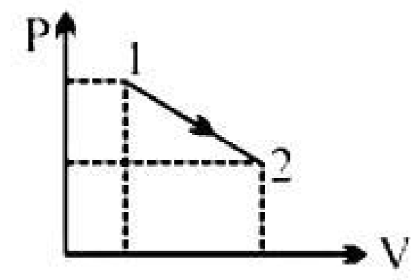
[SINGLE CORRECT CHOICE TYPE]

Q.1 10 moles of a diatomic perfect gas are allowed to expand at constant pressure. The initial volume and temperature are V_0 and T_0 respectively. If 7/2 RT_0 is transferred to the gas as heat then the final volume and temperature are

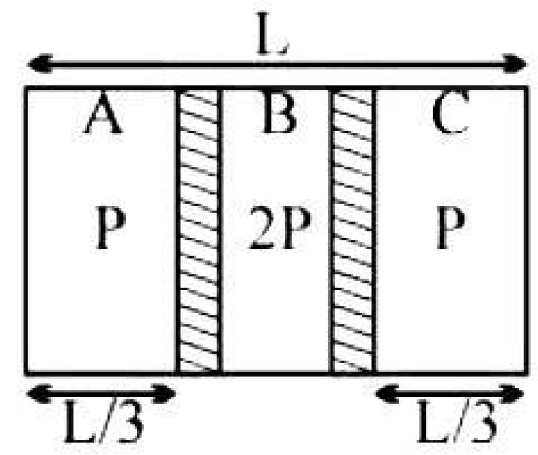
(A) 1.1 V_0, 1.1 T_0 (B) 0.9 V_0, 0.9 T_0 (C) 1.1 V_0, $10T_0/11$ (D) 0.9 V_0, $10T_0/9$

Q.2 A process 1→2 using monoatomic gas is shown on the P-V diagram on the right. $P_1 = 2P_2 = 10^6$ N/m^2, $V_2 = 4V_1 = 0.4$ m^3. The heat absorbed by the gas in this process will be :



(A) 350 kJ (B) 375 kJ
(C) 425 kJ (D) None

Q.3 Two pistons having low thermal conductivity divide an adiabatic container in three equal parts as shown. An ideal gas is present in the three parts A, B & C having initial pressures as shown and same temperatures. Now the pistons are released. Then the final equilibrium length of part A after long time will be **[3]**

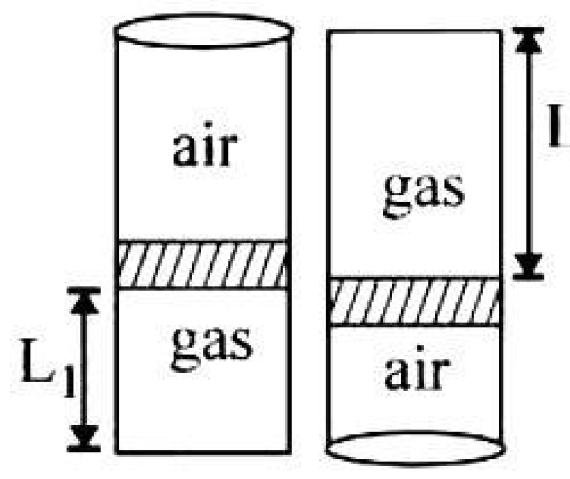


(A) L/8 (B) L/4 (C) L/6 (D) L/5

Q.4 Mercury stands at a height of 76 cm in a barometric tube 86 cm long and of cross-section 1 cm^2. Some air enters the tube and the mercury column is now only 67 cm long. The volume of air in cm^3 introduced at atmospheric pressure is

(A) 9 (B) 2 (C) 2.5 (D) 2.25

Q.5 An ideal gas is trapped inside a test tube of cross-sectional area 20×10^{-6} m^2 as shown in the figure. The gas occupies a height L_1 at the bottom of the tube and is separated from air at atmospheric pressure by a mercury column of mass 0.002 kg. If the tube is quickly turned isothermally, upside down so that mercury column encloses the gas from below. The gas now occupies height L_1 in the tube. The ratio $\frac{L_2}{L_1}$ is [Take atmospheric pressure = 10^5 Nm^{-2}]



(A) $\frac{102}{101}$ (B) $\frac{101}{99}$ (C) $\frac{99}{100}$ (D) $\frac{100}{99}$

