CBSE class 11 physics

Sample Paper 04

Time: 3Hrs.] [M.M.: 70]

General Instructions:

i. There are 26 questions in all. All questions are compulsory.
ii. This question paper has five sections: Section A, B, C, D and E.
iii. Section 'A' contains 5 questions of one mark each, section B contains 5 questions of two marks each, section C contains 12 questions of three marks each, section D contains 1 value based question of four marks and section 'E' contains 3 questions of five marks each.
iv. There is no overall choice. However an internal choice has been provided in one question of two marks, one question of three marks and all the three questions of five marks each. You have to attempt only one choice of these questions.

SECTION: A

1. Write the two physical quantities whose dimensions are same.
2. We place handles at maximum distance from the hinge in a door. Give reason.
3. Which is more elastic: rubber or steel?
4. Birds swell their feathers in winter. Why?
5. In an open organ pipe, third harmonic is 450 Hz. What is the frequency of fifth harmonic?

SECTION: B

6. A physical quantity X is given by:
   $X = \frac{P^2 Q^{3/2}}{R^4 S^{1/2}}$
   The percentage errors in P, Q, Rand S are 1%, 2%, 4% and 2%. Calculate the percentage error in X.
7. State law of parallelogram of vector addition,Show that the magnitude of resultant $\vec{R}$ of

two vectors $\vec{P}$ and $\vec{Q}$ inclined at an angle θ is $|\vec{R}| = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$

OR

For what value of m, the vector $A = 2\hat{i} + 3\hat{j} - 6\hat{k}$ is perpendicular to $\ddot{B} = 3\hat{i} - m\hat{j} + 6\hat{k}$?

8. The moment of inertia of two rotating bodies A and B are I_A and I_B ($I_A > 1_B$) and their angular momentum are equal. Which of them has greater kinetic energy?
9. A steel wire of length 4 m and diameter 5 mm is stretched by 5 kg-wt. Find the increase in its length, if the Young's Modulus of steel wire is 2.4 x 10^{12} dyne-cm^{-2}.
10. The frequencies of two tunning forks A and B are 250 Hz and 255 Hz respectively. Both are sounded together. How many beats will be heared in 5 s?

SECTION: C

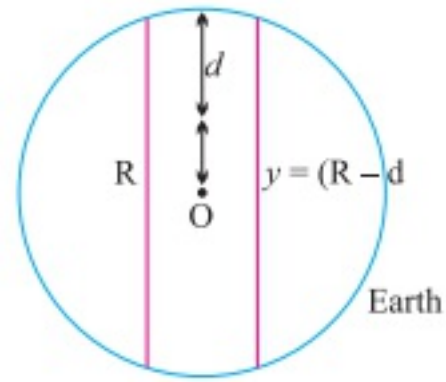
11. The time of oscillation t of a small drop of liquid under surface tension depends upon the density p, radius r and surface tension O. Show dimensionally that:
$t = \frac{\sqrt{pr^3}}{\sigma}$
12. The spring constant of the spring shown in fig. is 250 N/m. Find the maximum compression of the spring.

13. A train runs along an unbanked circular track of radius 30 m at a speed of 54 km/h. The mass of the train is 10^6kg. What is the centripetal force required for this purpose ? What is the angle of banking required to prevent wearing out of the rail?
14. Two balls of different masses m_1 and m_2 ($m_1 > m_2$) are thrown vertically upwards with the same initial speed v_0 simultaneously.
    a. Which one of the two balls, will rise to the greater height?
    b. Which of the two balls, will come back with greater speed to the point of projection?
    c. Which of the two balls, will comeback first to the point of projection ?

OR

Prove that Newton's second law of motion is the real law of motion.

15. Discuss the variation of g with depth. Derive an expression for it. What is the value of g at the centre of earth?
16. Define 'Radius of Gyration'. Derive an expression for it.
17. A liquid drop of diameter 4 mm breaks into 1000 droplets of equal size. Calculate the resultant change in surface energy. The surface tension of the liquid is 0.07 Nm^{-1}.
18. State first law of thermodynamics. Why $C_P > C_V$.? Prove $C_P - C_V = R$.
19. Derive an expression for the work done in an isothermal process.
20. A vessel is filled with a gas at a pressure of 76 cm of Hg at a certain temperature. The mass of the gas is increased by 50% by introducing more gas in the vessel at the same temperature. Find out the resultant pressure of the gas.
21. Derive an expression for the excess of pressure inside a liquid drop.
22. A body is dropped in a hole drilled across a diameter of the earth. Show that it execute S. H. M. Assume the earth to be homogenous sphere of radius R.



SECTION: D

23. Sunita, a Science student, was coming from school to her home. On the way she saw prayers were being done at various place. From Yamuna bridge she saw many people were taking dip in the Yamuna river. When she reached home, she was hungry. She asked her mother to give food, but she refused saying solar eclipse is occurring and would not cook food till eclipse get over. When she tried to take milk, she found Tulsi leaves in it. Mother again disallowed her to eat or drink anything till the eclipse is completed. She tried to perceive her mother that solar and lunar eclipse are the natural phenomenon and has no ill effect on anyone. But she was not ready to listen anything and advised her not to be unorthodox. She became frustrated and felt embrassed at the

superstitions of people and went to study.

a. What are the values shown by Sunita ?
b. Time period of a planet around the Sun is 11.6 years. How far is the planet from Sun ?

