MARK SCHEME

GCSE

PHYSICS

AQA - COMBINED SCIENCE

P4 - TEST 3

ATOMIC STRUCTURE

Intermediate

Mark schemes

1. 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]

2. *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]

3. (i) 50 ± 5

1

(ii) 50 ± 5

accept their (b)(i)

1

(iii) less

accept any way of indicating the correct answer

1

[3]

4. (a) 2 protons and 2 neutrons

accept 2p and 2n

accept (the same as a) helium nucleus

symbol is insufficient

do not accept 2 protons and neutrons

1

(b) (i) gamma rays

1

(ii) loses/gains (one or more) electron(s)

1

(c) any **one** from:

- wear protective clothing
- work behind lead/concrete/glass shielding
- limit time of exposure
- use remote handling

accept wear mask/gloves

wear goggles is insufficient

wear protective equipment/gear is insufficient

accept wear a film badge

accept handle with (long) tongs

accept maintain a safe distance

accept avoid direct contact

1

[4]

5. (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]

6. (a) **Y** and **Z**

1

they have the same number of protons **or** same atomic number

*accept they have the same number of electrons **or** same number of protons **and** electrons*

allow only different in number of neutrons N.B. independent marks

1

(b) **Quality of written communication**

*for correct use of terms underlined in B **or** C*

Q ✓ Q ✗

1

A – alpha particle passes straight through the empty space of the atom

or it is a long way from the nucleus

*describes 3 tracks correctly for **2** marks*
*describes 2 or 1 track correctly for **1** mark*

B – alpha particle deflected / repelled / repulsed by the (positive) nucleus

C – alpha particle heading straight for the nucleus is deflected / repelled / repulsed backwards

*do **not** accept hits the nucleus*
*do **not** accept answers referring to refraction*
*do **not** accept answers in terms of reflected backwards unless qualified in terms of repulsion*

mention of difference in charge on nucleus negates that track

max 2

[5]

7.

(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]

8.

(a) cell damage or cancer

accept kills / mutates cells

radiation poisoning is insufficient
ionising is insufficient

1

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

- use tongs to pick up source
- wear gloves
- use (lead) shielding
- minimise time (of exposure)
- maximise distance (between source and teacher).

accept any other sensible and practical suggestion

ignore reference to increasing / decreasing the number / thickness of lead sheets

1

(ii) <u>background</u>

1

(c) (i) curve drawn *from point 2,160*

*do **not** accept straight lines drawn from dot to dot*

1

(ii) (also) increases

less radiation passes through is insufficient

1

(iii) 50

accept any value from 40 to 56 inclusive

1

(d) gamma

1

only gamma (radiation) can pass through lead

*accept alpha **and** beta cannot pass through lead*
a general property of gamma radiation is insufficient

1

[8]

9. (a) suitable arrangement of source and GM tube ie <u>fixed distance apart</u>

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 <u>labelled</u> 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

[8]

10. (a) electron

1

atom

1

nucleus

1

orbit

1

(b) positive charge is provided by protons

1

(every atom of the same element contain the) same number of protons

*do **not** accept same number of protons and neutrons*

ignore reference to electrons

1

(c) $v = 300\,000\,000 \times \left(\frac{7}{100}\right)$

allow any correct method of determining 7% of 300 000 000

1

v = 21 000 000 (m/s)

allow 2.1×10^7 (m/s)

1

*an answer of 21 000 000 scores **2** marks*

(d) $r = 6 \times 2.5 \times 10^{-11}$

allow a ratio in the range of 5.7−6.3 or measurements that would give this range, correctly substituted

1

$r = 1.5 \times 10^{-10}$ (m)

allow 1.4×10^{-10} to 1.6×10^{-10}

*their ratio $\times 2.5 \times 10^{-11}$ correctly calculated scores **1** mark*

1

*an answer in the range 1.4×10^{-10} to 1.6×10^{-10} scores **2** marks*

[10]

11. (a) horizontal line drawn from 92 000 Bq

allow 90 000–94 000

1

1600 years

allow 1500–1700

1

(b) only (119) years have passed

1

activity has not dropped by much

1

(c)

Level 3: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5-6
Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.	3-4
Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1-2
No relevant content	0
Indicative content **properties** • alpha is the least penetrating • alpha is the most ionising • alpha has least range in air • beta is the second most penetrating • beta is the second most ionising • beta has the second longest range in air • gamma is the most penetrating • gamma is the least ionising • gamma has the greatest range in air **hazard** (linked to correct property) • short-range alpha most dangerous • mid-range beta most dangerous • long range gamma most dangerous	

6

[10]