

Instructions:

1. All parts from A to D are compulsory.
2. For Part – A questions, first written-answer will be considered for awarding marks.
3. Answers without relevant diagram / figure / circuit wherever necessary will not carry any marks.
4. Direct answers to numerical problems without relevant formula and detailed solutions will not carry any marks.

PART-A**I Pick the correct option among the four given options for all of the following questions: $15 \times 1 = 15$**

1. The SI unit of plane angle is
(A) degree (B) per degree (C) radian (D) steradian
2. A rectilinear motion is a motion
(A) along a circular path (B) in a plane
(C) along a parabolic path (D) along a straight line
3. A vector is multiplied with a negative integer. The direction of the resultant vector is
(A) same as that of the initial vector (B) opposite to that of the initial vector
(C) perpendicular to the initial vector (D) along arbitrary direction
4. A large force acting for a short time to produce a finite change in momentum is called
(A) an impulsive force (B) a frictional force
(C) a viscous force (D) a normal force
5. If two vectors \vec{A} and \vec{B} are acting at an angle of θ , the scalar product between them is written as
(A) $\vec{A} \times \vec{B} = AB \cos \theta$ (B) $\vec{A} \times \vec{B} = AB \sin \theta$
(C) $\vec{A} \cdot \vec{B} = AB \cos \theta$ (D) $\vec{A} \cdot \vec{B} = AB \sin \theta$
6. The analogue of mass in rotational motion is
(A) moment of inertia (B) angular mass
(C) momentum (D) centre of mass
7. Acceleration due to gravity ' g '
(A) decreases with height (B) increases with height
(C) increases with depth (D) is independent of height



8. Poisson's ratio is the ratio of
- (A) longitudinal stress to longitudinal strain
 (B) volume stress to volume strain
 (C) lateral strain to longitudinal strain
 (D) longitudinal strain to lateral strain
9. The resistance to the relative motion between layers of a liquid is called
- (A) friction (B) viscosity
 (C) surface tension (D) cohesion
10. The column-I is the list of modes of heat transfer and the column-II, the list of transport media. Identify the correct match.

Column-I	Column-II
(i) conduction	(a) fluid
(ii) convection	(b) no medium
(iii) radiation	(c) solid

- (A) (i) - (a), (ii) - (b), (iii) - (c) (B) (i) - (b), (ii) - (a), (iii) - (c)
 (C) (i) - (c), (ii) - (a), (iii) - (b) (D) (i) - (b), (ii) - (c), (iii) - (a)
11. First law of thermodynamics is equivalent to
- (A) law of conservation of charge (B) law of conservation of linear momentum
 (C) law of conservation of energy (D) law of conservation of angular momentum
12. At constant temperature, pressure of a given mass of a gas varies inversely with its volume. This statement is known as
- (A) Boyle's law (B) Charles' law
 (C) Kelvin's law (D) Gay Lussac's law
13. The circular motion of a particle with a constant speed is
- (A) periodic and oscillatory (B) periodic but not oscillatory
 (C) oscillatory but not periodic (D) neither periodic nor oscillatory
14. The minimum distance between two points on a wave having the same phase is called the
- (A) wave number (B) wavelength (C) wave speed (D) wavefront
15. Following are the two statements about the vibrations of air column.
- Statement-I: When an air column with one end closed vibrates, node is formed at the closed end.
 Statement-II: At the closed end, pressure changes are the largest, while the displacement is zero.
- (A) both I and II are true and II is the correct explanation of I.
 (B) both I and II are true but II is not the correct explanation of I.
 (C) I is true but II is false.
 (D) both I and II are false.



II Fill in the blanks by choosing appropriate answer given in the bracket for all the following questions. **5 × 1 = 05**

(thermometer, elastic, velocity, mean, pressure, calorimeter)

16. In pure translational motion at any instant of time, all particles of the body have the same_____.
17. A device used to measure heat is_____.
18. In an isobaric process, the quantity that remains constant is_____.
19. According to kinetic theory, all collisions between molecules of an ideal gas are_____.
20. In simple harmonic motion, the restoring force is always directed towards_____ position.

PART-B

III Answer any FIVE of the following questions. **5 × 2 = 10**

21. Write any two applications of dimensional analysis.
22. What is meant by free fall? What is the direction of acceleration in free fall?
23. Write the expression for centripetal acceleration and explain the terms.
24. Write any two methods of reducing friction.
25. State the two conditions under which a force does no work.
26. A structural steel rod has an area of cross section of $3.14 \times 10^{-4} \text{ m}^2$ and a length of 1.0 m. A 100 kN force stretches it along its length. Find the stress on the rod.
27. State the law of equipartition of energy. Give the number of degrees of freedom of a monoatomic gas molecule.
28. Write any two differences between longitudinal and transverse waves.



PART-C

IV Answer any FIVE of the following questions. **5 × 3 = 15**


29. Derive the kinematic equation $v = v_0 + at$ using $v - t$ graph, where the symbols have their usual meanings.
30. Define equal vectors, unit vector and null vector.
31. Using Newton's second law of motion, derive $F = ma$, where the symbols have their usual meanings.
32. A woman draws a bucketful of water weighing 10 kg from a well in which water level is 8 m below in 9.8 s. Find her average power. Take $g = 9.8 \text{ m s}^{-2}$.
33. What is meant by equilibrium of a rigid body? Write the conditions for the equilibrium of a rigid body.
34. State the three Kepler's laws of planetary motion.
35. What is meant by streamline flow and turbulent flow? Write the equation of continuity for a fluid flow.
36. Show that the volume coefficient, $\alpha_V = \frac{1}{T}$ for ideal gas, where T is the absolute temperature of the ideal gas.

PART-D

V Answer any THREE of the following questions. 3 × 5 = 15

37. Illustrate the conservation of mechanical energy in case of a body dropped from a height 'H'.
38. (a) Define torque and angular momentum. (2)
(b) Derive the relation between torque and angular momentum. (3)
39. Derive an expression for the escape speed from the surface of the earth.
40. (a) State and explain Zeroth law of thermodynamics. (2)
(b) Write the three differences between isothermal and adiabatic processes. (3)
41. With a schematic diagram showing the components of restoring force, derive an expression for the time period of an oscillating simple pendulum.

VI Answer any TWO of the following questions. 2 × 5 = 10

42. A ball is projected with a velocity of 50 m s^{-1} in a direction making an angle of 30° with the horizontal. Find the maximum height and time of flight of the ball. For what angle of projection, the range will be maximum?
43. A man pushes a car of mass 2000 kg at rest along a horizontal road with a steady force of 300 N . The resistance of the road is 0.05 N/kg . Find the velocity of the car at the end of 20 s and distance travelled by the car.
44. The base of a copper boiler is 2 cm thick and has an area of 0.01 m^2 . The steady difference in temperature between its faces is 5 K . Calculate the mass of water that evaporates in 1 hour. Given:  thermal conductivity of copper = $385 \text{ W m}^{-1} \text{ K}^{-1}$ and latent heat of steam = $2.2 \times 10^6 \text{ J kg}^{-1}$.
45. A string 1 m long is under a tension of 440 N . If the fundamental frequency is 100 Hz , find the mass per unit length of the string. What is the mass of the string?

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