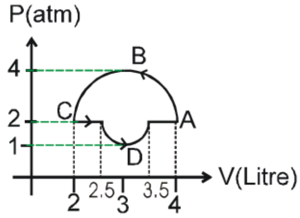
Exercise-2

✍ Marked Questions can be used as Revision Questions.

PART - I : OBJECTIVE QUESTION

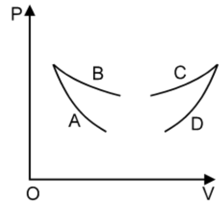
1.✍ Find work done by the gas in the process shown in figure :



(1) $\frac{5}{2}\pi$ atm L (2) $\frac{5}{2}$ atm L

(3) $-\frac{3}{2}\pi$ atm L (4) $-\frac{5}{4}\pi$ atm L

2.✍ Four curves A, B, C and D are drawn in the Fig. for a given amount of gas. The curves which represent adiabatic and isothermal changes are



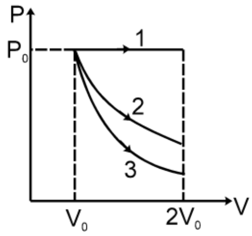
(1) C and D respectively (2) D and C respectively

(3) A and B respectively (4) B and A respectively

3. Three closed vessels A, B, and C are at the same temperature T and contain gases which obey the Maxwellian distribution of velocities. Vessel A contains only O_2, B only N_2 and C a mixture of equal quantities of O_2 and N_2. If the average speed of O_2 molecules in vessel A is V_1, that of the N_2 molecules in vessel B is V_2 ,the average speed of the O_2 molecules in vessel C will be :

(1) $(V_1 + V_2)/2$ (2) V_1 (3) $(V_1V_2)^{1/2}$ (4) $\sqrt{3kT/M}$

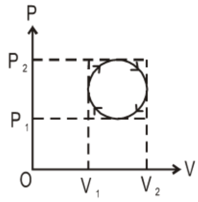
4.✍ A gas is expanded from volume V_0 to $2V_0$ under three different processes. Process 1 is isobaric process, process 2 is isothermal and process 3 is adiabatic. Let ΔU_1,ΔU_2 and ΔU_3 be the change in internal energy of the gas is these three processes. Then :



(1) $\Delta U_1 > \Delta U_2 > \Delta U_3$ (2) $\Delta U_1 < \Delta U_2 < \Delta U_3$

(3) $\Delta U_2 < \Delta U_1 < \Delta U_3$ (4) $\Delta U_2 < \Delta U_3 < \Delta U_1$

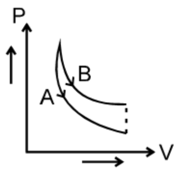
5.✍ In the cyclic process shown on the P – V diagram the magnitude of the work done is :



(1) $\pi\left(\frac{P_2 - P_1}{2}\right)^2$ (2) $\pi\left(\frac{V_2 - V_1}{2}\right)^2$

(3) $\frac{\pi}{4}(P_2 - P_1)(V_2 - V_1)$ (4) $\pi(P_2V_2 - P_1V_1)$

6.✍ A and B are two adiabatic curves for two different gases. Then A and B corresponds to :



(1) Ar and He respectively (2) He and H_2 respectively

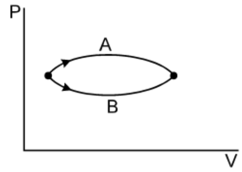
(3) O_2 and H_2 respectively (4) H_2 and He respectively

7. Which of the following quantities is the same for all ideal gases at the same temperature ?

(1) the kinetic energy of 1 mole (2) the kinetic energy of 1 g

(3) the number of molecules in 1 mole (4) the number of molecules in 1 g

8. Refer to fig. Let ΔU_1 and ΔU_2 be the changes in internal energy of the system in the processes A and B then



(1) $\Delta U_1 > \Delta U_2$ (2) $\Delta U_1 = \Delta U_2$
(3) $\Delta U_1 < \Delta U_2$ (4) $\Delta U_1 \neq \Delta U_2$

