



'সমানো মন্ত্র: সমিতি: সমানী'

UNIVERSITY OF NORTH BENGAL
B.Sc. Honours 1st Semester Examination, 2023

GE1-P1-PHYSICS

Time Allotted: 2 Hours

Full Marks: 40

The figures in the margin indicate full marks.

The question paper contains GE-1A and GE-1B. Candidates are required to answer any *one* from the *two* courses and they should mention it clearly on the Answer Book.

GE-1A

MECHANICS

GROUP-A

1. Answer any **five** questions from following: 1×5 = 5
- (a) What is Solenoid Vector?
 - (b) What is epoch of a SHM?
 - (c) What do you mean by elastic limit?
 - (d) If $\vec{A} = 2\hat{i} - 3\hat{j} + 6\hat{k}$ and $\vec{B} = a\hat{i} + \hat{j} + \hat{k}$ are perpendicular to each others, then find the value of a .
 - (e) Draw the graph how Gravity of hollow sphere is changed with distance.
 - (f) Write down the unit and dimension of strain.
 - (g) Define the term initial frame of reference.
 - (h) Define centre of mass of a system.

GROUP-B

Answer any *three* questions from the following 5×3 = 15

2. What is S.H.M.? Show that total energy of a S.H.M. is conserved. 1+4
3. (a) If $|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$, prove that \vec{A} and \vec{B} are perpendicular to each other. 2 $\frac{1}{2}$ +2 $\frac{1}{2}$
- (b) Find $\vec{\nabla} \cdot \vec{A}$ at point (1, 1, 1), where $\vec{A} = x^2y\hat{i} - 2y^3z^2\hat{j} + xy^2z\hat{k}$.
4. (a) Weightlessness in Artificial Satellite. Explain. 3+2
- (b) Why Noble gases are not found in Earth?

5. Solve the following differential equations. 5
 $y^2 y' - x^2 = 0$ given that $y(1) = 0$
6. (a) Write down the principle of conservation of angular momentum. 3+2
 (b) Establish the relation between torque and angular acceleration.

GROUP-C

Answer any *two* questions from the following

10×2 = 20

7. (a) Establish the differential equation of S.H.M. and find the solution of the equation. (2+4)+4
 (b) Show that a particle executing simple harmonic motion obeys the relationship $\omega^2 v^2 + f^2 = a^2 \omega^2$ where a, ω, v, f are amplitude, frequency of the oscillator and velocity and acceleration of the particle respectively.
8. (a) Define Young's Modulus. Find its dimension. (2+1)+4+3
 (b) Deduce an expression for the amount of energy stored in an elastic body due to longitudinal strain.
 (c) If radius of a cylindrical wire is made to be half and the length has been made double, calculate the change in Young's modulus of the wire.
9. (a) Prove that $\vec{\nabla} \times \vec{\nabla} \times \vec{A} = \text{grad div } \vec{A} - \nabla^2 \vec{A}$. 4+4+2
 (b) Show that the vectors $\vec{A} = 3\hat{i} - 2\hat{j} + \hat{k}$, $\vec{B} = \hat{i} - 3\hat{j} + 5\hat{k}$ and $\vec{C} = 2\hat{i} + \hat{j} - 4\hat{k}$ form a right angled triangle.
 (c) What do you mean by scalar triple product?
- 10.(a) State Kepler's laws of planetary motion. 2+3+5
 (b) Show that areal velocity of a particle moving in a central force field is always constant.
 (c) Determine the gravitational field at a point
 (i) outside
 (ii) inside
 (iii) on the surface of a hollow and thin spherical shell.

GE-1B

GROUP-A

1. Answer any *five* questions from the following: 1×5 = 5
 (a) What is the dimension of Boltzmann constant?
 (b) Pauli's exclusion principle applies to the particles which follow:
 (i) MB-statistics (ii) BE-statistics
 (iii) F-D statistics (iv) Both BE and FD statistics

- (c) Define quasi-static process.
- (d) What is ultraviolet catastrophe in Blackbody radiation?
- (e) What do you understand by principle of equipartition of energy?
- (f) What is reflection coefficient for a perfect blackbody?
- (g) Define Fermi temperature.
- (h) Name two particles which follows Bose-Einstein statistics.

GROUP-B

Answer any *three* questions from the following

5×3 = 15

- 2. Calculate the efficiency of Carnot's engine. 5
- 3. (a) Show that an adiabatic curve is steeper than the isothermal curve. 3
 (b) What do you understand by isentropic process? Give one example. 2
- 4. Find the number of possible arrangement of 3-particles in two states assuming the particles obey 5
 (i) MB-statistics (ii) BE-statistics, and (iii) FD-statistics
- 5. (a) Write down the Maxwell's velocity distribution law and show the graphical representation. 3
 (b) Calculate the most probable speed from the distribution law. 2
- 6. (a) Define entropy of a system. 1
 (b) 50 gm of water of 50°C is mixed with 100 gm of ice. Calculate the temperature of the mixture. 4

GROUP-C

Answer any *two* questions from the following

10×2 = 20

- 7. (a) Show that heat cannot flow from a colder body to a hotter body naturally. 3
 (b) The temperature of a blackbody is 5450 K. Find out the wavelength corresponding to maximum energy in radiated spectrum. 3
 (c) Calculate the degrees of freedom of a linear triatomic molecule. 1
 (d) At what temperature will average speed of molecule of hydrogen gas be double the average speed of oxygen at 300 K. 3
- 8. (a) Explain the first law of thermodynamics. What are the limitations of this law? 2+2
 (b) Show that the change in entropy in reversible process vanishes. 3
 (c) Using kinetic theory of gas, show that $P = \frac{1}{3} \rho c^2$, where ρ = density of the gas 3
 c = rms speed.

9. (a) Derive Maxwell's thermodynamic relation $\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$. 5

(b) Show that for van der Waal's gas 5

$$C_P - C_V = R\left(1 + \frac{2a}{RTV}\right)$$

Where, symbols have their usual meaning.

10.(a) What is electron gas? Give example. 3

(b) Show that from the probability distribution of BE and FD statistics, the MB statistics is the limiting case of both BE and FD statistics. 3

(c) Calculate the probability of finding an electron with energy 6 eV in an electron gas at 1000°C when the Fermi energy of the gas is 6 eV. 4

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