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INDIAN SCHOOL SALALAH

FINAL EXAMINATION - FEBRUARY 2025 (AY 2024-25)

PHYSICS (042)

Class: XI **Date: 9th Feb 2025**

Time: 3 Hrs. **Maximum Marks: 70**

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. All the sections are compulsory.
4. **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.
5. 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 must attempt only one of the choices in such questions.
6. Use of calculators is not allowed.
7. You may use the following values of physical constants wherever necessary.
   (i) $c = 3 \times 10^8$ m/s
   (ii) $G = 6.674 \times 10^{-11}\, m^2 kg^{-1} s^{-2}$
   (iii) $R = 8.31\, Jmol^{-1} K^{-1}$
   (iv) $N_A = 6.022 \times 10^{23}\, mol^{-1}$
   (v) $k_B = 1.38 \times 10^{-23}\, JK^{-1}$
   (vi) $\sigma = 5.67 \times 10^{-8} W\, m^{-2} K^{-4}$

SECTION A

1. Number of significant digits in 2.00 is: **1**

(A) 1 (B) 2 (C) 3 (D) 4

2. An object at rest started its motion from the origin with a uniform acceleration $-0.2\ m/s^2$. Its displacement at 4 s is: **1**

(A) 0 (B) -1.6 m (C) 1.6 m (D) -3 m

3. Choose vector quantity from the following **1**

(A) distance (B) acceleration (C) Temperature (D) Time

4. A 2 kg object is suspended from a rigid support by a spring. When the spring is suddenly cut from the support (top end), the object starts to fall. Which of the following best describes the acceleration of the object while falling? **1**

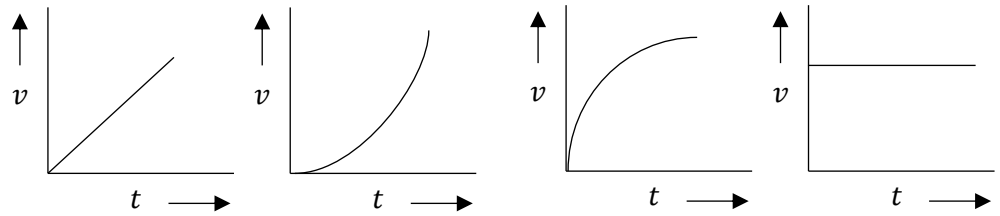
(A) The acceleration is 0 m/s^2

(B) The acceleration increases gradually until it reaches nearly 10 m/s^2.

(C) The acceleration is always 10 m/s^2.

(D) The acceleration is constant and equal to 5 m/s^2.

5. A body is moving unidirectionally with decreasing acceleration. velocity – time curve for its motion. **1**



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

6. Choose the **incorrect** statement **1**

(A) centre of mass is a point.

(B) Position vector of centre of mass has unit metre.

(C) Contre of mass always coincides with centre of gravity.

(D) Centre of mass can be lying outside the body.

7. Unit of moment of inertia is: **1**

(A) $kg^{-1}m^2$ (B) kgm^2 (C) kgm^{-2} (D) $kg\ m$

8. Restoring force per unit area is known as: **1**

(A) elastic potential (B) elasticity (C) strain (D) stress

9. The substance which can show decrease in volume with increase in temperature is: **1**

(A) Air (B) Copper (C) Aluminum (D) Water

10. The process in which substance changes its state from solid to gas without going through liquid state is **1**

(A) freezing (B) melting (C) sublimation (D) vaporisation

11. Cooking gas cylinders cannot be made of an insulator, because **1**

(A) Insulators are too heavy for the cylinder's structure.

(B) Insulators do not allow the easy transfer of heat, which could cause pressure buildup.

(C) Insulators are expensive and inefficient for manufacturing gas cylinders.

(D) Insulators may react with cooking gas, making them unsuitable for storage.

12. Equation of a plane progressive wave is given by $y = 0.6 \sin 2\pi(t - x)\, m$. Amplitude of the wave is: **1**

(A)2π m (B) 0.12 m (C) $0.6/2\pi$ m (D) $0.6\, m$

For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

(A) If both Assertion and Reason are true and Reason is correct explanation of Assertion.

