

61621

Sixth Semester B.Sc. Degree Examination, September/October 2021

(CBCS Scheme)

Physics

Paper VII — ATOMIC, MOLECULAR AND NUCLEAR PHYSICS

Time : 3 Hours]

[Max. Marks : 70

Instructions to Candidates : Answer **FIVE** questions from each Part.

PART – A

Answer any **FIVE** of the following questions. Each question carries **8** marks :

(5 × 8 = 40)

1. (a) What are the limitations of Bohr's model of an atom?  
(b) Write a note on spatial quantization and spin of electron. (2 + 6)
2. What is Zeeman effect? Give the theory of normal Zeeman effect. (8)
3. (a) What is Raman effect? Outline the quantum theory of Raman effect.  
(b) Give any two differences between Raman scattering and Compton scattering. (6 + 2)
4. Assuming the relation between impact parameter and angle of scattering, derive Rutherford's scattering formula. (8)
5. (a) Explain the different types of beta decay.  
(b) What is Pauli's neutrino hypothesis? (6 + 2)
6. (a) Explain the construction and working of Geiger-Muller counter.  
(b) Mention any one advantage and disadvantage of Geiger-Muller counter. (6 + 2)
7. (a) What is the Q-value of nuclear reaction? Derive an expression for Q-value of nuclear reaction.  
(b) What are Exoergic and Endoergic reactions? (6 + 2)
8. (a) What are elementary particles? How the elementary particles can be classified based on (i) spin and (ii) interaction?  
(b) Mention any three properties of quarks. (5 + 3)

61621

PART - B

Solve any **FIVE** of the following problems. Each problem carries **4** marks :

(5 × 4 = 20)

9. Calculate the value of the Bohr magneton using the following data.  
 $h = 6.625 \times 10^{-34}$  J.S,  $e = 1.6 \times 10^{-19}$  C and  $m = 9.1 \times 10^{-31}$  kg.
10. In Stern-Gerlach experiment hydrogen atoms moving at 500 m/s travel through a magnetic field of length  $20 \times 10^{-2}$  m and field gradient of 10 T/S. If the separation between the two traces on the screen is  $9 \times 10^{-3}$  m, calculate the magnetic moment of hydrogen atom. Given  $1 \text{ amu} = 1.67 \times 10^{-27}$  kg.
11. Calculate the force constant of CO molecule, if the spacing between the vibrational level is 0.09 eV. Given  $1 \text{ amu} = 1.66 \times 10^{-27}$  kg. Reduced mass of CO molecule =  $1.137 \times 10^{-26}$  kg.
12. Calculate the distance of the closest approach of an alpha particle of energy 5 MeV being scattered by a gold nucleus ( $z = 79$ ).
13. Neptunium  $[_{93}\text{Np}^{237}]$  emit  $\alpha$ -particles of energy 4.19 MeV. Calculate the kinetic energy of daughter nucleus and alpha disintegration energy.
14. What is the energy to which protons can be accelerated in a cyclotron with a "Dee" of diameter 2 m and a magnetic field of 0.7 T?  
[ $e = 1.6 \times 10^{-19}$  C,  $M_p = 1.673 \times 10^{-27}$  kg]
15. The threshold energy for the reaction  $_5\text{B}^{10}(\text{P}, \text{n})_6\text{C}^{11}$  is 3.016 MeV. Find the Q-value of the reaction.  
Given : Mass of  $_5\text{B}^{10} = 10.012939$  amu, mass of proton = 1.007825 amu,  $1 \text{ amu} = 1.67 \times 10^{-27}$  kg.
16. Verify Lepton number, Baryon number, Isospin and Z-component of isospin for the following strong interaction :  
 $\pi^0 + p^+ \rightarrow \pi^+ + n$ .

PART - C

Answer any **FIVE** of the following questions. Each question carries **2** marks :

(5 × 2 = 10)

17. (a) Does an electron in the outer orbit have greater speed? Explain.  
(b) Sky appears blue most of the time. Explain.

61621

Sixth Semester B.Sc. Degree Examination, September/October 2021

- (c) Is beta spectrum discrete or continuous? Explain.
- (d) Is a free neutron a stable particle? Explain.
- (e) Does an electron exist inside the atomic nucleus? Explain.
- (f) Can we use DC potential in cyclotron? Explain.
- (g) Can Q-value of the nuclear reaction be zero? Justify.
- (h) Is photon an elementary particle? Explain.

PHYSICS

(Max. Marks : 70)

Answer any FIVE of the following questions. Each question carries 8 marks.  
(5 × 8 = 40)

- (a) What are the limitations of Bohr's model of atom?  
(2 + 6)
- (b) Write a note on special quantization and spin of electron.  
(2 + 6)
- (c) What is Compton effect? Give the theory of Compton effect.  
(8)
- (d) What is Raman effect? Give the quantum theory of Raman effect.  
(8)
- (e) Give any two examples of Compton scattering and Compton effect.  
(6 + 2)
- (f) Derive an expression for Compton shift in terms of scattering angle and wavelength of incident X-ray.  
(8)
- (g) Explain the following:  
(i) What is neutrino hypothesis?  
(6 + 2)
- (ii) Explain the  $\beta^+$  decay and working of Geiger-Müller counter.  
(6 + 2)
- (iii) Mention the advantages and disadvantages of Geiger-Müller counter.  
(6 + 2)
- (a) What is the Q-value of nuclear reaction? Derive an expression for Q-value of nuclear reaction.  
(6 + 2)
- (b) What are Exothermic and Endothermic reactions?  
(6 + 2)
- (c) What are elementary particles? How the elementary particles can be classified based on (i) spin and (ii) interaction?  
(5 + 3)
- (d) Mention any three properties of quarks.  
(5 + 3)

