Roll No. _____ **Code : 112015-042-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.*

Questions 1 to 5 carry one mark each.

Questions 6 to 10 carry two marks each.

Questions 11 to 22 carry three marks each.

Question 23 carry four marks.

Questions 24 to 26 carry five marks each.

(iii) *There is no overall choice. However, internal choice has been provided in one question of two marks, one question of three marks and all questions of five marks. You have to attempt only one of the choices in such questions.*

(iv) *Fifteen minutes time has been allotted to read this question paper. During this time, you will only read the question paper and will not write anything in the answer booklet.*

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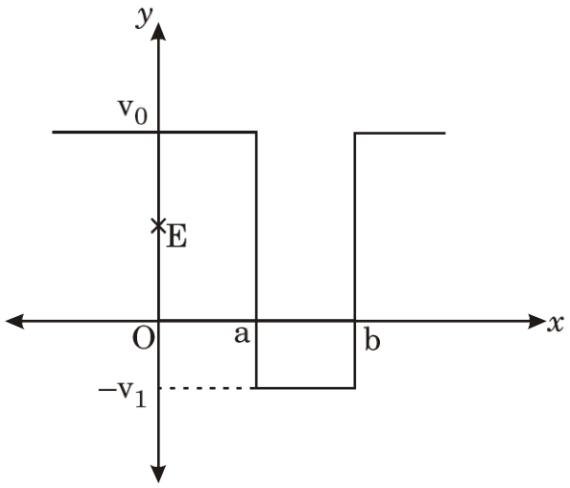
1. State the meaning of the term 'Precision' with reference to the measurement of a physical quantity. (1)

2. Write the formula for the co-ordinates of the centre of mass of two particles of mass m_1 and m_2 located at the points (x_1, y_1) and (x_2, y_2) respectively. (1)

3. The graph shown below represents the potential energy variation for a particle moving in one dimension. E represents the total energy of this particle. [E is marked on the ordinate axis with cross]. Write the values of x, as per the graph, for which the potential energy of the particle is more than its total energy. (1)



4. Define Bulk modulus of a material. (1)

5. State the relation between the average kinetic energy of a molecule of a gas and its absolute temperature. (1)

6. Derive formula for magnitude of the resultant $\vec{R}$ of two vectors $\vec{P}$ and $\vec{Q}$ using parellelogram law of addition of vectors.

OR

Draw the velocity–time graph for a uniformly accelerated motion. Use the graph to obtain a relation between the initial velocity (u), the final velocity (v), displacement (s) and acceleration (a). (2)

7. A dart, of mass 10 g, moving with a velocity of 100 ms^{-1}, strikes a wooden block of mass 990 g and gets embedded in it.

   Find the velocity with which the combined mass would move. Also find the loss in K.E. during this collision. (2)

8. State and prove the theorem that relates the work done by a force to the change in K.E. of the body. (2)

9. At what height above the surface of earth will the value of 'g' be reduced to 81% of its value at the surface ? (Take the radius of the earth as 6300 km). (2)

10. The apparent frequency, of the whistle of an approaching train engine, changes in the ratio 9 : 8 as the engine crosses a stationary observer on the platform. If the speed of sound is 340 ms^{-1}, find the speed of the train. (2)

11. The frequency (ν) of a tuning fork is known to depend on the length (l) of the prong, the density (d) and Young's modulus (Y) of its material. Derive an expression for ν, using the method of dimensional analysis. (3)

12. A balloon is ascending vertically with a constant acceleration of 0.2 ms^{-2}. Two stones are dropped from it at an interval of 2 seconds. Find the distance between the two stones 1.5 seconds after the second stone is dropped. (Take g = 9.8 ms^{-2}) (3)