Q.6 A diatomic gas of molecules weight 30 gm/mole is filled in a container at 27°C. It is moving at a velocity 100 m/s. If it is suddenly stopped, the rise in temperature of gas is :

(A) $\frac{60}{R}$ (B) $\frac{600}{R}$ (C) $\frac{6\times10^4}{R}$ (D) $\frac{6\times10^5}{R}$

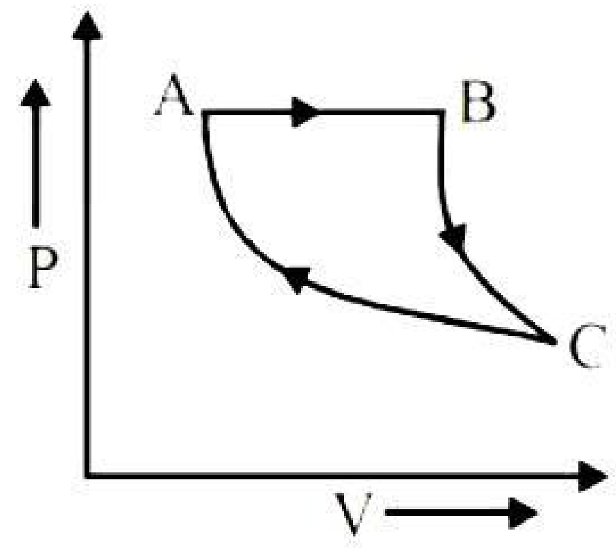
Q.7 If heat is added at constant volume, 6300J of heat are required to raise the temperature of an ideal gas by 150K. If instead, heat is added at constant pressure, 8800 joules are required for the same temperature change. When the temperature of the gas changes by 300K, the internal energy of the gas changes by

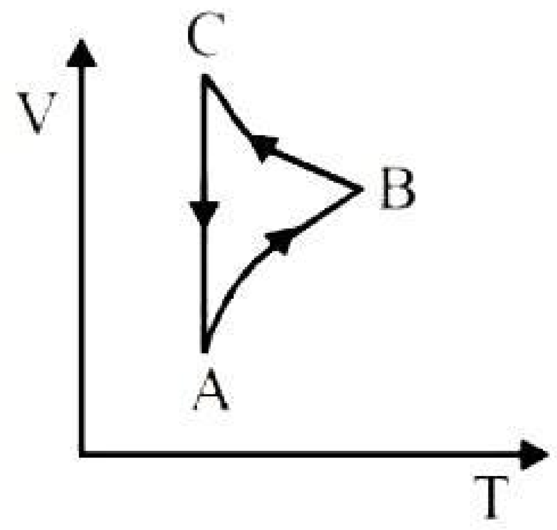
(A) 5000J (B) 12600J (C) 17600J (D) 22600J

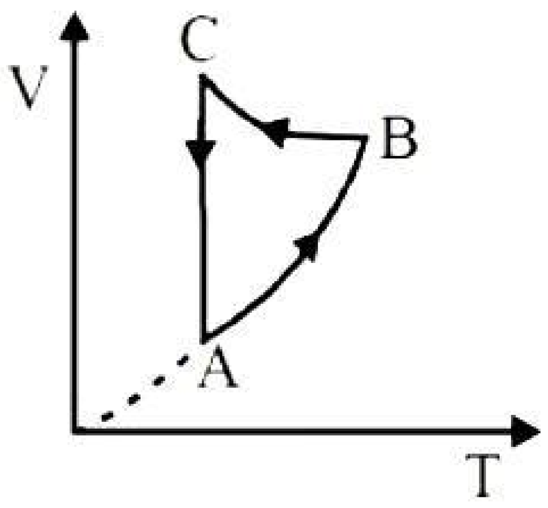
Q.8 1 gm water at 100°C and 10^5Pa pressure converts into 1841cm^3 of steam at constant temperature and pressure. If latent heat of vapourization of water is 2250 J/gm. The change in internal energy of water in this process is
(A) zero (B) 2250 J (C) 2066 J (D) none