(B) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(C) If Assertion is true but Reason is false.

(D) If both Assertion and Reason are false.

13. **Assertion (A):** $v - t$ graph of uniformly accelerated one dimensional motion is straight line inclined to the axes. **1**

Reason (R): velocity is directly proportional to the square root of displacement in uniformly accelerated one dimensional motion.

14. **Assertion (A):** Angle of friction is maximum when then surface is parallel to the horizontal **1**

Reason (R): Angle of friction decreases with angle of inclination of the surface.

15. **Assertion (A):** A body moving in a straight line parallel to Y axis can have angular momentum. **1**

Reason (R): We can employ the concept of angular momentum only in rotatory motion.

16. **Assertion (A):** Water is used as a coolant in radiators of automobiles. **1**

Reason (R): Water has a high specific heat capacity, which helps it absorb and store large amounts of heat**.**

SECTION B

17. A car starts from rest and accelerates uniformly with an acceleration for a time interval t, reaching a velocity v. It then continues to travel at this velocity v uniformly for a time interval $2t$. Finally, it decelerates uniformly to rest over the next time interval t. **2**

(a) Plot a velocity-time $(v - t)$ graph for the car's motion.

(b) Calculate the average velocity of the car over the entire trip.

18. An object of mass 200g is attached to a spring with a spring constant 50N/m. The object is displaced by 10cm from its equilibrium position and released. It is observed that the object's speed becomes zero when it reaches a position 5cm on the other side of the equilibrium. Calculate the magnitude of the non-conservative force acting on the object, if any. **2**

19. An object of mass m is raised to a height nR above the surface of the earth. Show that the change in the gravitational potential energy of the body is $\left(\frac{n}{n+1}\right)mgR$ **2**

20. When the tension in a metal wire is T_1, its length is l_1. When the tension is T_2, its length is l_2. Find the natural length of wire. **2**

21. (a) State Stefan-Boltzmann law **2**

(b) A person's body has a surface area of 1.9 m^2. The room temperature is 22°C, and the internal body temperature is 37°C. The temperature of the skin is 28°C. The emissivity of the skin is 0.97. Using the Stefan-Boltzmann law, calculate the rate of heat energy radiated from the body.

OR

An iron bar of length L_1, area of cross section A_1, coefficient of thermal conductivity K_1 and a brass bar of length L_2, area of cross section A_2 , coefficient of thermal conductivity K_2 are soldered end to end. The free ends of the iron bar and brass bar are maintained at T K and T_0 K respectively. Obtain expressions for (i) the temperature of the junction of the two bars, (ii) the equivalent thermal conductivity of the compound bar. **2**

SECTION C

22. The frequency ν of a vibrating string is hypothesized to depend on the applied load (tension) F , the length of the string l, and the mass per unit length m . Using the principles of dimensional analysis, derive an expression for the frequency ν in terms of F, l , and m . [Take value of dimensionless constant, k = 1/2] **3**

23. An object is moving along a circular path centred about the origin and its position vector is varying as $r = 4\cos 4t\,\hat{\imath} + 4\sin 4t\,\hat{\jmath}$. **3**

(a) Write an expression for its instantaneous velocity.

(b) Calculate the speed with which the object moves along the circular path.

(c) Find magnitude and direction of angular speed of the object.

(d) Calculate acceleration of the object.

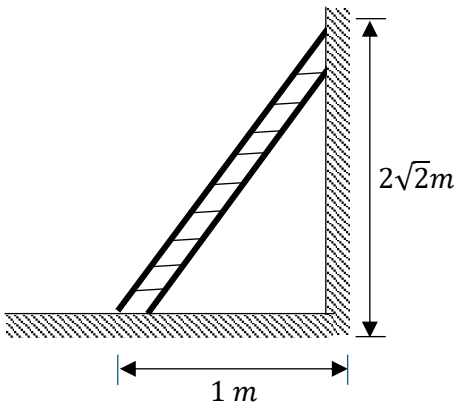
(e) Calculate the angular displacement of the object in π s.

