NS – 284

I Semester B.Sc. Examination, November/December 2016
(CBCS Fresh – 2016-17 and Onwards)
PHYSICS – I
Mechanics I, Heat and Thermodynamics – I

Time : 3 Hours Max. Marks : 70

Instruction : *Answer* ***five*** *questions from* ***each*** *Part.*

PART – A

Answer **any five** questions. **Each** question carries **eight** marks. **(5×8=40)**

1. a) State Newton's second law of motion.

   b) Define terminal velocity of a body falling under gravity in a resistive medium.

   c) Assuming the expression for instantaneous velocity of a body falling under gravity in a resistive medium at low speed, derive the expression for its instantaneous acceleration. **(2+2+4)**

2. a) State Kepler's laws of planetary motion.

   b) Define escape velocity of an object from a planet's surface and derive an expression for the same. **(3+5)**

3. a) State and explain work energy theorem.

   b) Derive an expression for the potential energy of a spring when it is stretched through a distance x from its unstretched position x = 0. **(2+6)**

4. Derive Planck's radiation formula in terms of frequency of radiation . **8**

5. a) Derive an expression for the mean (average) velocity of a gas molecule on the basis of Maxwell's law of distribution of molecular velocities.

   b) Deduce the perfect gas equation from the equation $PV = \frac{1}{3} mnc^2$ where the symbols have their usual meaning. **(4+4)**

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6. a) Define critical temperature of a real gas.

   b) Derive the expressions for critical volume and critical temperature of a real gas in terms of the Vander Waal's constants a and b. **(2+6)**

7. a) State First Law of thermodynamics and apply the same to an isochoric process.

   b) Derive the expression for work done by n moles of an ideal gas in an isothermal process. **(4+4)**

8. a) State Clausius's statement of second law of thermodynamics.

   b) Describe the construction and working of a Carnot's engine. Write the expression for its efficiency in terms of heat absorbed from the source and rejected to the sink. **(2+6)**

PART – B

Solve **any five** of the following problems. **Each** problem carries **four** marks. **(5×4=20)**

9. A block of mass 1 kg is placed on a horizontal surface. The coefficient of static friction between the block and the surface is 0.2. If an external force of 3 N is applied on the block parallel to the surface, find the acceleration of the block. Given $g = 10\ ms^{-2}$.

10. Calculate the magnitude of the gravitational intensity due to a solid sphere of mass 5000 kg and radius 0.5 m at a point 1.5 m from its surface.
    Given $G = 6.67 \times 10^{-11}\ Nm^2kg^{-2}$.

11. Two particles of mass 5 kg and 10 kg have position vectors $(3\hat{i}+6\hat{j}-3\hat{k})$ m and $(3\hat{i}-9\hat{j}+3\hat{k})$ m respectively from the origin of a co-ordinate system. Calculate the position vector and distance of their center of mass from the origin.

12. Calculate the wavelength corresponding to maximum intensity emitted by a black body at 2900 K.
    Given Wien's constant $= 2.9 \times 10^{-3}$ mK.

13. The mean free path of Nitrogen molecule at 273 K and 1 atmosphere pressure is 8×10^{-8} m. If the diameter of nitrogen molecule is 3.2 $\overset{0}{A}$, find the number of Nitrogen molecules per m^3.

14. The rms speed of a gas molecule is 490 ms^{-1}. Calculate the coefficient of viscosity of the gas given the density of the gas is 1.25 kg m^{-3} and the mean free path of the molecule is 8.85×10^{-8}m. Given : $\frac{V_{mean}}{V_{rms}} = 0.92$.

15. An ideal gas adiabatically expands from an initial volume 0.1 m^3 to a final volume 0.149 m^3.If the pressure of the gas decreases from 1Nm^{-2} to 0.57 Nm^{-2}, find the ratio of specific heat capacity at constant pressure to specific heat capacity at constant volume of the gas (γ).

16. Calculate the change in entropy when 0.05 kg of ice at 273 K melts into water and the temperature of water is raised to 300 K. Give entropy change in melting ice at 273 k = 61.5 Jk^{-1} and specific heat capacity of water = 4200 $Jkg^{-1}k^{-1}$.

PART – C

Answer **any five** of the following. **Each** question carries **two** marks. **(5×2=10)**

17. a) Two pieces of paper of equal size one plane and the other crumpled are dropped from rest in air. Which of them reaches the ground first ? Explain.

    b) Does the moon have an atmosphere ? Explain.

    c) A book is moved on a rough table top from one point to another. Does the work done by the external agent in moving the book against friction depend on the path taken by the book ? Explain.

    d) Where is the center of mass of the sun-earth system located ? Explain.

    e) Does a gas confined in a container exhibit the property of viscosity ? Explain.

    f) Can air be liquified at room temperature by the mere application of pressure ? Explain.

    g) Can a refrigerator be considered as a heat engine working in reverse direction ? Explain.

    h) In an adiabatic expansion of a gas how does the internal energy change ? Explain.