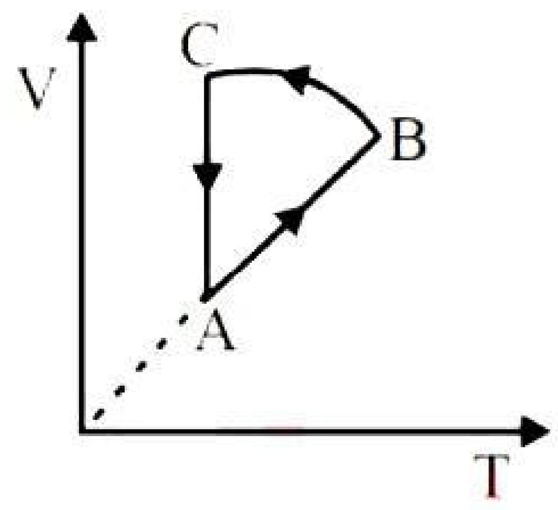
Q.9 A gas undergoes a process in which its pressure p and volume v are related as Vp^2 = constant. The bulk modulus for the gas in this process is
(A) p/2 (B) 2p (C) 2pv (D) 3p

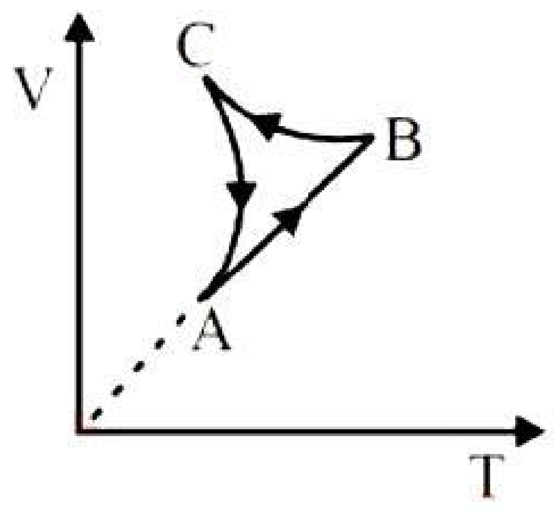
Q.10 For a given thermodynamic process, the P – V diagram is as shown below:
Which of the following is the V – T diagram for the process?
$A \rightarrow B$: isobaric
$B \rightarrow C$: adiabatic
$C \rightarrow A$: isothermal

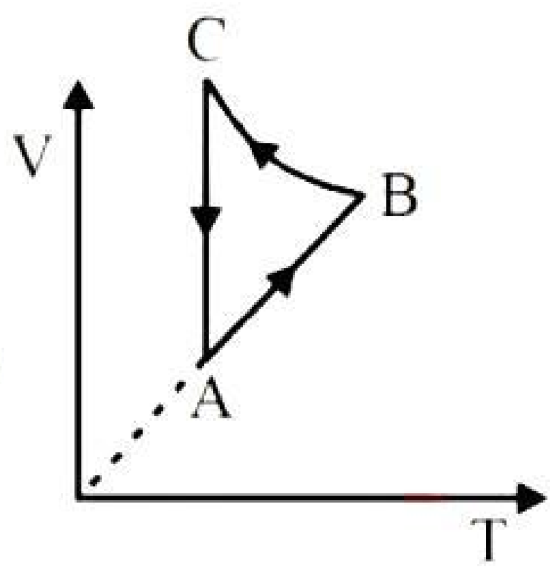


(A)


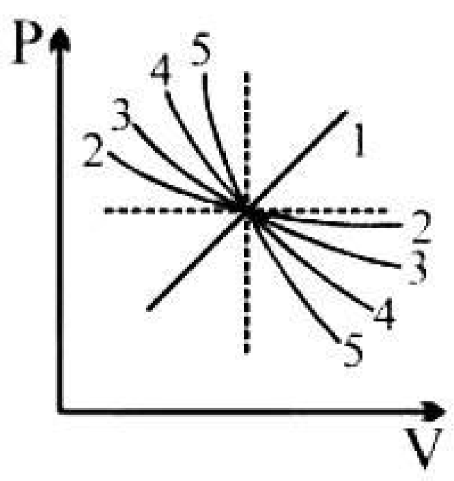
(B)


(C)


(D)


(E)


