

B. ETCE 1ST YEAR 1ST. SEM. SUPPLEMENTARY EXAM. – 2017

PHYSICS – IB

Time: 3 hours

Full Marks: 100

Answer any five questions.

1. a) Obtain the Hamilton's equation of motion of a system. How many equations will you get when the number of generalized coordinates is 1?
 b) Show that Hamiltonian is the total energy of the system. If Hamiltonian is not explicit function of time, then prove that it is conserved.

$$10 + (5+5) = 20$$

2. a) Find unit vector in cylindrical coordinate system. Prove that they are orthogonal to each other.

b) For $\vec{A} = z \hat{i} - 2x \hat{j} + y \hat{k}$, find A_ρ, A_ϕ and A_z .

c) Find $\vec{\nabla} \phi(r)$ for $\phi = \frac{1}{r}$. Prove that $\vec{\nabla} \times \vec{\nabla} \phi = 0$.

$$10 + 5 + 5 = 20$$

3. a) What do you mean by generalized coordinates? Determine the number of generalized coordinates to describe the motion of a particle moving in a plane.

b) What do you mean by cyclic coordinate? The Lagrangian of a body moving under central force field is given by $L = \frac{1}{2} \mu \dot{r}^2 + \frac{1}{2} \mu r^2 \dot{\theta}^2 - V(r)$. Identify the cyclic coordinate.

c) Hence prove that the angular momentum of the body moving under central force field is conserved.

d) Find the Lagrangian and Hamiltonian of a simple harmonic oscillator. Obtain the differential equation of motion of a simple harmonic oscillator from its Lagrangian.

$$(2+2) + 4 + 6 + 6 = 20$$

4. a) What do you mean by ensemble in statistical mechanics? Identify the differences among micro-canonical, canonical and grand-canonical ensembles.

b) Differentiate between closed and isolated system. Give one example for each system.

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c) What do you mean by phase space? Consider a system of N number of gas molecules. Write down the expression for infinitesimal volume element of phase space for this system.

d) Write down equipartition theorem.

$$5+4+(3+5)+3=20$$

5. a) Define entropy of a system. Calculate the change in entropy of a perfect gas between two stages of an isothermal changes.

b) Why change in entropy in an adiabatic reversible process is zero?

c) Differentiate between reversible and irreversible process?

d) Differentiate between enthalpy and internal energy.

$$8+3+4+5 = 20$$

6. a) Show the equivalence of Kelvin-Planck and Clausius statements.

b) State and prove Carnot's Theorem.

c) Explain the concept of entropy from Clausius inequality theorem.

d) Why entropy of the universe is always increasing?

$$5+6+5+4=20$$

7. a) State and explain briefly the first law of thermodynamics.

b) Derive the expression for ideal gas for the adiabatic expansion in terms of pressure, volume and the ratio of specific heats.

c) Why internal energy remains constant during isothermal expansion of an ideal gas?

d) Explain briefly about the Carnot cycle with diagram.

$$4+6+3+7=20$$

8. a) Write down (i) Stoke's theorem, and (ii) Gauss's divergence theorem in vector analysis.

b) Show that the slope of the adiabatic curve through a point on the P-V diagram of a perfect gas is γ times the slope of the isothermal curve through the same point.

$$(6+6)+8 = 20$$