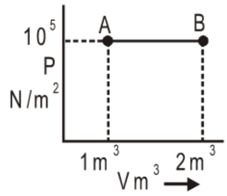
9. A gas undergoes a process in which its pressure P and volume V are related as VP^n = constant. The bulk modulus of the gas in the process is :
(1) nP (2) $P^{1/n}$ (3) P/n (4) P^n

10. For adiabatic process of an ideal gas the value of $\frac{dP}{P}$ is equal to -
(1) $-\gamma\frac{dV}{V}$ (2) $-\gamma\frac{V}{dV}$ (3) $\frac{dV}{V}$ (4) $-\gamma^2\frac{dV}{V}$

11. A system is given 400 calories of heat and 1000 joule of work is done by the system, then the change in internal energy of the system will be -
(1) 680 joule (2) 680 erg (3) 860 joule (4) – 860 joule

12. The change in internal energy of two moles of a gas during adiabatic expansion is found to be –100 joule.The work done during the process is -
(1) 100 joule (2) –100 joule (3) zero (4) 200 joule

13. The work done in the following figure is -
(1) 2×10^5 joule (2) 10^5 joule
(3) zero (4) 3×10^5 joule



14. Isobaric modulus of elasticity is -
(1) ∞ (2) zero (3) 1 (4) $\frac{C_p}{C_v}$

15. The internal energy of a mono-atomic gas is -
(1) $\frac{5RT}{2}$ (2) $\frac{3RT}{2}$ (3) $\frac{5RT}{3}$ (4) $\frac{7RT}{3}$

16. Two samples of a gas A and B initially at same temperature and pressure, are compressed to half their initial volume, A isothermally and B adiabatically. The final pressure in -
(1) A and B will be same (2) A will be more than in B
(3) A will be less than in B (4) A will be double that in B

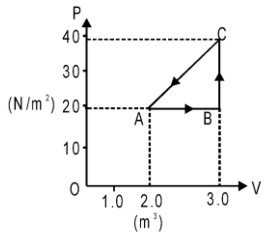
17. The amount of heat required to raise the temperature of 100 gm water from 20ºC to 40ºC will be -
(1) 100 calorie (2) 2000 calorie (3) 4000 calorie (4) zero

18. The isothermal bulk modulus of elasticity of a gas is 1.5×10^5 N/m^2. Its adiabatic bulk modulus of elasticity will be if $\gamma = 1.4$ -
(1) 1.5×10^5 N/m^2 (2) 3×10^5 N/m^2 (3) 2.1×10^5 N/m^2 (4) ∞

19. If the volume of a gas is decreased by 10% during isothermal process then its pressure will be -
(1) decrease by 10% (2) increase by 10% (3) decrease by 11.11% (4) increase by 11.11%

20. The volume of air increases by 5% in its adiabatic expansion. The percentage decrease in its pressure will be-
(1) 5% (2) 6% (3) 7% (4) 8%

21. In the indicator diagram shown, the work done along path AB is -
(1) zero (2) 20 joule
(3) –20 joule (4) 60 joule



22. In the above problem work done along path BC is -
(1) zero (2) 40 joule (3) 60 joule (4) none

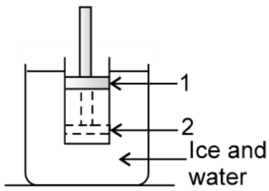
23. In the above problem the work done along path CA is -
(1) 20 joule (2) 30 joule (3) – 30 joule (4) zero

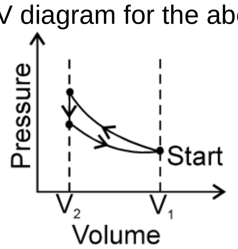
24. During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its absolute temperature. The value of γ for the gas is -
(1) $\frac{5}{3}$ (2) $\frac{7}{5}$ (3) $\frac{3}{2}$ (4) $\frac{11}{9}$