13. State Newton's second law.

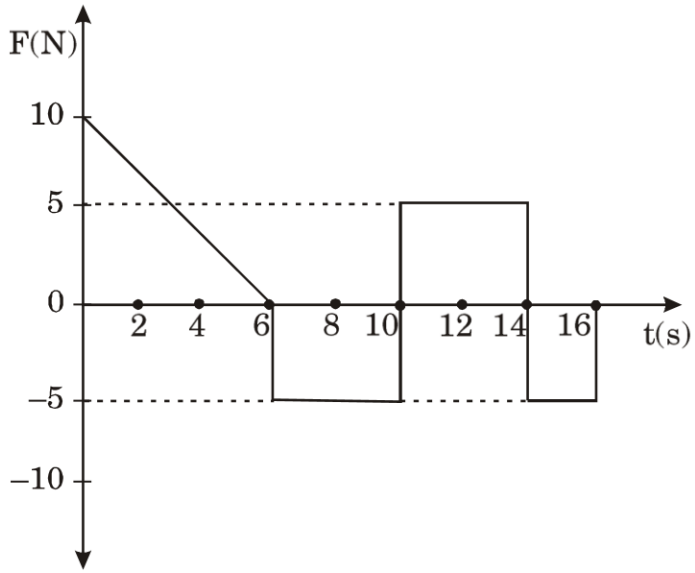
    Obtain the usual formula relating force, mass and acceleration, clearly mentioning how the constant of proportionality is made equal to one.

    Show that Newton's first law is involved in second law. (3)

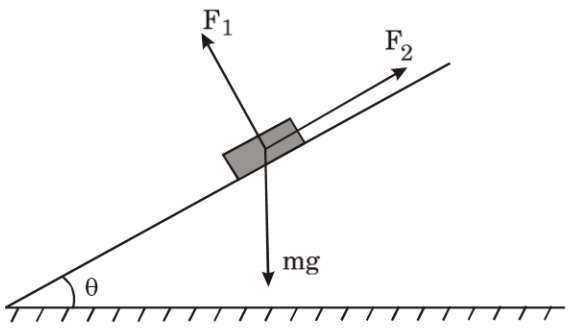
14. A particle of mass 2 kg is acted upon by a force 'F' which varies with time (t) in the manner shown in the figure.

    Identify the quantity that would equal the area enclosed by the F-t graph.

    Use this identification to find the momentum of the particle at t = 16 second. It is given that the momentum of the particle, at t = 0, is 20 Ns. (3)



15. A block of mass m is just on the point of sliding down a rough incline as shown in the figure.



(i) Name the forces marked as F_1 and F_2.

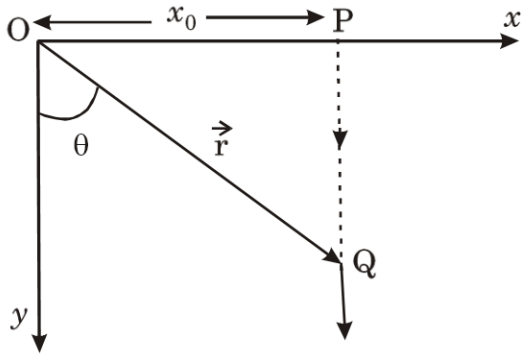
(ii) Write the expressions for these forces.

(iii) Find the relation between coefficient of friction (μ) and θ. (3)

16. Write the general formula for moment of inertia of a system of n particles.

State the theorem of (i) parallel axes and (ii) perpendicular axes, used in the calculation of moment of inertia. (3)

17. A particle of mass m is released from a point P (at $x = x_0$ on the X-axis) at $t = 0$. The X-Y plane shown is vertical. The particle falls under gravity, parallel to the Y-axis as depicted in the figure.



(i) Find the torque (τ), about 0, acting on the particle at a time 't', when the particle reaches the point Q.

(ii) Find the angular momentum (L), about 0, of the particle, when it is at the point Q at the time 't'.

(iii) Show that the values of τ and L, calculated by you, are in agreement with the relation $\tau = \frac{\theta L}{dt}$ (3)

18. An object of mass m, is released from a point at a height H above the surface of the earth. Show that its velocity (v), when it strikes the earth's surface, is given by :

$$v = \left[2\,GM\left(\frac{1}{R} - \frac{1}{r}\right)\right]^{1/2}$$

where M = mass of earth, R = radius of earth and r = R + H.

