विद्या सर्वार्थि साधिका

ANANDALAYA
ANNUAL EXAMINATION
Class : XI

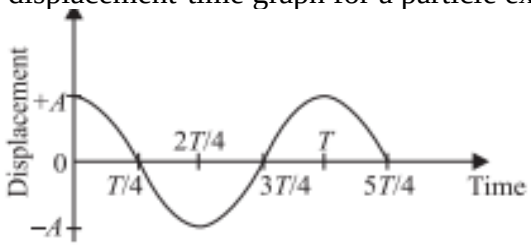
Subject: Physics MM : 70
Date : 07-03-2023 Time: 3 hours

General Instructions:
(1) There are 35 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. All the sections are compulsory.
(3) Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.
(4) There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.
(5) Use of calculators is not allowed.

SECTION A

1. The number of significant figures in the following numbers 2.000 and 0.002 are ____. (1)
(A) 1 and 4 (B) 4 and 1 (C) 1 and 1 (D) 4 and 4

2. The displacement-time graph for a particle executing SHM is as shown in figure. (1)



Which of the following statement is correct?
(A) The velocity of the particle is maximum at $t = 3T/4$.
(B) The velocity of the particle is maximum at $t = T/2$.
(C) The acceleration of the particle is maximum at $t = T/4$.
(D) The acceleration of the particle is maximum at $3T/4$.

3. When two waves of almost equal frequencies ν_1 and ν_2 reach at a point simultaneously, the time interval between successive maxima is _____. (1)
(A) $(\nu_1 + \nu_2)$ (B) $(\nu_1 - \nu_2)$ (C) $\frac{1}{\nu_1+\nu_2}$ (D) $\frac{1}{\nu_1-\nu_2}$

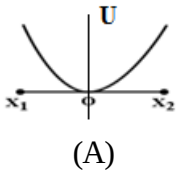
4. The normal modes of vibration of an open organ pipe are in the ratio _____. (1)
(A) 1:2:3:4…. (B) 1:3:5:7…. (C) 1:4:8:12… (D) 1:5:10:15…

5. According to equipartition law of energy, in equilibrium the total energy is equally distributed in all possible energy modes, with each mode having an average energy equal to____. (1)
(A) k_BT (B) $\frac{1}{2}k_BT$ (C) $\frac{1}{4}k_BT$ (D) $2\,k_BT$

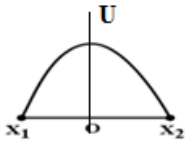
6. For an enclosure maintained at 1000 K, the maximum radiation occurs at wavelength λ_m. If the temperature is raised 2000 K, the peak will shift to ____. (1)
(A) $\lambda_m/2$ (B) $3\lambda_m/2$ (C) $5\lambda_m/2$ (D) $7\lambda_m/2$

7. Three vessels of equal capacity have gases at the same temperature and pressure. The first vessel contains neon, the second contains chlorine, and the third contains uranium hexafluoride. Which of the given statement is correct? (1)
(A) First and Second vessels have equal number of respective molecules.
(B) First and Third vessels have equal number of respective molecules.
(C) Second and Third vessels equal number of respective molecules.
(D) All three vessels have equal number of respective molecules.

8. A particle of mass m oscillates with simple harmonic motion between points x_1 and x_2, the equilibrium position being O. Its potential energy versus position is plotted. The correct graphical illustration is _. (1)



(A)



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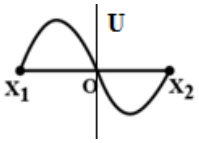
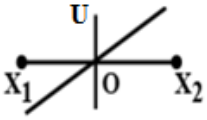


(C)



(D)

9. If the radii of two planets be R_1 and R_2 and their mean densities be $\rho_1$and ρ_2, then the ratio of accelerations due to gravity on the planets will be _____. (1)
(A) $R_1\rho_1 : R_2\rho_2$ (B) $R_1\rho_2 : R_2\rho_1$ (C) $R_1R_2 : \rho_1\rho_2$ (D)$\rho_1\rho_2 : R_1R_2$

10. The torque acting on an object about the origin if the force is $\vec{F} = mg\,\hat{j}$ and the position vector is $\vec{r} = x\,\hat{\imath} + y\,\hat{j}$ is _____. (1)
(A) $xmg\hat{\imath}$ (B) $xmg\hat{j}$ (C) $xmg\hat{k}$ (D) $mg(y\hat{\imath} - x\hat{j})$

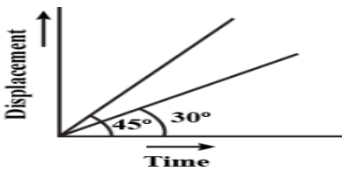
11. A body constrained to move along z-axis of a coordinate system is subject to a constant force given by $\vec{F} = (-i + 2j + 3k)$ N where i, j and k unit vectors along x, y,and z-axis of the system respectively. The work done by this force in moving the body at distance of 4 m along the z-axis is _____. (1)
(A) 4 J (B) 6 J (C) 12 J (D) 14 J

