Radioactivity

1 **(a)** What is meant by *radioactive decay*?

.....

.....

..... [2]

(b) Fig. 12.1 shows two samples of the same radioactive substance. The substance emits β-particles.

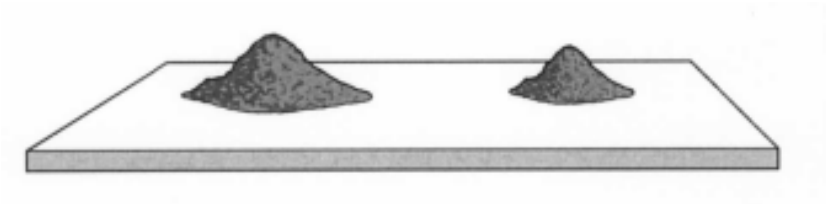

Fig. 12.1

Put a tick alongside any of the following quantities which is the same for both samples.

☐ the half-life

☐ the mass

☐ the number of atoms decaying each second

☐ the number of β-particles emitted each second

[1]

(c) Fig. 12.2 shows the decay curve for a particular radioactive substance.

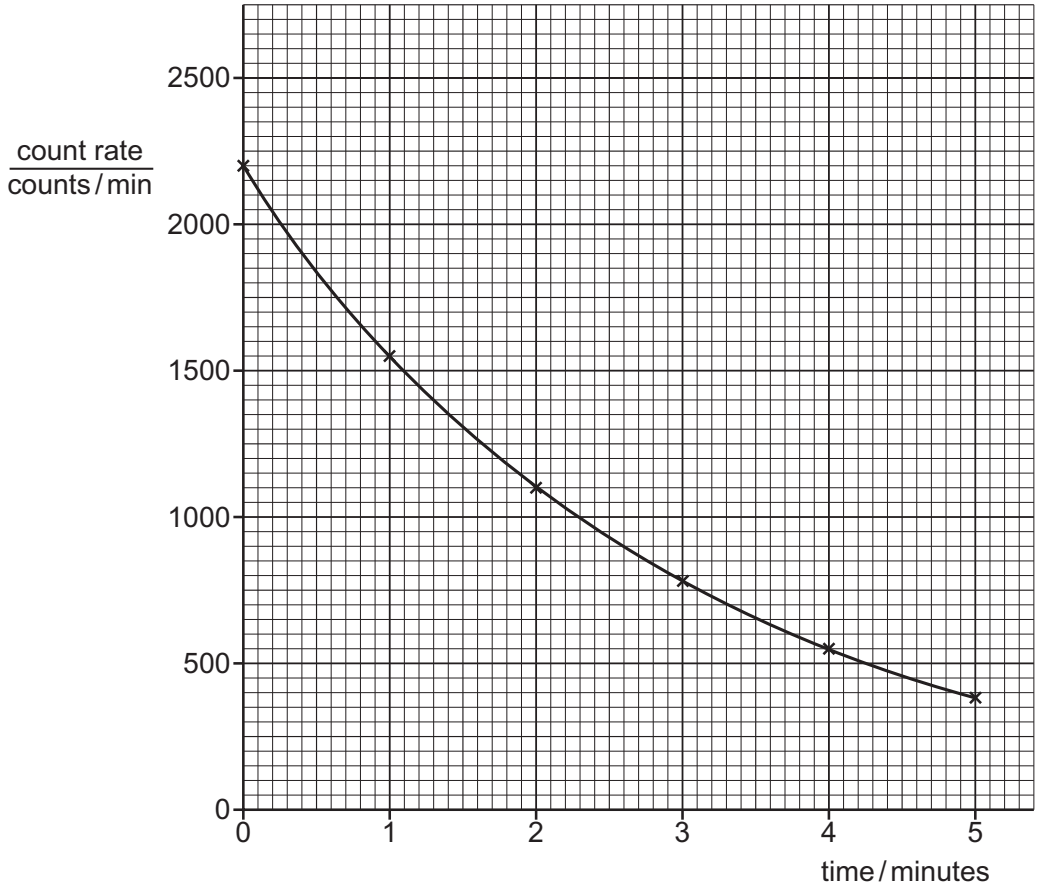

Fig. 12.2

(i) Select and use numbers from the graph to deduce the half-life of the radioactive substance.

half-life = ... minutes [3]

(ii) Predict the value of the count rate at a time of 6 minutes from the start of the measurements. Show your working.

count rate = ... counts / min [2]

(d) People handling radioactive substances need to take certain safety precautions.

