Chapter 3 Radioactivity and radiation

Chapter Test Answers Total marks 45

Section A

Question 1

**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 and an electron within the  
nucleus of a radioactive atom. 1

Question 2

**A** Gamma radiation is electromagnetic radiation and therefore travels at the speed of light: 3 × 108 m s–1. 1

Question 3

**C** An alpha (α) particle consists of 2 protons and 2 neutrons (i.e. a helium nucleus);   
beta-minus (β-) is one electron; gamma (γ) has no mass. 1

Question 4

**C** Alpha, since it has the highest charge of all radiation types: 2+. 1

Question 5

**A** Gamma; it can penetrate through several metres of concrete. 1

Question 6

**D** The Sun produces several different types of radiation, but not α, β or γ in large enough   
quantities to reach Earth’s surface. 1

Question 7

**C** 234; since the nucleus has ejected an α-particle the mass number must decrease by 4. 1

Question 8

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

Question 9

**C** 144 years is 5 half-lives, so amount remaining is:  = 2.8 × 108 1

Question 10

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

Therefore the mass has halved 3 times from its original amount.

Hence the original amount = 2 × 2 × 2 × 0.80 = 23 × 0.80 = 6.4 g. 1

Section B

Question 1

a.  1

b.  1

c.  1

Question 2

a.  2

b.  2

Question 3

a. 10.6 years = 2 half-lives 1  
mass = 50 × 10-6 × (1/2)2 = 12.5 × 10-6 = 12.5 µg 1

b. 15.9 years = 3 half-lives 1  
mass = 50 × 10-6 × (1/2)3 = 6.25 × 10-6 = 6.25 µg 1

c. 21.2 years = 21.2/5.3 = 4 half-lives 1  
mass = 50 × 10-6 × (1/2)4 = 3.125 × 10-6 = 3.125 µg 2

Question 4

Alpha has very weak penetration and would not pass through the skin. It is absorbed  
in several centimetres of air. 2

Question 5

a. Absorbed dose =  = 0.00256 Gy = 2.6 mGy 1

b. Dose equivalent = absorbed dose × quality factor = 2.56 × 10–3 × 1 = 2.6 mSv 1

c. The quality factor (QF) for α = 20, QF for γ = 1, so dose equivalent would  
be 20 times greater. 1

d. Energy *E* = 200 mJ =  = 1.3 × 1018 eV 1

Question 6

Beta-minus would be the best type of radiation. 1

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

Alpha radiation lacks penetrating power and would not reach all cancer cells. 1

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

Question 7

a. Activity is emissions per second =  = 1000 Bq 1

b. Amount has reduced by factor of 4 from 100 to 25 µg so 2 half-lives have elapsed. 1

Time elapsed is 1.5 h = 90 min is 2 half-lives 1

Half-life = 45 min 1

Question 8

a. 5 g is 25% of 20 g, 1

therefore, reading off the graph, the time taken is 8 hours. 1

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

c. After 6.0 hours, 38% remains; 1

38% of 20 g ≈ 7.6 g 1

**d.** 20 h = 5 half-lives 1

 1