Roll No. ________________ Code : 112016-042-A

Please check that this question paper contains **26** questions and **7** printed pages.

CLASS-XI
PHYSICS

Time Allowed : 3 Hours **Maximum Marks : 70**

General Instructions :

(i) All questions are compulsory.

(ii) There are 26 questions in all.

(iii) This question paper has five sections : Section A, Section B, Section C, Section D and Section E.

(iv) Section A contains five questions of one mark each, Section B contains five questions of two marks each, Section C contains twelve questions of three marks each, Section D contains one value based question of four marks and Section E contains three questions of five marks each.

(v) 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. You have to attempt only one of the choices in such questions.

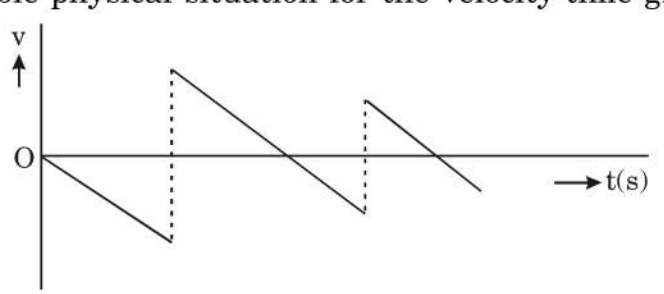
(vi) Fifteen minutes time has been allotted to read this question paper. During this time, the student will only read the question paper and will not write any answers on the answer script.

Section-A

1. State the number of significant figures in the following measure quantities :
   (i) 0.004700 km
   (ii) 12300 cm

2. Name the physical quantity, corresponding to the slope of the position-time graph at a particular instant. State whether this quantity is a scalar or a vector.

3. Suggest a suitable physical situation for the velocity-time graph given below :



4. Write the value of the time period of a geo-stationary satellite in its orbit around the earth.

5. State the relation between the (total) internal energy, of one mole of a monoatomic (perfect) gas, and its absolute temperature.

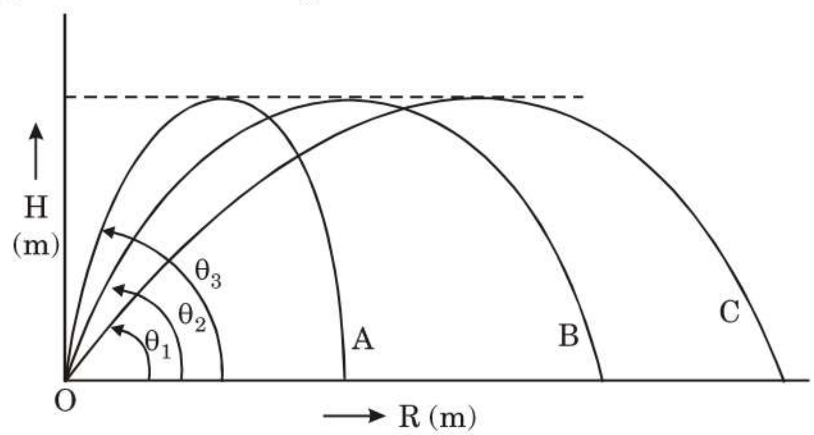
Section-B

6. The term 'Planck time' (t_p) refers to the time, after the 'Big Bang', at which the laws of physics began to be applied to understand physical phenomena. Check whether the proposed formula for Planck time, given below, is correct or not ?

$$t_p = \frac{1}{\sqrt{2\pi}} \sqrt{\frac{GE}{\nu\, c^5}},$$

Here G, E, c and ν correspond to the universal gravitational constant, energy, the speed of light, and frequency, respectively.

7. Three point objects, A, B and C, are projected at angles of projections, θ_1,θ_2 and θ_3, respectively, as shown in the figure.

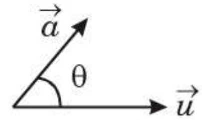


If all of them attain the same maximum height, show that their 'times of flight'are also identical.

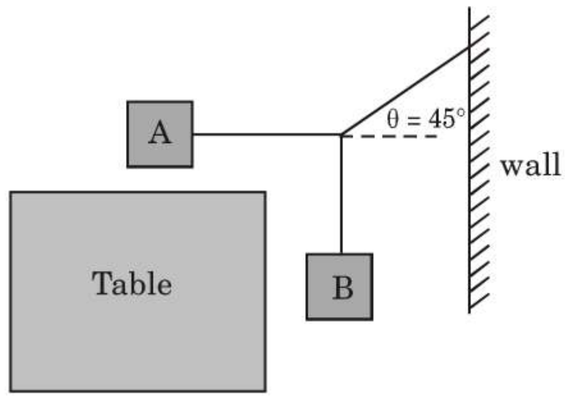
OR

A particle, initially moving with a velocity $\vec{u}$, along the x-axis, experiences a uniform acceleration, $\vec{a}$, in a direction inclined at an angle θ to the x-axis, for a time t.

