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(May)

PHYSICS

(Major)

Course : 603

(Nuclear Physics)

Full Marks : 60

Pass Marks : 24

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

1. Choose the correct answer from the following : 1×5=5

(a) The range of electromagnetic radiation is

(i) short range

(ii) finite

(iii) infinite

(iv) zero

- (b) In a nuclear reactor, cadmium rods are used to
- (i) absorb all neutrons
 - (ii) absorb some neutrons
 - (iii) speed-up neutrons
 - (iv) slow-down neutrons
- (c) In semi-empirical mass formula, the surface energy term is proportional to
- (i) $A^{\frac{1}{3}}$
 - (ii) $A^{-\frac{2}{3}}$
 - (iii) $A^{\frac{2}{3}}$
 - (iv) A
- (d) Sun releases energy by the process of
- (i) nuclear fission
 - (ii) nuclear fusion
 - (iii) nuclear combustion
 - (iv) pair production
- (e) The unit of reaction cross-section is
- (i) fermi
 - (ii) m^{-1}
 - (iii) rutherford
 - (iv) barn

2. Answer any *five* of the following questions :

2×5=10

- (a) "Nuclear density is independent of size."
Explain.
- (b) What are the advantages of using neutrons as projectiles for artificial transmutation?
- (c) "Electrons do not exist inside the nucleus." Justify the statement.
- (d) Why is high energetic projectile required for a nuclear transformation?
- (e) What are leptons? Write the characteristics of lepton.
- (f) Calculate the binding energy per nucleon in MeV of an α -particle. [Mass of the He nucleus = 4.002870 amu, mass of proton = 1.007825 amu]

3. What is nuclear magnetic dipole moment? Write the quantum numbers of individual nucleus. Give the significance of (a) principal quantum number and (b) angular momentum quantum number for individual nucleons.

1+2+2=5

Or

What is parity of nucleus? Describe a method for the determination of size of nucleus. 1+4=5

4. Explain the various terms in the semi-empirical mass formula of Weizacker. Show the various contributions to the formula graphically. 4+1=5

5. Write the various conservation laws in nuclear reactions with illustrative examples. Why are magnetic dipole moment and electrical quadrupole of the reacting nuclei not conserved in reaction? 1+4=5

Or

Define nuclear reaction cross-section. The cross-section of Cd^{113} for capturing thermal neutrons is 2×10^4 barn and its density is $8.64 \times 10^3 \text{ kgm}^{-3}$. Calculate the fraction of beam of thermal neutrons absorbed by Cd sheet of 0.1 mm thickness. [Natural Cd contains 12% Cd^{113}] 1+4=5

6. What is cyclotron? Derive an expression for the maximum kinetic energy achieved by a particle of mass m in terms of the applied magnetic field and dee radius. Express the kinetic energy in terms of the frequency of the applied field. 1+5+1=7

7. What is cosmic ray shower? How is it produced? Discuss the altitude and latitude effects of cosmic ray. 1+2+2+2=7

8. What is nuclear fission? Explain nuclear fission on the basis of liquid-drop model. Discuss the importance of nuclear fusion in universe.

1+4+2=7

Or

What is nuclear chain reaction? Explain with example. Calculate the energy released when 0.1 kg of Li^7 is converted into He^4 by proton bombardment.

[Mass of $\text{Li}^7 = 7.0183$ amu

Mass of $\text{He}^4 = 4.004$ amu

Mass of $\text{H}^1 = 1.0081$ amu]

1+1+5=7

9. Write short notes on any *three* of the following :

3×3=9

- (a) Proton-neutron hypothesis
- (b) Limitations of liquid-drop model
- (c) Artificial radioactivity
- (d) Quarks
