6 **(a)** Radioactive decay is *random* and *spontaneous*.

Explain what is meant by random and spontaneous.

random: ………………………………………………………………………………..

………………………………………………………………………………..

spontaneous: ……………………………………………………………………….

…………………………………………………………………………..…….. [2]

(b) A stationary polonium nucleus $^{210}_{84}Po$ decays to a lead (Pb) nucleus by emitting an alpha-particle.

(i) Write a nuclear equation to represent this emission.

…………………………………………………………….…………... [2]

(ii) Determine the ratio of $\dfrac{\text{kinetic energy of alpha-particle}}{\text{kinetic energy of lead nucleus}}$ after the nuclear reaction has occurred.

ratio = …………..……… [2]

(iii) A sample of polonium-210 has 4.2×10^{11} nuclei initially. The half-life of the nuclei is 138 days.

Calculate the activity of the source after 600 days.

activity = …………..……… Bq [3]

[Turn over

(iv) A Geiger counter is used to measure the rate of decay after 600 days.

State and explain how the reading will differ from your answer in **(b)(iii)**.

....

....

.... [1]

(c) Another nucleus, platinum-199, decays to gold-199 by emitting a beta particle. Fig. 6.1 shows the kinetic energy spectrum of the beta particles.
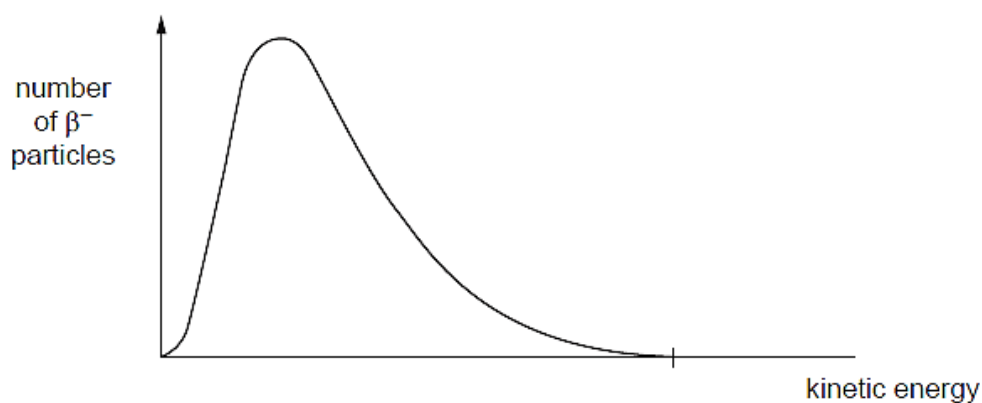

Fig. 6.1

(i) Explain how Fig. 6.1 predicts the existence of the neutrino.

....

....

....

.... [2]

(ii) The nucleus of gold-199 is not stable and will decay further to mercury-199 which is a stable nucleus.

A sample of radioactive isotopes consists of only platinum-199 nuclei initially. The half-life of platinum-199 is 30.8 months and the half-life of gold-199 is 3.13 days.

After 30.8 months, suggest which nuclei would be of the smallest percentage. Explain your answer.

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....

....

.... [2]

[Total: 14]