25. P_i, V_i are initial pressure and volumes and V_f is final volume of a gas in a thermodynamic process respectively. If PV^n = constant, then the amount of work done by gas is : ($\gamma = C_p/C_v$).
Assume same, initial state & same final volume in all processes.
(1) minimum for $n = \gamma$ (2) minimum for n = 1 (3) minimum for n = 0 (4) minimum for $n = \frac{1}{\gamma}$

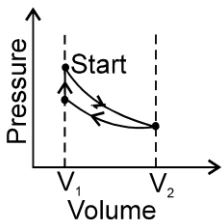
26. The value of $C_p - C_v$ is 1.09 R for a gas sample in state A and is 1.00 R in state B. Let T_A, T_B denote the temperature and p_A and p_B denote the pressure of the states A and B respectively. Then
(1) $p_A < p_B$ and $T_A > T_B$ (2) $p_A > p_B$ and $T_A > T_B$ (3) $p_A = p_B$ and $T_A < T_B$ (4) $p_A > p_B$ and $T_A < T_B$

27. Figure shows a conducting cylinder containing gas and closed by a movable piston. The cylinder is submerged in an ice-water mixture. The piston is quickly pushed down from position (1) to position (2). The piston is held at position (2) until the gas is again at 0°C and then is slowly raised back to position (1).
P-V diagram for the above process will be

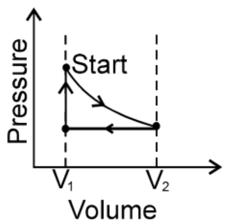




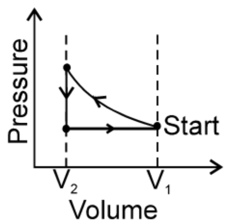
(1)



(2)

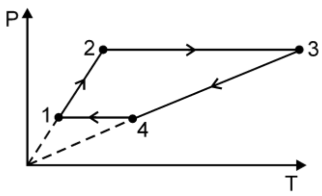


(3)



(4)

28. Three moles of an ideal monoatomic gas perform a cycle shown in figure. The gas temperatures in different states are T_1 = 400 K, T_2 = 800 K, T_3 = 2400 K, and T_4 = 1200 K. The work done by the gas during the cycle is :- $\left[R = \frac{25}{3} J/mol-k\right]$



(1) 5 kJ (2) 10 kJ
(3) 15 kJ (4) 20 kJ

PART - II : MISCELLANEOUS QUESTIONS

Section (A) : Assertion/Reasoning

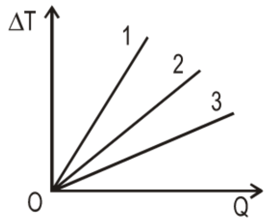
A-1. **STATEMENT-1 :** An ideal gas is enclosed within a container fitted with a piston. When volume of this enclosed gas is increased at constant temperature, the pressure exerted by the gas on the piston decreases.
STATEMENT-2 : In the above situation the rate of molecules striking the piston decreases. If the rate at which molecules of a gas having same average speed striking a given area of the wall decreases, the pressure exerted by gas on the wall decreases.
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

A-2. **STATEMENT-1 :** Different gases at the same conditions of temperature and pressure have same root mean square speed.
STATEMENT-1 : Average K.E. of gas is directly proportional to temperature in kelvin
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

A-3. **STATEMENT-1 :** Most probable velocity is the velocity possessed by maximum fraction of molecules at the same temperature.
STATEMENT-2 : On collision, more and more molecules acquire higher speed at the same temperature.
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

Section (B) : Match the column

B-1 The straight lines in the figure depict the variations in temperature ΔT as a function of the amount of heat supplied Q in different process involving the change of state of a monoatomic and a diatomic ideal gas. The initial states (P, V, T) of the two gases are the same. Match the processes as described, with the straight lines in the graph as numbered.



