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Sixth Semester B.Sc. Degree Examination, September/October 2022
(CBCS Scheme)
PHYSICS
Paper – VII : Atomic, Molecular and Nuclear Physics

Time : 3 Hours Max. Marks : 70

Instruction : *Answer **any five** questions from **each** Part.*

PART – A

Answer **any five** of the following. **Each** question carries **eight** marks. **(5×8=40)**

1. a) Mention any two limitations of Bohr's atomic model.
   b) Explain Sommerfeld's relativistic atomic model. **(2+6)**

2. a) State Pauli's exclusion principle.
   b) Obtain an expression for the maximum number electrons in a given shell of quantum number 'n'. **(2+6)**

3. a) Explain quantum theory of Raman effect.
   b) Mention any two applications of Raman effect. **(6+2)**

4. a) State any two assumptions behind Rutherford's theory of α-ray scattering.
   b) Obtain the relation between the impact parameter and the angle of scattering. **(2+6)**

5. a) Derive an expression for the Q-value in alpha decay.
   b) Write a note on Geiger-Nuttal law. **(6+2)**

6. a) What is Cyclotron ?
   b) Describe the construction and working of the Cyclotron. **(1+7)**

P.T.O.

7. a) Explain the Quark model.

   b) Mention any four properties of Quarks. **(4+4)**

8. a) Define nuclear reaction rate.

   b) Distinguish between direct nuclear reaction and compound nuclear reaction. **(2+6)**

PART – B

Solve **any five** of the following problems. **Each** problem carries **four** marks. **(5×4=20)**

9. In Stern-Gerlach experiment silver atoms travel a distance of 0.16 m in a non-homogeneous magnetic medium of field gradient $60 Tm^{-1}$. If the velocity of silver atoms is $410 ms^{-1}$, calculate the separation between the two traces on a collector plate placed at a distance 0.55 m from the pole pieces of the magnet. Given : mass of silver atom = 1.79×10^{-25} kg and $\mu = 9.2 \times 10^{-24} JT^{-1}$.

10. Calculate the magnetic field required to produce a Zeeman shift of 1.2 Å for a wavelength of spectral line 5000 Å. Given : $e/m = 1.76 \times 10^{11} C kg^{-1}$.

11. Calculate the rotational constant and the diameter of CO molecule. Given : Moment of inertia of the molecule = 1.453×10^{-46} kg m^2 and reduced mass of CO molecule = 1.14×10^{-26} kg.

12. A count rate meter measured 5000 counts per minute. After 5 minutes it is 2000 counts per minute. Find the decay constant and half life.

13. Potassium-40 decays into calcium by β^- emission. Write down the equation representing this decay and find Q value of the decay.

    Given : mass of K^{40} = 39.96399 amu, and mass of Ca^{40} = 39.96259 amu, and 1 amu = 931 MeV.

14. When a beam of 10^{14} particles per unit area per second on a $_3Li^7$ target of thickness 0.004 mm, 3×10^8 neutrons were produced. Calculate the cross section for this reaction. Given : Density of Li = 500 kg m^{-3}.

15. Calculate the Q-value of the reaction $_{7}Na^{14}$ (α, p)$_{8}O^{17}$ using the given data. Mass of He^{4} = 4.0026 amu, mass of Na^{14} = 14.0031 amu, mass of $_{1}H^{1}$ = 1.0078 amu, mass of O^{17} = 16.9994 amu and 1 amu = 931 MeV.

16. Find the threshold energy of the reaction $_{3}Li^{7}$ (p, n) $_{4}Be^{7}$ in MeV. Given : Mass of Li^{7} = 7.016005 amu, mass of Be^{7} = 7.016931 amu, mass of $_{1}H^{1}$ = 1.0078 amu, mass of $_{0}n^{1}$ = 1.008665 amu, 1 amu = 931 MeV.

PART – C

Answer **any five** of the following questions. **Each** carries **2** marks. **(5×2=10)**

17. a) Does the electron in stationary orbits radiate energy ? Explain.

    b) Alpha particles have high ionizing power when compared to the Beta and Gamma particles. Explain.

    c) Can radioactivity be controlled ? Explain.

    d) Is nuclear matter behave like a liquid ? Explain.

    e) Are nuclear energy levels equally spaced ? Explain.

    f) Is photon an elementary particle ? Explain.

    g) Hyperons and K-mesons are called as strange particles. Justify.

    h) Is there conservation of charge in all interactions ? Explain.