12. Centre of mass of the earth - moon system lies _____. (1)
(A) on the surface of the moon (C) within the earth
(B) on the surface of the earth (D) on the mid-point of line joining Earth and Moon

13. The velocity v of a particle at time t is given by $v = at + \left(\frac{b}{t^2}\right)$, where a and b are constants. The dimensions of a and b are ____. (1)
(A) [LT] and [LT^{-1}] (B) [LT^{-2}] and [LT^{-1}] (C) [LT^{-1}] and [LT^{-2}] (D) [LT^{-2}] and [LT]

14. Two blocks of mass 1kg and 2kg are connected by an inextensible string which passes over frictionless pulley. The acceleration of these blocks is _____ m/s^2. (1)
(A) $g/2$ (B) $g/3$ (C) $2g$ (D) $3g$

15. The displacement-time graphs of two moving particles make angles of 30° and 45° with the x-axis is shown here. The ratio of their velocities is _____. (1)



(A) $\sqrt{3} : 1$ (B) $1 : \sqrt{3}$
(C) $\sqrt{2} : 1$ (D) $1 : \sqrt{2}$

For question numbers 16 to 18, two statements are given-one labelled Assertion and the other labelled Reason. Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.
(A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion
(B) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(C) Assertion is true but Reason is false.
(D) Assertion is false and Reason is also false.

16. Assertion: Uniform circular motion is a uniformly accelerated motion. (1)
Reason: Centripetal acceleration is a constant vector.

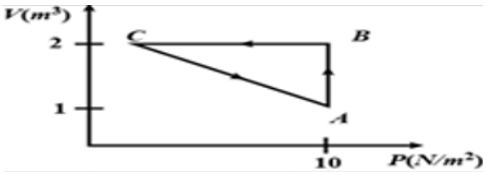
17. Assertion: Under given conditions of pressure and temperature, sound travels faster in a monoatomic gas than in diatomic gas. (1)
Reason: The speed of sound in a gas is $\sqrt{\frac{\gamma P}{\rho}}$ and it is independent of pressure.

18. Assertion: Impulse force is large and acts for a short time. (1)
Reason: Finite change in momentum should be produced by the force.

SECTION B

19. For an ideal gas, prove that $C_P - C_V = R$. (2)

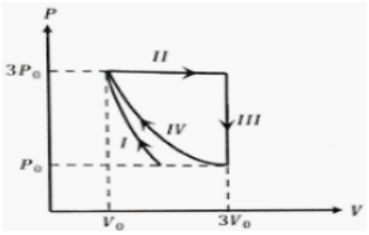
20. An ideal gas is taken through the cycle A → B → C → A, as shown in the figure. If the net heat supplied to the gas in the cycle is 5 J, what is the work done by the gas in the process C → A? (2)



OR

One mole of a monoatomic ideal gas undergoes four thermodynamic processes as shown schematically in the PV- diagram below. Among these four processes, one is isobaric, one is isochoric, one is isothermal and one is adiabatic. Match the processes mentioned in List - I with the corresponding statements in List - II.

List I	List II
In process I	(a) Work done by the gas is zero
In process II	(b) Temperature of the gas remains unchanged
In process III	(c) No heat is exchanged between the gas and its surroundings
In process IV	(d) Work done by the gas is $6P_0V_0$



21. The transverse displacement of a string (clamped at its both ends) is given by (2)
$$y(x,t) = 0.06\sin(\pi x)\cos(2\pi t)$$
(a) Does the function represent a travelling wave or a stationary wave?
(b) Interpret the wave as a superposition of two waves travelling in opposite directions.

22. (a) Define the coefficient of thermal conductivity. (2)
(b) Two metal rods 1 and 2 of same lengths have same temperature difference between their ends. Their thermal conductivities are K_1 and K_2 and cross sectional areas A_1 and A_2, respectively. Find the ratio of K_1 and K_2, if the rate of heat conduction in 1 is four times that in 2.

OR

Show that the coefficient of areal expansion, $\left(\frac{\Delta A}{A}\right)\left(\frac{1}{\Delta T}\right)$, of a rectangular sheet of the solid is twice its linear expansion α_l.

23. (a) State: Kepler's third law. (2)
(b) A planet revolves around sun at a distance *x* with time period 'T'. Compare the time period of earth which is at a distance $3x$ from the sun.

24. Obtain the orbital velocity and time period of a satellite placed at an altitude 'h' from earth surface. (2)

25. The centripetal force F acting on a particle of mass m moving with velocity v in a circle of radius r. Prove dimensionally that $F = mv^2/r$. (2)

SECTION C

26. A simple harmonic motion is represented by the equation $y = 10\sin(20t + 0.5)$. Here y and t are in cm and second respectively. What are the values of (i) amplitude, (ii) angular frequency, (iii) maximum velocity and (iv) maximum acceleration? (3)

27. Draw typical stress versus strain curve for a loaded wire. (3)
On the graph, mark: (a) Permanent set (b) Elastic limit (c) Yield strength (d) Fracture point.

