10 Carbon-15 ($^{15}_{6}C$) is an isotope of carbon that undergoes radioactive decay to nitrogen-15 ($^{15}_{7}N$), which is a stable isotope of nitrogen.

Radioactive decay is both a random and a spontaneous process.

(a) State what is meant by:

(i) random

.....

..... [1]

(ii) spontaneous.

.....

..... [1]

(b) A small sample of carbon-15 decays. The mass M of carbon-15 in the sample decreases with time t.

Fig. 10.1 shows the variation with t of the value of ln ($M / 10^{-16}$ g).

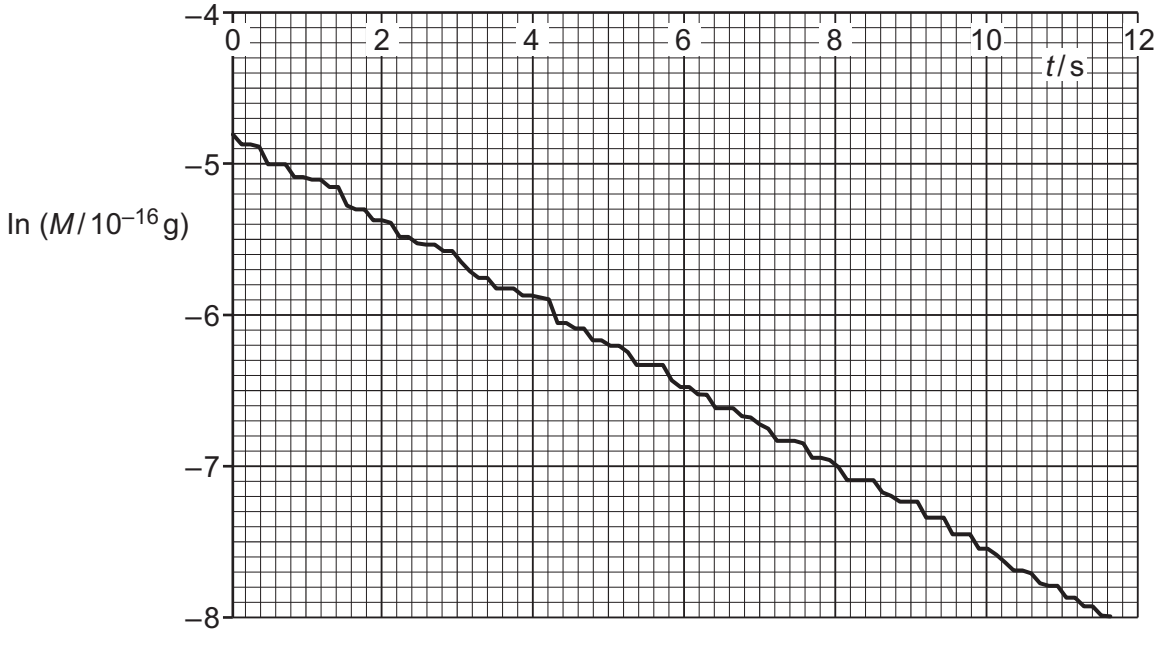

Fig. 10.1

(i) State how Fig. 10.1 demonstrates that radioactive decay is random.

.....

..... [1]

(ii) On Fig. 10.1, draw the straight line of best fit. [1]

(iii) Show that the decay constant λ of carbon-15 is given by the magnitude of the gradient of your line in **(b)(ii)**.

[1]

(iv) Use your line in **(b)(ii)** to determine λ. Give a unit with your answer.

λ = ... unit ..... [2]

(v) Use your answer in **(b)(iv)** to calculate the half-life of carbon-15.

half-life = ... s [1]

(c) The equation for the decay of carbon-15 can be written as

$$^{15}_{6}C \longrightarrow {}^{15}_{7}N + {}^{0}_{-1}\beta + {}^{0}_{0}\bar{\nu}.$$

State and explain how the mass of the products of the decay must compare with the mass of the carbon-15 nucleus.

.....

.....

..... [2]

[Total: 10]