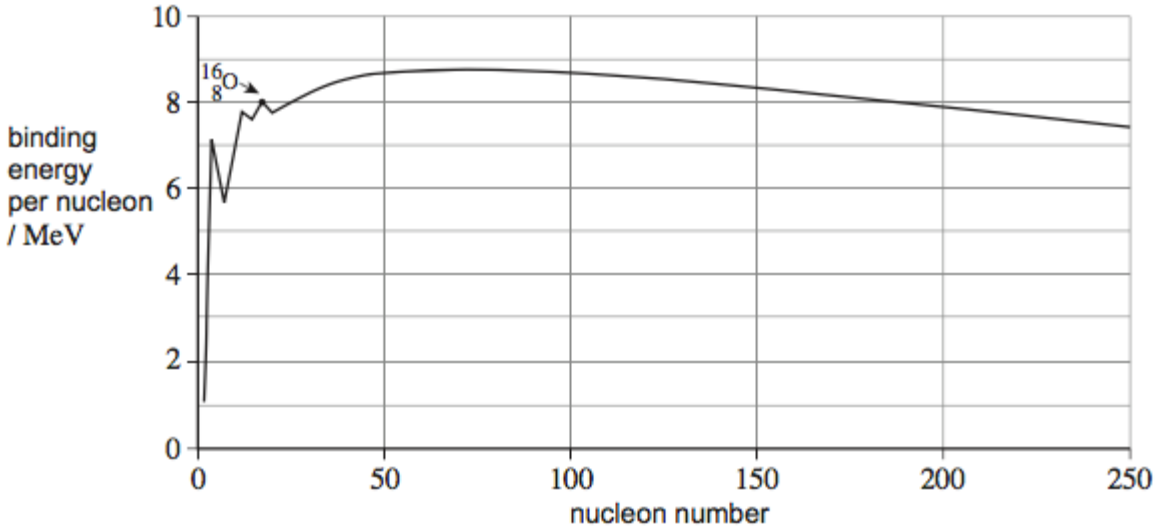
Name of the Student:_____
Max. Marks : 22 Marks **Time : 22 Minutes**

Q1.

The diagram shows how the binding energy per nucleon varies with nucleon number.



(a) (i) Fission and fusion are two nuclear processes in which energy can be released. Explain why nuclei that undergo fission are restricted to a different part of the graph than those that undergo fusion.

_____

_____

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_____

_____

(2)

(ii) Explain, with reference to the diagram, why the energy released per nucleon from fusion is greater than that from fission.

_____

_____

_____

_____

_____

_____

_____

(2)

(b) (i) Calculate the mass difference, in kg, of the $^{16}_{8}O$ nucleus.

mass of $^{16}_{8}O$ nucleus = 15.991 u

mass difference = _____ kg

(2)

(ii) Using your answer to part **(b)(i)**, calculate the binding energy, in MeV, of an oxygen $^{16}_{8}O$ nucleus.

binding energy = _____ MeV

(1)

(iii) Explain how the binding energy of an oxygen $^{16}_{8}O$ nucleus can be calculated with information obtained from the diagram.

_____

_____

_____

(1)

(Total 8 marks)

Q2.

(a) Which ionizing radiation produces the greatest number of ion pairs per mm in air? Tick (✓) the correct answer.

α particles	
β particles	
γ rays	

X−rays	

(1)

(b) (i) Complete the table showing the typical maximum range in air for α and β particles.

Type of radiation	Typical range in air / m
α	
β	

(2)

(ii) γ rays have a range of at least 1 km in air.

However, a γ ray detector placed 0.5 m from a γ ray source detects a noticeably smaller count-rate as it is moved a few centimetres further away from the source.

Explain this observation.

_____

_____

_____

(1)

(c) Following an accident, a room is contaminated with dust containing americium which is an α−emitter.

Explain the most hazardous aspect of the presence of this dust to an unprotected human entering the room.

_____

_____

_____

_____

(2)

(Total 6 marks)

Q3.

(a) Scattering experiments are used to investigate the nuclei of gold atoms.
In one experiment, alpha particles, all of the same energy (monoenergetic), are incident on a foil made from a single isotope of gold.

(i) State the main interaction when an alpha particle is scattered by a gold nucleus.

_____

_____

(1)

(ii) The gold foil is replaced with another foil of the same size made from a mixture of

isotopes of gold. Nothing else in the experiment is changed.

Explain whether or not the scattering distribution of the monoenergetic alpha particles remains the same.

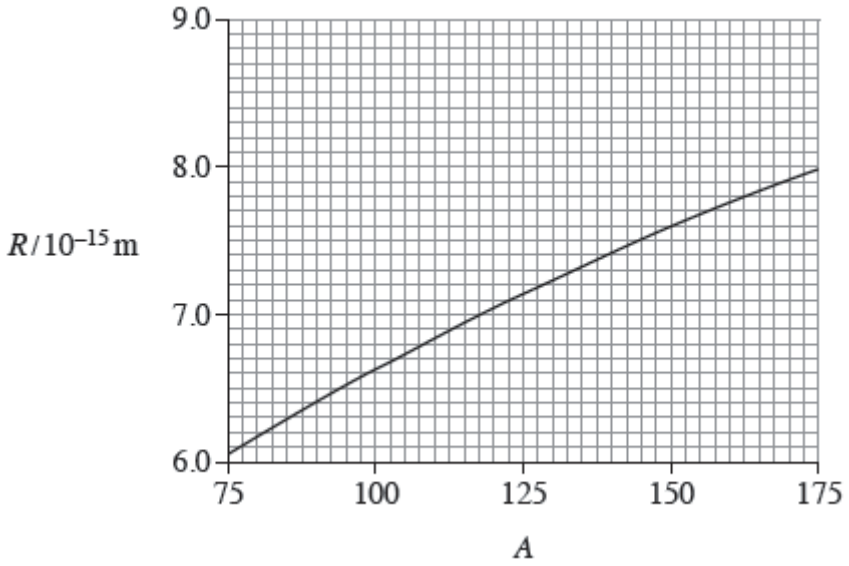
_____

_____

_____

(1)

(b) Data from alpha−particle scattering experiments using elements other than gold allow scientists to relate the radius R, of a nucleus, to its nucleon number, A.
The graph shows the relationship obtained from the data in a graphical form, which obeys the relationship $R = r_0 A^{\frac{1}{3}}$



(i) Use information from the graph to show that r_0 is about 1.4×10^{-15} m.

(1)

(ii) Show that the radius of a $^{51}_{23}\mathrm{V}$ nucleus is about 5×10^{-15} m.

(2)

(c) Calculate the density of a $^{51}_{23}\mathrm{V}$ nucleus.

State an appropriate unit for your answer.

density _____ unit _____

(3)
(Total 8 marks)