



‘সমানো মন্ত্র: সমিতি: সমানী’

UNIVERSITY OF NORTH BENGAL
B.Sc. Honours 1st Semester Examination, 2022

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

Answer any *five* questions from the following

1×5 = 5

1. If $\vec{A} = 3\hat{i} + 4\hat{j} + \hat{k}$ and $\vec{B} = \hat{i} + 5\hat{j} - \hat{k}$, then calculate $(\vec{A} \times \vec{B})$. 1
2. What does ‘rotational invariance of space’ imply? 1
3. What is meant by a conservative force? 1
4. Find out the dimension of modulus of rigidity. 1
5. Write down the differential equation of a simple harmonic motion. 1
6. What do you understand by the centre of mass of a system of particles? 1
7. Give an example of inertial frame of reference. 1
8. Write the expression of relativistic addition of two velocities. 1

GROUP-B

Answer any *three* questions from the following

5×3 = 15

9. (a) For what value of m , the two vectors $\vec{A} = m\hat{i} + 5\hat{j} + 3\hat{k}$ and $\vec{B} = -2\hat{i} + \hat{j} - \hat{k}$ will be perpendicular to each other? 3
- (b) If $|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$, then prove that \vec{A} and \vec{B} are perpendicular to each other. 2

10. For a particle subjected to a central force prove that:
- (a) the particle moves in a fixed plane. 2
 - (b) the areal velocity of the radius vector remains constant. 3
11. On the basis of Lorentz transformation explain:
- (a) length contraction $2\frac{1}{2}$
 - (b) time dilation. $2\frac{1}{2}$
12. Solve the following differential equation: 5
 $y^2y' - x^2 = 0$ given that $y(1) = 0$.
13. A particle of mass 2 kg is initially at rest at co-ordinates $(-2, +4)$ m. At $t = 0$ it is acted upon by two forces $\vec{F}_1 = (-6\hat{i} - 4\hat{j})\text{N}$ and $\vec{F}_2 = (-3\hat{i} + 7\hat{j})\text{N}$
 Examine the system and work out:
- (a) the velocity of the particle, in vector component form, at $t = 10$ sec. 3
 - (b) the displacement of the particle, in vector component form at $t = 10$ sec. 2

GROUP-C

Answer any two questions from the following

10×2 = 20

- 14.(a) Derive an expression for the total energy of a harmonic oscillator. 4
 (b) What are the characteristics of SHM? 2
 (c) A body executes SHM of amplitude 1.0 cm and frequency 12 cycles/second. What is the velocity when displacement is 0.5 cm? 4
- 15.(a) Define elastic limit, perfect elasticity and Poisson's ratio. Write the relation between Young's modulus (Y), Bulk's modulus (k) and Poisson's ratio. 5+2
 (b) If the Young's modulus (Y) and Bulk's modulus of elasticity (k) for silver be 7.25×10^{11} dyne/cm² and 11×10^{11} dyne/cm² respectively, find the Poisson's ratio for silver. 3
16. Write short notes on:
- (a) Twisting couple on a cylinder 5
 - (b) Kepler's law of planetary motion. 5
- 17.(a) Show that if the total torque acting on a particle is zero then, the angular momentum is always conserved. 3
 (b) Given, $\vec{A} = x^2z\hat{i} - 2y^3z^3\hat{j} + xy^2z\hat{k}$, find $\nabla \cdot \vec{A}$ at the point $(0, 1, 1)$. 2
 (c) Prove that: $\vec{A} \times (\vec{B} \times \vec{C}) + \vec{B} \times (\vec{C} \times \vec{A}) + \vec{C} \times (\vec{A} \times \vec{B}) = 0$ 5

GE-1B

THERMAL PHYSICS AND STATISTICAL MECHANICS

GROUP-A

1. Answer any *five* questions from the following: 1×5 = 5
- (a) What are extensive thermodynamic variables? Give an example.
 - (b) Write the dimension of entropy.
 - (c) Why C_p is greater than C_v ?
 - (d) In cyclic process write the form of first law of thermodynamics.
 - (e) What is the relation between mean free path and density of a gas?
 - (f) Write the physical significance of entropy.
 - (g) Give an example of second order phase transition.
 - (h) Draw indicator diagram for isochoric process.

GROUP-B

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

2. (a) Find the expression of work done during adiabatic process. 3
 (b) 5.6 litre of helium gas at STP is adiabatically compressed to 0.7 litre. Taking the initial temperature T_1 , find the expression of work done in the process. 2
 Given $\gamma = 5/3$.
3. (a) Show that for an irreversible thermodynamic process change in entropy is positive. 4
 (b) State the third law of thermodynamics. 1
4. Prove the first $T-dS$ equation 5

$$TdS = C_v dT + T\alpha E_T dV$$
 Where, α is the volume coefficient expansion, $E_T =$ Thermal elasticity.
5. Find the coefficient of viscosity of a gas due to transport phenomena for vertical case. 5
6. (a) State and explain law of equipartition of energy. 2
 (b) A system is composed of two level atoms, the excited state is 0.1 eV above the ground state. At $t = 27^\circ\text{C}$ find the fraction of atoms at the first excited state. 3

GROUP-C

Answer any *two* questions from the following

10×2 = 20

7. (a) Represent a Carnot cycle on (i) P-V diagram (ii) T-S diagram and hence find the efficiency of a Carnot cycle. 1 $\frac{1}{2}$ + 2 $\frac{1}{2}$
- (b) Show that working between the same temperature, no heat engine can be more efficient than a reversible one. 3
- (c) A Carnot engine has an efficiency of 30%. Its efficiency is to be increased to 50%. By what must the temperature of the source be increased if the sink is at temperature 300 K? 3
8. (a) Establish Maxwell's four thermodynamic relations. 6
- (b) Prove that: (i) $U = \left\{ \frac{\partial(F/T)}{\partial(1/T)} \right\}_V$ (ii) $F = \left\{ \frac{\partial(G/P)}{\partial(1/P)} \right\}_T$ 2+2
9. (a) What are assumptions of MB-Statistics? 3
- (b) An ideal gas containing N -particles at $T = 300$ K, obeys the MB-Statistics. Calculate 3+2+2
- (i) Average thermal energy in eV.
- (ii) Internal energy and
- (iii) Heat capacity at constant volume.
- 10.(a) State Wien's displacement law and explain in graph for the two different temperatures. 3
- (b) Derive the expression for Joule-Thomson coefficient. 5
- (c) Define inversion temperature and Boyle temperature and write the relation between this two temperatures. 2

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