Obtain an expression for the magnitude, ν, of the final velocity $\left(\vec{v}\right)$ of the particle.



8. In the figure given below, the block A is of mass 10 kg. Coefficient of limiting friction, between block A and the horizontal table, is 0.25. The angle 'θ', between the horizontal segment of the string and the oblique part, is maintained at 45°. Find the maximum weight, of block B, for which the system would remain in equilibrium. (Take $g \simeq 10\ ms^{-2}$)



9. The power developed, when a force of $\vec{F} = \left(\hat{i} + 2\hat{j} - \hat{k}\right)$ N, acting on a body, producing a velocity of $\vec{v} = \left(-\hat{i} + \hat{j} - a\hat{k}\right) ms^{-1}$ in it, is found to be 3 watt. Find the value of a.

10. A refrigerator maintains eatables, kept inside, at 9°C. If the room temperature is 37.2°C, calculate the coefficient of performance of the refrigerator.

Section-C

11. The equation, for an adiabatic process, is given as : $pV^{\gamma} = K$, where K is a constant. What does γ stand for ?

    Using this equation, derive an expression, for the work done, when an ideal gas undergoes a change in its state, adiabatically, from (P_1, V_1) to (P_2, V_2).

12. State the law of equipartition of energy. Use it to obtain the expressions for the molar specific heat capacity at (i) constant volume (C_v) and (ii) at constant pressure (C_p) for diatomic gases.

13. Prove that the oscillation of a simple pendulum are simple harmonic in nature only for small amplitude of its oscillations. Hence obtain a formula for its time period.

    OR

    Give the meaning of the term : 'Doppler effect in sound'. Obtain a formula, for the apparent frequency of sound, observed when the source of sound is moving away from a stationary observer.

14. A wave, propagating along a string, is described by the expression :

$y_{(x,\, t)} = 0.005 \sin (3.0\, t - 31.42\, x)$

The numerical constants are in SI units. Calculate the

(a) amplitude

(b) wavelength and

(c) time period

for this wave.

15. Give one example to show that

(a) the magnitude, of the average velocity of a particle, is not always equal to its average speed.

(b) a particle, moving with a constant speed, may not be having a uniform motion.

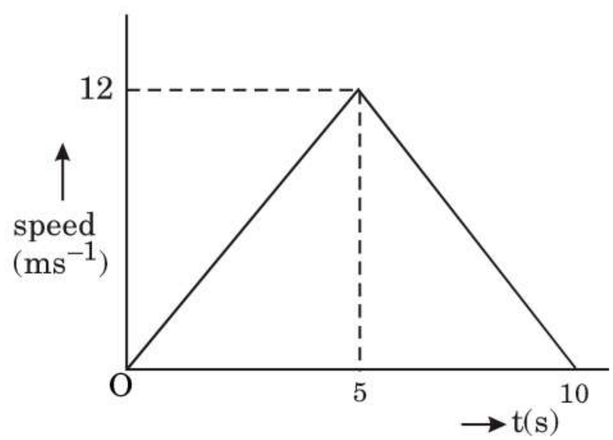
(c) a person, caught in a rain, falling vertically, does not necessarily hold the umbrella along the vertical direction.

16. The speed-time graph for a particle, moving along a straight line, is shown in the figure.

Find out the average speed of the particle between the time intervals :

(i) $t = 0$ and $t = 10$ s

(ii) $t = 2$ s and $t = 6$ s



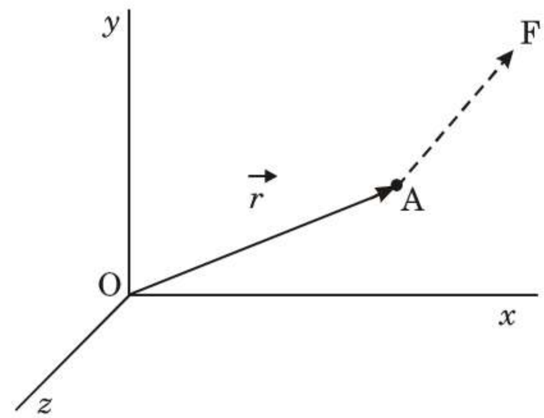
17. Explain the following :

(a) A cricketer moves his hands backwards while catching a ball thrown towards him.

(b) We say that in nature, forces always appear in pairs.

(c) The weight of a person, standing on a weighing machine, can be more than his true weight, if the weighing machine with the person on it, is moving up with some acceleration.

