1.

An ideal gas is held in a container of volume V at pressure P. The average speed of a gas molecule under these conditions is v. If now the volume and pressure are changed to 2V and 2P, the average speed of a molecule will be

(A) 1/2 v (B) v (C) 2v (D) 4v

$\boxed{P, V}$ $\boxed{2V, 2P}$

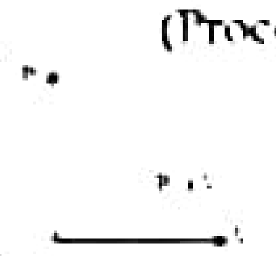
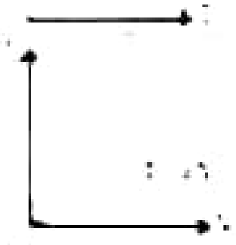
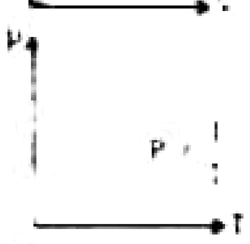
$v = \sqrt{\frac{8PV}{\pi m}}$

$v' = \sqrt{\frac{8\,2P\,2V}{\pi m}}$

$\boxed{v' = 2v}$

2.

One mole of ideal monoatomic gas is taken through following process. Match the molar heat capacity of gas in the column II with process in column I

Column I (Process)		Column-II (Molar Heat capacity)
(A) 	$\to S$	(P) $\frac{R}{2}$
(B) 	$\to P$	(Q) $\frac{7R}{2}$
(C) 	$\to S$	(R) $\frac{5R}{2}$
(D) 	$\to Q$	(S) 2R

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

$PV^a =$ Const

$C_{process} = C_V + \frac{R}{1-a}$

$= \frac{3}{2}R + \frac{R}{1-a}$

A) $P \propto V \Rightarrow PV^{-1} =$ Const

$C_{process} = \frac{3R}{2} + \frac{R}{2} = 2R$

B) $V \propto \frac{1}{T} \Rightarrow V \propto \frac{1}{PV} \Rightarrow PV^2 =$ Const

$C_{process} = \frac{3R}{2} + \frac{R}{1-2} = \frac{R}{2}$

C) $U \propto V^2$

$T \propto V^2$

$PV \propto V^2$

$PV^{-1} =$ Const

$C_{process} = 2R$

D) $P \propto \frac{1}{T}$

$P \propto \frac{1}{PV}$

$P^2V = C$

$PV^{1/2} = C$

$C_p = \frac{3R}{2} + \frac{R}{1-\frac{1}{2}}$

$= \frac{7R}{2}$

3.

A gaseous mixture consists of 16gm of helium and 16gm of oxygen. The ratio $\frac{C_P}{C_V}$ of the mixture is-

(A) 1.4 (B) 1.54 (C) 1.59 (D) 1.62

He

$m = 16gm \quad n_1 = \frac{16}{4} = 4$

$\gamma_1 = \frac{5}{3} \quad C_{V_1} = \frac{R}{\frac{5}{3}-1}$

$C_{V_1} = \frac{3R}{2}$

O_2

$n_2 = \frac{16}{32} = \frac{1}{2}$

$\gamma_2 = \frac{7}{5}$

$C_{V_2} = \frac{R}{7/5 - 1}$

$C_{V_2} = \frac{5R}{2}$

$C_{V\,MIX} = \frac{n_1 C_{V_1} + n_2 C_{V_2}}{n_1 + n_2}$

$= \frac{4 \times \frac{3R}{2} + \frac{1}{2} \times \frac{5R}{2}}{4 + \frac{1}{2}}$

$C_{V\,mix} = \frac{29R}{18}$

$C_{P\,mix} = C_{V\,mix} + R$

$= \frac{47R}{18}$

$\gamma_{mix} = \frac{C_{P\,mix}}{C_{V\,mix}} = \frac{47}{29}$

$= 1.62$

4.