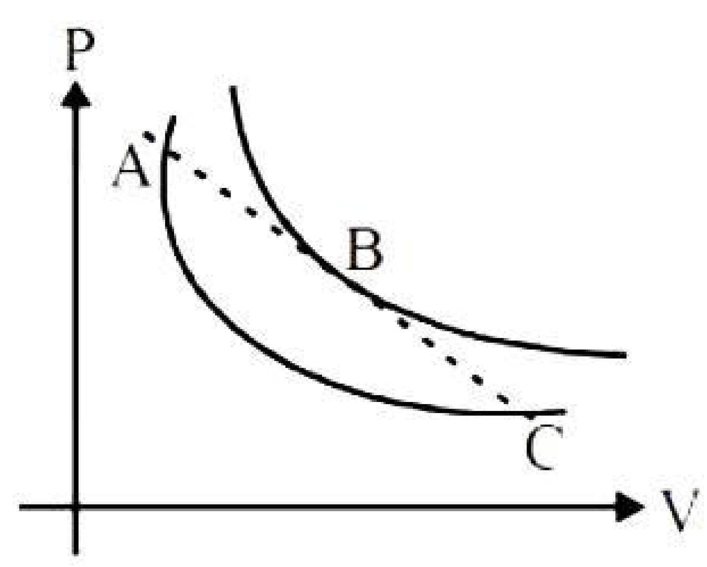
Q.11 Figure shows P vs V curve for various processes performed on an ideal gas. All the processes are polytropic (PV^m = constant). For 1, m = –1; for 2, m = 0.5; for 3, m = 1; for 4, m = 1.25 and for 5, m = γ.



(A) Molar heat capacity (C) for process 2, $C < C_p$
(B) Molar heat capacity for process (1) is $\frac{C_p + C_v}{2}$
(C) Molar heat capacity for process 5 is $C > C_v$
(D) Any polytropic process that lies between 3 & 4 will have positive heat capacity

[REASONING TYPE]

Q.12 Curves in below P-V diagram represent isotherms. There are three states A, B, C of an ideal gas.



Statement-1 : As the ideal gas is taken from A to B to C along a process represented by straight line ABC its temperature first increases and then decreases.
Statement-2 : Along isotherms as pressure increases volume decreases.
(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.
(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.
(C) Statement-1 is true, statement-2 is false.
(D) Statement-1 is false, statement-2 is true.

[PARAGRAPH TYPE]

Pargraph for Q.No.13 to 15

A very tall vertical cylinder is filled with a gas of molar mass M under isothermal conditions at temperature T. The density and pressure of the gas at the base of the container is ρ_0 and p_0, respectively

Q.13 Choose the correct statement(s)

(A) Pressure decreases with height

(B) The rate of decreases of pressure with height is a constant.

(C) $\frac{dp}{dh} = -\rho g$ where ρ is density of the gas at a height h.

(D) $p = \rho \frac{RT}{M}$

Q.14 Choose the correct statement(s) if gravity is assumed to be constant throughout the container

(A) Both pressure and density decreases exponentially with height.

(B) The variation of pressure is $p = p_0 e^{-\frac{Mgh}{RT}}$

(C) The variation of density $\rho = \rho_0 e^{-\frac{Mgh}{RT}}$

(D) The molecular density decreases as one moves upwards.

Q.15 Choose the correct statement(s)

(A) The density of gas cannot be uniform throughout the cylinder.

(B) The density of gas cannot be uniform throughout the cylinder under isothermal conditions.

(C) The density of gas is constant if $\left|\frac{dT}{dh}\right| = \frac{R}{Mg}$

(D) The density of gas is uniform if $\left|\frac{dT}{dh}\right| = \frac{Mg}{R}$

[MULTIPLE CORRECT CHOICE TYPE]

Q.16 At ordinary temperatures, the molecules of a diatomic gas have only translational and rotational kinetic energies. At high temperatures, they may also have vibrational energy. As a result of this, compared to lower temperatures, a diatomic gas at higher temperatures will have

(A) lower molar heat capacity (B) higher molar heat capacity

(C) lower isothermal compressibility (D) higher isothermal compressibility

Q.17 An ideal gas contained in an adiabatic vessel expands into vacuum. Which of the following hold true (symbols have usual meaning)

(A) $\Delta U = 0$ (B) $\Delta P = 0$ (C) $W = 0$ (D) $W > 0$

Q.18 A given mass of ideal gas is taken at constant pressure from state A(Pressure P, Volume V) to state B (Pressure P, Volume 4V). Subsequently, the gas is taken at constant volume from state B to state C (Pressure P/4, volume 4V). Select the correct statement (S) from the following:

(A) A quantity of heat (say Q_1) is given to the system is going from A to B

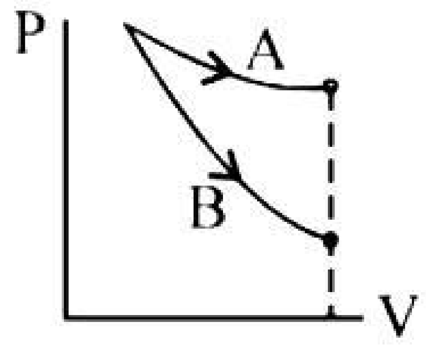
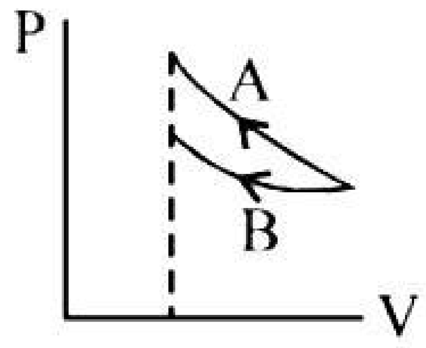
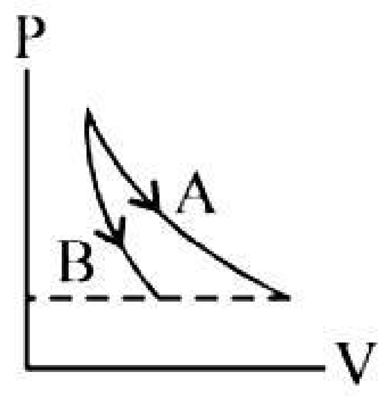
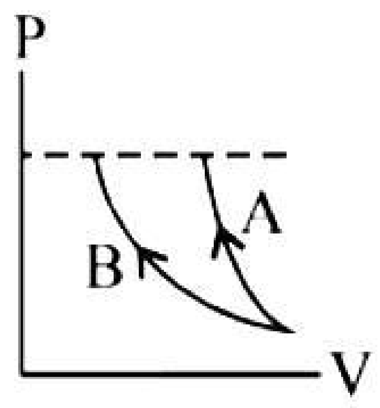
(B) A quantity of heat (say Q_2) is taken out of the system is going from B to C

(C) $Q_1 > Q_2$

(D) $Q_1 = Q_2$

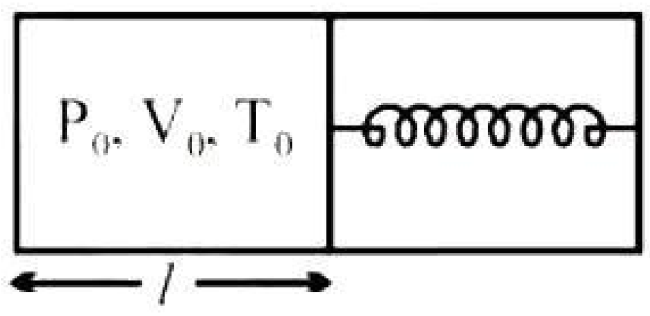
[MATRIX TYPE]

Q.19 An ideal gas undergoes two processes A and B. One of these is isothermal and the other is adiabatic.

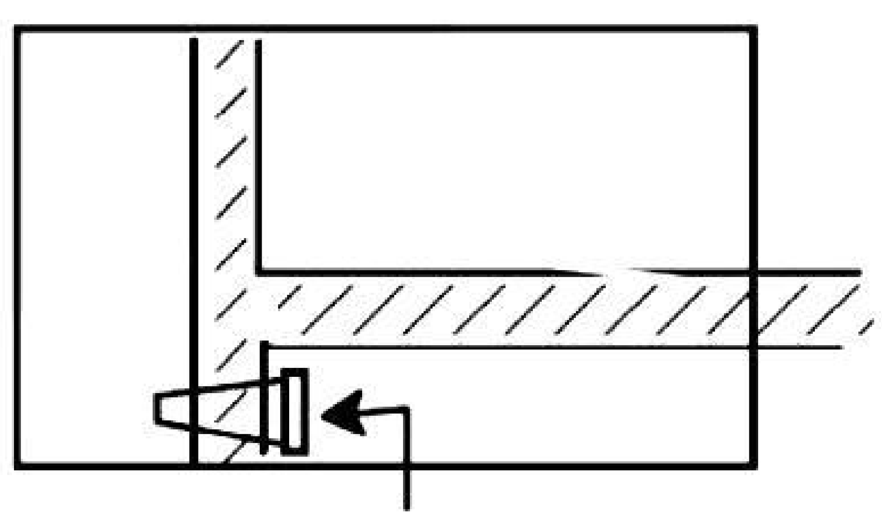
	Column-I		**Column-II**
(A)		(P)	Heat supplied during curve A is positive
(B)		(Q)	Work done by gas in both processes positive
(C)		(R)	Internal energy increases in adiabatic process
(D)		(S)	Temperature of gas in process B is constant