(i) Explain why safety precautions are necessary.

.....

..... [2]

(ii) State **two** safety precautions used by people handling radioactive substances.

1. .....

2. .....

[2]

[Total: 12]

2 Two radioactive sources are used by a teacher. One source emits only alpha particles and the other source emits only beta particles.

(a) Suggest how the sources can be identified.

.....

.....

.....

.....

.....[2]

(b) The teacher also has a source that emits gamma rays.

State **two** ways in which gamma rays are different from alpha particles.

1. .....

2. .....
[2]

(c) State an effect of ionising radiation on living things.

.....[1]

[Total: 5]

3 **(a)** Any atomic nucleus can be represented as ${}^{A}_{Z}X$.

(i) State which letter, A, X or Z, is the

- chemical symbol, ...
- nucleon number, ...
- proton number. .....

[2]

(ii) A nucleus of americium-241 can be written as ${}^{241}_{95}Am$.

1. Determine the number of electrons in a neutral atom of americium-241.

number of electrons = ... [1]

2. Determine the number of neutrons in a nucleus of americium-241.

number of neutrons = ... [1]

(b) Explain what is meant by *isotopes* of an element.

.....

.....

.....

..... [2]

[Total: 6]

4 **(a)** A radioactive nucleus decays by the emission of a β-particle.

State what a β-particle is and give its charge.

.....

..... [2]

(b) The graph in Fig. 12.1 shows how the count rate from a sample of a radioactive substance varies with time.

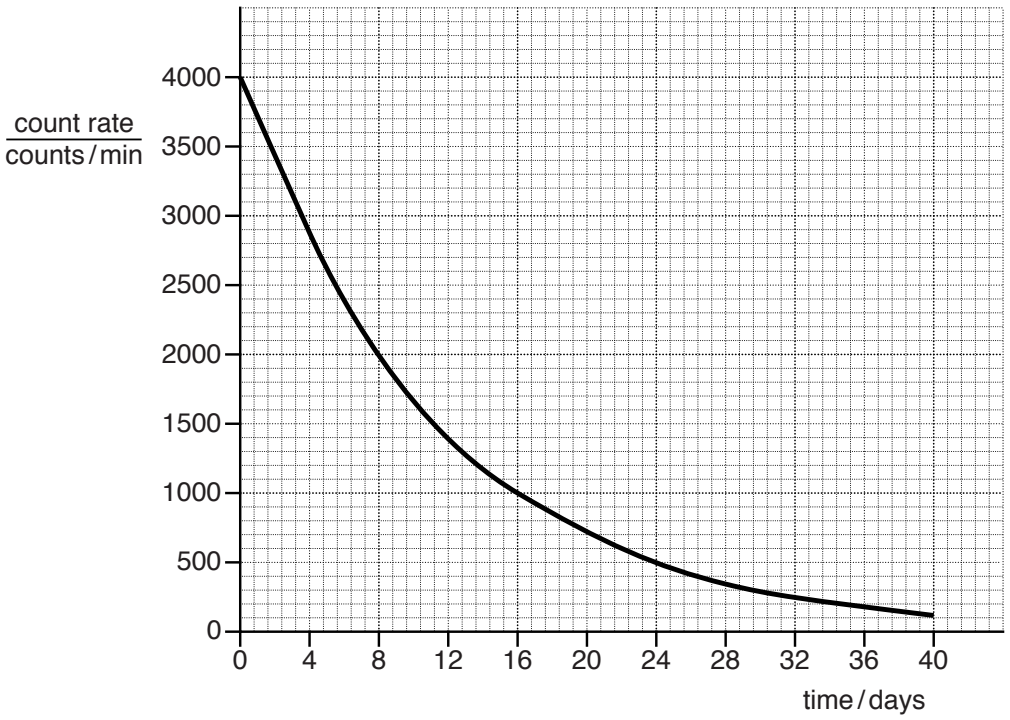

Fig. 12.1

Use the graph to find the half-life. Show your working on the graph.

half-life = ... days [2]

(c) Following an accident, the soil around a nuclear power station is contaminated by caesium-137, which is radioactive.

A sample of this soil containing caesium-137 has a count rate of 180 counts / min. Caesium-137 has a half-life of 30 years and decays by β-emission.

(i) Calculate the count rate from the caesium-137 in the sample after 60 years.

count rate = ... counts / min [2]

(ii) Suggest why people do not want to live near the power station, even after it has closed.

