Roll No. _____ Code : 11201819PH-A

Please check that this question paper contains 27 questions and 8 printed pages.

Class : XI
PHYSICS (THEORY)

Time Allowed : 3 Hours Maximum Marks : 70

General Instructions :

1. All the questions are compulsory. There are 27 questions in all.
2. The question paper has four sections : Section A, Section B, Section C and Section D.
3. Section A (Q. No. 1 to 5) has five questions of one mark each.
   Section B (Q. No. 6 to 12) has seven questions of two marks each.
   Section C (Q. No. 13 to 24) has twelve questions of three marks each.
   Section D (Q. No. 25 to 27) has three questions of five marks each.
4. There is no overall choice. However an internal choice has been provided in two questions of one mark each, two questions of two marks each, four questions of three marks each and all the three questions of five marks weightage. You have to attempt only one of the choices in these questions.
5. Fifteen minutes time has been allotted to read this question paper. During this time, the students will only read the question paper and will not write any answer on the answer script.

SECTION - A

1. The length of a string tied to two rigid support is L. Write the value of the maximum wavelength of stationary waves that can be produced in it. 1

2. State the condition (in terms of scalar / vector products) under which two vectors : 1

   (i) $\vec{A}$ and $\vec{B}$, are parallel to each other.

   (ii) $\vec{P}$ and $\vec{Q}$ are perpendicular to each other.

3. Two circular discs of same mass and same radius are shaped like a convex and a concave lens, respectively. If both are rotated about an axis perpendicular to their planes and passing through their centres, which one will have a greater moment of interia? Give reason.

OR

For a planet orbiting the Sun in a (nearly) circular orbit, give the magnitude of the torque acting on the planet due to the (gravitational) force exerted on it by the Sun. Give reason for your answer. 1

4. Write the SI unit for the universal gravitational constant (G). 1

5. State the reason for the reddish appearance of the Sun at sunrise.

OR

State the reason for keeping the refractive index of the core of an optical fibre more than the refractive index of its cladding. 1

SECTION - B

6. A given container, maintained at a temperature T, has three types of molecules : A, B and C with masses $m_A > m_B > m_C$. 2
Compare the
(a) average kinetic energy
(b) rms speed
of the three types of molecules.

7. A physical quantity P, depends on four observables a, b, c and d as per the relation : 2

$$P = a^3 b^2 \Big/ \left(\sqrt{c}\right) d$$

If the percentage errors, in the measurements of a, b, c and d, are w%, x%, y% and z%, respectively, obtain the formula for the percentage error in the quantity P.

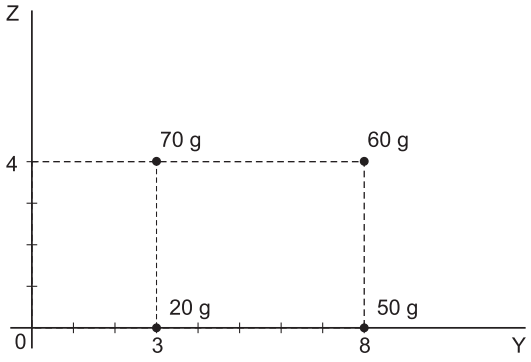
8. An object 2 cm high is placed at a distance of 10 cm from a concave mirror of radius of curvature 40 cm. Find the position and the size of the image formed. 2

9. A projectile, of mass 50g is projected with a velocity of 10 ms^{-1} from the ground at an angle of 45^0 with the horizontal. Find the magnitude of the change in its momentum between 'leaving' and 'arriving back' to the ground.

OR

Show that a given gun will shoot three times as high when elevated at an angle of 60^0 as compared with firing at an angle of 30^0. 2

10. Find the co-ordinates of the centre of mass of a system of four particles, located as shown is the (y, z) plane 2

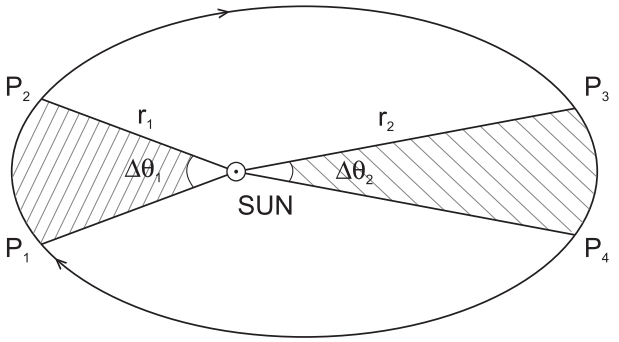


11. The acceleration due to gravity, at a depth d below the surface of the earth, equals g_d. Obtain the formula for the ratio (g_d/g_e) where g_e is the acceleration due to gravity on the surface of the earth.

