For Examiner's Use

6 **(a)** Define *half-life*.

……

……

…… [1]

(b) Explain what is meant by the terms *spontaneous* and *random* when describing radioactive decay.

spontaneous: ……..

……

random: ……..

…… [2]

(c) Carbon-14 ($^{14}_{6}C$) undergoes β^- decay to form Nitrogen (N).

(i) Complete the nuclear equation below for the decay of carbon-14 to form nitrogen.

$$^{14}_{6}C \rightarrow {}^{\cdots\cdots}_{\cdots\cdots}N + {}^{\cdots\cdots}_{\cdots\cdots}\ldots\ldots + \text{ energy}$$

[1]

(ii) The half-life of Carbon-14 is 5730 years.

Calculate the decay constant λ of Carbon-14.

λ = …….. s^{-1} [2]

For Examiner's Use

(iii) A fossil of a Neanderthal (an extinct species of archaic humans) was found. Carbon-14 dating was used to determine the age of this fossil.

A 10 kg sample of this fossil was found to have an activity rate of 5.4 Bq. On the other hand, a fresh 1.0 g sample taken from a living organism is expected to have an activity rate of 0.23 Bq.

Determine the age of the fossil.

age = …….. years [3]

(d) A sample of polonium-210 (Po) undergoes α-decay forming lead-206 (Pb) with no other products.

The Po nucleus was stationary before the decay and the α-particle was emitted with a velocity of v_α.

(i) Using momentum considerations, show that $\frac{\text{kinetic energy of Pb nucleus}}{\text{kinetic energy of } \alpha\text{-particle}}$ is 0.0194.

[3]

[Turn over

For Examiner's Use

(ii) Fig. 6.1 shows the initial positions of of the α-particle and Pb nucleus right after the decay.

The radioactive decay took placed in a magnetic field directed into the plane of the page.

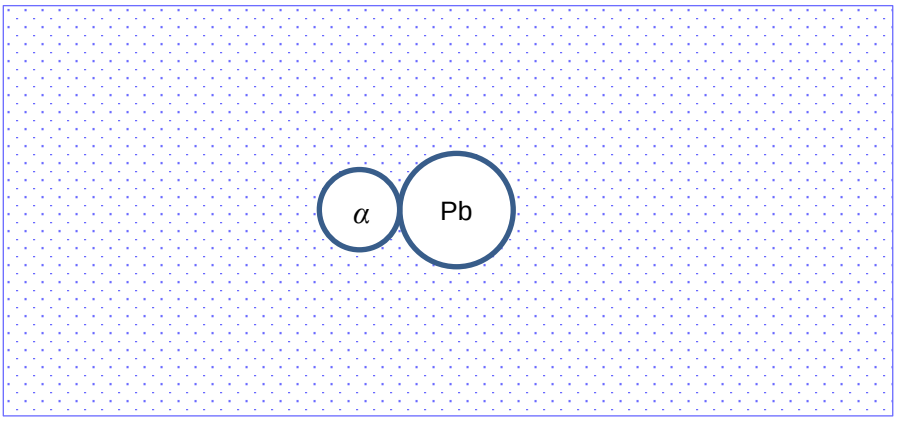

Fig. 6.1

On Fig. 6.1, sketch the paths of the emitted Pb nucleus and α-particle.

[2]

[Total: 14]