Name of the Student:_____
Max. Marks : 24 Marks **Time : 24 Minutes**

Q1.

(a) The mass of a nucleus ${}^{A}_{Z}X$ is M.

(i) If the mass of a proton is m_p, and the mass of a neutron is m_n, give an expression for the mass difference Δm of this nucleus.

Δm = _____

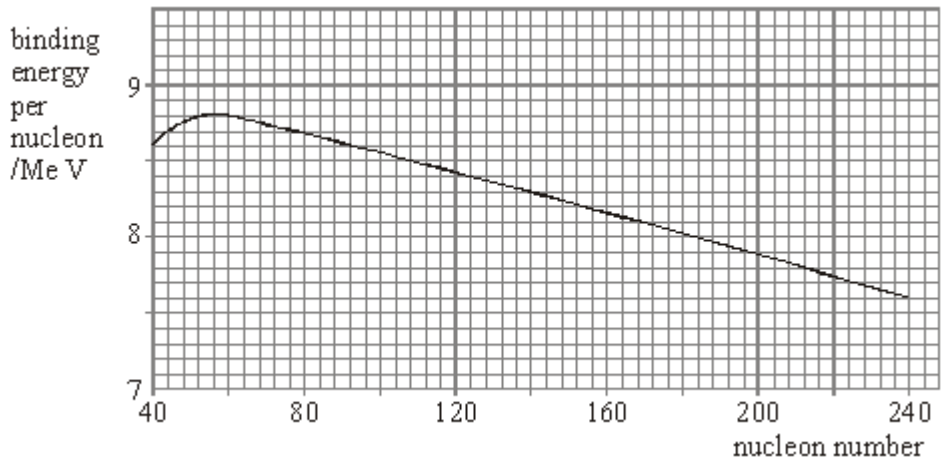
(ii) Give an expression for the binding energy per nucleon of this nucleus, taking the speed of light to be c.

_____

_____

(2)

(b) The figure below shows an enlarged portion of a graph indicating how the binding energy per nucleon of various nuclides varies with their nucleon number.



(i) State the value of the nucleon number for the nuclides that are most likely to be stable. Give your reasoning.

_____

_____

_____

_____

(ii) When fission of uranium 235 takes place, the nucleus splits into two roughly equal parts

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and approximately 200 Me V of energy is released. Use information from the figure above to justify this figure, explaining how you arrive at your answer.

(5)
(Total 7 marks)

Q2.

(a) Suggest **two** reasons why an α particle causes more ionisation than a β particle of the same initial kinetic energy.

You may be awarded marks for the quality of written communication in your answer.

(2)

(b) A radioactive source has an activity of 3.2×10^{9} Bq and emits α particles, each with kinetic energy of 5.2 Me V. The source is enclosed in a small aluminium container of mass 2.0×10^{-4} kg which absorbs the radiation completely.

(i) Calculate the energy, in J, absorbed from the source each second by the aluminium container.

(ii) Estimate the temperature rise of the aluminium container in **1 minute**, assuming no energy is lost from the aluminium.

specific heat capacity of aluminium = 900 J kg^{-1} K^{-1}

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(5)
(Total 7 marks)

Q3.

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 $^{64}_{30}Zn$.

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mass of $^{64}_{30}Zn$ 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)

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