



UNIVERSITY OF NORTH BENGAL
B.Sc. Honours 3rd Semester Examination, 2019

GE-PHYSICS

Time Allotted: 2 Hours

Full Marks: 40

*The figures in the margin indicate full marks.
Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.*

**The question paper contains GE3A and GE3B.
The candidates are required to answer any *one* from *two* courses.
Candidates should mention it clearly on the Answer Book.**

GE3A

MECHANICS

GROUP-A

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| 1. Answer any <i>five</i> questions from the following: | 1×5 = 5 |
| (a) What is Geosynchronous orbit? | 1 |
| (b) Define shearing stress. | 1 |
| (c) What is solenoidal vector? | 1 |
| (d) Explain the term 'Ether' in Michelson-Morley Experiment. | 1 |
| (e) Define the term Resonance. | 1 |
| (f) What is the difference between impulse of force and impulsive force? | 1 |
| (g) Write the dimension of torque. | 1 |
| (h) Write down the most general form of a homogeneous first order differential equation. | 1 |

GROUP-B

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| Answer any <i>three</i> questions from the following | 5×3 = 15 |
| 2. (a) A linear harmonic oscillator is characterized by $y = a \cos \omega t$. Calculate the displacement at which K.E. is equal to its P.E. | 2 |
| (b) What is damped vibration? How does it differ from free vibration? | 1+2 = 3 |
| 3. (a) Show that the vectors $\vec{a} = \hat{i} - 2\hat{j} + 3\hat{k}$, $\vec{b} = -2\hat{i} + 3\hat{j} - 4\hat{k}$ and $\vec{c} = -\hat{j} + 2\hat{k}$ are coplanar. | 2 |
| (b) Find the gradient of the scalar function $\phi(x, y, z) = 4e^{(2x-y+z)}$ at the point (1, 1, -1). | 3 |

4. (a) State Kepler's laws in connection with planetary motion. 3
 (b) A disc of mass 50 g and radius 2 cm is rolling down with linear velocity 5 cm/s. Find out its linear and rotational kinetic energy. 2
5. (a) Find the general solution of differential equation $\frac{d^2y}{dx^2} - 5\frac{dy}{dx} + 6y = 0$. 3
 (b) Establish the relation between total energy and momentum of a relativistically moving body. 2
6. (a) Derive an expression for the energy stored in an elastic body in the case of longitudinal strain. 2
 (b) The compressibility of water is 44×10^{-6} / atm, if 125 atm pressure is applied to 200 cc of water, then find the volume compressed. 3

GROUP-C

Answer any two questions from the following

10×2 = 20

7. (a) Write down Lorentz transformation equations. 2
 (b) On the basis of Lorentz transformation, discuss 'Time dilation'. 4
 (c) A spaceship of rest length 120 m passes an observer on earth in 4.5 μ s. Find the velocity of the spaceship with respect to the earth. 4
8. (a) A force $\vec{F} = 3\hat{i} + 2\hat{j} - 4\hat{k}$ is applied at the point (1, -1, 2). Find the moment of the force about the point (2, -1, 3). 3
 (b) Determine the height of the Geosynchronous Satellite from the earth surface. 4
 (c) Prove Newton's 3rd law of motion from the conservation principle of linear momentum. 3
9. (a) If the distance between the Sun and Earth is reduced to half of their present distance. What will be the length of the year? 3
 (b) If the length of a simple pendulum is increased by 75%. Find the percentage increase in its time period. 3
 (c) Prove that the resultant motion of two Simple Harmonic Motion's having same period and amplitude but a phase difference of $\pi/2$ is circular. 4
- 10.(a) Show that the torsional couple per unit twist of a wire is $\frac{\pi\eta r^4}{2l}$, where the symbols are their usual meanings. 4

- (b) A wire of 50 cm length and 1 mm^2 cross-sectional area has Young's modulus of $1.24 \times 10^{12} \text{ dyne/cm}^2$. Find out workdone to increase its length by 1 mm. 3
- (c) Show that Poisson's ratio σ lies between -1 to $\frac{1}{2}$. 3

GE3B

THERMAL PHYSICS AND STATISTICAL MECHANICS

GROUP-A

1. Answer any *five* questions from the following: 1×5 = 5
- (a) State the principle of equipartition of energy. 1
 - (b) What is the change of internal energy in a reversible cycle? 1
 - (c) State Wien's displacement law. 1
 - (d) What is the dimension of the entropy? 1
 - (e) State the Carnot theorem. 1
 - (f) What is the reflective power of a perfect black body? 1
 - (g) Write down the expression for "pressure of radiation". 1
 - (h) What is the value of $\ln 10!$ according to the Stirling's formula? 1

GROUP-B

Answer any *three* questions from the following

2. (a) What is free expansion? Is it an adiabatic process? 5×3 = 15
1+1
- (b) Show that for an ideal gas, the internal energy depends only on the temperature not on pressure and/or volume. 3
3. (a) What is the meaning of mean free path of the molecules of a gas? 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) Write down the relation between the coefficient of viscosity and thermal conductivity of a gas? 1
4. (a) What are bosons? Give examples. 1+1
- (b) Discuss the difference between the Fermi-Dirac and the Bose-Einstein statistics. 3
5. (a) Mention the physical significance of the Gibb's potential. 2
- (b) Show that the ratio of the adiabatic to isothermal elasticity is γ . 2
- (c) Write down the Clausius-Clapeyron equation of state. 1

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| 6. (a) State Kirchhoff's law of radiation. | 1 |
| (b) Using dimensional analysis establish the Stefan-Boltzmann law. | 3 |
| (c) What is the limitation of Newton's law of cooling? | 1 |

GROUP-C**Answer any two questions from the following****10×2 = 20**

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| 7. (a) Distinguish between extensive and intensive variables. Give examples. | 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 their usual meaning. | 3 |
| (d) Find the work done in compressing 1 gm of air adiabatically at NTP (initially) to half of its original volume. The density of air at NTP = 0.000129 gm/cc and $\gamma = 1.4$. | 3 |
| 8. (a) If ' αdt ' be the probability of a gas molecule making a collision in the time interval ' dt ', then find the probability of a molecule experiencing no collision during the interval ' t '. | 3 |
| (b) At what temperature will average speed of molecules of hydrogen gas be double the average speed of oxygen at 300 K. | 3 |
| (c) Calculate the degrees of freedom of a linear triatomic molecule. | 2 |
| (d) Show that $\gamma = 1 + \frac{2}{f}$, where the symbols have their usual meaning. | 2 |
| 9. (a) Calculate the change in entropy when 2 gm of ice melt's into water at the same temperature. The latent heat of ice 80 cal/gm. | 3 |
| (b) Using Maxwell's thermodynamical relation, prove that for a Van der Waals gas | 4 |
| $C_P - C_V = R \left(1 + \frac{2a}{RTV} \right)$ | |
| (c) Give two statements of second law of thermodynamics and show that they are equivalent. | 3 |
| 10. (a) Discuss on the conditions for the application of Maxwell-Boltzmann statistics. | 2 |
| (b) The Fermi velocity of the electron in a metal is 0.7×10^6 m/s. Calculate the Fermi velocity. | 3 |
| (c) Show that adiabatic curves are steeper than the isothermal ones. | 2 |
| (d) Using Maxwell's thermodynamic relations show that the ratio of adiabatic to isobaric volume expansivity is $\frac{1}{1-\gamma}$. | 3 |

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