[SUBJECTIVE TYPE]

Q.20 An insulating piston separates a thermally insulated vessel into two parts. The left part contains one mole of an ideal monatomic gas and right part is empty. The piston is connected to the right wall of the vessel, through a spring whose unstretched length is equal to length of the vessel. The gas is heated by means of a heating coil inside the gas chamber. Ignore friction and heat capacities of the spring, vessel and piston. If the pressure of gas becomes $2P_0$, the temperature becomes nT_0. Find n.



Q.21 A cylinder of volume $0.6\ m^3$ is provided with a piston, the wall of which has a stop cock. The left part of the cylinder contains 10 mol of a gas ($\gamma = 1.5$) at a temperature of 300 K; the right chamber is evacuated. Initially the gas occupies one third of the total volume of the cylinder. The walls of the cylinder are adiabatic. The piston is moved quassi-statically so that the volume of the gas is doubled. The valve in the piston is then opened so that the gas fills the entire volume. Calculate the final pressure and temperature of the gas , work done and change in internal energy.



ANSWER KEY

Q.1	A	Q.2	B	Q.3	B	Q.4	D	Q.5	B	Q.6	A	Q.7	B
Q.8	C	Q.9	A	Q.10	D	Q.11	B	Q.12	B	Q.13	A,C,D		
Q.14	A,B,C,D			Q.15	B,D	Q.16	B, C	Q.17	A, C	Q.18	A,B,C		

Q.19 (A)-PQ, (B)-RS, (C)-PQ, (D)-RS Q.20 0004

Q.21 $3.2 \times 10^4 N/m^2$, $150\sqrt{2}$ K, $1.52 \times 10^4 J$, $-1.52 \times 10^4 J$

