors not wanting to be sued (for harm caused by using radium)*
- doctors thought (possible) benefits outweighed (possible) risks
- do **not** accept did not know radium could be harmful*
- believe radium could treat illnesses is insufficient* 1

[9]

7.

- (a) has an equal amount of positive charge 1
- accept pudding/it is positive*
- (b) (experimental) results could not be explained using 'plum pudding' model 1
- or**
- (experimental) results did not support plum pudding model
- accept (experimental) results disproved plum pudding model*
- (c) (i) **A** – most of atom is empty space **or** most of atom concentrated at the centre 1

B – nucleus is positive (so repels alpha particles)
accept nucleus has the same charge as alpha

1

C – nucleus is very small
accept nucleus is positive if not scored for B

or

nucleus is a concentrated mass
accept nucleus has a very concentrated charge

1

(ii) (if predictions correct, this) supports the new model
answers should be in terms of the nuclear model
accept supports his/new/nuclear theory
accept proves for supports
accept shows predictions/ Rutherford was correct

1

[6]

8.

(a) isotopes

1

(b) ${}_{90}^{231}\text{Th}$

1

correct order only

1

(c) (i) (nuclear) fission

accept fision

do not accept any spelling that may be confused with fusion

1

(ii) neutron / neutrons

1

(d) plutonium (239)

accept MOX (mixed oxide)

accept Pu

do not accept uranium 238 / hydrogen

1

[6]

9.

(a) (i) (atoms / elements with) the same number of protons but different numbers of neutrons

accept (atoms / elements with) different mass number but same atomic number

1

- (ii) substances that give out radiation
accept alpha, beta or gamma for radiation
accept an unstable nucleus that decays
radioactive decay takes place is insufficient 1
- (b) 85 years
 ± 2 years
allow 1 mark for showing correct method on the graph 2
- (c) (i) a helium nucleus
accept 2 neutrons and 2 protons
accept ${}_2^4\text{He}$
*do **not** accept helium atom* 1
- (ii) the rate of decay (of plutonium) decreases
accept fewer (plutonium) nuclei (to decay)
accept radioactivity decreases 1
- less heat produced
*do **not** accept energy for heat* 1
- (d) (i) (outside the body)
 alpha (particles) cannot penetrate into the body
 (inside the body) 1
- (heat produced from decay) damages / kills cells / tissues
accept causes cancer for damages / kills cells / tissues
*accept **highly** toxic* 1
- (ii) any **one** from:
- worried same could happen again
 - an accident may cause radiation to be spread around the Earth / atmosphere
 - idea of soil contamination resulting from accident / release of radioactive material
 - idea of negative effect on health resulting from accident / release of radioactive material
- accept any sensible suggestion* 1