Chapter 3 Radioactivity and radiation

Chapter test answers Total marks 50

Section A

Question 1

1. Gamma radiation is electromagnetic radiation and therefore travels at the speed of light:

3 × 108 m s–1. (1 mark)

Question 2

D. Radiation is always emitted from a nucleus. A beta-minus particle is a high-speed electron   
ejected from a nucleus when a neutron decays into a proton. (1 mark)

Question 3

A. Gamma; it can penetrate through several metres of concrete. (1 mark)

Question 4

C. As the nucleus has ejected an alpha-particle, the mass number must decrease by 4. (1 mark)

Question 5

A. 90 (neutrons + protons) – 38 protons = 52 neutrons (1 mark)

Question 6

D. 144 years is 5 half-lives, so the amount remaining is:  = 5.6 × 108 (1 mark)

Section B

Question 7

a gamma radiation, beta, alpha (1 mark)

b Gamma (γ) is electromagnetic radiation and has no mass. Beta-minus (β–) is an electron and beta-plus (β+) is a positron. An alpha (α) particle is much heavier as it is a helium nucleus and consists of 2 protons and 2 neutrons. (2 marks)

Question 8

a gamma, beta, alpha(1 mark)

b All of the types of radiation listed can ionise atoms. The ionising ability depends on charge. Gamma radiation has no charge so is least effective. Beta-minus has a charge of –1 and beta-plus has a charge of +1. Alpha radiation has the highest charge of all radiation types (+2) and so is the most ionising. (2 marks)

Question 9

5.5 hours = 330 minutes = 3 × 110 minutes = 3 half-lives

The mass has halved three times from its original amount.

Hence the original amount = 2 × 2 × 2 × 0.80 = 23 × 0.80 = 6.4 g. (2 marks)

Question 10

a  (1 mark)

b  (1 mark)

c  (1 mark)

Question 11

a  (2 marks)

b  (2 marks)

Question 12

a 10.6 years = 2 half-lives (1 mark)  
mass = 70 × 10–6 ×  = 17.5 × 10–6 = 17.5 µg (1 mark)

b 15.9 years = 3 half-lives (1 mark)  
mass = 70 × 10–6 ×  = 8.75 × 10–6 = 8.75 µg (1 mark)

c 17.5 years =  = 3.30 half-lives (1 mark)  
mass = 70 × 10–6 ×  = 7.12 × 10–6 = 7.12 µg (1 mark)

Question 13

Alpha has very weak penetrating ability and would not pass through the skin. It is absorbed  
in several centimetres of air. (2 marks)

Question 14

a absorbed dose =  = 0.00294 Gy = 2.94 mGy (1 mark)

b dose equivalent = absorbed dose × quality factor = 2.94 × 10–3 × 1 = 2.94 mSv (1 mark)

c The quality factor for alpha = 20, and the quality factor for gamma = 1, so the dose equivalent is 20 times greater.

Therefore the dose equivalent = 20 x 2.94 × 10–3 = 0.0588 Sv = 58.8 mSv (1 mark)

d energy, *E* = 250 mJ =  = 1.56 × 1018 eV (1 mark)

Question 15

Beta-minus would be the best type of radiation to use. (1 mark)

Beta-minus radiation is able to penetrate short distances, so it would reach all the surrounding   
cancer cells, but few, if any, of the healthy cells further away. (1 mark)

Alpha radiation lacks penetrating power and would not reach all of the cancer cells. (1 mark)

Gamma is too penetrating and would affect too many healthy cells. (1 mark)

Question 16

a Activity is emissions per second =  = 1500 Bq (1 mark)

b The amount has reduced by factor of 8 from 120 to 15 µg, 8= 23 so 3 half-lives   
have elapsed. (1 mark)

The time elapsed is 1.5 h = 90 mins (1 mark)

If 3 half-lives = 90 mins, then the half-life = 30 mins (1 mark)

Question 17

a 10 g is 25% of 40 g (1 mark)

Therefore, reading from the graph, the time taken is 8 hours. (1 mark)

b The half-life is the time for 50% of the sample to decay = 4 hours. (1 mark)

c Reading from the graph, after 10 hours, 18% remains. (1 mark)

18% of 40 g ≈ 7.2 g (1 mark)

Question 18

a The radiation could be beta radiation and/or gamma radiation. (2 marks)

Beta radiation would be reduced by increasing the thickness of the aluminium, but gamma radiation will continue to penetrate.

b The magnetic field will bend the path of radiation that is charged. Beta radiation is negatively charged, but gamma radiation is uncharged.   
Therefore the radiation has to be beta radiation. (2 marks)