PHYSICS

SECTION – 1 : (Maximum Marks : 56)

- This section contains **FOURTEEN** questions
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct
- For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS
- For each question, marks will be awarded in one of the following categories :

Full Marks	:	+4	If only the bubble(s) corresponding to all the correct option(s) is(are) darkened.
Partial Marks	:	+1	For darkening a bubble corresponding to **each correct option,** provided NO incorrect option is darkened.
Zero Marks	:	0	If none of the bubbles is darkened.
Negative Marks	:	–2	In all other cases.

- For example, if (A), (C) and (D) are all the correct options for a question, darkening all these three will result in +4 marks ; darkening only (A) and (D) will result in +2 marks and darkening (A) and (B) will result in –2 marks, as a wrong option is also darkened.

1. Two radio station that are 250m apart emit radio waves of wavelength 100m. Point A is 400m from both station. Point B is 450m from both station. Point C is 400m from one station and 450 m from the other. The radio station emit radio waves in phase. Which of the following statement is true ?
(A) There will constructive interference at A and B, and destructive interference at C.
(B) There will be destructive interference at A and B, and constructive interference at C.
(C) There will be constructive interference at B and C, and destructive interference at A.
(D) There will be destructive interference at A, B and C.

2. The apparent frequency of a sound wave as heard by an observer is 10% more than actual frequency. If the velocity of sound in air is 330 m/s.
(A) the source may be moving towards the stationary observer with a velocity of 30 m/s
(B) the source may be moving towards the stationary observer with a velocity of 33 m/s
(C) the observer may be moving towards the stationary source with velocity of 30 m/s
(D) the observer may be moving towards the stationary source with velocity of 33 m/s

Space for Rough Work

3. At displacement node in standing sound waves :
(A) displacement is minimum
(B) Pressure may be maximum at any instant
(C) Pressure may be minimum at any instant
(D) Particle's speed is zero

4. Two wave functions in a medium along x direction are given by -

$$y_1 = \frac{1}{2+(2x-3t)^2}\text{m} \qquad y_2 = -\frac{1}{2+(2x+3t-6)^2}\text{m}$$

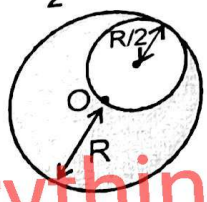
where x is in metres and t is in seconds
(A) There is no position at which resultant displacement will be zero at all times.
(B) There is no time at which resultant displacement will be zero everywhere.
(C) Both waves travel along the same direction.
(D) Both waves travel in opposite directions.

5. A string of length L fixed at both end vibrate in its second overtone.
(A) It contain 4 node and 4 antinode.
(B) It contain 3 node and 4 antinode.
(C) it's vibration frequency 5 time of fundament frequency
(D) Its wavelength is one third of the wavelength in its fundamental mode of vibration.

6. A small ball of mass m is released from rest at a height h_1 above ground at time t = 0. At time $t = t_0$, the ball again comes to rest at a height h_2 above ground. Consider the ground to be perfectly rigid and neglect air friction. In the time interval from t = 0 to $t = t_0$, pick up the correct statements.
(A) Work done by gravity on ball is $mg(h_1 - h_2)$
(B) Work done by gravity on ball is $mg(h_2 - h_1)$
(C) Average acceleration of the ball is zero.
(D) Net work done on the ball by all forces except gravity is $mg\,(h_2 - h_1)$.

Space for Rough Work

7. A uniform disc of mass m & radius R is pivoted at its centre O with its plane vertical as shown in figure A circular portion of disc of radius $\frac{R}{2}$ is removed from it. Then choose the correct option(s)



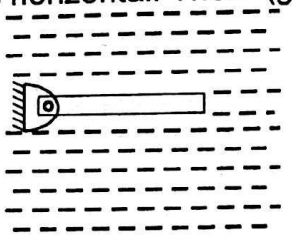
(A) Time period of small oscillations of remaining portion about O is $\pi\sqrt{\frac{13R}{g}}$

(B) Time period of small oscillations of remaining portion about O is $2\pi\sqrt{\frac{13R}{g}}$

(C) The centre of mass of the remaining disc is at a distance of $\frac{R}{6}$ from O.

(D) The centre of mass of the remaining disc is at a distance of $\frac{R}{8}$ from O.