(1) Isobaric process of monoatomic gas.	(P) 1
(2) Isobaric process of diatomic gas	(Q) 2
(3) Isochoric process of monoatomic gas	(R) 3
(4) Isochoric process of diatomic gas	(S) x-axis (i.e. 'Q' axis)

B-2 Match the following (Where the letters dQ, dU and dW have usual meaning)

Column I	**Column II**
(1) Adiabatic expansion	(P) $dQ = 0$
(2) Adiabatic free expansion	(Q) $dU = 0$
(3) Isochoric cooling	(R) $dW = 0$
(4) Isobaric expansion	(S) $dQ = dU + dW$

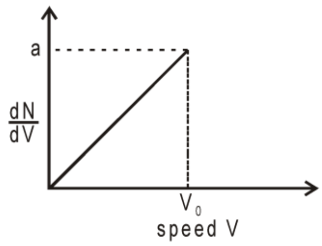
Section (C) : One or More Than One Options Correct

C-1. Which of the following is incorrect regarding the first law of thermodynamics?
(1) It is not applicable to any cycle process
(2) It is a restatement of the principle of conservation of energy
(3) It introduces the concept of the internal energy
(4) It introduces the concept of the entropy

C-2. Hydrogen gas and oxygen gas have volume $1cm^3$ each at N.T.P.
(1) Number of molecules is same in both the gases.
(2) The rms velocity of molecules of both the gases is the same.
(3) The internal energy of each gas is the same.
(4) The average velocity of molecules of each gas is the same.

C-3. During an experiment, an ideal gas is found to obey a condition $\frac{P^2}{\rho}$ = constant [ρ = density of the gas]. The gas is initially at temperature T, pressure P and density ρ. The gas expands such that density changes to $\frac{\rho}{2}$
(1) The pressure of the gas changes to $\sqrt{2}$ P.
(2) The temperature of the gas changes to $\sqrt{2}$ T.
(3) The graph of the above process on the P-T diagram is parabola.
(4) The graph of the above process on the P-T diagram is hyperbola.

C-4. 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 veloicty)
(1) The value of aV_0 is 2N.
(2) The ratio V_{avg}/V_0 is equal to 2/3.
(3) The ratio V_{rms}/V_0 is equal to $1/\sqrt{2}$.
(4) Three fourth of the total particle has a speed between 0.5 V_0 and V_0.



C-5. Number of collisions per unit time of molecules of a gas on the wall of a container per m^2 will :
(1) Increase if temperature and volume both are doubled.
(2) Increase if temperature and volume both are halved.
(3) Increase if pressure and temperature both are doubled.
(4) Increase if pressure and temperature both are halved.

C-6. A closed vessel contains a mixture of two diatomic gases A and B. Molar mass of A is 16 times that of B and mass of gas A, contained in the vessel is 2 times that of B. :
(1) Average kinetic energy per molecule of gas A is equal to that of gas B.
(2) Root mean square value of translational speed of gas B is four times that of A.
(3) Pressure exerted by gas B is eight times of that exerted by gas A.
(4) Number of molecules of gas B in the cylinder is eight times that of gas A.

C-7. One mole of an ideal monatomic gas is taken from temperature T_0 to $2T_0$ by the process T^4P^{-1} = constant.
(1) The molar specific heat of gas is $-\frac{3R}{2}$ (2) The molar specific heat of gas is $\frac{3R}{2}$
(3) Work done by gas is $-3RT_0$ (4) Work done by gas is $3R_0T_0$

C-8. One mole each of monoatomic, diatomic and triatomic ideal gases (kept in three different containers) whose initial volume and pressure are same, each is compressed till their pressure becomes twice the initial pressure then which of the following statements is/are correct?
(1) If the compression is isothermal then their final volumes will be same
(2) If the compression is adiabatic, then final volume will be different
(3) If the compression is adiabatic, then triatomic gas will have maximum final volume
(4) If the compression is adiabatic, then monoatomic gas will have maximum final volume

C-9. An ideal gas expand from volume v_1 to v_2 in three different process : isobaric, isothermal & adiabatic then. Change in internal energy (Δu) is :
(1) positive in adiabatic process (2) positive in isobaric process
(3) negative in adiabatic process (4) negative in isobaric process

C-10. 70 calories of heat is required to raise the temperature of 2 moles of an ideal gas at constant pressure from
30° C to 35° C (R = 2 cal/mol–°C). The gas may be :
(1) H_2 (2) He (3) CO_2 (4) NH_3