OR

A given planet takes the same time (say, Δt), in going from point P_1 to point P_2 in its orbit, as it takes in going from point P_3 to P_4.

Find the (approximate) value of the ratio $\left(\frac{r_1}{r_2}\right)$ in terms of $\Delta\theta_1$ and $\Delta\theta_2$. 2



12. The speed of a particle of mass m, moving in a circle of radius r, is changing at a constant rate $a_T\ ms^{-2}$.

Write the expression for the magnitude of its instantaneous resultant acceleration.

Can we say that the direction of this instantaneous resultant acceleration would be along the instanteneous (inward) radial direction? 2

SECTION - C

13. Derive the expression for the rise of liquid in capillary tube. Hence show that the height of the liquid column supported is inversely proportional to the radius of the capillary tube.

OR

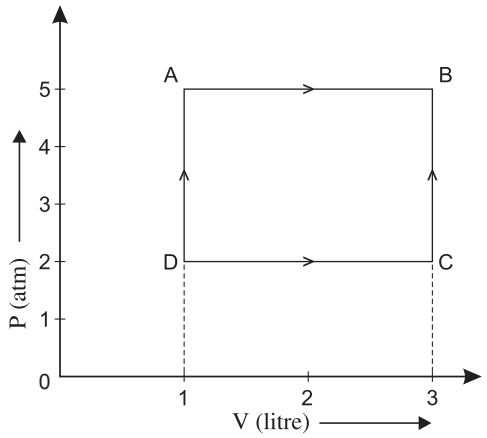
A rectangular iron bar (coefficient of thermal conductivity = K_1) and a rectangular brass bar (coefficient of thermal conductivity = K_2) are soldered end to end. The length of the iron bar is double that of the brass bar while its area of cross section is half that of the brass bar.

If the free ends of the iron bar and the brass bar are maintained at temperatures of T_1 and T_2, respectively, obtain an expression for the (equilibrium) temperature of the junction of the two bars. 3

14. Define the term 'escape speed'. Obtain an expression for the 'escape speed' of an object for a planet of mass M and radius R. 3

15. (a) Draw a labelled ray diagram for a (refracting type) astronomical telescope kept in its normal adjustment position.
    (b) Give two advantages of reflecting type of (astronomical) telescopes over refracting type of such telescopes. 3

16. One mole of an ideal gas undergoes a cyclic change ABCD where the (P, V) co-ordinates are A(5, 1), B(5, 3), C(2, 3) and D(2, 1). The 'units' of P and V are as indicated in the diagram. Calculate the work done along each of the segments AB, BC, CD and DA. Also find the net work done in the process. (Given 1 atm = 1.01×10^5 Nm^{-2}) 3



17. A particle is executing simple harmonic motion. Write the equation for the instantaneous displacement (x) of this particle from the origin.
Use this equation to obtain the relations between the (i) instantaneous velocity (v) and (ii) instantaneous acceleration(a), in terms of the instantaneous displacement(x) of the particle.

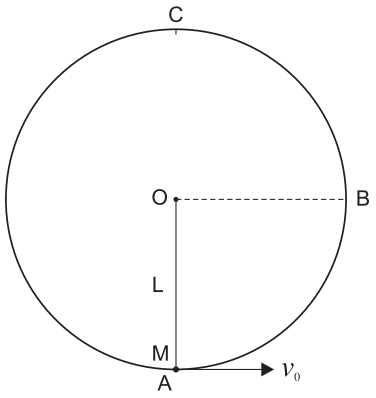
OR

When do we observe the phenomenon of beats?
A given sitar string is observed to produce beats when sounded with a given standard source of frequency 'N'. It is given that 'N' is greater than the frequency of the note being produced by the sitar string.
The tension of this sitar string is slightly increased.
Will the beat frequency increase or decrease? Justify your answer. 3

18. Define the term 'spring constant' for an ideal spring. Write its SI unit.
A block, attached to a spring, rests on a smooth horizontal surface.
Find the work done (i) by the spring force and (ii) by the external force when the block is moved from an inital displacement x_i to a final displacement x_f (from its equilibrium position).

