SECTION – 3 : (Maximum Marks : 16)

This section contains **TWO** questions

Each question contains two columns, **Column I** and **Column II**

Column I has **four** entries (A),(B), (C) and (D)

Column II has **four** entries (P),(Q), (R) and (S)

Match the entries in **Column I** with the entries in **Column II**

One or more entries in **Column I** may match with one or more entries in **Column II**

The ORS contains a 4 × 4 matrix whose layout will be similar to the one shown below :

(A)	(P)	(Q)	(R)	(S)
(B)	(P)	(Q)	(R)	(S)
(C)	(P)	(Q)	(R)	(S)
(D)	(P)	(Q)	(R)	(S)

For each entry in **Column I**, darken the bubbles of all the matching entries. For example, if entry (A) in **Column I** matches with entries (P), (Q) and (R), then darken these three bubbles in the ORS. Similarly, for entries (B), (C) and (D).

Marking scheme :

For each entry in **Column I**

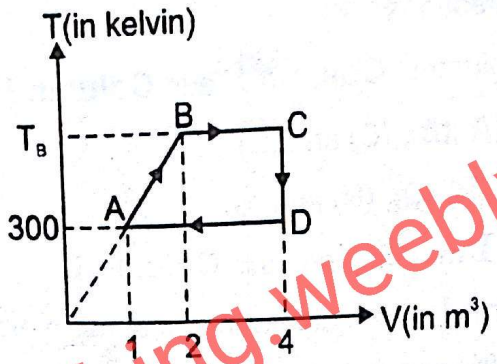
+2 If only the bubble(s) corresponding to all the correct match(es) is (are) darkened

0 If none of the bubbles is darkened

–1 In all other cases

Space for Rough Work

21. A sample of He gas is taken through a cyclic process ABCDA as shown.



Column–I		Column–II	
(A)	$\frac{P_A}{P_B}$	(P)	2
(B)	$\frac{T_B}{T_A}$	(Q)	1
(C)	$\left\lvert\frac{\Delta Q_{B\to C}}{\Delta Q_{D\to A}}\right\rvert$	(R)	3
(D)	$\frac{P_{max}}{P_{min}}$	(S)	4

Space for Rough Work

22. An ideal gas consists of a large number of identical molecules. Absolute temperature of the gas is T(in kelvin), molecular weight of gas is M and R is gas constant. Match the statements given in column-I with column-II.

Column-I	Column-II
(A) Root mean square speed of molecules is greater than	(P) $\sqrt{\frac{RT}{M}}$
(B) Most probable speed of molecues is smaller than	(Q) $1.5\sqrt{\frac{RT}{M}}$
(C) Average velocity of a molecule is smaller than	(R) $2\sqrt{\frac{RT}{M}}$
(D) Speed of a molecule may be greater than	(S) $2.5\sqrt{\frac{RT}{M}}$

Space for Rough Work

SECTION – 4 : (Maximum Marks : 72)

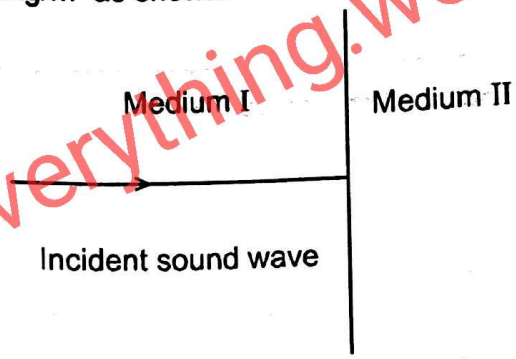
- This section contains **EIGHTEEN** questions
- The answer to each question is a **SINGLE DIGIT INTEGER** ranging from 0 to 9, both inclusive
- For each question, darken the bubble corresponding to the correct integer in the ORS
- Marking scheme :

+4 If the bubble corresponding to the answer is darkened
0 If none of the bubbles is darkened
−1 In all other cases

23. A string 120 cm in length and fixed at both ends sustains a standing wave, with the consecutive points of the string at which the displacement amplitude is equal to 3.5 mm (not maximum) being separated by 15.0 cm. To which overtone do these oscillations correspond ?

24. In the resonance tube experiment, first resonant length is ℓ_1 and the second resonant length is ℓ_2, then the third resonant length is $n\ell_2 - m\ell_1$, find (m + n).

25. A sound wave propagating along x-axis, in medium I of density $\rho_1 = 1.5$ kg/m³ is transmitted to a medium II of density $\rho_2 = 3$kg/m³ as shown.



The equation of excess pressure developed by wave in medium I and that in medium II respectively are

$p_1 = 4 \times 10^{-2} \cos \omega \left(t - \frac{x}{400}\right)$ (in SI units)

$p_2 = 3 \times 10^{-2} \cos \omega \left(t - \frac{x}{1200}\right)$ (in SI units)

Then the ratio of intensity of transmitted wave I_2 (wave in medium II) to the intensity of incident wave I_1 (wave in medium I), that is $\frac{I_2}{I_1}$, is $\frac{n}{32}$ find n.

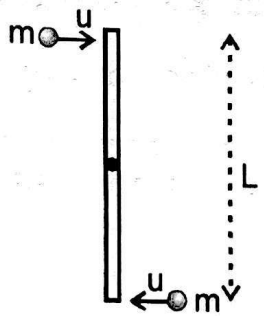
Space for Rough Work

26. A non–uniform string of mass 45 kg and length 1.5 m has a variable linear mass density given by $\mu = kx$, where x is the distance from one end of the string and k is a constant. Tension in the string is 15 N which is uniform. Find the time (in second) required for a pulse generated at one end of the string to travel to the other end

27. A sonometer wire has length of 114 cm between two fixed ends. Two bridges are placed so as to divide the wire in to three segments whose fundamental frequencies are in the ratio 1 : 3 : 4. If length of largest segment is 12x cm, then fill the value of x.

