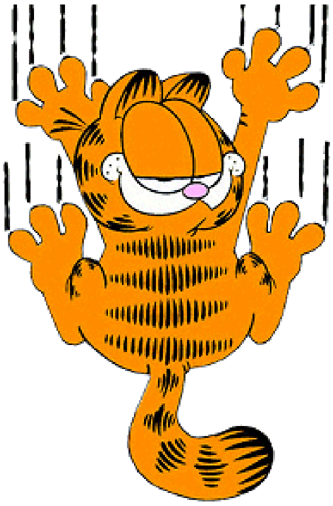
A2 Physics - Mass and Energy interchange…



1. The mass of the beryllium nucleus, ${}^{7}_{4}\mathrm{Be}$, is 7.01473 u.

What is the binding energy **per nucleon** of this nucleus?

Use the following data:

mass of proton = 1.00728 u
mass of neutron = 1.00867 u
1u = 931.3 MeV

A 1.6 MeV nucleon^{-1}
B 5.4 MeV nucleon^{-1}
C 9.4 MeV nucleon^{-1}
D 12.5 MeV nucleon^{-1}

(Total 2 marks)

2. What is the mass difference of the nucleus ${}^{7}_{3}\mathrm{Li}$?

Use the following data:
mass of a proton = 1.00728 u
mass of a neutron = 1.00867 u
mass of a ${}^{7}_{3}\mathrm{Li}$ nucleus = 7.01436 u

A 0.03912 u
B 0.04051 u
C 0.04077 u
D 0.04216 u

(Total 2 marks)

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

(2)

(b) (i) The iron isotope ${}^{56}_{26}\mathrm{Fe}$ (***atomic*** mass: 55.93493) has a very high binding energy per nucleon. Calculate its value in MeV.

(ii) If the isotope ${}^{56}_{26}\mathrm{Fe}$ were assembled from its constituent particles, what would be the mass change, in kg, during its formation?

(6)
(Total 8 marks)

4. You may be awarded marks for the quality of written communication provided in your answers to part (a)

(a) In the context of an atomic nucleus,

(i) state what is meant by *binding energy*, and explain how it arises,
(ii) state what is meant by *mass difference*,
(iii) state the relationship between binding energy and mass difference.

(4)

(b) Calculate the average binding energy per nucleon, in MeV nucleon^{-1}, of the zinc nucleus ${}^{64}_{30}\mathrm{Zn}$.

mass of ${}^{64}_{30}\mathrm{Zn}$ atom = 63.92915 u
mass of proton = 1.00728 u
mass of neutron = 1.00867 u
mass of electron = 0.00055 u

(5)

(c) Why would you expect the zinc nucleus to be very stable?

(1)
(Total 10 marks)

5. Nuclei of $^{218}_{84}\text{Po}$ decay by the emission of an α particle to form a stable isotope of an element X. You may assume that no γ emission accompanies the decay.

(a) (i) State the proton number of X.

(ii) State the nucleon number of X.

(2)

(b) Each decaying nucleus of Po releases 8.6×10^{-13} J of energy.

(i) State the form in which this energy *initially* appears.

(ii) Using **only** the information provided in the question, calculate the difference in mass between the original $^{218}_{84}\text{Po}$ atom and the combined mass of an atom of X and an α particle.

speed of light in vacuum = $3.0 \times 10^{8}\text{ms}^{-1}$

(3)
(Total 5 marks)

6. (a) (i) Copy and complete the equation below to represent the emission of an α particle by a $^{238}_{92}\text{U}$ isotope.

$$^{238}_{92}\text{U} \qquad \rightarrow$$

(ii) Calculate the energy released when this $^{238}_{92}\text{U}$ isotope nucleus emits an α particle

(5)

(b) $^{238}_{92}\text{U}$ decays sequentially by emitting α particles and β^{-} particles, eventually forming $^{206}_{82}\text{Pb}$, a stable isotope of lead.

(i) There are eight α particles in the sequence. Calculate the number of β^{-} particles in the sequence.

(5)

(ii) State the nuclear change that occurs during positron emission. Hence, explain why no positrons are emitted in this sequence.

(6)
(Total 11 marks)

