विद्या सर्वार्थि साधिका

ANANDALAYA
ANNUAL EXAMINATION
Class : XI

Subject: Physics (042) M.M : 70
Date: 22-02-2025 Time : 3 hours

General Instructions:

1. There are 33 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3. Section A contains sixteen questions, twelve MCQ and four Assertion- Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study based questions of four marks each and Section E contains three long answer questions of five marks each.
4. There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.

SECTION A

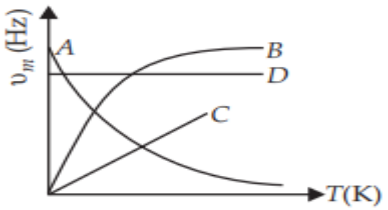
1. The angle between $\vec{A} = \hat{\imath} + \hat{\jmath}$ and $\vec{B} = \hat{\imath} - \hat{\jmath}$ is _____. (1)

(A) 0^0 (B) 45^0 (C) 90^0 (D) 180^0

2. The ranges and heights for two projectiles projected with the same initial velocity and at angles 42^0 and 48^0 with the horizontal are R_1, R_2 and H_1 and H_2 respectively. Choose the correct option. (1)

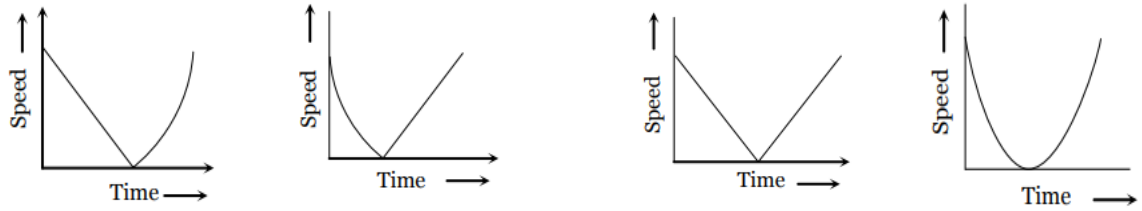
(A) $R_1 > R_2$ and $H_1 = H_2$
(B) $R_1 < R_2$ and $H_1 = H_2$
(C) $R_1 = R_2$ and $H_1 > H_2$
(D) $R_1 = R_2$ and $H_1 < H_2$

3. Which one of the following is $\nu_m - T$ graph for perfectly black body? ν_m is the frequency of radiation with maximum intensity and T is the absolute temperature. (1)



(A) A (B) B (C) C (D) D

4. A ball is thrown vertically upwards. Which of the following plots represents the speed-time graph of the ball during its flight if the air resistance is ignored? (1)



(A) (B) (C) (D)

5. Three particles each of mass m are kept at vertices of an equilateral triangle of side l. The gravitational potential at centre of the triangle due to these particles is _____. (1)

(A) $\frac{3\sqrt{3}GM}{l}$ (B) $\frac{-3\sqrt{3}GM}{l}$ (C) $\frac{3\sqrt{3}GMm}{l}$ (D) $-\frac{3\sqrt{3}GMm}{l}$

6. A lift is moving upwards with acceleration a. A man stands on a weighing machine in a lift and observe his weight. The apparent weight of the man is _____. (1)

(A) more than his actual weight (C) equal to his actual weight

(B) less than his actual weight (D) equal to zero

7. The liquid surface is usually curved when it is in contact with the solid. The particular shape that it takes depends on the relative strengths of cohesive and adhesive forces and the angle of contact between the interfaces is θ. Match the following columns and then choose the correct option given below: (1)

Column I	Column II
(x) Adhesive force > Cohesive force	(p) $\theta = 15^0$, Convex meniscus
(y) Adhesive force < Cohesive force	(q) $\theta = 15^0$, Concave meniscus
	(r) $\theta = 135^0$, Convex meniscus
	(s) $\theta = 135^0$, Concave meniscus

(A) (x-p), (y-q) (B) (x-q), (y-r) (C)(x-r), (y-s) (D) (x-s), (y-p)

8. A point mass 'm' is moving in a vertical circle of radius'r' with the help of a string. The minimum velocity of the mass is $\sqrt{5gr}$ at the lowest point. The tension in the string at the lowest point is _____. (1)

(A) 3mg (B) 5mg (C) 6mg (D) 7mg

9. The weight of body at earth's surface is W. At a depth half way to the centre of the earth, it will be (assuming density of earth as uniform) _____. (1)

(A) W (B) W/2 (C) 2W (D) zero

10. Two satellites P and Q are in the same circular orbit round the earth. The mass of P is greater than the mass of Q. It follows that the speed of P is _____. (1)

(A) equal to the speed of Q (C) less than that of Q

(B) greater than that of Q (D) increases at first and then decreases

11. No work is done between the system and the surrounding. Then the thermodynamical process is ____. (1)

(A) isothermal (B) adiabatic (C) isobaric (D) isochoric

12. If α, β and γ are coefficients of linear, superficial and volume expansion respectively, then __. (1)

(A) $\frac{\beta}{\alpha} = \frac{1}{2}$ (B) $\frac{\beta}{\gamma} = \frac{2}{3}$ (C) $\frac{\gamma}{\alpha} = \frac{3}{2}$ (D) $\frac{\alpha}{\gamma} = \frac{3}{2}$

In the following questions (Q.No. 13 to 16), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(A) Both A and R are true, and R is the correct explanation of A.

