1 Bismuth-214 is radioactive. It has a half-life of 20 minutes.

(a) The nuclide notation for bismuth-214 is $^{214}_{83}Bi$.

State the composition of the nucleus of bismuth-214.

.....

..... [2]

(b) Bismuth-214 decays by β-decay to an isotope of polonium, Po.

Complete the equation for the decay of bismuth-214.

$$^{214}_{83}Bi \rightarrow \begin{matrix}\cdots\cdots\\ \cdots\cdots\end{matrix}\beta + \begin{matrix}\cdots\cdots\\ \cdots\cdots\end{matrix}Po$$

[3]

(c) The count rate from a sample of bismuth-214 is 360 counts / s.

Predict the count rate from the sample after 60 minutes.

count rate = ... [2]

(d) State **two** of the social, economic or environmental issues involved in the storage of radioactive materials with very long half-lives.

.....

.....

.....

..... [2]

[Total: 9]

2 **(a)** State, in terms of the particles in each nucleus, how the nuclei of two isotopes of the same element are different.

.....[1]

(b) Fig. 11.1 shows a graph of nucleon number against proton number. The nucleus $^{212}_{83}Bi$ is plotted on the graph at the cross marked P.

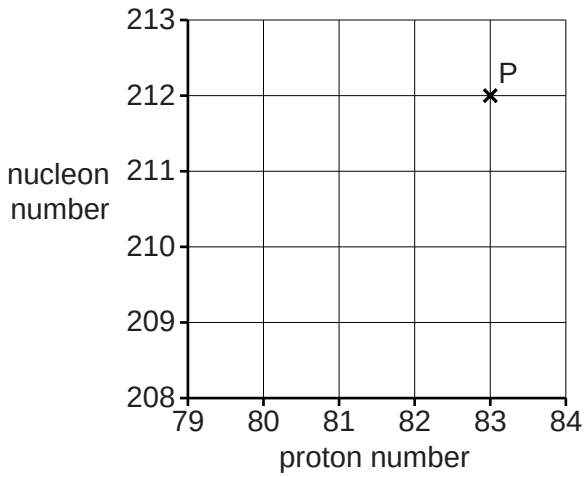

Fig. 11.1

(i) On Fig. 11.1,

1. plot a cross labelled Q for the nucleus formed when the $^{212}_{83}Bi$ nucleus emits an α-particle,

2. plot a cross labelled R for the nucleus formed when the $^{212}_{83}Bi$ nucleus emits a β-particle.

[4]

(ii) The half-life for the decay of $^{212}_{83}Bi$ is 60 minutes.

A sample of $^{212}_{83}Bi$ is placed at a fixed distance from a detector. The initial measurement of the count rate from the sample of $^{212}_{83}Bi$ is 2400 counts per minute.

Calculate the count rate from the sample 5.0 hours later.

count-rate = ...[2]

[Total: 7]

3 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]

4 Fig. 10.1 shows a variable resistor (rheostat) and a solenoid (long coil) connected to a battery.

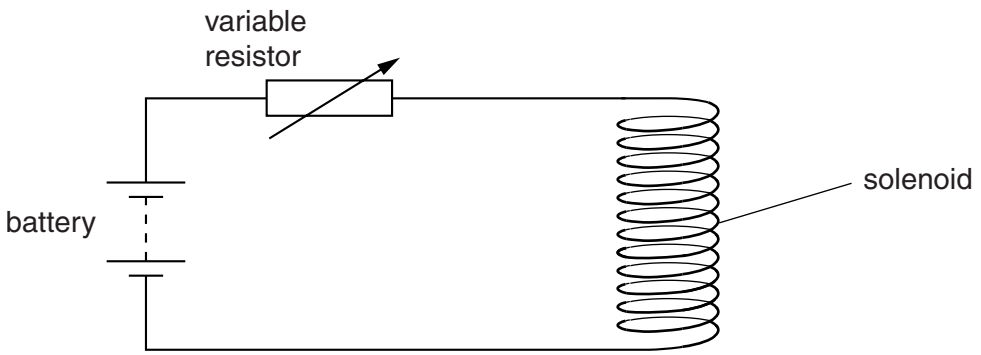

Fig. 10.1

The current in the solenoid produces a magnetic field.

(a) **(i)** On Fig. 10.1, draw lines to show the pattern of the magnetic field due to the current. [2]

(ii) State the feature of the pattern of the magnetic field lines that indicates the strength of the magnetic field at particular points.

.....

..... [1]

(b) State and explain the effect on the magnetic field of increasing the resistance of the variable resistor.

.....

.....

.....

..... [2]

(c) In a laboratory vacuum chamber, some current-carrying coils produce a very strong magnetic field near a source of α-particles.

Fig. 10.2 shows the arrangement.

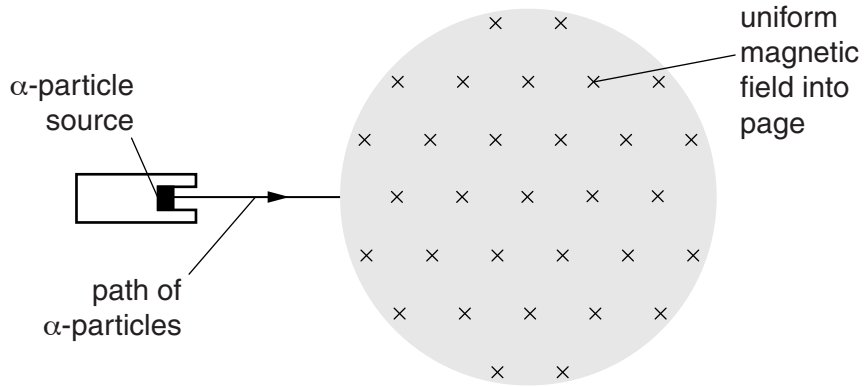

Fig. 10.2

(i) In the shaded region of Fig. 10.2, draw a possible path for the α-particles in the magnetic field. [2]

(ii) State and explain the effect on this path of reversing the current in the coils.

.....

.....

..... [2]

[Total: 9]

5 **(a)** Chlorine has two isotopes, one of nucleon number 35 and one of nucleon number 37. The proton number of chlorine is 17.

Table 11.1 refers to neutral atoms of chlorine.

Complete Table 11.1.

	nucleon number 35	**nucleon number 37**
number of protons		
number of neutrons		
number of electrons		

[3]

Table 11.1

(b) Some isotopes are radioactive.

State the three types of radiation that may be emitted from radioactive isotopes.

1. .....

2. .....

3. ..... [1]

(c) **(i)** State one practical use of a radioactive isotope.

.....

..... [1]

(ii) Outline how it is used.

.....

.....

.....

.....

..... [1]

[Total: 6]