Mark scheme

Radioactivity

Physics 0625 · Questions from Paper 3 and Paper 4

Total marks

70

MARKS FOR EACH QUESTION

1	2	3	4	5	6	7	8	9	10	Total
4	5	7	7	7	7	7	8	8	10	**70**

Question 1 [4]

1(a)	alpha (particles) not emitted	**M1**
	any **one** from idea that count rate for paper is similar to count rate for air OR if alpha emitted count rate for paper would decrease/be less (than 480)	**A1**
1(b)	gamma (rays) emitted	**M1**
	any **one** from idea that count rate for (10 mm) lead is less (than count rate for (2 mm) aluminium/air/paper owtte) OR (most/some of) gamma (rays) are absorbed by lead	**A1**

Question 2 [5]

2(a)	rocks, buildings, (natural) radon, air, cosmic rays, sun, food, drink	**B1**
2(b)(i)	evidence of using graph	**C1**
	TWO pairs of coordinates seen	**C1**
	7.5 (min)	**A1**
2(b)(ii)	Use a lead(-lined) box / container	**B1**

Question 3 [7]

3(a)(i)	α or alpha	**1**
3(a)(ii)	α or alpha	**1**
3(b)(i)	beta or β	**1**
	beta emission would be affected by the thickness of the metal owtte	**1**
3(b)(ii)	(counter) reading higher	**1**
3(b)(iii)	rollers move apart/provide less force/pressure owtte	**1**
3(b)(iv)	38	**1**

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Question 4 **[7]**

4 (a) γ not deflected — NOT extra(s) in γ column — B1

α towards –ve or +ve AND β opposite — NOT extra(s) in α or β column — B1

α towards –ve AND β towards +ve — NOT extra(s) in α or β column — B1

(b) atoms / molecules (condone particles) lose / gain electrons OR become charged
NOT α or β particles lose / gain electrons OR become charged — B1

(c) maximum three points (to include at least one explanation) from:
maximum two points from:

- α is charged / is a helium ion (is scored if 3rd explanation bullet point scored)
- γ is not charged
- α has mass
- γ does not have mass
- α has large size
- γ has negligible / no size
- γ is electromagnetic (wave) / photon
- α travels more slowly (than γ, but NOT more slowly than speed of light unless next bullet point is also scored)
- γ travels at the speed of light / faster (than α)

any explanation (maximum three) e.g.:

- α makes frequent collisions (with air molecules) so range short
- γ has few (successful) collisions (with electrons) so not very ionising / range long
- α more ionising because it has greater charge
- γ has no charge so less ionising
- α loses some energy with each collision so range short
- γ loses energy in single rare collision so takes longer distance before losing all energy
- γ faster so travels further before energy is lost
- different methods of ionisation make α more ionising

B3

[Total: 7]

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Question 5 [7]

5(a)(i)	(isotopes are) forms of an element with the same number of protons but a different number of neutrons (in the nucleus) **OR** (isotopes are) the same element with a different number of neutrons	**B1**
5(a)(ii)		**B1**

particle	number in each atom of strontium	location
electron	38	outside nucleus
neutron		
proton	38	Inside nucleus

B1

particle	number in each atom of strontium	location
	38	outside nucleus
neutron	52	Inside nucleus
	38	Inside nucleus

5(b)(i)	(there is a) different count rate with different thicknesses of metal **OR** number of β-particles detected varies with thickness	**A2**
	(beta (β) particles) can penetrate thin / 0.75mm metal **OR** (beta (β) particles) are stopped by thick metal	C1
5(b)(ii)	(approximate) percentage of source remaining (after 15 years) stated **AND** in range 63–70% (approximate) percentage of sample lost (after 15 years) stated **AND** in range 30–37%	**B1**
	Any **one** from: • count rate / activity (too) low (to detect differences in thickness) owtte • detector needs high activity (to detect differences in thickness) owtte • count rate / activity too close to background owtte • less difference in activity for different thicknesses owtte	**B1**

Question 6 [7]

6(a)	radiation that is always present **or** due to environment **or** in everyday life	**B1**
	soil / rocks / earth / cosmic rays / space / Sun / weapons testing / radon / nuclear waste	**B1**
6(b)(i)	alpha-emission (only)	**B1**
	alpha-particles do not penetrate (two sheets of) paper **or** β-particles **and** γ-rays pass through (two sheets of) paper	**B1**
6(b)(ii)	$^{208}_{84}Po \rightarrow {}^{4}_{2}\alpha$ / $^{4}_{2}He$	**B1**
	^{204}Pb... **or** $_{82}Pb$	**C1**
	$^{204}_{82}Pb$	**A1**

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Question 7 [7]

7(a)	equal number of electrons OR equal number of protons	**B1**
7(b)(i)	$^{13}_{5}X$	**C1**
	$^{0}_{-1}\beta$	**C1**
	$^{13}_{6}Y$	**A1**
7(b)(ii)	any **three** from: • β-particles have charge of smaller size • β-particles have smaller mass • β-particles have less energy • β-particles travel faster / less time near to air molecule • effect / force on electrons in air molecules less	**B3**

Question 8 [8]

8(a)(i)	$^{0}_{-1}\beta$	**B1**
	$^{208}_{82}Pb$	**B1**
	$^{208}_{82}Pb$	**B1**
8(a)(ii)	γ-emission / it consists of waves / rays **OR** γ-emission has no mass / charge	**B1**
8(a)(iii)	(it contains) too many / excess of neutrons **OR** (nucleus is) too heavy	**B1**
8(b)	smooth curve (through magnetic field) **AND** labelled β	**B1**
	path towards bottom of page **AND** no upward component **AND** labelled β	**B1**
	(continuation of beam along) horizontal line through magnetic field **AND** labelled γ	**B1**

Question 9 [8]

9 **(a)** any mention background B1
background/radiation varies randomly o.w.t.t.e. OR rate of decay very small OR
sample nearly all decayed B1 [2]

(b) correctly deducts correct background (13 – 15 /s) B1
takes 2 detector readings, one twice the other B1
correct working, with/without background subtraction, i.e. use of graph B1
half life = 1.2 – 1.8 days OR follows from working B1 [4]

(c) α (very) short range in air OR will not reach researcher
NOT will not penetrate skin B1
γ long range/very penetrating/heavy shielding needed OR will reach researcher B1 [2]

[Total: 8]

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Question 10 [10]

10(a)(i)	(americium-241 has) one neutron fewer (in the nucleus)	**B1**
10(a)(ii)	(different) number of protons (in nucleus)	**B1**
	(different) number of neutrons (in nucleus)	**B1**
10(b)(i)	$^{241}_{95}Am \rightarrow {}^{237}_{93}Np + {}^{4}_{2}a$	**A3**
	any two from: $_{95}Am$ ^{237}Np $^{4}_{2}a$	C2
10(b)(ii)	(α-particles have) more kinetic energy (than β-particles)	**B1**
	(α-particles have) more charge (than β-particles)	**B1**
10(b)(iii)	Low(er) (initial) activity OR Few emissions per unit time	**M1**
	so smoke detectors are not hazardous to humans **OR** so disposal of old detectors is cheap / easy	**A1**

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