24. (a) List any two features of elastic collision. **3**

(b) In a glancing collision between two identical elastic bodies, show that after the collision, the bodies will move perpendicular to each other. Assume the collision is perfectly elastic, and the bodies are identical in mass.

25. (a) Under what conditions can an object be said to be in mechanical equilibrium? **3**

(b) A 3m long ladder weighing 20 kg leans on a frictionless wall. Its feet rest on the floor 1 m from the wall as shown in figure Find the reaction forces of the wall and the floor.



26. (a) State Kepler's laws of planetary motion. **3**

(b) With the help of well labelled diagram, give a mathematical proof Kepler's second law.

27. (a) Why the internal energy of a compressed gas is less than that of a rarefied gas the same temperature? **3**

(b) Why is the change in internal energy different for the same amount of heat absorbed during melting and boiling?

(c) Why is the work done in adiabatic expansion smaller than that in isothermal expansion for the same change in volume?

OR

A gas cylinder pumped to a pressure of 8 atm at temperature $127^0\ C$ suddenly bursts. Calculate the **3**

(a) Fall in temperature.

(b) Work done per one mole of the gas. Take $\gamma = 1.5$.

28. (a) Using the expression for pressure exerted by gas, obtain the expression for average translational kinetic energy per garam molecule of the gas. **3**

(b) State law of equipartition of energy.

(c) Using this law show that molar specific heat of water molecule is 9R.

SECTION D

29. At a local carnival, a game challenges participants to toss watermelons from a platform into a basket placed some distance away. The platform is 10 m above the ground, and the basket is positioned on the ground 20 m horizontally away from the base of the platform. A participant throws a watermelon with an initial velocity v_0 at an angle θ to the horizontal. Assume the acceleration due to gravity is $g = 10m/s^2$, and air resistance is negligible. **4**

Answer the following questions.

(i) Choose the correct statement.

(A) Increasing θ always increases the time of flight.

(B) Increasing θ decreases the time of flight if $\theta > 45°$.

(C) The time of flight depends only on the vertical component of the initial velocity $v_0 sin\theta$, and independent of the initial height h.

(D) The time of flight is independent of the launch angle θ .

(ii) If the basket is moved farther away horizontally, how must the initial velocity v_0 or angle θ be adjusted?

(A) Decrease v_0 or decrease θ to achieve a longer horizontal range.

(B) Increase v_0 or increase θ to achieve a longer horizontal range.

(C) Decrease v_0 or increase θ to achieve a longer horizontal range.

(D) Both v_0 and θ must remain constant to achieve the horizontal range.

OR

What is the effect of increasing the initial height h on the horizontal range of the given projectile?

(A) The horizontal range decreases because the projectile's vertical velocity reduces.

(B) The horizontal range increases because the projectile stays in the air longer.

(C) The horizontal range remains unchanged because h does not affect horizontal motion.

(D) The horizontal range depends only on the angle θ , not the height h .

(iii) To guarantee the watermelon lands in the basket, what is the minimum initial velocity v_0 needed if the angle of throw is fixed at 30^0?

(A) 11 m/s (B) 13 m/s (C) 15 m/s (D) 16.5 m/s

(iv) At what height above the ground will the watermelon be when it is horizontally halfway to the basket if the angle of throw is fixed at 30^0?

(A) 11 m (B) 13 m (C) 15 m (D) 16.5 m

30. At the science fair, a second exhibit complements the pendulum and spring systems with a **reference circle model**. The model uses a rotating disc with a point marked on its edge, casting a shadow on a nearby wall. Visitors notice that the shadow of the point moves back and forth in simple harmonic motion (SHM). The students explain how this demonstration shows the relationship between uniform circular motion and SHM: **4**

1. The projection of the point's position on the horizontal axis corresponds to displacement (x) in SHM.
2. The projection of its velocity and acceleration on the horizontal axis represents the velocity (v) and acceleration (a) in SHM.
3. The phase of the SHM corresponds to the angular position of the rotating point.

