



‘समानो मन्त्रः समितिः समानी’

UNIVERSITY OF NORTH BENGAL

B.Sc. Honours 3rd Semester Examination, 2022

GE2-P1-PHYSICS

Time Allotted: 2 Hours

Full Marks: 40

**The question paper contains GE-3A and GE-3B.
The candidates are required to answer any *one* from *two* courses.
Candidates should mention it clearly on the Answer Book.**

GE-3A**MECHANICS****GROUP-A**

1. Answer any *five* questions: 1×5 = 5
- (a) Write down the dimension of the gravitational constant ‘ G ’. 1
- (b) Calculate the magnitude of the summation of the following two vectors: 1
- $$\vec{A} = 5\hat{i} + 6\hat{j} + 8\hat{k} \quad \text{and} \quad \vec{B} = 3\hat{i} + 7\hat{j} - 10\hat{k}$$
- (c) What do you mean by the term ‘axial vector’? Mention an example of an axial vector. 1
- (d) Define shearing stress. 1
- (e) What do you mean by central force? 1
- (f) What do you mean by the geosynchronous orbit of a satellite around the earth? 1
- (g) The equation of a particle vibrating simple harmonically is given by, 1

$$x = 10 \sin(\omega t + \pi/3) m .$$

What is the significance of $\pi/3$ occurring in the argument of sine?

- (h) Write down the order and degree of the following differential equation. 1

$$\left(\frac{d^3y}{dx^3}\right)^2 + \left(\frac{d^2y}{dx^2}\right)^4 + xy = 0$$

GROUP-B**Answer any *three* questions****5×3 = 15**

2. (a) Find out the general solution of the differential equation 3
- $$\frac{d^2y}{dx^2} - 5\frac{dy}{dx} + 6y = 0$$
- (b) Show that the vectors $\vec{a} = -\hat{j} + 2\hat{k}$, $\vec{b} = \hat{i} - 2\hat{j} + 3\hat{k}$ and $\vec{c} = -2\hat{i} + 3\hat{j} - 4\hat{k}$ are coplanar. 2

3. (a) State Kepler's laws in connection with planetary motion. 3
 (b) If the distance between the sun and the earth is reduced to half of their present distance, what will be the length of the year? 2
4. (a) A circular disc of mass m and radius r is set rolling on a table. If ω be the angular velocity, show that the total energy of the disc is given by, 3

$$E = \frac{3}{4} m \omega^2 r^2 .$$

 (b) Establish the relationship between the torque and the angular momentum. 2
5. (a) Define the modulus of rigidity of an elastic material. 1
 (b) Show that, for a homogeneous elastic medium 4

$$Y = 3k(1 - 2\sigma)$$

 where the symbols have their usual meaning.
6. (a) Derive an expression for the energy stored in an elastic body subjected to a longitudinal strain. 2
 (b) If $3f + 12x = 0$, be the equation of motion of a particle, oscillating simple harmonically find out its time period. Here f and x representing the acceleration and the displacement of the particle, respectively. 3

GROUP-C

Answer any two questions

10×2 = 20

7. (a) Show that the total mechanical energy of a particle moving in simple harmonic motion is constant with respect to time. 3
 (b) If the earth suddenly contracts to $\frac{1}{64}$ th of its initial volume keeping its mass constant, what will be the length of the day? 2
 (c) Show that the areal velocity of a particle moving under central force is constant. 3
 (d) Write the applications of GPS system. 2
8. (a) Write down the postulates of Einstein's special theory of relativity. 2
 (b) Two particles are moving with equal velocity $0.8c$ towards each other. Calculate their relative velocity. 3
 (c) Explain the phenomenon of length contraction in special theory of relativity and find out the relation between the length of a rod (L) moving with velocity v and its proper length (L_0). 3
 (d) Explain the phenomenon of damped oscillations. 2

9. (a) Show that the torsional rigidity of a cylindrical wire is given by $\frac{\pi\eta R^4}{2l}$ 5

where, η = Modulus of rigidity of the material of the wire,

R = Radius of the wire,

l = Length of the wire.