The distance between Sun and earth is 1.5 x 10^8 km.

SECTION: E

24. A projectile is fired at an angle θ upward with the horizontal with velocity u.
    a. Show that its trajectory is parabolic.
    b. Obtain expression for:
        i. Maximum height attained
        ii. Time of flight
        iii. Horizontal range
    c. At what value of 0 the range is maximum?

OR

Derive an expression for velocity of a car on a banked circular road having coefficient of friction μ and $v_0 > v_0$. Write the expression for optimum velocity of the car. (v: speed of car, v_0: optimum speed)

25. State and prove Bernoullie's theorem.

OR

Give the postulates of kinetic theory of gases. Derive the expression for pressure exerted by gas molecules in a container. Use it to relate kinetic energy with pressure.

26. Find the total energy of the particle executing SHM and show graphically the variation of PE and KE with time in SHM. What is the frequency of these energies w.r.t. the frequency of the particle executing SHM ?

OR

An incident wave and a reflected wave are represented by:
$y_1 = a \sin \frac{2\pi}{\lambda}(vt - x)$
and $y_2 = a \sin \frac{2\pi}{\lambda}(vt + x)$
Derive the equation of the stationary wave and calculate the position of the nodes and

antinodes.

Answers

Section A

1. Stress and Young's Modulus or Work and Energy Or any other correct example.
2. For develop more torque with less force.
3. Steel
4. Birds swell their feathers and maintain a thick layer of air which is an insulator.
5. $v_s = 3v_1 = 450 \therefore v_1 = 150$ Hz.

   fifth harmonic $v_5 = 5v_1 = 750$ Hz

Section B

6. % error in $X = 2\left[\frac{\Delta A}{A}\right] \times 100 + \frac{3}{2}\frac{\Delta Q \times 100}{Q} + \frac{h\Delta C}{C} \times 100 + \frac{1}{2}\frac{\Delta s}{s} \times 100$ calculation.

   Result 22%
7. Correct derivation.

Section C

8. Angular Momentum $L = I\omega$

   K.E. of rotation, $K = \frac{1}{2}IW^2$

   $K = \frac{1}{2}\frac{I^2W^2}{I} = \frac{1}{2I}L^2$

   L is constant,

   $K\alpha\frac{1}{I}$

   As $I_A > I_B, \therefore K_B > K_A$

   B has greater K.E.
9. F = 5000 x 980 dyne

   l = 400 cm.

   r = 0.25 cm.

   y = 2.4 x 10^{12}

   $y = \frac{F}{\pi r^2}\frac{l}{\Delta l}$

$\Delta l = 0.0041 cm.$

10. v_1= 250 Hz, v_2 = 255 Hz

    No. of beats/s = 255-250 = 5

    No. of beats in 5 sec = 25

Section C

11. Correct derivation.
12. K.E. of mass = Elastic Potential Energy of spring

    $\frac{1}{2}mv^2 = \frac{1}{2}kx^2$

    $x = \sqrt{\frac{mv^2}{k}} = \frac{3m}{\sqrt{2}}$
13. Centripetal force $= \frac{mv^2}{r} = \frac{10^6 \times 15^2}{30}$

    = 75 x 10^5N

    Angle of Banking, $\theta = \tan^{-1}\frac{v^2}{vg} = 37^\circ.$
14. Since they are thrown with same speed both of them will rise to the height and will have same speed while coming back to the point of projection because equation of motion does not depend upon mass.

OR

Correct explanation.

15. Correct derivation.

    The value of g is 0 at centre because

    $g' = g\left(1 - \frac{d}{R}\right), d = R$
16. Correct definition

    Correct expression for radius of gyration.
17. $\sigma = 0.07 Nm^{-1}$, $R = \frac{D}{2} = 2 \times 10^{-3} m$

    N = 1000

    Change in surface energy $W = \sigma\left[N4\pi r^2 - 4\pi R^2\right]$

    r = $RN^{-1/3}$ Calculation

    W = 31.68 x 10^{-6}J
18. Correct statement

    Correct explanation of $C_p > C_v$.

Correct Proof

19. Correct derivation of expression.
20. According to kinetic theory of gases, pressure exerted by the gas,

    $P = \frac{1}{3} r\, C^2 = \frac{1}{3} \frac{M}{V} C^2$

    As T constant therefore C^2 constt,

    Also V is constant.

