

ONE HOUR FORTY MINUTES

A list of constants is enclosed.

UNIVERSITY OF MANCHESTER

Nuclear Physics

29th May 1997, 2.00 p.m. - 3.40 p.m.

Answer TWO questions

Electronic calculators may be used, provided that they cannot store text.

The numbers indicate the relative weights of the different parts of each question and do NOT represent a marking scheme.

P.T.O.

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1. Explain what is meant by the binding energy of a nucleus.

[5 marks]

The binding energy of nuclei (BE) can be expressed as a function of A and Z as follows:

$$BE = \alpha A - \beta A^{\frac{2}{3}} - \gamma \frac{(A - 2Z)^2}{A} - \epsilon \frac{Z(Z - 1)}{A^{\frac{1}{3}}} + \delta(A, Z).$$

[10 marks]

Identify the term that is due to the Coulomb repulsion of the protons and hence estimate the value of the coefficient of this term using any appropriate physical constants.

Explain how the shape of the above binding energy curve can account for the phenomena of fission and fusion.

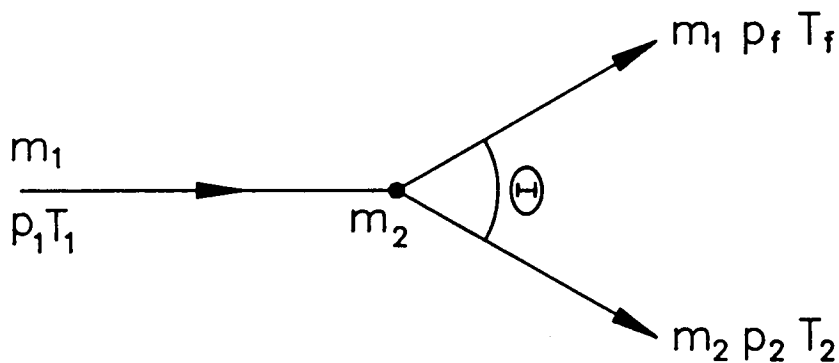
[10 marks]

2. A particle of mass m , momentum p_1 and kinetic energy T_1 scatters elastically off a stationary target nucleus of mass m_2 as shown in the figure. If the angle between the two final state particles is Θ , derive an expression for Θ in terms of the masses and kinetic energies.

[13 marks]

Describe the essential features of an experiment which uses a measurement of Θ in order to determine the relative abundances of the various isotopes of lead. Calculate the angular resolution of Θ which is required.

[12 marks]



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3. Draw a labelled sketch of the "line of stability" of nuclei.

[5 marks]

Explain why nuclei which are far off the line of stability are not found in nature.

[8 marks]

The table lists three nuclear isobars with atomic mass number 101 and shows their atomic number Z and their measured nuclear masses.

	Z	Nuclear mass (MeV/c^2)
Tc	43	93995.2
Ru	44	93993.6
Rh	45	93994.2

By calculating the Q values of the processes involved, show which transitions can take place between these nuclei.

[12 marks]
