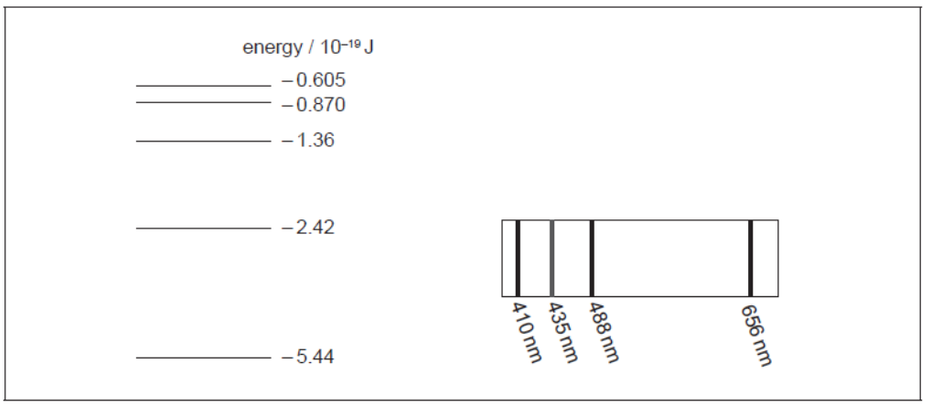
1. The diagram shows the position of the principal lines in the visible spectrum of atomic hydrogen and some of the corresponding energy levels of the hydrogen atom. **(4 marks)**



(a) Determine the energy of a photon of blue light (435nm) emitted in the hydrogen spectrum.

(b) Identify, with an arrow labelled B on the diagram, the transition in the hydrogen spectrum that gives rise to the photon with the energy in (a).

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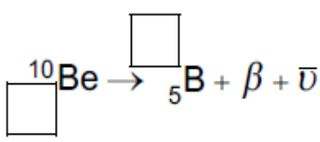
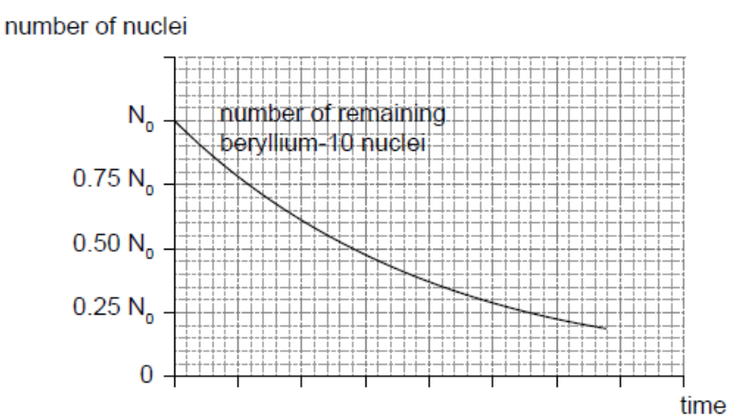
2. The radioactive nuclide beryllium-10 (Be-10) undergoes beta minus (β–) decay to form a stable boron (B) nuclide. **(8 marks)**

(a) Identify the missing information for this decay.



The initial number of nuclei in a pure sample of beryllium-10 is N_0. The graph shows how the number of remaining **beryllium** nuclei in the sample varies with time.



(b) **On the graph**, sketch how the number of **boron** nuclei in the sample varies with time.

(c) After 4.3×10^6 years, the following ratio exists. Determine the half-life of Beryllium-10.

$$\frac{\text{number of produced boron nuclei}}{\text{number of remaining beryllium nuclei}} = 7.$$

(d) Beryllium-10 is used to investigate ice samples from Antarctica. A sample of ice initially contains 7.6×10^{11} atoms of beryllium-10. State the number of remaining beryllium-10 nuclei in the sample after 2.8×10^6 years.

3. Rhodium-106 ($^{106}_{45}\mathrm{Rh}$) decays into palladium-106 ($^{106}_{46}\mathrm{Pd}$) by beta minus (β^-) decay. **(8 marks)**

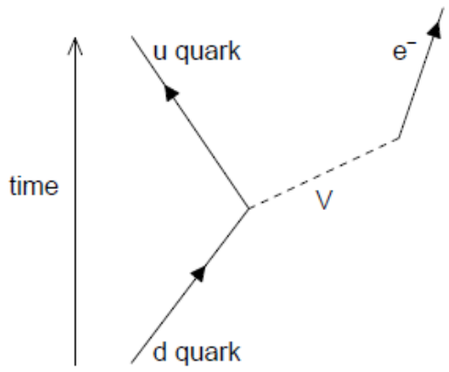
The binding energy per nucleon of rhodium is 8.521 MeV and that of palladium is 8.550 MeV.

(a) State what is meant by the binding energy of a nucleus.

(b) Show that the energy released in the β^- decay of rhodium is about 3 MeV.

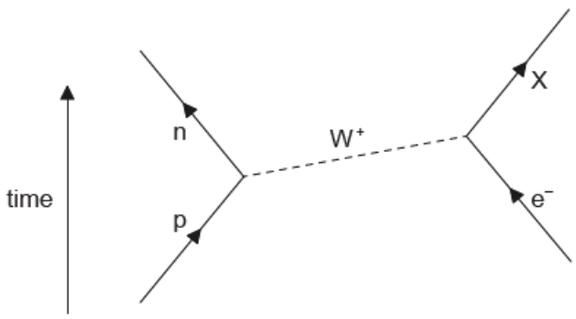
(c) β^- decay is described by the following incomplete Feynman diagram.

(d) Draw a **labelled arrow** to *complete* the Feynman diagram.



(e) Identify particle V.
(Conservation laws will help)

4. The Feynman diagram shows electron capture. **(4 marks)**



State and explain the nature of the particle labelled X. (Conversation laws will help.)