HINTS AND SOLUTIONS

Q.1 A

Q.2 B

Sol. $W = \frac{1}{2} \times 3v_0 \times P_0 + 3v_0 \times P_0$

$W = \frac{3}{2} P_0v_0 + 3v_0P_0$

$W = \frac{9}{2} P_0v_0$

$\Delta U = nC_v\Delta T = n\left(\frac{3R}{2}\right)(T_f - T_i)$

$\Delta U = \frac{3}{2} nR(T_f - T_i) = \frac{3}{2}[P_fV_f - P_iV_i]$

$\Delta U = \frac{3}{2}[4P_0V_0 - 2P_0V_0]$

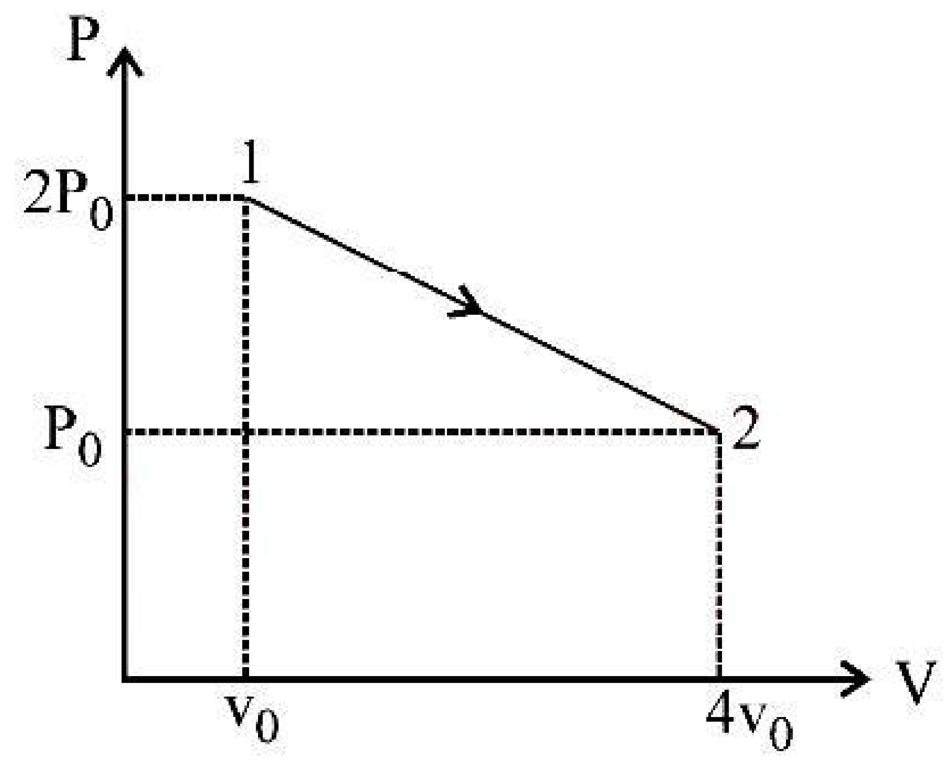
$\Delta U = 3P_0V_0$

$\Delta Q = \Delta U + W = \frac{9}{2} P_0V_0 + 3P_0V_0 = \frac{15}{2} P_0V_0$

$P_0 = \frac{10^6}{2}$, $V_0 = 0.1$

$\Delta Q = \frac{15}{2} \times \frac{10^6}{2} \times 0.1 = 375000 \text{ J}$

$\Delta Q = 375 \text{ kJ}$]



Q.3 B

Sol. $n = \frac{PV}{RT}$

Final pressure & temperature is same hence volume will be in ratio of number of moles.

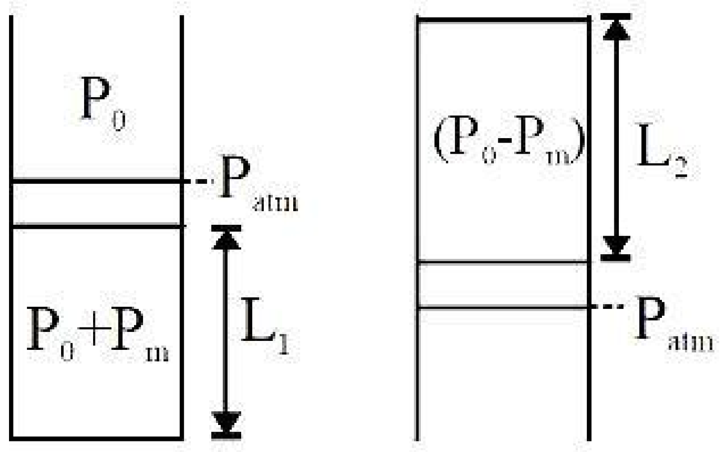
Q.4 D

Sol. $(76 - 67)\rho g \times (19 \times 1) = 76 \rho gV$

$V = \frac{9}{4} = 2.25$

Q.5 B

Sol. P_m = Pressure due to mercury.



For constant, 'T'

$$(P_0 + P_m) L_1A = (P_0 - P_m) L_2A \qquad \text{... (i)}$$

$$P_m = \frac{mg}{A} = \frac{0.0029}{20\times10^{-6}} = 10^3 \text{ Pa}$$

So, from (i), $\frac{L_2}{L_1} = \frac{101}{99}$

Q.6 A

Sol. Δ K.E. = ΔU

$$\frac{1}{2} \times n \times 30 \times 10^{-3} \times (100)^2 = n \times \frac{5}{2} R \times \Delta T$$

$$\Delta T = \frac{60}{R}$$

Q.7 B

Q.8 C

Q.9 A

Sol. $Vp^2 = C$

$$\beta = - V\left(\frac{dp}{dv}\right)$$

$$p^2 + 2vp\frac{dp}{dv} = 0$$

$$\frac{dp}{dv} = \frac{-p}{2v}$$

$$\beta = -v \times \left(\frac{-p}{2v}\right) = \frac{p}{2}$$

Q.10 D

Q.11 B

Sol. $C_1 = \frac{R}{\gamma-1} - \frac{R}{m-1} = \frac{R}{\gamma-1} + \frac{R}{2} = C_v + \frac{R}{2} = \frac{C_p + C_v}{2}$