8. A rod of mass m = 2kg, length ℓ = 1m, has uniform cross–section area A = $\frac{8}{3} \times 10^{-3}$ m^2 but its density is non–uniform. It is hinged about one end and kept in water of density $\rho_w = 10^3$ kg/m^3. At the equilibrium, the rod becomes horizontal. Then (g = 10 m/s^2) :



(A) Centre of mass of the rod is at a distance of $\frac{2}{3}$ m from the hinged end

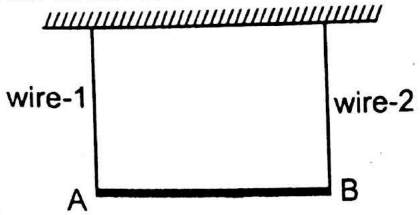
(B) Centre of mass of the rod is at a distance of $\frac{3}{4}$ m from the hinged end

(C) Force exerted by the rod on the hinge support is $\frac{20}{3}$ N

(D) It we displace the rod slightly by rotating downwards, it will oscillate

Space for Rough Work

9. A rod of length 0.3 m having variable linear mass density from A to B as $\lambda = \lambda_0 x$(x is distance from A in meter), where $\lambda_0 = 100$ kg/m² is suspended by two light wires of same length. Ratio of their linear mass density is 2 : 9. Then which of the following is/are correct :



(A) Ratio of wave speed in wire–1 to wire–2 is 3 : 2
(B) Ratio of wave speed in wire–1 to wire–2 is 3 : 1
(C) Second harmonic in wire–1 has same frequency as third harmonic in wire–2
(D) Third overtone in wire–1 has same frequency as fifth overtone in wire–2

10. A particle is moving along x-axis. Its position 'x' varies with time 't' as follows

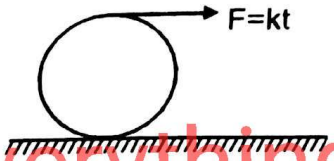
$$x = A + A(1 - \cos\omega t)$$

Then select the correct alternatives :
(A) particle is doing SHM between point x = 2A and x = A
(B) the speed of particle is maximum at x = 2A
(C) time taken by particle from x = A to directly x = 3A is $\frac{\pi}{\omega}$
(D) time taken by particle from x= A to directly x = 2A is $\frac{\pi}{2\omega}$

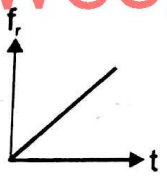
11. A source emit sound waves of frequency 1000 Hz. The source moves to the right with a speed of 32 m/s relative to ground. On the right a reflecting surface moves towards left with a speed of 64 m/s relative to ground. The speed of sound in air is 332 m/s :
(A) wavelength of sound ahead of source is 0.3 m
(B) number of waves arriving per second which meets the reflected surface is 1320
(C) speed of reflected wave is 268 m/s
(D) wavelength of reflected waves is nearly 0.2 m

Space for Rough Work

12. A uniform solid cylinder of mass m, radius R is at rest on an extremely rough horizontal surface. Now a force F = kt where k = constant and t = time, is applied at the highest point on the cylinder. Assume that the cylinder is not slidding at all.



(A) The friction force acting on the cylinder varies with time as



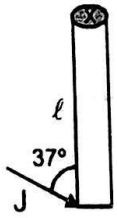
(B) Velocity of the highest point after time t will be $\frac{2kt^2}{3m}$

(C) Velocity of the highest point after time t will be $\frac{4kt^2}{3m}$

(D) If the coefficient of friction between the ground and the cylinder is μ, the cylinder will start slidding at $t = \frac{3\mu mg}{k}$.

Space for Rough Work

13. A thin rod of mass m and length ℓ is free to rotate on a smooth horizontal plane about its one fixed end. When it is at rest, it receives a horizontal impulse J at its other end, at angle of 37° with the length. Immediately after impact :



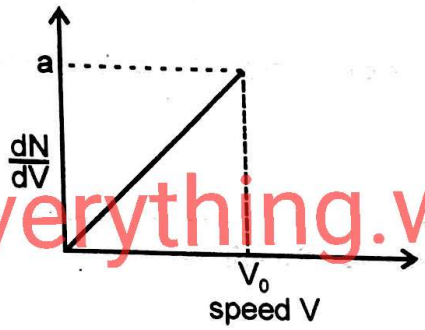
(A) Angular momentum of the rod is $0.6\ J\ell$

(B) Angular velocity of the rod is $\frac{1.8J}{m\ell}$

(C) Kinetic energy of the rod is $\frac{0.54J^2}{m}$

(D) Linear velocity of the centre of mass of the rod is $\frac{9}{10}\frac{J}{m}$

14. Graph shows a hypothetical speed distribution for a sample of N gas particle (for $V > V_0$; $\frac{dN}{dV} = 0$, $\frac{dN}{dV}$ is rate of change of number of particles with change in velocity)



(A) The value of aV_0 is 2N.

(B) The ratio V_{avg}/V_0 is equal to 2/3.