The root mean square (rms) speed of oxygen molecules (O_2) at a certain absolute temperature is v. If the temperature is doubled and the oxygen gas dissociates into atomic oxygen, the rms speed would be -

(A) v (B) $\sqrt{2}v$ (C) 2v (D) $2\sqrt{2}v$

$V_{rms} = \sqrt{\frac{3RT}{M}}$

$O_2 :\rightarrow v = \sqrt{\frac{3RT}{32}}$

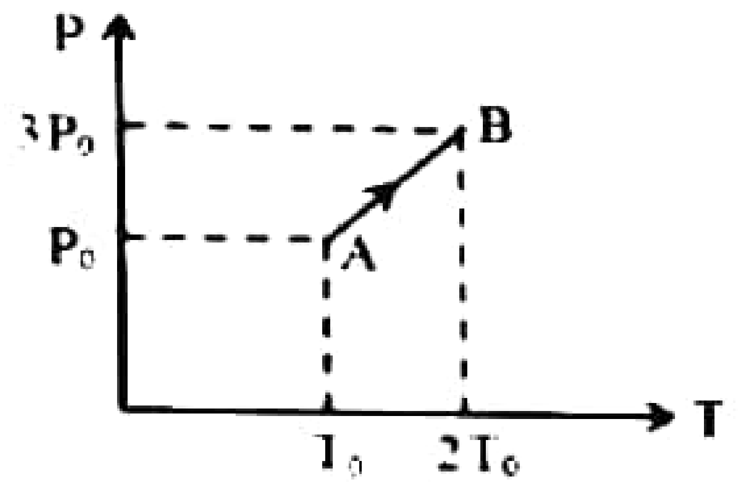
$(O) = v' = \sqrt{\frac{3R \times 2T}{16}}$

$\frac{v}{v'} = \sqrt{\frac{1}{2} \times \frac{16}{32}}$

$\boxed{v' = 2v}$

5.

Pressure versus temperature graph of an ideal gas is as shown in figure. Density of the gas at point A is ρ_0. Density at B will be –



(A) $\frac{3}{4}\rho_0$ (B) $\frac{3}{2}\rho_0$ (C) $\frac{4}{3}\rho_0$ (D) $2\rho_0$

$$P = \frac{\rho R T}{M}$$

$$P_0 = \frac{\rho_0 R T_0}{M} \quad -(1)$$

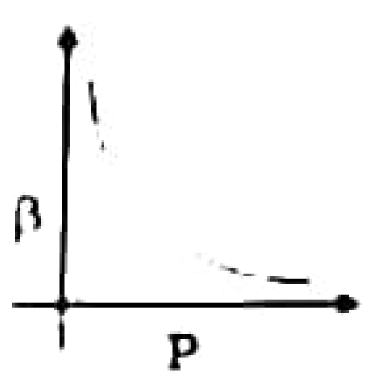
$$3P_0 = \frac{\rho_0 R \times 2T_0}{M} \quad -(2)$$

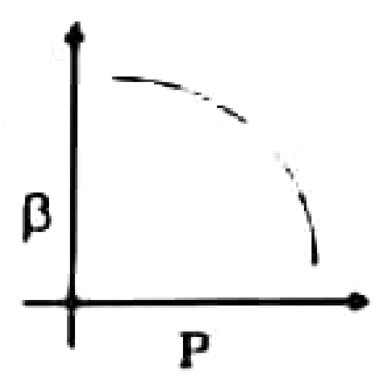
$$\frac{1}{3} = \frac{\rho_0 \times \frac{1}{2}}{\rho_0}$$