28. (a) State parallelogram law of vector addition. (3)
(b) The maximum resultant of two concurrent forces is 10 N and their minimum resultant is 4 N. What is the magnitude of the larger force?

OR

The position of a particle is given by $\vec{r} = (6.0\ t\ \hat{\imath} - 2.0\ t^2\hat{\jmath})\ m$, where t is in seconds and the coefficients have the proper units for $\vec{r}$ to be in metres. Find the velocity and the acceleration of the particle at t = 2 sec.

29. Derive an expression for pressure of a gas in a container. (3)

OR

Derive an expression for mean free path of a gas molecule. On which factors does the mean free path depend?

30. Prove that the trajectory of a projectile is parabola. (3)

SECTION D

31. Draw a force diagram of a moving car negotiating a curve of radius R in a banked road. Obtain the expression for the maximum possible velocity of the body. Also find the velocity when the friction is zero. (5)

OR

Give reason for the following:
(a) Passengers in the bus fall back as it accelerates.
(b) Static friction is a self- adjusting force.
(c) Wheels are made circular in automobiles.
(d) It is easier to pull a lawn mower than to push it.
(e) A horse cannot pull a cart and run in empty space.

32. (a) Distinguish between elastic and inelastic collisions. (5)
(b) A bullet is fired into a block of wood. If the bullet gets totally embedded in it and the system moves together as one entity, then state what happens to the initial kinetic energy of the bullet and derive necessary equation.

OR

(a) Obtain an expression for the potential energy of a stretched spring.
(b) Sketch a graph showing the variation of potential and kinetic energy with displacement.
(c) Two springs A and B with constants k_A and k_B ($k_A > k_B$) are given. In which of the springs more work is to be done if,(i) they are stretched by the same amount(ii) they are stretched by same force.

33. (a) Obtain a relation between the area of cross-section and the velocity of liquid at any point in a tube of flow. What conclusion do you draw from it? (5)
(b) Water flows through a horizontal pipe of radius 1cm at a speed of 2m/s, what should be the diameter of its nozzle if the water is to come out at a speed of 10m/s.

OR

(a) Derive the ascent formula for rise of liquid in capillary tube.
(b) Water rises to a height of 10cm in a certain capillary tube. The level of mercury in the same tube depressed by 3.42cm. Compare the surface tensions of water and mercury. Specific gravity of mercury is 13.6g/cc and angle of contact for water and mercury are 0^o and 135°.

SECTION E

Questions 34 and 35 are Case Study Based questions and are compulsory. Each question carries 1 mark.

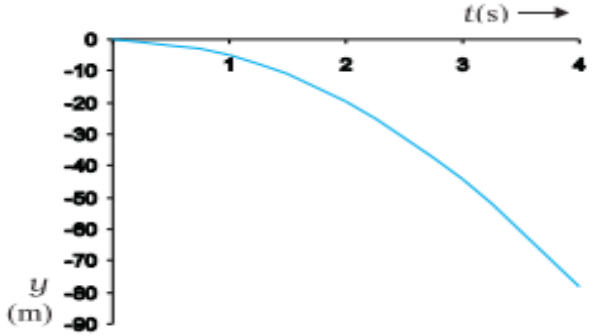
34. A body released near the surface of the earth is accelerated downward under the influence of force of gravity. In the absence of air resistance, all bodies fall with the same acceleration near the surface of the earth. This motion of a body falling towards the earth from a small height ($h << R_E$) is free fall. The body falls with a constant acceleration 'g', equal to 9.8 m/s^2. Free fall is thus an example of motion with constant acceleration. (4)

(i) Write any two equations of motion for a body under free fall.

(ii) The direction of acceleration is same as the direction of velocity during free fall. Is the statement true? Justify your answer.

(iii) What will be the ratio of the distances moved by a freely falling body from rest 4th and 5th seconds of journey?

Distance versus time graph for an object under free fall is shown here.



(iv) Draw $v - t$ graph for the object under free fall?

OR

(iv) Draw $a - t$ graph for the object under free fall?

35. Rigid body basically executes two types of motion, they are translational motion and rotational motion. The movement of a rigid body which is 'not fixed' or 'pivoted' shows a translation motion while a body moving with a fixed axis shows a rotational motion. There are many examples in our day today life to explain rotational stability of rigid bodies. For example, earth rotates around its own axis, a ballet dancer with his hands stretched rotates around his own axis, a diver jumping from a spring board exhibits somersaults in air before touching the water surface and the speed of the inner layers of the whirlwind in a tornado is alarming high etc. (4)

(i) Name the physical quantity which is conserved in the above examples.

(ii) How does a ballet dancer vary his angular speed by outstretched his arms and legs?

(iii) The disc initially at rest, starts rotating about its own axis, with a constant angular acceleration of 0.2 rad/s^2. What is the time taken by the disc to rotate by 10 rad?

(iv) Under what condition, does a rigid body remain in rotational equilibrium?

OR

(iv) Write one physical significance of moment of inertia.