.....

.....

.....

..... [2]

[Total: 8]

5 **(a)** State the nature of γ-rays.

.....

..... [1]

(b) A beam of α-particles and β-particles passes, in a vacuum, between the poles of a strong magnet.

Compare the deflections of the paths of the two types of particle.

.....

.....

..... [2]

(c) A beam of β-particles passes, in a vacuum, through the electric field between a pair of oppositely charged metal plates.

Describe the path of the particles.

.....

.....

..... [2]

(d) The nuclear equation shows the decay of an isotope of polonium.

$$^{A}_{Z}Po \rightarrow {}^{206}_{82}Pb + {}^{4}_{2}X$$

(i) State the nature of X.

.....

..... [1]

(ii) Calculate the values of A and Z.

A = ... Z = ... [1]

[Total: 7]

6 **(a)** State the nature of an α-particle.

.....

.....[1]

(b) Describe how an electric field between two charged plates could be used to determine whether a beam of particles consists of α- or β-particles.

.....

.....

.....[2]

(c) Describe the path of γ-rays in a magnetic field.

.....

.....[1]

(d) State what is meant by the term *isotopes*. Use the terms proton number and nucleon number in your explanation.

.....

.....

.....

.....

.....[3]

[Total: 7]

7 Uranium-238 and uranium-234 are radioactive isotopes of the element uranium.

A uranium-238 nucleus is different from a uranium-234 nucleus but both decay by the emission of an α-particle.

(a) **(i)** In terms of the particles in each, state how a nucleus of uranium-238 differs from a nucleus of uranium-234.

.....

.....[2]

(ii) Although the two nuclei are different, they are both nuclei of uranium.

State a property that makes these isotopes the same element.

.....

.....[1]

(b) When α-particles pass through air, they are more strongly ionising than β-particles.

Suggest **two** reasons why this is so.

.....

.....[2]

(c) In an experiment, α-particles are allowed to strike a thin gold foil in a vacuum.

Almost all the α-particles pass straight through the gold undeflected. Only a very small number of α-particles are deflected from their original path.

This result reveals certain features of the atoms of the gold.

State what is shown about atoms by the fact that

(i) most α-particles pass straight through the gold undeflected,

.....

.....[1]

(ii) some α-particles are deflected back the way they came.

.....

.....[1]

[Total: 7]

8 **(a)** Complete the table below for the three types of radiation.

radiation	nature	charge	stopped by
γ	electromagnetic radiation		
β		negative	
α			thick paper

[3]

(b) An isotope of strontium is represented in nuclide notation as $^{90}_{38}Sr$.

For a neutral atom of this isotope, state

(i) the proton number, ...

(ii) the nucleon number, ...

(iii) the number of neutrons, ...

(iv) the number of electrons. .....

[3]

(c) A sample of a radioactive material is placed near a radiation detector. A count-rate of 4800 counts/s is detected from the sample. After 36 hours the count-rate has fallen to 600 counts/s.

Calculate how many more hours must pass for the count-rate to become 150 counts/s.

9 Fig. 11.1 shows a beam of radiation that contains α-particles, β-particles and γ-rays. The beam enters a very strong electric field between charged plates in a vacuum.

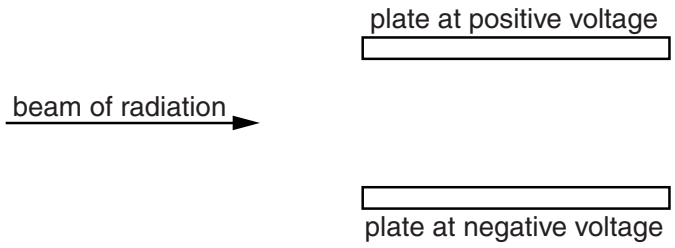

Fig. 11.1

(a) Indicate the deflection, if any, of the α-particles, β-particles and γ-rays, by placing **one** tick in **each** column of the table.

possible deflection	α-particles	β-particles	γ-rays
no deflection			
towards positive plate			
towards negative plate			
out of the paper			
into the paper			

[3]

(b) The radiation is said to be *ionising*. Explain what this means.

.....

.....[1]

(c) α-particles are more strongly ionising and have a shorter range in air than γ-rays.

Use your knowledge of the nature of these radiations to explain these differences.

.....

.....

.....

..... [3]

[Total: 7]