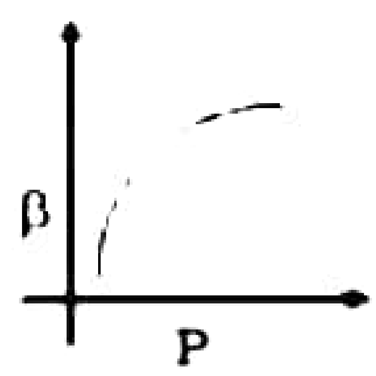
$$\boxed{\rho_0 = \frac{3}{2}\rho_0}$$

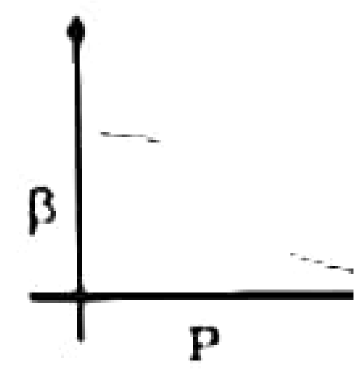
6.

Which of the following graphs correctly represents of variation of $\beta = -(dV/dP)/V$ with P for an ideal gas at constant temperature –

(A) 

(B) 

(C) 

(D) 

$PV = $ Const

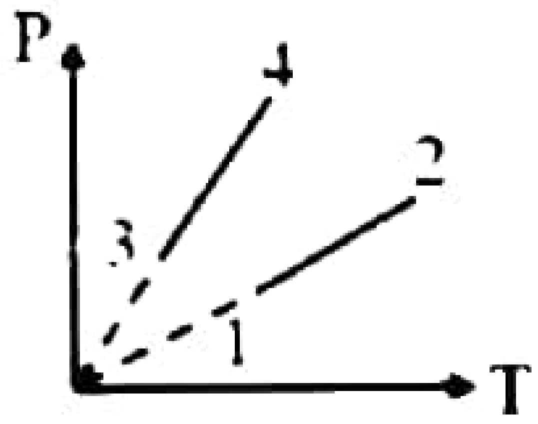
$$\frac{dP}{dV} \times V + P = 0$$

$$-\frac{dP}{dV} \times V = P$$

$$\boxed{\beta = -\frac{dV}{V\,dP} = \frac{1}{P}}$$

7.

Pressure versus temperature graph of an ideal gas of equal number of moles of different volumes are plotted as shown in figure. Choose the correct alterative



(A) $V_1 = V_2$, $V_3 = V_4$ and $V_2 > V_3$ (B) $V_1 = V_2$, $V_3 = V_4$ and $V_2 < V_3$

