1 **(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]

2 (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]

3 **(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.

number of hours = ... [3]

[Total: 9]

4 **(a)** A radioactive source emits α-, β- and γ-radiation.

Which of these radiations

(i) has the shortest range in air, ...

(ii) has a negative charge, ...

(iii) is not deflected in a magnetic field? .....

[2]

(b) In a famous experiment, carried out in a vacuum, a very thin sheet of gold was placed in the path of alpha particles.

It was found that a large number of the alpha particles passed through the sheet with little or no deflection from their original path. A very small number of the alpha particles were reflected back towards the source.

(i) Explain, in terms of the force acting, why the direction of motion of an alpha particle changes when it comes close to the nucleus of a gold atom.

.....

.....

..... [2]

(ii) State **two** conclusions, about the nuclei of atoms, that were made from the results of this experiment.

1. .....

.....

2. .....

.....

[2]

[Total: 6]

5 **(a)** Six different nuclides have nucleon and proton numbers as follows:

nuclide	nucleon number	proton number
A	214	84
B	214	85
C	211	84
D	211	86
E	210	82
F	210	83

State which two nuclides are isotopes of the same element. ..... and ..... [1]

(b) Thorium-232 has a half-life of 1.4×10^{10} years.

At a particular instant, the activity of a sample of thorium-232 is 120 Bq.

(i) Calculate the time taken for the activity of this sample to fall to 15 Bq.

time taken .....[1]

(ii) Explain why, when the activity has become 15 Bq, much of the sample will no longer be thorium-232.

.....

.....

.....[1]

(iii) The sample of thorium-232 is used in an experiment in a laboratory.

Explain why its activity may be regarded as constant.

.....

.....

.....[1]

[Total: 4]

6 **(a)** An atom consists of a nucleus made up of protons and neutrons, surrounded by orbiting electrons.

(i) Which of these particles has a positive charge? .....[1]

(ii) Which two of these particles have almost equal mass?

..... and ..... [1]

(b) A silver nucleus is denoted by $^{107}_{47}Ag$. State the number of protons and the number of neutrons in this nucleus.

number of protons = ... number of neutrons = ... [2]

(c) The graph in Fig. 11.1 shows part of the decay curve of a radioactive nuclide. The count rate is plotted against time.

