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Reg. No. : ....

Name : ....

Second Semester M.Sc. Degree Examination, April 2023.

Physics With Specialization In Nano Science/Physics With Specialization In Space Physics

PHNS 522/PHSP 522 : THERMODYNAMICS, STATISTICAL PHYSICS AND BASIC QUANTUM MECHANICS

(2020 Admission Onwards)

Time : 3 Hours Max. Marks : 75

SECTION – A

Answer any **five** questions. **Each** question carries **3** marks.

1. What are thermodynamic potentials? Express relations of any two of them to the thermodynamic variables.

2. Define and hence distinguish between the microcanonical, canonical and grand canonical ensembles.

3. Define density matrix. How is the principle of detailed balance reflected in the density matrix?

4. Distinguish between first and second order phase transitions. Give one example each.

5. State the basic postulates of quantum mechanics.

6. Bring out the qualitative difference between the Schrodinger, Heisenberg and interaction pictures.

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7. Comment on the wavefunction for a free particle in 3D and its normalization.

8. What is the simple schematic form suggested for the potential function for a deuteron. Write down the Schrodinger equation for the deuteron in its potential well.

(5 × 3 = 15 Marks)

SECTION – B

Answer **all** questions, **Each** question carries **15** marks.

9. (a) State Nernst heat theorem and briefly describe its consequences.

(b) Explain Gibb's phase rule. Give an example of its use.

OR

10. (a) State Liouville's theorem and briefly describe its consequences.

(b) Explain Gibb's paradox and also its resolution.

11. (a) Illustrate how quantum statistics was able to explain the behaviour of the electron gas in metals.

(b) Explain phase space.

OR

12. (a) Define the Ising model.

(b) Illustrate the usefulness of Ising model in analysing phase transitions.

13. (a) Derive the general uncertainty relation regarding measurements made on two variables.

(b) Hence obtain the position momentum uncertainty relation.

OR

14. (a) Solve the rigid rotator problem.

(b) What is its application in spectral studies?

(3 × 15 = 45 Marks)

SECTION – C

Answer **any three** questions. **Each** question carries **5** marks.

15. Assuming that the latent heat of sublimation of ice L = 2500 kJ/kg is independent of temperature and that the specific volume of the solid phase is negligible compared to the specific volume of the vapour phase, $v_{vapour} = \frac{kT}{P\sigma(T)}$, integrate the Clausius - Clapeyron equation $\frac{dP\sigma}{dT} = \frac{L}{T\Delta v}$ to obtain the co-existence pressure as a function of temperature.

16. Obtain an expression for the Helmholtz free energy of a classical ideal gas in terms of its partition function.

17. Calculate the Fermi energy of sodium at 0 K if it has one free electron per atom and density 970 kg/m^3 and atomic weight 23.

18. The Sun may be regarded as a black body at a temperature 5800 K. Its diameter is about 1.4×10^9 m while its distance from the earth is about 1.5×10^{11} m. Calculate the total radiant intensity in W/m^2 of sunlight at the surface of the earth.

19. Obtain the eigen value equation in matrix form. Delineate how eigen values and eigen functions are obtained.

20. Following the operator method show that the energy of the ground state of a simple harmonic oscillator is equal to $\frac{1}{2}\hbar\omega$.

(3 × 5 = 15 Marks)