(C) The ratio V_{rms}/V_0 is equal to $1/\sqrt{2}$.

(D) Three fourth of the total particle has a speed between $0.5\ V_0$ and V_0.

Space for Rough Work

SECTION – 2 : (Maximum Marks : 24)

- This section contains **THREE** paragraphs
- Based on each paragraph, there will be **TWO** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct
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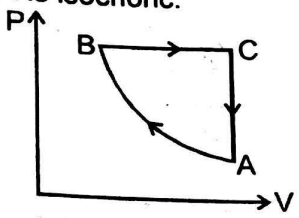
Paragraph for Question Nos. 15 to 16

An ideal diatomic gas is taken along the cyclic process ABCA. Heat given by the system in the process A to B 50 J and workdone on the gas is 50 J. In the process B to C volume doubles at constant pressure. The process CA is isochoric.



15. The relation between temperature T_A and T_B is

(A) $T_A > T_B$ (B) $T_A < T_B$ (C) $T_A = T_B$ (D) data inadequate

16. The ratio $\frac{P_C}{P_A}$ is

(A) 1 (B) 2 (C) 3 (D) data inadequate

Space for Rough Work

Paragraph for Question Nos. 17 to 18

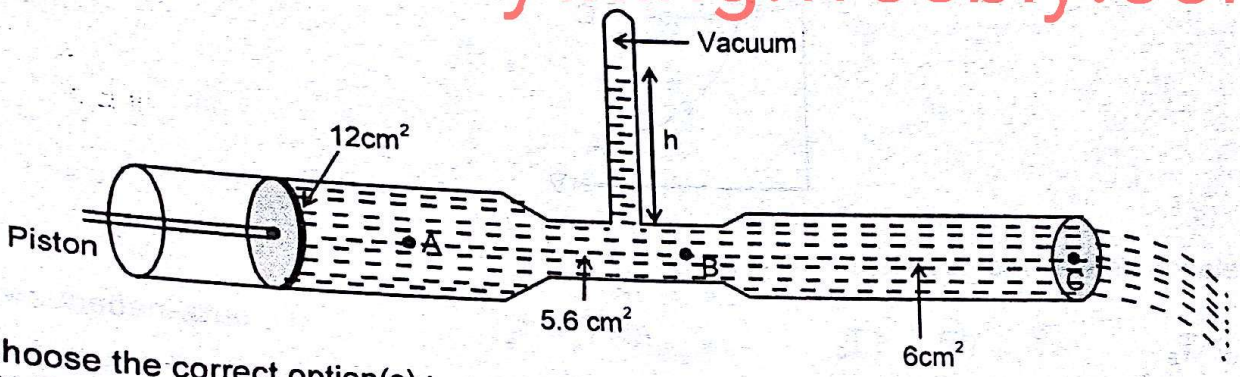
In a flexible balloon, 2 moles of SO_2 having initial volume of 1kℓ at a temperature of 27°C is filled (SO_2 is a linear triatomic gas). The gas is first expanded to thrice its initial volume isobarically and then expanded adiabatically so as to attain its initial temperature. Assuming gas is ideal and $R = \frac{25}{3}$ $Jmol^{-1}K^{-1}$.

17. Change in internal energy of the gas in the isobaric process is :
(A) 2.5×10^4 J (B) 1.2×10^6 J (C) 3×10^5 J (D) 0.5×10^3 J

18. Work done by the gas in the whole process is:
(A) 2kJ (B) 3.2kJ (C) 35kJ (D) 15kJ

Paragraph for Question Nos. 19 to 20

A glass tube has three different cross sectional areas with the values indicated in the figure. A piston at the left end of the tube exerts pressure so that the mercury within the tube flows from the right end with a speed of 8.0 m/s. Three points within the tube are labeled A, B and C. The atmospheric pressure is 1.01×10^5 N/m²; and the density of mercury is 1.36×10^4 kg/m³. (use g = 10 m/s²)



19. Choose the correct option(s) :
(A) The speed of mercury flowing at the point A is 4.0 m/s.
(B) The speed of mercury flowing at the point A is 8.0 m/s.
(C) The speed of mercury flowing at the point B is 4.0 m/s.
(D) The speed of mercury flowing at the point B is 12.0 m/s.

20. Choose the correct option(s) :
(A) The pressure at point A is nearly equal to 4.27×10^5 Pa.
(B) The pressure at point A is nearly equal to 1.01×10^5 Pa.
(C) The pressure at point C is nearly equal to 1.01×10^5 Pa.
(D) The pressure at point C is nearly equal to 4.27×10^5 Pa.

Space for Rough Work