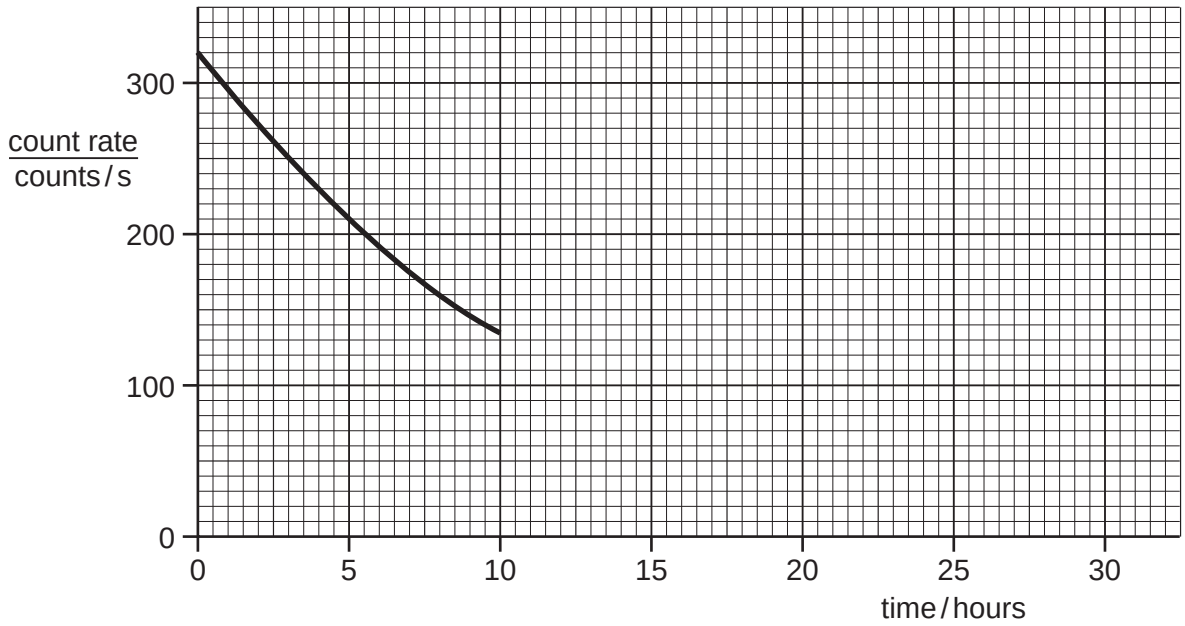

Fig. 11.1

(i) Use the graph to find the half-life of this nuclide.

half-life = ...[1]

(ii) Plot two more points on Fig. 11.1 at times greater than 10 hours. Use a dot in a circle to indicate each point. [2]

[Total: 7]

7 Fig. 11.1 shows the paths of three α-particles moving towards a thin gold foil.

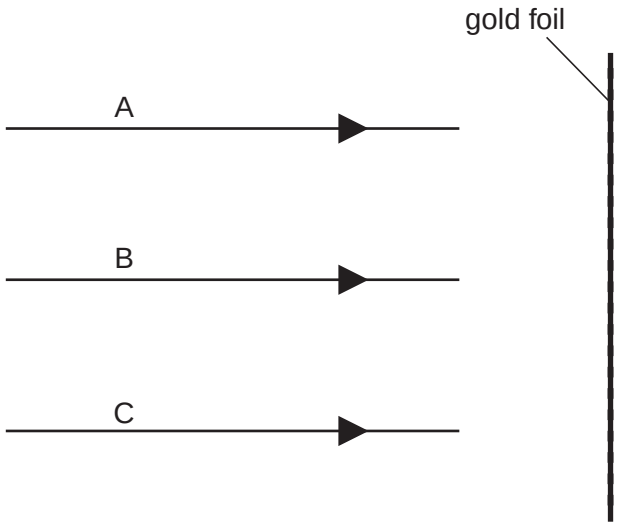

Fig. 11.1

Particle A is moving directly towards a gold nucleus.
Particle B is moving along a line which passes close to a gold nucleus.
Particle C is moving along a line which does not pass close to a gold nucleus.

(a) On Fig. 11.1, complete the paths of the α-particles A, B and C. [3]

(b) State how the results of such an experiment, using large numbers of α-particles, provides evidence for the existence of nuclei in gold atoms.

.....

.....

.....

..... [3]

[Total: 12]

8 **(a)** A sodium nucleus decays by the emission of a β-particle to form magnesium.

(i) Complete the decay equation below.

$$^{24}_{11}\text{Na} \longrightarrow \quad \text{Mg} \; +$$

(ii) Fig. 11.1 shows β-particles from sodium nuclei moving into the space between the poles of a magnet.

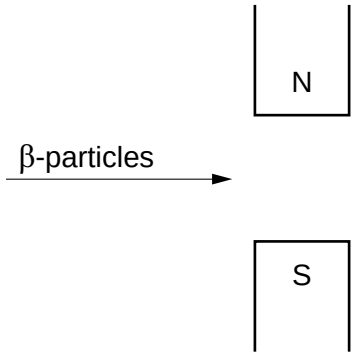

Fig. 11.1

Describe the path of the β-particles between the magnetic poles.

.....

.....

.....

[5]

(b) Very small quantities of a radioactive isotope are used to check the circulation of blood by injecting the isotope into the bloodstream.

(i) Describe how the results are obtained.

.....

.....

.....

.....

(ii) Explain why a γ-emitting isotope is used for this purpose rather than one that emits either α-particles or β-particles.

.....

.....

.....

[4]

[Total : 9]