    $P \alpha M$ or $\frac{P_2}{P_1} = \frac{M_2}{M_1}$

    $\frac{P_2}{76} = \frac{\left(M_1 + \frac{50}{100} M_1\right)}{M_1} = \frac{3}{2}$

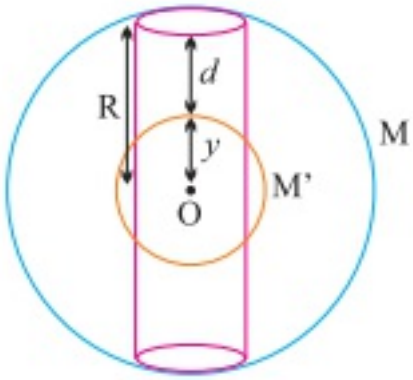
    $P_2 = \frac{3}{2}{}' 76 = 114 cm\ of\ Hg.$
21. Correct Derivation of expression.
22. Let a body of mass 'm' be dropped in straight hole in the earth of mass M, density p and radius R. The body will be attracted towards the centre of the

    earth with a force given by,

    $F = \frac{GMm}{R^2} = mg$

    or $g = \frac{GM}{R^2} = \frac{G \frac{4}{3} p R^3 r}{R^2}$

    $g = \frac{4p}{3} Gr\rho$



When the body is dropped into the straight hole, and it falls through the depth 'd' the value of acceleration due to gravity.

$g' = \frac{GM'}{(R-d)^2}$

$\frac{g'}{g} = \frac{R-d}{R}$ or $g' \alpha (R - d)$

i.e., acceleration of the body is directly proportional to the displacement from the centre of earth O. Thus the motion is SHM.

{tex}T = 2\pi \sqrt {\frac{{Displacement}}{{Acceleration}}} \{/tex}

Or $T = 2\pi\sqrt{\frac{(R-d)}{\frac{(R-d)}{R}}} \cdot g$

Or $T = 2\pi\sqrt{\frac{R}{g}}$

Section D

23.

a. Not Superstitious, scientific knowledge.

b. T_p = 11.6 year r_p = ?

T_e = 1 year r_e = 1.5 x 10^{11} m

$T^2 \alpha r^3 \quad \frac{T_p^2}{T_e^2} = \frac{r_p^2}{r_e^2}$

Or $r_p = r_e \frac{T_p^2}{T_e^2} = 1.5 \times 10^{11} \times \left(\frac{11.6}{11}\right)^{\frac{2}{3}}$

=7.68 x 10^{11} m.

Section E

24.

a. Correct derivation.

b.

i. Correct derivation.

ii. Correct derivation

c. $\theta = 45^\circ$

OR

Correct derivation.

25. Correct derivation.

OR

Postulates

Derivation

$P = \frac{1}{3}\frac{nmc^2}{V}$

or $PV = \frac{2}{3}{}'\frac{1}{2}nmc^2 = \frac{2}{3}E$

26. In SHM. $y = A\sin\omega t$

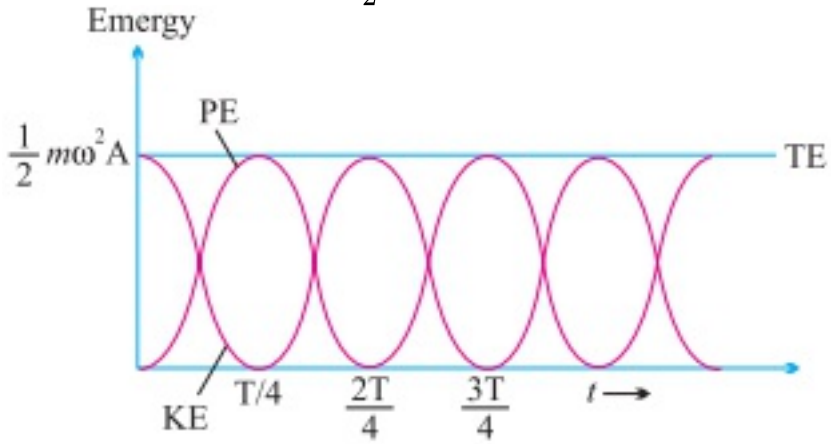
$PE = \frac{1}{2}ky^2 = \frac{1}{2}m\omega^2 y^2$

$PE = \frac{1}{2}m\omega^2 A^2\sin^2\omega t$

$KE = \frac{1}{2}mv^2 = \frac{1}{2}m\cdot\left(\frac{dy}{dt}\right)^2$

$KE = \frac{1}{2}mv^2 A^2\cos^2\omega t$

$T.E = PE + KE = \frac{1}{2}m\omega^2 A^2$



OR

According to principle of superposition.

$\delta = \delta_1 + \delta_2$

$\delta = 2a\sin\frac{2\pi}{\lambda}x\cos\frac{2\pi}{\lambda}ut$

as the reflected wave will be out of phase by π radians besides oppositely directed.

Amplitude $A = 2a\sin\frac{\pi}{\lambda}x$.

A is minimum at nodes

$\therefore$ at x = 0, x = l for nodes.

$\frac{2\pi}{\lambda}x = 0, \pi, 2\pi.... n\pi$

$x = N\frac{\lambda}{2}\ or\ l = N\frac{\lambda}{2}$

So at all points seperated by $\frac{\lambda}{2}$ a from one end nodes are formed.