2024/07

SET A

B.Sc. PHYSICS
FIRST SEMESTER
ELEMENTS OF MECHANICS
BSP – 102 [SPECIAL REPEAT]
[USE OMR FOR OBJECTIVE PART]

Duration: 3 hrs. **Full Marks: 70**

Objective

Time: 30 min. **Marks: 20**

Choose the correct answer from the following: ***1×20=20***

1. Which law of Newton helps in finding the reaction forces on a body?
   a. First law b. Second law
   c. Third law d. Fourth law

2. A batsman hits a ball with a force a 5 N. What force does the bat experience?
   a. 5 N b. 10 N
   c. 15 N d. 20 N

3. At what angle of projectile (θ) is the horizontal range minimum?
   a. $\theta = 45°$ b. $\theta = 60°$
   c. $\theta = 90°$ d. $\theta = 75°$

4. Momentum is a _____ quantity
   a. Scalar b. Vector
   c. Infinite d. Zero

5. When a cricket bat hits a cricket ball, impulse is applied on the _____
   a. Bat b. Ball
   c. Bat and Ball d. No impulse is applied

6. According to the work-energy theorem, total change in energy is equal to the _____
   a. Total work done b. Half of the total work done
   c. Total work done added with frictional losses d. Square of the total work done

7. Which of the following is true?
   a. Potential energy decreases as altitude increases b. Potential energy increases as altitude increases
   c. Potential energy first increases and then decreases as altitude increases d. Potential energy first decreases and then increases as altitude increases

8. The energy possessed by an object because of its motion is termed _____
   a. Potential Energy b. Kinetic energy
   c. Nuclear energy d. Solar energy

9. For a freely falling body, which of the following quantities will not change?
   a. Total kinetic energy b. Total potential energy
   c. Total mechanical energy d. None of the mentioned

10. When two same masses travelling in opposite directions with different velocities collide perfectly elastically, their velocities _____.
    a. Exchange
    b. Remain unchanged
    c. Increase
    d. Decrease

11. The moment of inertia of a solid sphere about its diameter is given by____
    a. $I = \frac{2}{5}MR^2$
    b. $I = \frac{1}{5}MR^2$
    c. $I = MR^2$
    d. $I = \frac{1}{2}MR^2$

12. The whole mass of the flywheel is concentrated in _____.
    a. Its Center
    b. In the axle
    c. On the rim
    d. On its surface

13. According to the right-hand rule, if you curl the fingers of your right hand in the direction of angular velocity, your thumb points in the direction of
    a. Torque
    b. Angular acceleration
    c. Linear velocity
    d. Angular momentum

14. The moment of inertia of a hollow sphere about its diameter is given by____
    a. $I = \frac{5}{2}MR^2$
    b. $I = \frac{2}{5}M\left(\frac{r_2^5 - r_1^5}{r_2^3 - r_1^3}\right)$
    c. $I = \frac{5}{2}M\left(\frac{r_2^5 - r_1^5}{r_2^3 - r_1^3}\right)$
    d. $I = \frac{2}{5}M\left(\frac{r_2^2 - r_1^2}{r_2^3 - r_1^3}\right)$

15. Dimension of Torque is
    a. $[MLT^{-2}]$
    b. $[MT^{-2}]$
    c. $[ML^2T^{-1}]$
    d. $[ML^2T^{-2}]$

16. Which of the following equation is true for compound pendulum?
    a. $L = \frac{k^2}{l} + l$
    b. $L = \frac{k^2}{l} + l^2$
    c. $L = \frac{k^2}{l} - l$
    d. $L = \frac{k^2}{l^2} + l$

17. The change in potential energy is related to the work done by the internal forces as
    a. equal to the negative
    b. equal to positive
    c. inversely proportional
    d. unequal

18. Gravitational forces obey the principal of superposition
    a. True
    b. False
    c. in special circumstances
    d. only on earth

19. As altitude increases, the acceleration due to gravity
   a. Decreases
   b. increases
   c. remains constant
   d. fluctuates throughout

20. Gravitaional force experienced by a mass moving towards the centre of earth.
   a. Increases and turns zero at centre
   b. decreases and turns zero at centre
   c. increases and turns infinity at the centre
   d. remains constant

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Descriptive

Time : 2 hrs. 30 mins. **Marks : 50**

[Answer question no.1 & any four (4) from the rest]

1. Examine particle (P) rotational motion within a rotating frame of reference. Determine its velocity relative to another frame and dérive the operator equation for acceleration. **10**

2. **a.** Define the center of mass of an object and derive the expression for the center of mass of a two-particle system. **7+3=10**

   b. Three masses 3, 4, & 5 kg are located at the corners of equilateral triangle of side 1 m. Locate the center of mass.

3. **a.** Explain the Work-Energy theorem for a constant force and a variable force. **6+2+2 =10**

   b. A body of mass 4 kg initially at rest is subject to a force of 16 N. What is the kinetic energy acquired by the body at the end of 10 sec.

   c. A shot travelling at the rate of 100 m/s is just able to pierce a plank 4 cm thick. What velocity is required to just pierce a plank 9 cm thick?

4. a. State the principle of conservation of mechanical energy. Explain the conservation of mechanical energy for a freely falling body and hence draw the energy vs. height graph for the same. **8+2=10**

   b. Calculate the velocity of the bob of a simple pendulum at its mean position if it's able to raise to a vertical height of 10 cm. Take g = 9.8 m/s².

5. What is a compound pendulum? Explain its working principle. Show that it has 4 points with the same time period. **1+5+4 =10**

6. Find out the moment of inertia of a hollow cylinder about an axis passing through its center and perpendicular to its own axis. A hollow steel sphere has its inner and outer radii 5 cm and 12 cm respectively. Calculate its moment of inertia about a diameter. Density of steel is $7.8 \times 10^3 kgm^{-3}$. Assuming earth to be a sphere of uniform density 5520 $kgm^{-3}$and radius 6400 km.Calculate the M.I. about its axis of rotation. **5+3+2 =10**

7. a. Two particles of masses 1.0 kg and 2.0 kg are placed at separation of 50 cm. Assuming that the only forces acting on the particles are their mutual gravitation, find the initial accelerations of the two particles. **5+5=10**

   b. Derive the expression for gravitational potential due to a uniform ring at a point on its axis to calculate the potential of a ring of mass 250 gm at a distance 5cm.

8. a. A thin uniform annular disc of mass M has an outer radius 4R and inner radius 3R. Calculate the work done to take a unit mass from point P on its axis to infinity. Also calculate the work done in taking a mass of 3kg from P to its axis at infinity if the thickness of the ring is 2m. **5+5=10**

   b. A linear mass density ~ 10-5Kg/m is buried on earth such that the depth is one third of earth's radius.Calculate the gravitational force experienced by it if earth shrinks by 100 times.

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