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**GN-216**

V Semester B.Sc. Examination, December - 2019  
(CBCS) (F+R) (2018-19 and Onwards)

**PHYSICS - V**

**Statistical Physics, Quantum Mechanics-I, Atmospheric  
Physics And Nano-material**

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 **8** marks. **5x8=40**

**Note :** Non-programmable scientific calculators are permitted.

1. (a) Define the terms microstate and phase-space for a thermodynamic system. **2+6**  
(b) Derive the Maxwell-Boltzmann distribution law  $n_i = g_i e^{-(\alpha + \beta E_i)}$ .
2. What are bosons ? Derive Bose-Einstein's distribution law. **1+7**
3. Give an account of the failure of classical physics to explain : **4+4**  
(a) Photoelectric effect and  
(b) Atomic spectra
4. (a) From Planck's law of radiation, arrive at Rayleigh-Jean's law for energy distribution in the blackbody spectrum. **3+5**  
(b) Derive expression for the de Broglie wavelength in terms of energy of a non-relativistic particle.
5. Explain the construction and theory of Thomson's experiment, with a neat diagram. What is the significance of the result ? **7+1**
6. (a) Define the terms group velocity and phase velocity. Derive relation between them. **5+3**  
(b) Give any two mathematical forms of the Heisenberg's uncertainty principle. What is the physical significance of the principle ?

**P.T.O.**



7. Based on the vertical distribution of temperature, explain the formation of different layers in earth's atmosphere.
8. (a) What is "greenhouse effect" ? Mention any two greenhouse gases.  
 (b) Write a short note on Carbon nano-tube and Graphene.

### PART - B

Answer **any five** of the following. Each question carries **4** marks. **5x4=20**

Common data :

$$h = 6.625 \times 10^{-34} \text{ Js}, C = 3 \times 10^8 \text{ ms}^{-1}, m_e = 9.1 \times 10^{-31} \text{ kg}, m_n = 1.67 \times 10^{-27} \text{ kg},$$

$$m_p = 1.67 \times 10^{-27} \text{ kg}$$

9. A system has two particles 'x' and 'y'. Using appropriate diagram, show how they can be arranged in three quantum states according to :  
 (a) M B distribution and  
 (b) F D distribution **2+2**
10. The free electron density of silver and aluminium are  $5.85 \times 10^{28} \text{ m}^{-3}$  and  $1.8 \times 10^{29} \text{ m}^{-3}$ , respectively. Find the Fermi energy of silver, given fermi energy of aluminium is 11.63 eV.
11. Five bosons have to be distributed in two compartments having 3 and 4 cells respectively. Find the thermodynamic probability for the macro state (4, 1) and (5, 0). **2+2**
12. UV radiation has wavelength 234 nm. Find its frequency and energy (eV). **2+2**
13. For proton and electron to have same de Broglie wavelength, compare their speeds.
14. Calculate the earth's atmospheric pressure at an altitude of 1 km. Given  $R = 8.31 \text{ Jmol}^{-1}\text{K}^{-1}$ ,  $g = 9.8 \text{ ms}^{-2}$ ,  $t = 12^\circ\text{C}$ , Mean molar mass of air  $= \mu = 29 \text{ g/mol}$  and 1 atm pressure  $= 1.013 \times 10^5 \text{ Pa}$ .
15. A layer in the earth's atmosphere has thickness 225 m, density  $0.15 \text{ kg m}^{-3}$  on which radiation is incident at angle  $65^\circ$ . Calculate the absorbance and the optical thickness of the layer.
16. Find the total mass of air present in the earth's atmosphere. Assume pressure of air at mean sea level  $= 1.013 \times 10^5 \text{ Pa}$ ,  $g = 9.8 \text{ ms}^{-2}$  and the radius of earth  $= 6400 \text{ km}$ .

**PART - C**

Answer **any five** of the following. Each question carries **2** marks.

**5x2=10**

17. (a) The isotopes  ${}^3_2\text{He}$  and  ${}^4_2\text{He}$  obey which distribution law at low temperature ?
- (b) In metals, what is the occupation index :  
(i) Below Fermi energy and  
(ii) Above Fermi energy.
- (c) Can we use M-B statistics to explain the properties of photon gas ?
- (d) Two particles have same mass and speed, with one of them charged and the other neutral. Can they have same de Broglie wavelength ? Justify your answer.
- (e) Wave nature of matter is not observed in bulk bodies. Why ?
- (f) 'Quantum dot is zero dimensional'. Justify.
- (g) Electrically and thermally, what is remarkable about Graphene ?
- (h) Is nano gold yellow in colour ? Justify.

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