(B) Both A and R are true, but R is not the correct explanation of A.

(C) A is true, but R is false.

(D) A is false, but R is false.

13. A: The internal energy of a real gas is function of both, temperature and volume. (1)

R: Internal kinetic energy depends on temperature and internal potential energy depends on volume.

14. A: The ratio of the distance covered by a freely falling body in the 1st, 2nd, 3rdanf 4th second is 1:3:5:7. (1)

R: The total mechanical energy of a freely falling body remains constant throughout its fall.

15. A: The acceleration vector of a particle in uniform circular motion averaged over one cycle is a unit vector. (1)

R: The net acceleration of a particle in circular motion is always along the radius of the circle towards the centre.

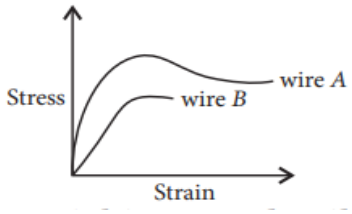
16. A: A rigid body can execute translational and rotational motion. (1)
R: Rolling motion is a combination of translational and rotational motion.

SECTION B

17. The excess pressure inside a soap bubble is thrice the excess pressure inside a second soap bubble. What is the ratio between the volumes of the first and the second bubble? (2)

18. Derive an expression for the time period of a simple pendulum. (2)

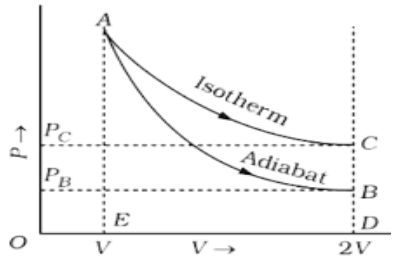
19. Stress-strain curve for two wires of material A and B are as shown in the figure. (2)
(a) Which of the two is stronger material and why?
(b) Which material is more brittle and why?



20. On what factors does the amount of heat flowing through a body [conductivity] depend? Obtain the expression for the heat conducted. (2)

OR

Two gases have the same initial pressure, volume and temperature. They expand to the same final volume, one adiabatically and the other isothermally.
(a) In which case is the final pressure greater and why?
(b) In which case is the work done greater and why?



21. Prove that the rate of change of angular momentum is equal to torque acting on the particle. (2)

SECTION C

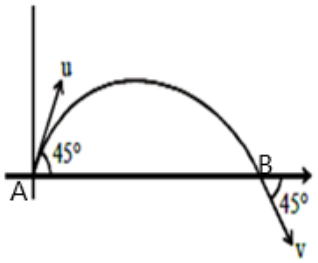
22. Explain why: (3)
(a) In a tug of war, the team that pushes harder against the ground wins.
(b) Buffers are provided between the bogies of a railway train.
(c) A cricket player lowers his hands to catch the ball safely.

23. A large fluid star oscillates in shape under the influence of its gravitational field. Using the dimensional analysis, find an expression for the time period of oscillation (T) in terms of radius (R), mean density of fluid (ρ) and universal gravitational constant (G). (3)

24. State and prove that the kepler's second law of planetary motion. (3)

25. The position of a particle as a function of time is given by $x = 2t^2 - t^3$. (3)
(a) What type of motion does the particle describe?
(b) When is the acceleration of particle zero?

26. The projectile motion of a particle of mass 5 g is shown in the figure. The initial velocity of a particle is $5\sqrt{2}$ m/s and air resistance is assumed to be negligible. (3)
(a) What will be the velocity of projectile at maximum height?
(b) Find the magnitude of change in momentum between the points A and B.



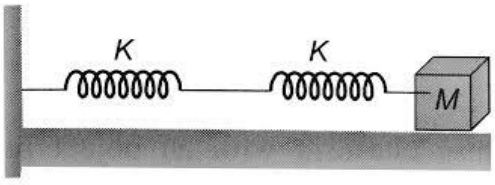
27. (a) Define moment of inertia of a body. (3)
(b) Write any two factors on which MI of a body depends.
(c) Two bodies have their moments of inertia I and 2I respectively about their axis of rotation. Find the ratio of their angular velocity if their kinetic energies of rotation are equal.

28. The speed of longitudinal wave v in a given medium of density ρ is given by the formula $v = \sqrt{\frac{\gamma P}{\rho}}$. Use the formula to explain why the speed of sound in air: (a) is independent of pressure, (b) increases with temperature and (c) increases with humidity. (3)

OR

(a) State the force law for a simple harmonic motion.

(b) The frequency of oscillations of a mass M connected horizontally by a spring of spring constant K is 4 Hz. The spring is replaced by two identical springs (in series) as shown in the figure. What is the effective frequency of this combination?