$$C_2 = \frac{R}{\gamma-1} - \frac{R}{0.5-1} = \frac{R}{\gamma-1} + 2R = C_v + 2R = C_p + R$$

$$C_3 = -\infty$$

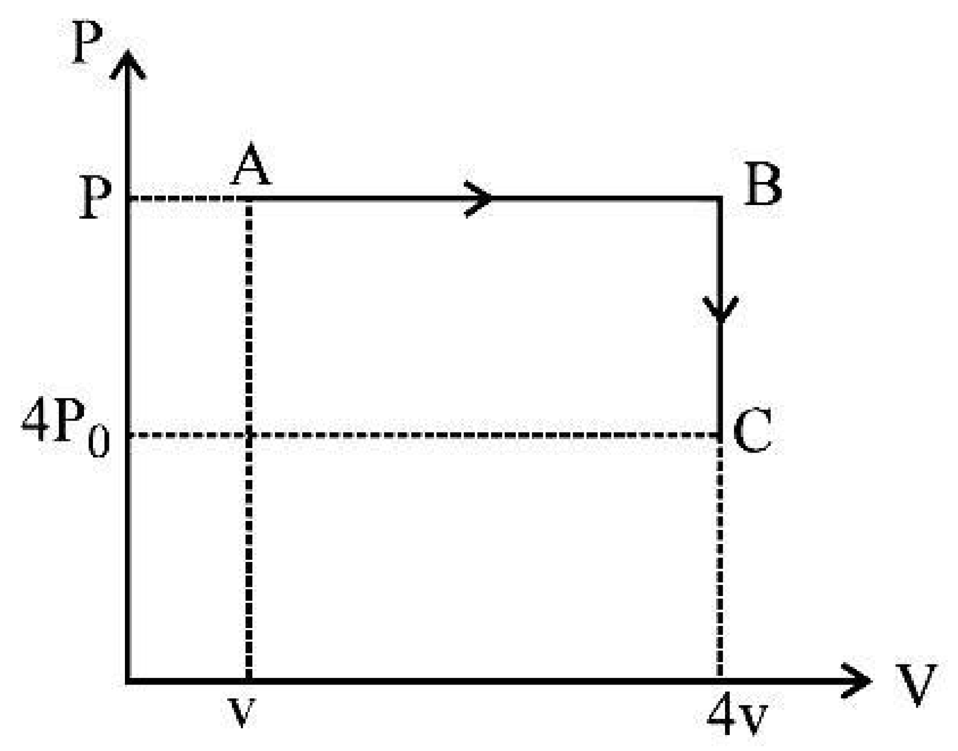
$$C_4 = \frac{R}{\gamma-1} - \frac{R}{1.25-1} = C_v - 4R = -ve$$

$$C_5 = \frac{R}{\gamma-1} - \frac{R}{\gamma-1} = 0$$

Q.12 B
Q.13 ACD
Q.14 ACBD
Q.15 BD
Q.16 BC
Sol. as f↑ , C ↑

assuming P ↑ as T↑, $\frac{1}{P}$ ↓, compressibility ↓.]

Q.17 AC
Q.18 ABC
Sol. (A) , (B) (temp ↓) (C) $Q_1 > Q_2$



Q.19 [Ans. (A)-PQ, (B)-RS, (C)-PQ, (D)-RS]

Sol. (A) Isothermal process, $\Delta V = 0$, $W = +ve \Rightarrow \Delta Q = +ve$)
Since volume is increasing in both processes
(B) A is adiabatic with –ve work done $\Rightarrow \Delta U = +ve$
B is isothermal
(C) Same as A
(D) Same as B

Q.20 [Ans. 0004]

Sol.
$$\left.\begin{aligned} P_0 &= \frac{k\ell}{A} \\ 2P_0 &= \frac{k\ell'}{A} \end{aligned}\right\} \Rightarrow \ell' = 2\ell$$

$$T' = \frac{2P_0(2\ell A)}{R} = \frac{2P_0 2V_0}{R} = \frac{4P_0 V_0}{R}$$
$= 4T_0 = nT_0$

Q.21 [Ans:$3.2 \times 10^4 N/m^2$, $150\sqrt{2}$ K, $1.52 \times 10^4 J$, $-1.52 \times 10^4 J$]