ST.JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
B.Sc. – I SEMESTER
SEMESTER EXAMINATION – OCTOBER 2019
PH 118 : Mechanics, Heat and Thermodynamics

Time : 2½ hrs   **Max. Marks: 70**

*This question paper has **two** printed pages and **three** parts.*

PART – A

Answer any **four** of the following: (4X10=40)

1. a) If (r, θ, Φ) are the polar co-ordinates of the particle P at any instant and (x, y, z) the corresponding cartesian co-ordinates find the components of velocity in spherical co- ordinate system and give the physical significance.
   b) Explain the term Coriolis force with an example.   (8+2)

2. a) Show that the centre of mass divides internally the line joining the two particles in inverse ratio of their masses.
   b) Find the expression for decrease in kinetic energy in perfectly inelastic collision.
                                                                             (3+7)

3. a) State and prove the perpendicular axis theorem.
   b) Obtain the expression for the acceleration of a body rolling down an inclined plane.
                                                                             (4+6)

4. a) Based on kinetic theory of gases deduce an expression for pressure exerted by an ideal gas.
   b) Give the graphical interpretation of Maxwell's velocity distribution law.   (6+4)

5. a) List the differences between adiabatic and isothermal changes. Show that $PV^{\gamma}=$ constant for an adiabatic process.
   b) State and explain Carnot's theorem.   (8+2)

6. a) Arrive at any two Maxwell's thermodynamic relations from thermodynamic potentials.
   b) Draw and explain Andrew's isothermal curves for real gases.   (5+5)

PART-B

Solve any **four** of the following: (4X5=20)

7. A rocket of mass 10 kg has 90 kg of fuel. The exhaust velocity of fuel is 1.6 km/s. Calculate the ultimate speed gained by the rocket when the rate of consumption of fuel is 2 kg/s and the time taken to attain it.

8. A frame **S'** is moving with velocity $5\hat{\imath}+7\hat{\jmath}$ m/s relative to an inertial frame **S**. A particle is moving with velocity $(t+5)\,\hat{\imath} + 9\hat{\jmath}$ m/s with respect to **S**. Find the acceleration of the particle in the frame **S'**.

9. The kinetic energy of a metal disc rotating at a constant speed of 5 revolution per second is 100 Joules. Find the angular momentum of the disc.

10. Estimate the mean free path and collision frequency of a nitrogen molecule in a cylinder containing nitrogen at 2 atm and temperature 17°C. Radius of a nitrogen molecule is 1 A°.

11. 50 g of water at 0°C is mixed with an equal mass of water at 80°C. Calculate the resultant increase in entropy. Specific heat of water is 4200 J/kg/K.

12. The Vander Waals constants a and b for one mole of hydrogen are
    a = 0.245 atm- litre^2/mol^2 and   b = 0.0267 litre/mole. Calculate the critical constants.

PART-C

13. Answer any **five** of the following: (5X2=10)

a. Can two vectors of different magnitudes be combined to give a zero resultant? Justify.

b. A boy sitting in a moving train throws a ball straight up into the air. The ball falls behind him. Comment on the velocity of the train.

c. Find the moment of inertia about the axis of a solid cylinder of mass 20 kg and radius 10 cm.

d. A reversible engine has ideal thermal efficiency of 30%. When it is used as a refrigerating machine with all other conditions unchanged, what will be the coefficient of performance?

e. How does the internal energy of an ideal gas vary with volume at constant temperature? Explain.

f. Does adiabatic demagnetization result in cooling or heating? Give reason.