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**1 SEM TDC PHY M 1**

**2021**

( Held in January/February, 2022 )

**PHYSICS**

( Major )

Course : 101

( **Mechanics and Properties of Matter** )

*Full Marks : 80*

*Pass Marks : 24*

*Time : 3 hours*

*The figures in the margin indicate full marks  
for the questions*

1. Choose the correct option from the following : 1×8=8

(a) Which one of the following is a conservative force?

(i) Frictional

(ii) Viscous

(iii) Gravitational

(iv) None of the above

- (b) Torque can be defined as
- (i) moment of charge
  - (ii) moment of force
  - (iii) moment of inertia
  - (iv) moment of momentum
- (c) In one-dimensional elastic collision of two bodies of equal masses, the bodies simply exchange
- (i) velocities
  - (ii) masses
  - (iii) energies
  - (iv) None of the above
- (d) Dimensional formula of gravitational constant  $G$  is
- (i)  $[M^{-1}L^3T^{-2}]$
  - (ii)  $[M^{-1}L^{-2}T^3]$
  - (iii)  $[M^{-2}L^{-1}T^3]$
  - (iv)  $[M^{-1}L^{-3}T^{-2}]$

(e) Moment of inertia of a uniform rod about an axis through its centre and perpendicular to its length is given by

(i)  $\frac{Ml^2}{3}$

(ii)  $\frac{Ml^2}{12}$

(iii)  $\frac{Ml^2}{4}$

(iv) None of the above

(f) The ratio of the tangential stress to the shearing strain is called

(i) Young's modulus

(ii) bulk modulus

(iii) modulus of rigidity

(iv) All of the above

(g) If the velocity of the particle is directed towards north in the northern hemisphere, then the deflection due to Coriolis force is towards

(i) north

(ii) east

(iii) south

(iv) west

(h) The Lagrangian function  $L$  is defined by

(i)  $L = T + V$

(ii)  $L = T - V$

(iii)  $L = T + E$

(iv)  $L = V - T$

2. Answer the following :

2×8=16

- (a) What do you mean by Galilean transformation and Galilean invariance?
- (b) Show that Newton's first law is a special case of second law.
- (c) What is a non-inertial frame? Give one example.
- (d) Distinguish between real and pseudo forces.
- (e) What do you understand by gravitational potential and gravitational field?
- (f) What do you mean by degrees of freedom? If a particle is constrained to move in a plane, how many degrees of freedom will it have?

- (g) What is the difference between scleronomous and rhenomous constraints? Give an example of each.
- (h) Establish the relation among kinetic energy, moment of inertia and angular velocity.
3. (a) State the principle of conservation of linear momentum. Show that when vector sum of the external forces acting upon a system equals zero, the total linear momentum of the system remains constant. 1+3=4
- (b) Deduce the equation of motion of the centre of mass. 3
- (c) Show that the angular momentum about any point of a single-particle moving with constant velocity remains constant throughout the motion. 5
- (d) Define reduce mass of a system. How can two-body problem be reduced into one-body problem? Explain. 1+4=5
4. (a) Prove that under central force field areal velocity of radius vector is constant. 3

- (b) Define impulse of a force. Show that the change in momentum is equal to the impulse. 1+3=4

5. (a) State and prove the theorem of perpendicular axes. 1+3=4

- (b) If a circular disc of mass 2 kg and diameter 0.4 meter makes 10 revolutions per second about an axis passing through its centre, find out the angular velocity and kinetic energy of the disc. 3

- (c) Find an expression for the excess pressure inside a liquid drop. 4

- (d) Prove the following relation : 4

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

6. (a) Using Lagrange's equation, show that the motion of a simple pendulum is SHM. 3

- (b) What do you understand by virtual displacement? State and derive the principle of virtual work. 1+4=5

- (c) Explain the effect of Coriolis force on a body falling freely under the influence of gravity. 4

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7. Write a short note on any one of the following :

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(a) Generalised coordinates

(b) Lagrangian function  $L$

(c) Foucault's pendulum

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