SECTION D

29. Equation of Continuity and Bernoulli's theorem:
When an incompressible and non-viscous liquid flows in streamlined motion through a tube of non uniform cross section, the total mass of the liquid going into the tube through any cross section per second should be equal to the total mass coming out of the same tube from any cross section per second. Equation of continuity for an ideal liquid implies that liquid velocity at any cross section of the pipe is inversely proportional to the cross section of the pipe at that section. Bernoulli's theorem states that the sum of pressure, kinetic energy per volume and potential energy per volume of an ideal liquid in motion remains constant.
Equation of continuity: $av = \text{constant}$.
Bernoulli's theorem: $P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}$
Answer the following questions based on the passage given:

(i) Bernoulli's theorem is based on the law of conservation of _____. (1)
(A) mass (B) angular momentum (C) energy (D) linear momentum

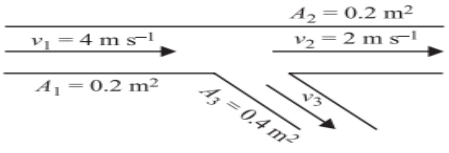
(ii) Why is Bernoulli's theorem not valid for viscous fluids? (1)

(iii) How is dynamic lift of an aeroplane explained using Bernoulli's theorem? (1)

(iv) An incompressible fluid flows steadily through a cylindrical pipe which has radius $2r$ at point X and r at a point Y further along the flow direction. If the velocity at X is v, then that at Y is _____. (1)
(A) v/2 (B) v (C) 2v (D) 4v

OR

(iv) In the figure, the velocity v_3 will be ___.
(A) zero (B) 4 m/s
(C) 3 m/s (D) 1 m/s



30. Banking of the curved road: When a vehicle negotiates a curved road, the force of friction between road and the tyres provides necessary centripetal force to keep the vehicle in motin around the curve. The large value of frictional force produces considerable wear and tear of the tyres. So, to minimise friction, roads are banked. In a banked curve, the normal force is not vertical, so both friction and the horizontal component of the normal force contribute to the centripetal force that keeps the object in its circular path without slipping. When a vehicle negotiates a circular turn of radius r and banked at an angle θ, the maximum safe velocity is given by:
$v = \sqrt{rg\tan\theta}$, in the absence of frictional forces.
$v = \sqrt{rg\frac{(\mu+\tan\theta)}{(1-\mu\tan\theta)}}$, in the presence of frictional forces.

(i) Which of the following is the dimension of coefficient of friction? (1)
(A) $[M^0L^1T^{-1}]$ (B) $[M^0L^0T^0]$ (C) $[M^1L^1T^{-2}]$ (D) $[M^1L^0T^1]$

(ii) Why does skidding of vehicle take place on a rainy day along the curved path? (1)

(iii) A circular race track of radius 300 m is banked at an angle 15^0. What is the optimum speed of the car to avoid wear and tear on its tyres? (2)
Take g = 10 m/s^2, μ = 0.2 and $\tan 15^0 = 0.2679$.

OR

(iii) A body moving along a circular path of radius 10 m on a horizontal surface and the coefficient of friction is 0.5. What should be its angular speed in rad/s, if it is not to slip from the surface? Take g = 10 m/s^2.

SECTION E

31. (a) Using the law of equipartition of energy, determine the values of C_V, C_P and $\boldsymbol{\gamma}$ for (i) monoatomic gases and (ii) diatomic gases. (5)

(b) Calculate the total K.E. of a mole of nitrogen gas at 300 K. Take R = 8.31 J mol^{-1}K^{-1}.

OR

(a) What is meant by mean free path of a gas molecule? Derive expression for it.

(b) Calculate the ratio of the mean free paths of the molecules of two gases having molecular diameters 1 Å and 2 Å. The gases may be considered under identical conditions of temperature, pressure and volume.

32. (a) Obtain an expression for the final velocities for two bodies of different masses undergoing elastic collision in one dimension. (5)

(b) Prove that if the masses are equal, after collision the velocities get interchanged.

OR

(a) Show that the elastic force of a spring is a conservative force. Hence write an expression for the potential energy of an elastic stretch of spring.

(b) When a spring is stretched by a distance x, it exerts a force given by $F = 6x^2\ N$. Find the work done by the spring when it is stretched from 0 m to 0.1m.

33. The equation of a plane progressive wave is represented by (5)

$$y = 3\,sin\ (100\pi\ t - 0.25x\ )$$

where x and y are in cm and t in seconds. Find the (i) amplitude, (ii) direction of the wave propagation, (iii) frequency, (iv) speed of the wave and (v) the displacement of the wave at $x = 80\ cm$ and $t = \frac{1}{\pi}\ sec$.

OR

(a) Draw first three modes of vibration of stationary waves in (i) closed pipe and (ii) open pipe.

(b) An open pipe is suddenly closed at one end with the result that the frequency of third harmonic of the closed is found to be higher by 100 Hz than the fundamental frequency of the open pipe. What is the fundamental frequency of the open pipe?