- (b) Show that, the energy stored in unit volume in an elastic body under shearing strain is equal to $\frac{1}{2} \times \text{Shearing stress} \times \text{Shearing strain}$. 3
- (c) Mention the theoretical limiting values of Poisson's ratio. 1+1
Does Poisson's ratio have negative value? Justify your answer.
- 10.(a) Write down Lorentz transformation equations for a particle in S' -frame moving w.r.t. S-frame. 2
- (b) Calculate the gradient of the scalar function 3
 $\phi(x, y, z) = 4e^{(2x-y+z)}$ at the point (1, 1, -1)
- (c) What do you mean by frame of reference? Differentiate between inertial frame of reference and non-inertial frame of reference. 1+2
- (d) Explain the phenomenon of weightlessness in the space-ship. 2

GE-3B

THERMAL PHYSICS AND STATISTICAL MECHANICS

GROUP-A

1. Answer any *five* questions from the following: 1×5 = 5
- (a) Write down the ratio of the r.m.s velocity and the most probable velocity of an ideal gas particle. 1
- (b) What is a heat engine? 1
- (c) State Wien's displacement law. 1
- (d) Write down the dimension of entropy. 1
- (e) What are bosons? 1
- (f) What is the reflective power of a perfect black body? 1
- (g) Define the Fermi temperature. 1
- (h) What do you mean by quasi static process? 1

GROUP-B

Answer any *three* from the following

5×3 = 15

2. (a) Explain isothermal process. 2
(b) Show that for an idea gas C_p is greater than C_v . 3
3. (a) Show that an adiabatic curve is γ times steeper than an isothermal curve. 3
(b) What is free expansion? Is it an adiabatic process? Explain. 2
4. (a) Define mean free path of a gas molecule. Show that it is equal to $\frac{1}{\pi n d^2}$, where n is the number of molecules per unit volume and d is the diameter of each molecules. 1+3
(b) State the principle of equipartition of energy. 1

5. (a) Give three examples of fermions. 1
 (b) Discuss the difference between the three fundamental statistics. 4
 (i) M.B – Maxwell Boltzmann.
 (ii) B.E – Bose-Einstein
 (iii) F.D – Fermi-Dirac.
6. (a) Define the Latent heat of sublimation. 1
 (b) Deduce the Clausius-Clapeyron's equation for a liquid. From this equation 2+2
 explain the variation of boiling point of that liquid on its pressure.

GROUP-C

Answer any two questions from the following

10×2 = 20

7. (a) Distinguish between extensive and intensive variables. Give example. 2
 (b) Represent (i) an isobaric process and (ii) an isochoric process on a P - V diagram. 2
 (c) Show that for an adiabatic process $TV^{\gamma-1} = \text{constant}$, where the symbols have 3
 their usual meanings.
 (d) A motor car tyre has a pressure of 2 atmospheres at the room temperature of 27°C. If the tyre suddenly bursts find out the resulting temperature. 3
8. (a) Explain first law of thermodynamics. What are the limitations of that law? 2+2
 (b) Show that for a perfect gas $\left(\frac{\partial U}{\partial V}\right)_T = 0$. 3
 (c) Show that the change in entropy in a reversible process is zero. 2
 (d) "For a system entropy is increasing". What does it mean? 1
9. (a) State Planck's law of radiation. 2
 (b) Using dimensional analysis establish the Stefan-Boltzmann law. 3
 (c) What is the limitation of Newton's law of cooling? 1
 (d) Show that the radiation pressure $P = \frac{u}{3}$, u is the energy density. 4
- 10.(a) Calculate the change in entropy when 2 gm of ice melt's into water at the same 3
 temperature. The latent heat of ice 80 cal/gm.
 (b) Using T-S diagram derive an expression for the efficiency of Carnot's engine. 4
 (c) Write down the statements of the second law of thermodynamics and show that 3
 they are equivalent.

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