

Radioactivity answers

- 1)
- 12 (a)** break up of unstable nuclei [1]
 emission of ionising radiation / alpha / beta / gamma [1]
- (b)** only half-life ticked [1]
- (c) (i)** clear statement of start point (can be inferred from markings on graph) [1]
 clear halving [1]
 2 minutes [1]
- (ii)** 550/2 OR 1100/4 OR 2200/8 e.c.f. **(c) (i)** [1]
 275 (counts / min) e.c.f. **(c) (i)** [1]
- (d) (i)** any two from:
 emissions (from radioactive substances) are ionising
 (ionising) radiation can damage cells / body tissue / burns
 risk of cancer
 risk of radiation sickness
 risk of mutations / damage to offspring [max 2]
- (ii)** any two different examples from:
 use of gloves
 tweezers
 lead / concrete
 maintain distance
 minimise exposure time [max 2]

2)

Question	Answer	Marks
12(a)	idea of paper between source and detector OR measuring range (in air) OR pass through an electric or magnetic field	B1
	alpha stopped by paper OR larger range in air for beta OR identify deflection when in field	B1
12(b)	any two from: gamma travel at the speed of light gamma rays have no charge gamma rays have no mass gamma is a wave OR part of the electromagnetic spectrum gamma less ionising greater penetration not deflected by electric or magnetic fields	B2
12(c)	damages cells/tissues/DNA OR causes (cell) mutations OR <u>radiation sickness</u>	B1
		Total: 5

3)

Question	Expected answer	Mark
11(a)(i)	(chemical symbol): X (nucleon number): A (proton number): Z any two for one mark	B2
11(a)(ii)	1. 95 2. 146	B1 B1
11(b)	same number of protons (in nucleus) different numbers of neutrons (in nucleus)	B1 B1
		Total: 6

Radioactivity answers

4)

Question	Expected answer	Mark
12(a)	(fast moving) electron negative (charge)	B1 B1
12(b)	line from count rate of 2000 8 (days)	C1 A1
12(c)(i)	$180 \div 4$ 45 (counts/min)	C1 A1
12(c)(ii)	any two from: radiation mutates DNA/damages (living) cells radioactive material still present (in soil/reactor core/after many years) negative public perception of nuclear power radioactive waste on site contains isotopes with long half-lives	B2
		Total: 8

5)

- 11 (a)** electromagnetic (waves / radiation / rays / spectrum) B1
 OR (high energy) photons
- (b)** α and β deflected in opposite directions B1
- any 1 from: B1
- β deflected more (than α)
 - deflections perpendicular to field direction and to paths of particle
 - paths (of particles) are curves / circular / arcs
- (c)** curved path B1
- (deflected/attracted) towards positively charged plate B1
 OR in opposite direction to field
- (d) (i)** α -particle OR helium nucleus OR 2 protons + 2 neutrons B1
- (ii)** $A = 210$ $Z = 84$ B1

[Total: 7]

6)

- 10 (a)** 2 protons and 2 neutrons OR helium nucleus B1
- (b)** α in direction of field OR α towards negative (plate)
 OR β in opposite direction to field OR β towards positive (plate)
 OR α and β deflected in opposite directions C1
- α in direction of field OR α towards negative (plate)
 AND
 β in opposite direction to field OR β towards positive (plate) A1
- (c)** not deflected B1
- (d)** versions of same element B1
- (isotopes of same element have) same proton number/number of protons/atomic number/Z B1
- (isotopes of same element have) different nucleon numbers/ number of neutrons/mass number/A B1

Radioactivity answers

- 7) 11 (a) (i) number of/more neutrons
4 more neutrons B1
B1
- (ii) same number of protons/proton number/atomic number/chemical reactions/
number of electrons (in neutral atom) B1
- (b) any **two** lines from:
larger charge
slower moving
more massive
greater volume/more chance of collision
more energy B2
- (c) (i) atom is mostly empty space OR nucleus very small OR mass concentrated at
centre/nucleus OR greater distance between nuclei B1
- (ii) charge concentrated at centre/nucleus B1
- [Total: 7]**
- 8) 11 (a) γ : none/zero/0/neutral AND
2 cm (or more) of lead/thick lead/50 cm (or more) of concrete B1
- β : particle/electron AND
any named metal/glass/concrete OR 1 m of air B1
- α : particle/helium nucleus/2 protons + 2 neutrons/ ${}^4_2\text{He}/{}^4_2\alpha$ AND
positive OR + OR +2 B1
- (b) (i) 38
- (ii) 90
- (iii) 52
- (iv) 38 B3
- (c) 36 hours = 3 half-lives
OR halving in steps from 4800 to 600 seen C1
- half-life = 12 hours OR 3 half-lives OR 2/3 of 36 C1
- (further time to reduce to 150 Bq =) 24 (hours) A1
- [Total: 9]**

Radioactivity answers

- 9) **11 (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]