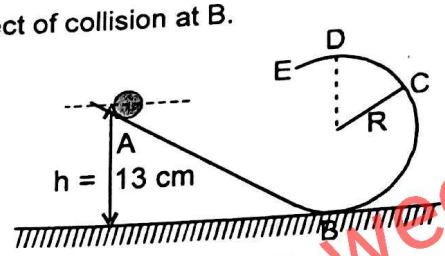
28. A thin uniform rod of mass 0.25 kg and length 1.20 m is smoothly hinged about a point passing through its centre of mass. Its angular momentum as a function of time t is given by $L = \frac{2}{3}t^3 + 2t^2$ (where t is in sec. are L is in kg m^2/sec.). Angular accleration of the rod at $t = \frac{3}{2}$ sec. is 50X (in rad/sec^2) then find 'X'.

29. A uniform rod of mass 200 grams and length L = 1m is initially at rest in vertical position. The rod is hinged at centre such that it can rotate freely without friction about a fixed horizontal axis passing through its centre. Two particles of mass m = 100 grams each having horizontal velocity of equal magnitude u = 6 m/s strike the rod at top and bottom simultaneously as shown and stick to the rod. Find the angular speed (in rad/s) of rod when it becomes horizontal.

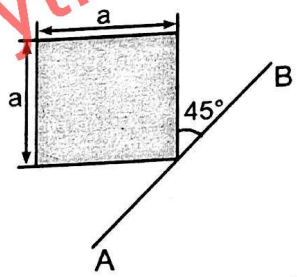


Space for Rough Work

30. A rough track ABCDE ends in a circular loop of radius R as shown in figure. A solid cylinder of radius 2 cm slides down the track from point A which is at height h = 13 cm. Find the maximum value of R for the cylinder to complete the loop successfully. Friction is sufficient to provide pure rolling. Do not consider effect of collision at B.



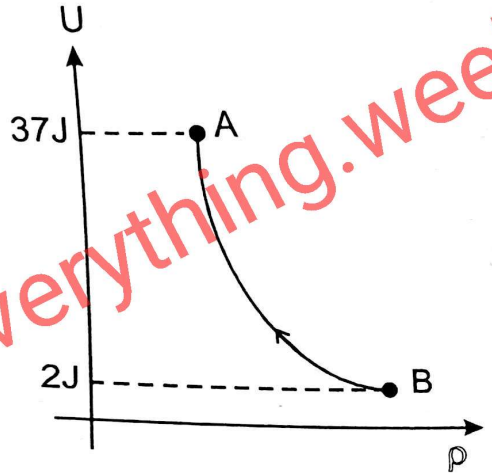
31. Find the moment of inertia (in kg.m^2) of a thin uniform square sheet of mass M = 3kg and side a = 2m about the axis AB which is in the plane of sheet :



32. How many degrees of freedom have the gas molecules, if under standard conditions the gas density is $\rho = \frac{1400}{1089}$ kg/m^3 and the velocity of sound propagation in it is ν = 330 m/s.

Space for Rough Work

33. Figure shows the variation of internal energy "U" with the density""of one mole of ideal diatomic gas. Process BA is a part of rectangular hyperbola. If the work done by gas in the process BA is 2W joules. Find W ?



34. 2 moles of oxygen and 5 moles of helium are put in a rigid container at temperature 300 K. Heat of 25 calories is added to the gaseous mixture.Take R= 2 cal/mole K.The increase in temperatue of the gas will be (in K) :

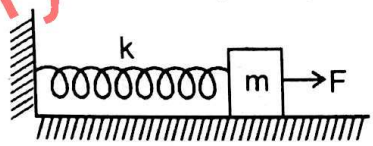
35. A wheel of moment of inertia I and radius R is rotating about its axis (fixed) at an angular speed ω_0. It gently picks up a stationary particle of mass m at its edge. If the new angular speed of the wheel is $\omega_2 = \frac{I\omega_0}{I + xmR^2}$, then x is.

Space for Rough Work

36. Two particles P_1 and P_2 of equal mass situated at (0, 0) and (10, 0) respectively at t = 0 and moving with constant velocities collided head on at point (4, 0) after time t_0. If the coefficient of restitution is 1 and the x-co-ordinate of centre of mass of the two particles at $t = 2t_0$ is $\frac{12}{n}$ then value of n is.

37. A source of sound of frequency 1.8 kHz moves uniformly along a straight line at a distance 250 m from observer. The velocity of source is 0.8 C where C is the velocity of sound. Find out the frequency of sound received by observer (in kHz) at the moment when the source gets closest to him. Fill the value.

38. A block of mass m = 2 kg is connected to a spring of force constant k = 50 N/m. Initially the block is at rest and the spring has natural length. A constant force F = 60 N is applied horizontally towards right, the maximum speed of the block (in m/s) will be (neglect friction).



39. A uniform solid sphere of specific gravity 8 has a concentric spherical cavity and just sinks in water. If the ratio of radius of cavity to that of outer radius of the sphere is $\frac{x^{1/3}}{2}$ then what will be the value of x.

40. Two sound waves with wavelength 5m and 5.5m respectively, each propagate in a gas with velocity 330 m/s, then the number of beat per second is x. Find x.

Space for Rough Work