2020

PHYSICS
(Theory)

Full Marks : 70

Pass Marks : 21

Time : Three hours

All questions are compulsory.

The figures in the right margin indicate full marks for the questions.

*Question Nos. **1** to **10**, are **"Very Short Answer"** type questions carrying **1** mark each.*

1. Photon is quantity of radiation with energy $E = h\nu$, where ν is frequency and h is Planck's constant. Determine the dimension of h. 1

2. State the law of conservation of linear momentum. 1

3. A particle moves on a circular path with decreasing speed. What happens to its angular momentum ? 1

4. If the orbital velocity of a satellite is slowed down. What would happen to the satellite ? 1

5. Why does a glass crack when hot water is poured into it ? 1

6. Why the bicycle pump is heated when air is filled in the tube ? 1

7. When a gas filled in a closed vessel is heated, what will be the effect on its pressure ? 1

8. If the door of a running refrigerator be open, will the room get cooled ? Give reason. 1

9. Find the ratio of root mean square speed of an ideal gas at 270 K and 30 K. 1

10. Draw the graphical representation of displacement as a function of time for damped oscillations. 1

Question Nos. ***11*** to ***20,*** *are* ***'Short Answer Type-II'*** *questions carrying 2 marks each.*

11. What are fundamental and derived units ? 2

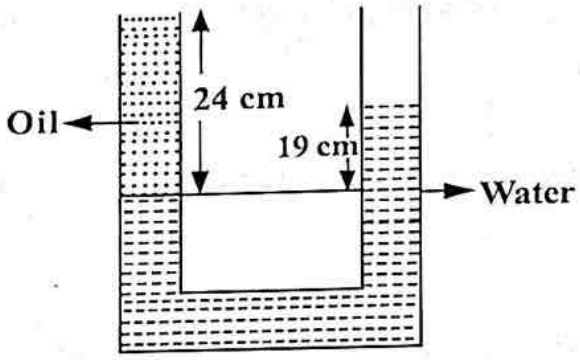
12. A man runs across the roof-top of a tall building and jumps horizontally with the hope of landing on the roof of the next building which is lower height than the first. If his speed is 9 ms^{-1}, the horizontal distance between the two buildings is 10 m and the height difference is 9 m, will he be able to land on the next building ? (Take $g = 10\ ms^{-2}$) 2

13. While swimming, why does a person push the water backwards ? 2

14. What are conservative and non-conservative forces ? 2

15. Moment of inertia of a uniform square plate of side a and mass m about an axis passing through its centre of mass and perpendicular to its plane is $ma^2/6$. Find the moment of inertia of this plate about an axis perpendicular to its plane and passing through one of its corners. 2

16. Assume that the two liquids in the U-shaped tube of figure are water and oil. Compute the density of the oil, if the water stands 19 cm above the interface and the oil stands 24 cm above the interface. 2



17. Draw a schematic diagram illustrating the principle behind the hydraulic lift, a device used to lift heavy loads. 2

18. Write the assumptions of kinetic theory of an ideal gas. 2

19. A mass of 250 g hangs on a spring and oscillates vertically with a period of 1.1 s. What mass must be added to double the period ? 2

20. State two characteristics of progressive waves. 2

Question Nos. ***21*** to ***27, are 'Short Answer Type-I'*** *questions carrying 3 marks each.*

21. A boat takes two hours to travel 8 km and back in still water. If the velocity of water is 4 kmh^{-1}, what is the total time taken for going upstream 8 km and coming back ? 3

22. A 20 g bullet is fired horizontally with a speed of 600 ms^{-1} into a 7 kg block sitting on a table top; the bullet (b) lodges in the block (B). If the coefficient of kinetic friction between the block and the table top is 0.4, what is the distance the block will slide ? 3

23. Obtain a relation between linear velocity and angular velocity in a uniform circular motion. 3

24. Deduce the relation for potential energy of a stretched spring. 3

25. Using a thin uniform rod, show that the centre of mass of homogenous bodies lies at their geometric centre. 3

26. At a certain height, the acceleration due to gravity becomes $\frac{g}{9}$, where g is the acceleration due to gravity on the surface of earth. What is the height in terms of the radius of earth R ? 3

27. Give three limitations of the first law of thermodynamics. 3

Question Nos. 28 to 30, are 'Long Answer Type' questions carrying 5 marks each.

28. Define unit vector. Resolve a vector into its rectangular components.

A displacement vector of 2 kilometres makes an angle 30° with x-axis. Find the x and y components of the displacement. 1+4=5

OR

What is a projectile ? Derive the expressions for maximum height, time of flight and horizontal range when a projectile is fired at an angle θ with the horizontal. 1+4=5

29. Derive Bernoulli's equation for an ideal fluid having stream-line flow through a pipe of varying area of cross-section. 5

OR

On the basis of Newton's law of cooling derive the relationship between temperature difference of hot body and its surroundings and time taken by a body to cool through a particular temperature range. 5

30. What is simple pendulum? Derive the relation for the time period of simple pendulum executing S.H.M. 1+4=5

OR

What is progressive wave ? Derive the equation of a progressive wave travelling along positive x-axis. 1+4=5

Question Nos. 31 to 34, are ***'Multiple Choice Type'*** *questions carrying 1 mark each. Choose the correct answer out of the four alternatives and rewrite the correct answer.*

31. The working of a rocket is based on the principle of 1

(A) Elasticity

(B) Kepler's law

(C) Conservation of momentum

(D) Newton's law of gravitation

32. A body of mass m accelerates uniformly from rest to v_1 in time t_1. The instantaneous power delivered to the body as a function of time t is 1

(A) $\frac{mv_1 t}{t_1}$

(B) $\frac{mv_1^2 t}{t_1^2}$

(C) $\frac{mv_1 t^2}{t_1}$

(D) $\frac{mv_1^2 t}{t_1}$

33. When the planet comes near the sun, its angular speed 1

(A) remains the same

(B) increases

(C) decreases

(D) becomes zero

34. A gas can be liquefied by pressure only when its temperature is 1

(A) higher than its critical temperature

(B) lower than its critical temperature

(C) equal to its Boyle temperature

(D) equal to its critical temperature