18. A particle of mass 'm' is situated at point A, which has a position vector of $\vec{OA} = \vec{r}$. Force $\vec{F}$ acts on this particle, as shown in the figure. The linear velocity of the particle at this instant is $\vec{v}$ (not necessarily in the direction of the force $\vec{F}$)



(a) Write the vector expressions for

(i) the torque $\left(\vec{\tau}\right)$ produced by $\vec{F}$ and (ii) the angular momentum $\left(\vec{L}\right)$ of the particle about O.

(b) Using the above expressions, obtain the relation between the torque $\left(\vec{\tau}\right)$ and the angular momentum $\left(\vec{L}\right)$

19. A uniform circular disc has radius 5 cm and mass 2 kg.

Calculate the moment of inertia of this disc about an axis :

(i) perpendicular to its plane and passing through its centre

(ii) coinciding with one of its diameters

(iii) lying in its plane and tangential to its rim.

20. (a) State the relation between 'g' (on the surface of earth) and 'G'; in terms of the mass (M) and the radius (R) of earth.

(b) Obtain an expression, relating the value of 'g' at a point situated at a height 'h' above the surface of the earth, to its value, on the surface of the earth.

21. (a) Name the three different types of energy, possessed by an incompressible fluid, in stream-line flow.

(b) Mention any three applications of Bernoulli's theorem.

22. A wire, of area of cross-section 3.0 mm^2, and natural length 50 cm, is fixed at one end and a mass of 2.1 kg is hung from the other end. Determine the elastic potential energy stored in the wire in the steady state.

[Given : Young's modulus of the material of the wire = 2.0×10^{11} Nm^{-2} and g $\simeq$ 10 ms^{-2}.]

Section-D

23. Vini, while doing the resonance column experiment, noticed that when the conditions became suitable for 'resonance', the loudness of sound became maximum and it remained sustained for long. On coming back home, she narrated her observations to her grandfather. Though he was unable to understand the physics of the phenomenon, he realised that similar things happen in real life too. He told Vini that when we align, and orient, our thinking and actions, in an adaptive and accommodating way, our life becomes more vibrant, happy and productive. We are then in resonance with the environment and the society.

Answer the following questions based on the above passage :

(a) Mention two values displayed by :

(i) Vini

(ii) her grandfather

(b) Sketch the standing waves, produced in the (closed tube) air column, for first and second resonances, showing the positions of the node and the antinode.

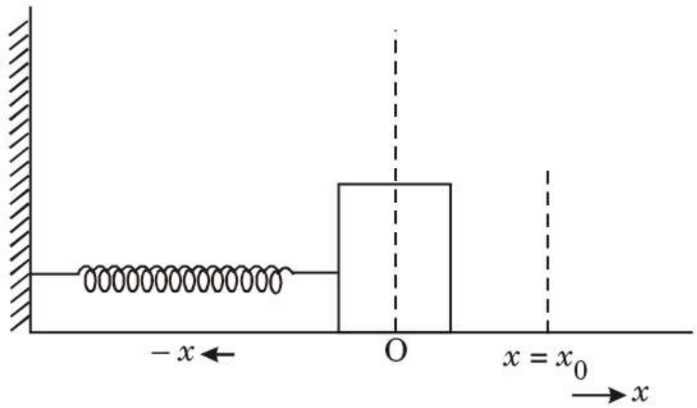
Section-E

24. Draw a diagram showing the various forces acting on a vehicle moving on a banked road. Deduce a formula for the maximum velocity with which the vehicle can move along the banked road, when 'friction' is also present.

OR

State Newton's second law of motion. From this law, obtain a vector expression for force, in terms of acceleration. Hence give the definition of the SI unit of force.

25. One end of an ideal spring, of spring constant k, is fixed to a rigid wall and the other end is attached to a small block of mass m, resting on a horizontal frictionless table, as shown below. The spring is set to remain parallel to the table.



(a) Derive an expression for the potential energy stored in the spring, when the block is moved along the table from x = 0 (the idle position) to $x = x_0$.

(b) Using the law of conservation of mechanical energy, predict, how will the kinetic energy of the block change, if it is released after being moved to $x = x_0$. Show the variation of K.E. graphically.

OR

A body of mass m_1, moving with velocity u_1, collides head on with another body of mass m_2 at rest (i.e. $u_2 = 0$). The system remains isolated from the surroundings.

(a) Derive formulae, for the velocities with which m_1 and m_2 will move after the collision, if the collision is perfectly elastic.

(b) Obtain an expression for the final kinetic energy of the system when the collision is perfectly inelastic.

26. (a) State Stoke's law.

(b) Using Stoke's law, prove that a body would attain a terminal speed when falling through a viscous fluid, under gravity. Derive an expression for this terminal velocity.

OR

(a) Define 'angle of contact'.

(b) Show that a liquid can rise, in a capillary tube, to a certain height.

Obtain an expression for the height of rise of the liquid in the capillary tube.