

1. All questions are compulsory.
2. All questions carry equal marks.
3. Draw neat, labelled diagrams wherever necessary.

**Q.1 A] Attempt any one of the following: [10M]**

- i) Explain how to determine the size of nucleus on the basis of Rutherford  $\alpha$ - particle scattering.
- ii) State and explain the law of radioactive disintegration. Derive necessary relation.

**Q.1 B] Attempt any two of the following: [Each 5M]**

- i) Write a note on "nuclear size and nuclear density".
- ii) Determine: a) Radius of a nucleus b) Volume c) Mass of copper nucleus, having atomic mass number 63. [ $r_0=1.3$  fm]
- iii) Define half -life period of radioactive sample. Show that  $\tau=0.693/\lambda$ .
- iv) If a sample of radium has half -life time of the order 22 years. Find the time taken by a sample to decrease to 10%.

**Q.2 A] Attempt any one of the following: [10M]**

- i) Define Q-value of the nuclear reaction. Obtain an expression for Q equation.
- ii) Explain construction and working of proportional counter.

**Q.2 B] Attempt any two of the following: [Each 5M]**

- i) Write shorts notes on the following: a) direct nuclear reactions. b) Elastic Scattering.
- ii) Write a short note on Bremsstrahlung process.
- iii) Explain the interaction between particles and matter.
- v) What is Geiger counter?

**Q.3 A] Attempt any one of the following: [10M]**

- i) State & explain de Broglie hypothesis & how de Broglie supports the Bohr quantization rule.
- ii) How are x-rays produced? List some important properties of x-rays.

**Q.3 B] Attempt any two of the following:**

**[Each 5M]**

- i) Write a short note on Black body.
- ii) What is de Broglie wavelength associated with a proton moving with a velocity equal to  $1/30^{\text{th}}$  of the velocity of light? [Mass of proton =  $1.67 \times 10^{-27}$  kg]
- iii) Write a short note on Theory of Black holes.
- iv) The first order Bragg reflection in a crystal takes place at glancing angle of  $14^\circ 42'$ . Calculate the angle for the second order Bragg reflection.

**Q.4 Attempt any three of the following:**

**[Each 5M]**

- i) Define: a) Binding energy and b) packing fraction.
- ii) Using the given data find the B.E. of neutron in the  ${}_3\text{Li}^7$  nucleus. Express it in MeV and joules.  
[Given:  ${}_3\text{Li}^7 = 7.016004$ ,  ${}_3\text{Li}^6 = 6.015125$  and  ${}_0\text{n}^1 = 1.008665$ ]
- iii) Define: a) nuclear fusion. b) Nuclear fission.
- iv) Find the energy released when two deuterium nuclei fuse to form alpha particle.  
[Given: atomic mass of deuterium =  $2.014102$  a.m.u., mass of helium =  $4.002603$  a.m.u.]
- v) An electron is moving along x-axis & its location is uncertain by  $10^{-9}$  m. Determine the uncertainty in the x- component of its momentum.
- vi) Describe single crystal Bragg-spectrometer.

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