Practice Question Set For A-Level

Subject : Physics

Paper-2 Topic: Fields And Their Consequences(Nuclear Physics)

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Name of the Student:____

Max. Marks : 20 Marks **Time : 20 Minutes**

Q1.

The table shows the binding energy per nucleon for two nuclei.

nucleus	binding energy per nucleon/10^{-12}J
helium-4	1.1332417
beryllium-8	1.1314027

(a) (i) Explain what is meant by the total binding energy of a nucleus.

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(1)

(ii) It is more usual to quote binding energies of nucleons in MeV rather than J.
Calculate the total binding energy, in MeV, of a beryllium-8 nucleus.

binding energy ______________________MeV

(3)

(b) (i) Calculate the change in mass that occurs when two helium-4 nuclei fuse to form a beryllium-8 nucleus.

mass change ______________________kg

(2)

(ii) Two helium-4 nuclei are initially separated by a large distance and are travelling toward one another. The helium nuclei become influenced by the strong force when their centres are separated by a distance of 3.82×10^{-15} m.
Calculate the total initial kinetic energy of the nuclei needed for them to reach this

separation.

kinetic energy ______________________ J

(3)

(iii) Explain why the kinetic energy calculated in part (b)(ii) will not enable the helium nuclei to fuse and produce a beryllium-8 nucleus.

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(3)

(Total 12 marks)

Q2.

The fissile isotope of uranium, $^{233}_{92}U$, has been used in some nuclear reactors. It is normally produced by neutron irradiation of thorium-232. An irradiated thorium nucleus emits a β^- particle to become an isotope of protactinium.

This isotope of protactinium may undergo β^- decay to become $^{233}_{92}U$.

(a) Complete the following equation to show the β^- decay of protactinium.

$$^{\cdots\cdots}_{\cdots\cdots}Pa \rightarrow {}^{233}_{92}U + \beta^- + \ldots\ldots\ldots$$

(2)

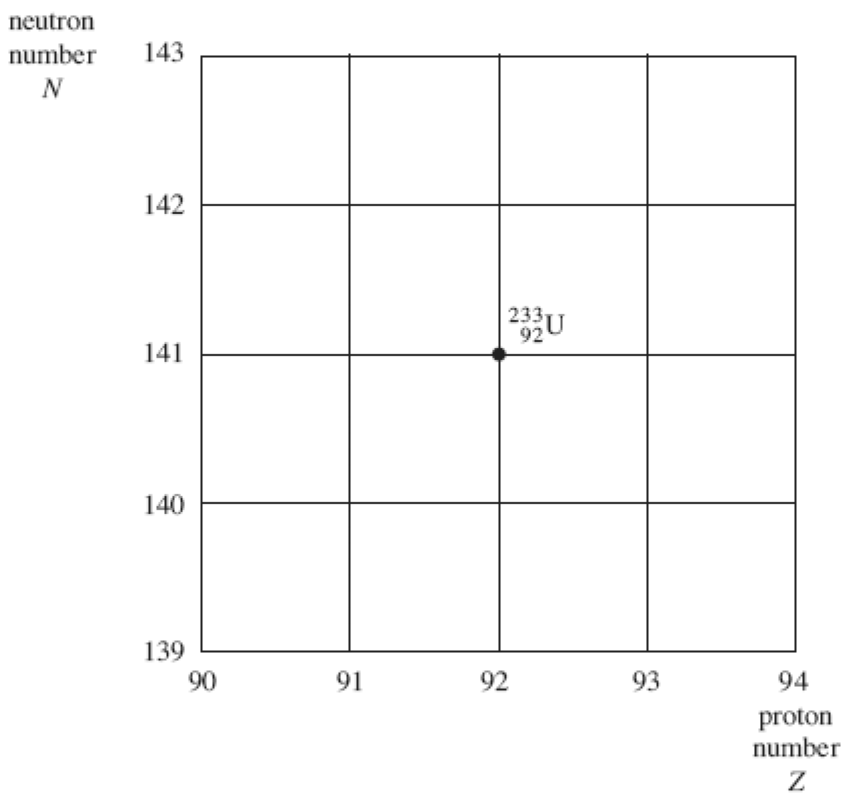
(b) Two other nuclei, **P** and **Q**, can also decay into $^{233}_{92}U$.

P decays by β^+ decay to produce $^{233}_{92}U$.

Q decays by α emission to produce $^{233}_{92}U$.

The figure below shows a grid of neutron number against proton number with the position of the $^{233}_{92}U$ isotope shown.

On the grid label the positions of the nuclei **P** and **Q**.



(2)

(c) A typical fission reaction in the reactor is represented by

$$^{233}_{92}U + ^{1}_{0}n \rightarrow ^{91}_{36}Kr + ^{139}_{56}Ba + x \text{ neutrons}$$

(i) Calculate the number of neutrons, *x*.

answer = ______________________neutrons

(1)

(ii) Calculate the energy released, in MeV, in the fission reaction above.

mass of neutron = 1.00867 u

mass of $^{233}_{92}U$ nucleus = 232.98915 u

mass of $^{91}_{36}Kr$ nucleus = 90.90368 u mass of $^{139}_{56}Ba$ nucleus = 138.87810 u

answer = ______________________MeV

(3)

(Total 8 marks)