The students also display a graph of energy versus time for a block-spring system executing SHM, illustrating:

1. The **kinetic energy (KE)** is maximum at the equilibrium position and zero at the extremes.
2. The **potential energy (PE)** is maximum at the extremes and zero at the equilibrium.
3. The total energy remains constant throughout the motion.

Answer the following Questions:

(i) Which of the following correctly describes the phase difference between displacement and velocity in SHM?

(A) 0 rad (B) $\pi/2\ rad$ (C) $\pi\ rad$ (D) $3\pi/2\ \ rad$

(ii) What happens to the total energy of an SHM system when the amplitude of motion doubles?

(A) remains same (B) doubles

(C) becomes four times (D) becomes half

OR

A simple pendulum of length L=2m is displaced to a small angle and released. If the time period of oscillation is T, which of the following affects T?

(A) Increasing the amplitude of oscillation.

(B) Increasing the mass of the pendulum bob.

(C) The acceleration due to gravity, g.

(D) Changing the material of the pendulum bob.

(iii) In a mass-spring system with $k = \pi^2\ N/m$, the block of mass 1 kg is displaced from equilibrium and released. The possible time interval during which total energy is equally shared between kinetic energy and potential energy is:

(A) 0.5 s (B) 0.8 s (C) 2.5 s (D) 2.25 s

(iv) A particle executes SHM with an amplitude of $A = 5m$ and angular frequency $\omega = 2rad/s$. At $t = 0$, the particle is at its positive maximum displacement. What is its acceleration at $t = 1.5\ s$? (Approximately)

(A) 10 m/s^2 (B) -10 m/s^2 (C) 20 m/s^2 (D) -20 m/s^2

SECTION E

31. (a) State Newton's second law of motion. Show that both first and third laws are contained in second law. **5**

(b) Two blocks A and B, having masses 10 kg and 20 kg respectively, are placed on a horizontal frictionless surface. They are connected by a light, flexible, and inextensible string that can withstand a maximum tension of 60 N. Determine the maximum force that can be applied on the system so that the blocks move together without breaking the string.

OR

(a) What is meant by banking of roads? With the help of neat diagram, obtain an expression for the maximum speed, with which a vehicle can safely negotiate a curved road banked at an angle θ. **5**

(b) A particle describes a horizontal circle on the smooth inner surface of a conical funnel. The height of the plane of the circle above the vertex is 10 cm. What is the speed of the particle? Take $g = 10\ m/s^2$.

32. (a) The pressure difference across a curved liquid surface arises due to surface tension. The concave side experiences higher pressure compared to the convex side. Derive an expression for the pressure difference between the two sides of a liquid surface. **5**

(b) A drop of oil placed on the surface of water spreads out. But a drop of water placed on oil contracts to a spherical shape Why?

(c) Why do raindrops falling from a sufficiently large height reach a certain maximum velocity and then continue to fall with constant velocity?

OR

(a) "For a streamline flow of an ideal fluid, the total energy per unit volume is constant". With the help of neat diagram, prove this statement mathematically. **5**

(b) why a small air bubble rises slowly through a liquid whereas the bigger one rises rapidly?

(c) Why do machine parts often get jammed during winter?

33. (a) Derive Newton's formula for velocity of sound in air. What is Laplace's correction? **5**

(b) Show that velocity v of sound at temperature t^0C is given by the equation $v = v_0 + 0.61t$ Where v_0 is the temperature at 0^0C.

OR

(a) What are beats? Prove that the number of beats per second is equal to the difference between the frequencies of the two superimposing waves. **5**

(b) Illustrate the graphical representation of beat formation resulting from the superposition of two waves with frequencies 10 Hz and 12 Hz. Provide a labelled diagram and explain the variation in amplitude over time.

(c) Two tuning forks A and B produce 4 beats per second. On loading B with wax, 6 beats per second are heard. Find the frequency of B if the frequency of A is 256 Hz.

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