Use the above result to show that the velocity v^1 with which a meteorite, from far-off space, would strike the earth, equals the escape velocity (v_E) needed by a particle to escape from the gravitational field of the earth. (Neglect air-resistance)

OR

(a) Obtain the formula for the orbital speed of a satellite of the earth.

(b) An object is thrown vertically upwards from the surface of the earth, with a speed of V_0. Its speed at a height h (where h << R), is V. Show that :

$$V_0^2 - V^2 = 2gh\left(1 - \frac{h}{R}\right)$$ (3)

19. Draw schematic diagrams showing the basic features of :

(i) a heat engine

(ii) a refrigerator

Write expressions for the :

(a) efficiency of a heat engine

(b) coefficient of performance of a refrigerator. (3)

20. Five moles of a gas expand isothermally from an initial volume of 5 m^3 to a final volume of 10 m^3 at a constant temperature of 27°C. Find the work done by the gas during this isothermal expansion. (R = 8.3 J mol^{-1} K^{-1}) (3)

21. Derive the formula for the pressure exerted by an ideal gas on the walls of the container, in terms of the root mean square velocity. (3)

22. Prove that the vertical oscillations of a loaded spring are simple harmonic. Derive formula for the time-period of these oscillations. (3)

23. Arun, a student of class XI, was used to carry his tiffin, and water for drinking, to his school. He belonged to a family with modest means. He was surprised when his mother presented him with a thermosflask on his birthday. She told him that he could now also have hot milk for drinking in his school. She, however, advised him not to fill the flask to the brim. Arun was thankful to his mother but was also curious to know the reason for her advice. He asked his teacher about it and she gave him the proper scientific explanation for his mother's advice.

(i) State the values displayed by

(a) Arun

(b) his mother

(ii) Why are the inner walls of the thermosflask highly polished ?

(iii) Write the scientific explanation that the teacher had given to Arun. (4)

24. (a) State Bernoulli's theorem applicable for a liquid having a stream-line flow.

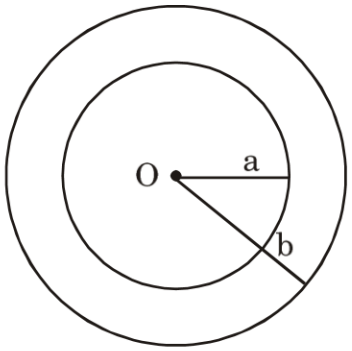
(b) Prove the same, using a neatly drawn diagram of a tube of flow, of non-uniform cross-section.

OR

(a) Derive expression for excess pressure inside a spherical soap bubble in air.

(b) A spherical soap bubble, of radius a, is contained within a larger spherical bubble of radius b.

Find the pressure of air inside the inner bubble of radius a. (5)



25. Show, diagramatically, the first, the second and the third modes of standing waves obtained in a closed organ pipe.

(a) Write the formula for the frequency of the waves, in each case, in terms of the Length (L) of the pipe and speed (v) of the wave.

(b) A particle, of mass m, is executing a simple harmonic motion represented by :

$$y = a \sin (\omega t + \alpha)$$

Obtain an expression for the kinetic energy of this particle in terms of its displacement.

OR

(a) Two progressive waves of slightly different frequencies ν_1 and ν_2 superpose to produce beats. Derive mathematically the formula for beat frequency.

(b) Graphically represent the phase relationship between velocity (v) and acceleration (a) for an SHM whose displacement is represented as :

$$y = A \sin (\omega t)$$

Also, write the formulae for v and a in terms of y. (5)

26. A body is projected with a speed 'u' at an angle of projection 'θ' with the horizontal. Obtain the equation for the trajectory of its motion. States its nature.

From the equation obtained deduce the expression for horizontal range (R).

OR

A particle is executing uniform horizontal circular motion with a speed '*v*' along a circular path of radius 'r'.

(i) Why do we regard the particle as having an accelerated motion, even though its speed is constant ?

(ii) Obtain the expression for this acceleration.

(iii) Write this expression in vector form.

(iv) Show that this acceleration is centripetal in nature. (5)