OR

A bob of mass 'm' is suspended by a light string of length L. It is imparted a horizontal velocity v_0 at the lowest point A, such that it completes a semicircular trajectory in the vertical plane with the string becoming slack only on reaching the topmost point C. Obtain an expression for v_0 in terms of L.



3

19. (a) A body is moving along a straight line with a uniform negative acceleration. Draw the shape of its displacement vs time graph.

(b) The displacement of a body is given to be proportional to the cube of time elapsed. How does the acceleration of this body change with time? 3

20. For a thermodynamic system, define the terms :

(i) isothermal process

(ii) isochoric process

(iii) isobaric process

(iv) adiabatic process

In which of these processes is the work done by the gas zero and why?

OR

Write (any one) statement of the second law of thermodynamics.

Draw a diagram showing the schematic representation of a heat engine.

Write the formula for the efficiency of a heat engine. 3

21. State the law of equipartition of energy. Use it to obtain the value of $\gamma\left(=C_P/C_V\right)$ for a monoatomic gas. 3

22. An object of mass M, moving with a velocity V, makes a head-on elastic collision with a body of mass m, initally at rest. After the collision, the velocity of the object of mass M, along its original direction, equals V/n.

Obtain an expression for the ratio m/M. 3

23. The equation of a plane progressive wave is $y = 10 \sin 2\pi (t - 0.005x)$

where y and x are in cm and t is in seconds. Find the amplitude, frequency, wavelength and velocity of this wave. 3

24. The engine of a car, moving with a speed of $36 kmh^{-1}$, is switched off as it reaches an inclined road, inclined at 30^0 with the horizontal. If the coefficient of friction, between the road surface and the wheels of the car is $1/\sqrt{3}$, find the distance travelled by the car on this inclined road before it comes to rest. 3

(Take $g = 10\ ms^{-2}$)

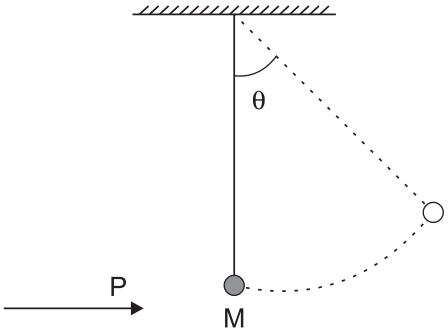
SECTION - D

25. When is a particle (in mechanics) said to be in a state of (translational) equilibrium?

Why do we say that a particle, in equilibrium, need not necessarily be at rest?

A particle of mass M, is suspended vertically from an inextensible light string of length L. When a horizontal force P acts on the particle, it comes to equilibrium with the string inclined at an angle θ to its original position.

Obtain the expression for θ.



OR

A vehicle is moving on a circular road of radius R that has been banked at an angle θ.

Obtain a formula for the maximum safe speed of the car. It is given that the coefficient of static friction, between the car wheels and the road, is μ_s.

Draw a graph, showing the dependence of the maximum (safe) speed on $\sqrt{\tan\theta}$, when $\mu_s = 0$. 5

26. A point object O, lies on the principle axis of a convex spherical surface, of radius of curvature R. This surface separates a rarer medium of refractive index μ_1 from a denser medium of refractive index μ_2. The point object (at distance u) is so placed that its real image gets formed in the denser medium (at a distance v). Derive the relation between the refractive indices, object distance, image distance and radius of curvature of spherical surface.

OR

Define the term 'angle of deviation' for a ray of light incident on an equilateral prism of angle A.

Draw a graph showing the dependence of the angle of deviation on the angle of incidence.

Use the relevant ray diagram to obtain a formula for the refractive index of the material of an equilateral prism in terms of the angle (<A) of the prism and the angle ($<\delta_m$) of minimum deviation. 5

27. Prove that the sum of the 'pressure head', 'velocity head' and the 'gravitational head' remains constant during the stream line flow of an ideal liquid.

OR

(a) Define Young's modulus of elasticity. Give its unit and dimensions.

(b) With the help of stress vs strain graph, depict the changes that happen when a load on a metal wire, suspended from a rigid support, is gradually increased. Mark the different regions of the graph. 5