61501

Fifth Semester B.Sc. Degree Examination, March/April 2021

(CBCS Scheme – Freshers – 2020-21 and onwards)

Physics

Paper V — STATISTICAL PHYSICS, QUANTUM MECHANICS – I, ATMOSPHERIC PHYSICS AND NANO-MATERIALS

Time : 3 Hours] *[Max. Marks : 70*

Instructions to Candidates : Answer any five questions from each Part.

PART – A

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

1. (a) Write any four basic postulates of statistical physics.

   (b) What is thermodynamic probability? Obtain the relation $S = K \ln \Omega$. **(4 + 4)**

2. What is meant by Fermi gas? Derive an expression for Fermi-Dirac distribution function. **(1 + 7)**

3. (a) What are bosons? Give an example.

   (b) Compare the Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac distribution functions. **(2 + 6)**

4. Describe briefly the failure of classical mechanics to explain (a) stability of atom (b) photoelectric effect. **(4 + 4)**

5. Explain with relevant theory Davisson-Germer experiment to demonstrate de-Broglie hypothesis. **(8)**

6. Define the terms : (a) Phase velocity (b) Group velocity. Derive the relation between them. **(4 + 4)**

7. What is meant by hydrostatic balance? Obtain the condition for hydrostatic balance and hence derive the expression for variation of pressure with altitude in the atmosphere. **(2 + 6)**

8. (a) Write a note on Carbon nano tube.

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

PART – B

Answer any **FIVE** of the following. Each question carries **4** marks : **(5 × 4 = 20)**

Common data :

$h = 6.625 \times 10^{-34}$ Js ; $k = 1.38 \times 10^{-23}$ JK^{-1} ; $c = 3 \times 10^{8}$ ms^{-1} ; $m_e = 9.1 \times 10^{-31}$ kg ; $m_n = 1.67 \times 10^{-27}$ kg .

9. At what temperature rms velocity of hydrogen will be double the rms velocity of oxygen at 300 K. Given molecular weight of hydrogen and oxygen are 2 and 32 respectively.

10. A system has only two particles. Show with a diagram how these particles can be arranged in three quantum states 1, 2, 3 using Bose-Einstein statistics.

11. Estimate the fraction of electrons excited above the Fermi level at room temperature for copper. Given Fermi energy of copper is 7 eV.

12. Calculate the de-Broglie wavelength of neutron of energy 28.8 eV.

13. Calculate the frequency and energy (in eV) of a photon of wavelength 4000 Å.

14. An electron has a speed of 200 ms^{-1} accurate to 0.01%. With what accuracy can we locate the position of the electron?

15. Calculate the pressure gradient force per unit mass at a hill station if the pressure gradient is 3 Pa/Km. Given air density is 1.2 Kgm^{-3}.

16. Calculate the Coriolis force at a hill station at 30°N having a zonal wind speed of 20 ms^{-1}.

PART – C

Answer any **FIVE** of the following. Each question carries **2** marks : **(5 × 2 = 10)**

17. (a) Can we use Maxwell-Boltzmann statistics to explain the properties of photon gas? Explain.

(b) Does $_2He^3$ obey Bose-Einstein statistics? Explain.

(c) An electron and a proton have same velocity, which one will have greater de-Broglie wavelength? Explain.

(d) The concept of trajectory is meaningless in quantum mechanics. Explain.

(e) Is Coriolis force maximum at the poles? Explain.

(f) In which layer of the atmosphere are the satellites placed? Explain.

(g) Can nano objects be seen by optical microscope? Explain.

(h) Fullerenes are stable physically. Why?
