2021
PHYSICS

Total marks : 70 Time : 3 hours

General instructions:

i) Approximately 15 minutes is allotted to read the question paper and revise the answers.
ii) The question paper consists of 30 questions. All questions are compulsory.
iii) Marks are indicated against each question.
iv) Internal choice has been provided in some questions.

N.B: Check that all pages of the question paper is complete as indicated on the top left side.

1. The dimensional formula of impulse is **1**
   (a) $[MLT^{-1}]$ (b) $[MLT^{-2}]$
   (c) $[ML^{-1}T^{-2}]$ (d) $[ML^{-1}T^{-1}]$
2. A particle is said to be in equilibrium if the net external force on the particle is **1**
   (a) zero (b) constant
   (c) positive (d) negative
3. A couple produces **1**
   (a) purely rotational motion
   (b) purely linear motion
   (c) linear and rotational motion
   (d) no motion
4. The relation connecting Kelvin temperature (T) and Celsius temperature(t_c) is **1**
   (a) $T= t_c + 273$ (b) $T= t_c - 273$
   (c) $T= t_c + 373$ (d) $T= t_c - 373$
5. Which of the following does not represent a simple harmonic motion? **1**
   (a) $y= a \sin \omega t$ (b) $y= a \cos \omega t$
   (c) $y= a \sin \omega t + b \cos \omega t$ (d) $y= a \tan \omega t$
6. What is static friction? **1**
7. Show that the vectors $A= \hat{i} + 2\hat{j} + 4\hat{k}$ and $B= 2\hat{i} - \hat{j}$ are perpendicular. **1**
8. What is a geostationary satellite? What is its time period? **1**
9. State Hooke's law. **1**

10. On what factors does the angular frequency of a simple harmonic motion depend upon? **1**

11. **a.** A car is moving along a straight line say OP. It moves from O to P in 18s. If the distance from O to P is 360m, what will be the average velocity and average speed of the car in going from O to P.

Or **2**

b. The position of an object moving along x-axis is given by $x = a + bt^2$ where a = 8.5m, b = 2.5ms^{-2} and t is measured in seconds. What is its velocity at t = 0s and t = 2.0s?

12. **a.** Differentiate between exothermic and endothermic reaction.

Or **2**

b. State and prove the work-energy theorem for a variable force.

13. Find the torque of a force $7\hat{i} + 3\hat{j} - 5\hat{k}$ about the origin. The force acts on a particle whose position vector is $\hat{i} - \hat{j} + \hat{k}$. **2**

14 What is central force? On what factors does the magnitude of central force depend on? **2**

15. **a.** State second law of thermodynamics in its two usual forms.

Or **2**

b. Prove that the specific heat of solids are given by the formula C=3R, where R is the universal gas constant.

16. Define mean free path. Write its mathematical expression. **2**

17. Consider a simple pendulum, having a bob attached to a string, that oscillates under the action of the force of gravity. Suppose that the period of oscillation of the simple pendulum depends on its length (l), mass of the bob (m) and acceleration due to gravity (g). Derive an expression for its time period using method of dimensions. **3**

18. Draw the position-time graphs for two objects A & B with
a) equal velocities
b) unequal velocities
c) opposite velocities. **3**

19. Derive an expression for maximum velocity of a car while moving on a banked road. **3**

20. **a.** What is friction? Explain why is friction a necessary evil.

Or **3**

b. What is centripetal acceleration? Derive an expression for the centripetal force of a body moving in a circular path of radius 'r' with a uniform speed 'v'.

21. **a.** Show that the total mechanical energy of a system is conserved if the forces doing work on it are conservative.

Or **3**

b. Two bodies A & B having masses m_1 & m_2 moving with v_1 & v_2 velocities undergoes completely inelastic collision. Show that the heavier mass (m_2) is undisturbed while the lighter mass (m_1) reverses its velocity.

22. **a.** Derive a relation between the angular velocity and linear velocity.

Or **3**

b. Prove that the total momentum of a system of particle is equal to the product of the total mass of the system and the velocity of centre of mass.

23. **a.** Show that $T_o = 2\pi\sqrt{\frac{R_E}{g}}$ where R_E is radius of the earth.

Or **3**

b. Show that $(V_i)_{min} = \sqrt{2gR_E}$ where $(V_i)_{min}$ is the escape speed of satellite.

24. Explain the stress – strain curve of a metal wire with the help of a suitable diagram. **3**

25. Derive an expression for the work done during an isothermal process. **3**

26. Prove that the pressure exerted by an ideal gas is $P = \frac{1}{3}\rho\bar{v}^2$ where ρ is the density of the gas and $\bar{v}^2$ is the mean square speed of gas molecules. **3**

27. Define frequency. Write the formula in terms of time period. What is its S.I unit? **3**

28. **a.** A projectile is projected with a velocity 'v' making an angle 'θ' with the horizontal. Show that path followed by the projectile is parabolic. Find the expression for time of flight, maximum height and horizontal range.

Or **5**

b. What is average acceleration? Obtain an expression for the motion in a plane with constant acceleration.

29. **a.** State and prove Bernoulli's principle.

Or **5**

b. What is venturimeter? Derive an expression for the speed of fluid with the help of a schematic diagram.

30. **a.** Define displacement. Establish the relation D = $\sqrt{A^2 + B^2}$, and write the importance of periodic sine and cosine functions.

Or **5**

b. Derive the expression for the total energy for a particle executing simple harmonic motion.

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