

Indian Institute of Technology Delhi
MAJOR TEST

Ist Semestar (2006-07)
Sub: Nuclear Science and Engineering

Course no: EPL332

Date: 29.11.2006
Time: 10:30-12:30
Room: MS418

Full Marks: 40

Page used for Rough calculations must be clearly indicated.

Attempt all questions:

{Marks corresponding to each question is indicated in []}

Q1. A] With a sketch explain very briefly (in a qualitative manner) how confinement of plasma is done in a tokamak. [3]

B] A thermonuclear device consists of a torus of diameter 3 m with a tube of diameter 1 m. It contains a deuterium gas at 10^{-2} mm Hg pressure and at temperature $\sim 20^\circ\text{C}$. A large capacitor of 1200 μf is discharged through the tube at 40 kV. If only 10 % of the electrical energy is transformed to plasma kinetic energy, what is the maximum temperature attained? Assume the energy is equally shared between the electrons and deuterons in the plasma. [5]

Q2. A] In a successive transformation of $P \rightarrow D \rightarrow S$ (P: parent, D: daughter, S: stable nucleus) find out N_D at any instant t and deduce the condition for secular equilibrium. [4]

B] In an archaeological expedition, charcoal from an ancient fire-pit was excavated. This sample showed a ^{14}C activity of 11.3 counts per gm per min. The absolute activity of ^{14}C in a living tree is independent of species and it is ~ 15.3 counts per gm per min. Estimate the age of the charcoal sample. [4]

Q3. A] What is the principle of nuclear magnetic resonance? How it is used in imaging of any biological specimen? [3+2]

B] Assuming soft living tissue absorbs ~ 93 erg/g for 1R of gamma radiation what is the dose rate received from working at an average distance of 50 cm from a 100 μCi ^{22}Na source? ($\Gamma_{\text{Na}}=12$) [3]

Q4. A] How neutron activation analysis (NAA) can be used to quantify a trace element in any sample? [4]

B] In forward scattering experiment 100 MeV $^{28}\text{Si}^{4+}$ ion of current 10 nA is bombarded on C film. A detector of area 300 mm^2 is mounted at a distance of 0.5 m to detect the C recoils. If the forward scattering yield is 1000 C atoms and the reaction cross section is 10^{-15} m^2 what is the areal concentration of C in the film? [4]

Q5. A] Write down the expression for mass of any nucleus as given by 'semi-empirical mass formula' and explain the *asymmetry energy* term [1+3]

B] Considering nucleus as a spherical liquid charge drop, evaluate the coulomb energy by calculating the energy needed for full nuclear charge in terms of spherical shells dr filled in one after the other. [4]

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1 MeV = 1.6021×10^{-6} erg
e = 1.6021×10^{-19} Coul
g = 9.81 m/s^2