

Attempt any FIVE Questions by selecting at least Two Questions from each Section. All Questions carry equal marks.

### SECTION-A

- 1- a) State and prove Stokes' Theorem. 4,3,1  
 b) Two vectors lying in the xy-plane are given by the equation  $A = 2i + 3j$  and  $B = -i + 2j$ . Find  $A \times B$  and verify that  $A \times B = -B \times A$ . Find the angle between these two vectors.  
 c) Vector A lies in the xy plane. For what orientations of vector A will both of its components be negative? For what orientations will its components have opposite sign?
- 2- a) Define Frictional Force. How to differentiate between the static friction and kinetic friction? 4,3,1  
 b) A hockey puck (disk) on a frozen pond is given an initial speed of 20.0 m/s. If the puck always remains on the ice and slides 115 m before coming to rest, determine the coefficient of kinetic friction between the puck and ice.  
 c) Is there any effect of mass of the body on the frictional force?
- 3- a) Define a resistive medium. Find out the acceleration of the body moving in a resistive medium. What is the importance of a resistive medium in everyday life? 4,3,1  
 b) A small sphere of mass 2.00 g is released from rest in a large vessel filled with oil, where it experiences a resistive force proportional to its speed. The sphere reaches a terminal speed of 5.00 cm/s. Determine the time constant ' $\tau$ ' and the time it takes the sphere to reach 90% of its terminal velocity.  
 c) How the acceleration of the body is affected when it reaches its terminal speed.
- 4- a) Describe in detail the 'work-kinetic energy theorem.' Give examples. 4,3,1  
 b) The force acting on a particle is  $F_x = (8x - 16)$  N, where x is in meters.  
 i) Make a plot of this force versus x from  $x = 0$  to  $x = 3.00$  m.  
 ii) From your graph, find the net work done by this force as the particle moves from  $x = 0$  to  $x = 3.00$  m.  
 c) Can the kinetic energy of an object be negative? Explain.
- 5- Write a comprehensive note on any two of the following: 4,4  
 a) Rocket Propulsion                      b) Energy and the Automobiles                      c) Pseudo Forces

### SECTION-B

- 6- a) Differentiate between elastic and inelastic collision. How the center of mass of a right angle triangle can be calculated. 4,3,1  
 b) Proton 1 collides elastically with proton 2 that is initially at rest. Proton 1 has an initial speed of  $3.50 \times 10^5$  m/s and makes a glancing collision with proton 2. After the collision, proton 1 moves at an angle of  $37.0^\circ$  to the horizontal axis, and proton 2 deflects at an angle  $\phi$  to the same axis. Find the final speeds of the two protons and the angle  $\phi$ .  
 c) If two particles have equal momenta, are their kinetic energies necessarily equal?
- 7- a) Define moment of inertia of a rigid body. Calculate it for a uniform solid cylinder. 4,3,1  
 b) A wheel rotates with a constant angular acceleration of  $3.50 \text{ rad/s}^2$ . If the angular speed of the wheel is  $2.00 \text{ rad/s}$  at  $t_1 = 0$ ;  
 i) though what angle does the wheel rotate in 2 s?                      ii) What is the angular speed at  $t = 2.00$  s?  
 c) If you see an object rotating, is there necessarily a net torque acting on it?
- 8- a) Describe the precessional motion of a system. Derive the precessional frequency of a system. 4,3,1  
 b) Kepler's Second Law Status: "The radius vector from the sun to a planet sweeps out equal areas in equal time." Show that this law follows directly from the law of conservation of angular momentum and the fact that the force of gravitational attraction between a planet and the sun acts along the line joining the two celestial objects.  
 c) How much work is done by the force of gravity when a top precesses through one complete circle?
- 9- a) Explain three consequences of the special theory of relativity. 4,3,1  
 b) i) The rest mass of a proton =  $1.67 \times 10^{-27}$  kg. Find its rest energy in electron volts.  
 ii) If the total energy of a proton is three times its rest energy, with what speed is proton moving?  
 iii) Determine the kinetic energy of proton in electron volts.  
 c) Give a physical argument that shows that it is impossible to accelerate an object of mass m to the speed of light, even if it has a continuous force acting on it.
- 10- Write a comprehensive note on any two of the following: 4,4  
 i) Equivalence of Mass and Energy                      ii) Fluid Dynamics                      iii) Elastic Properties of Solids