(C) $V_1 = V_2 = V_3 = V_4$ (D) $V_4 > V_3 > V_2 > V_1$

$V_1 = V_2$

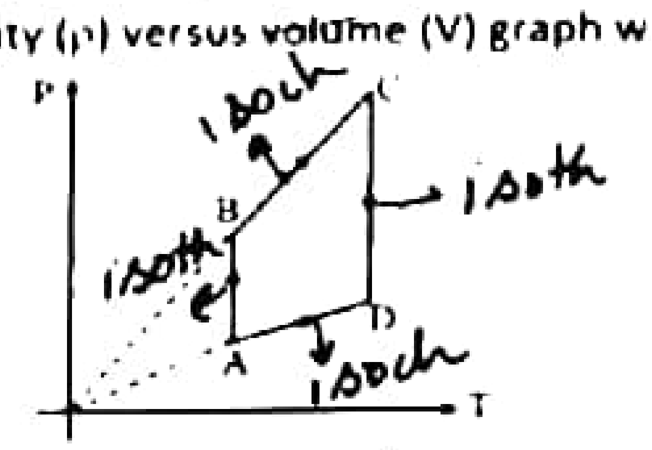
$V_3 = V_4$

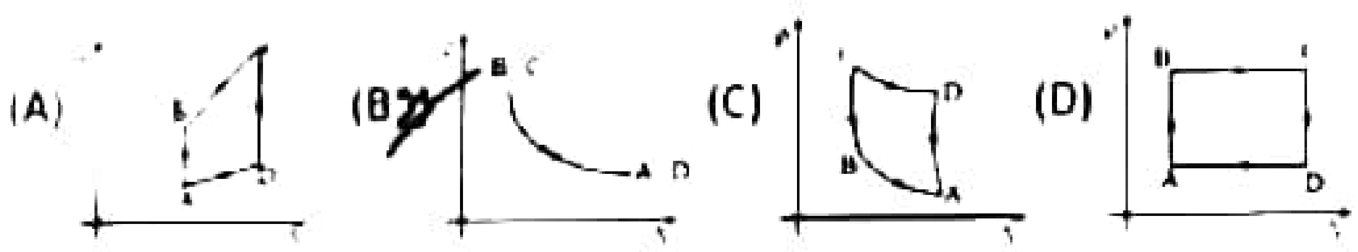
Slope $= \frac{nR}{V}$

$V_3 = V_4 < V_1 = V_2$.

8.

Pressure versus temperature graph of an ideal gas is as shown in figure. corresponding density (ρ) versus volume (V) graph will be -





AB : Isothermal : T = Const

$P = \frac{\rho R T}{M}$

$P \propto \rho \propto \frac{1}{V}$

$P(\uparrow)$ $\rho(\uparrow)$ $V(\downarrow)$

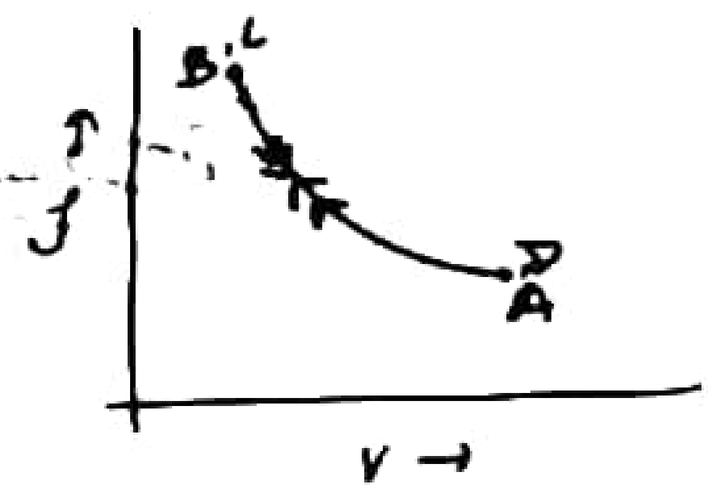
BC : V = Const

ρ = Const

CD : Isoth

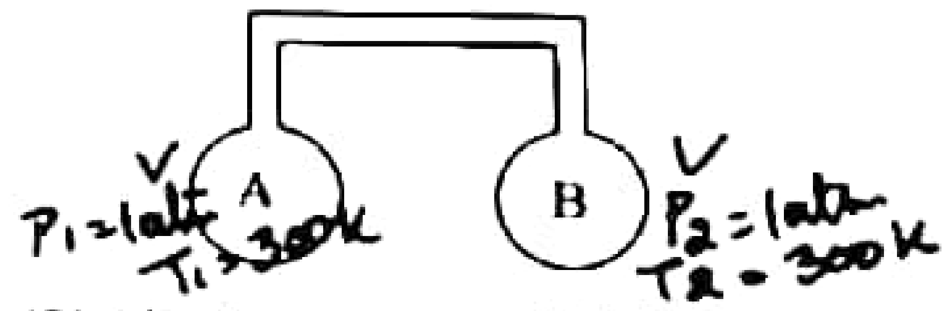
$P \propto \rho \propto \frac{1}{V}$

$P(\downarrow)$ $\rho(\downarrow)$ $V(\uparrow)$



9.

Two spherical vessels of equal volumes are connected by a narrow tube. The appratus contain an ideal gas at one atmosphere and 300K. Now if one vessel is immersed in a bath of constant temperature 600 K and the other in a bath of constant temperature 300 K then the common pressure will be –



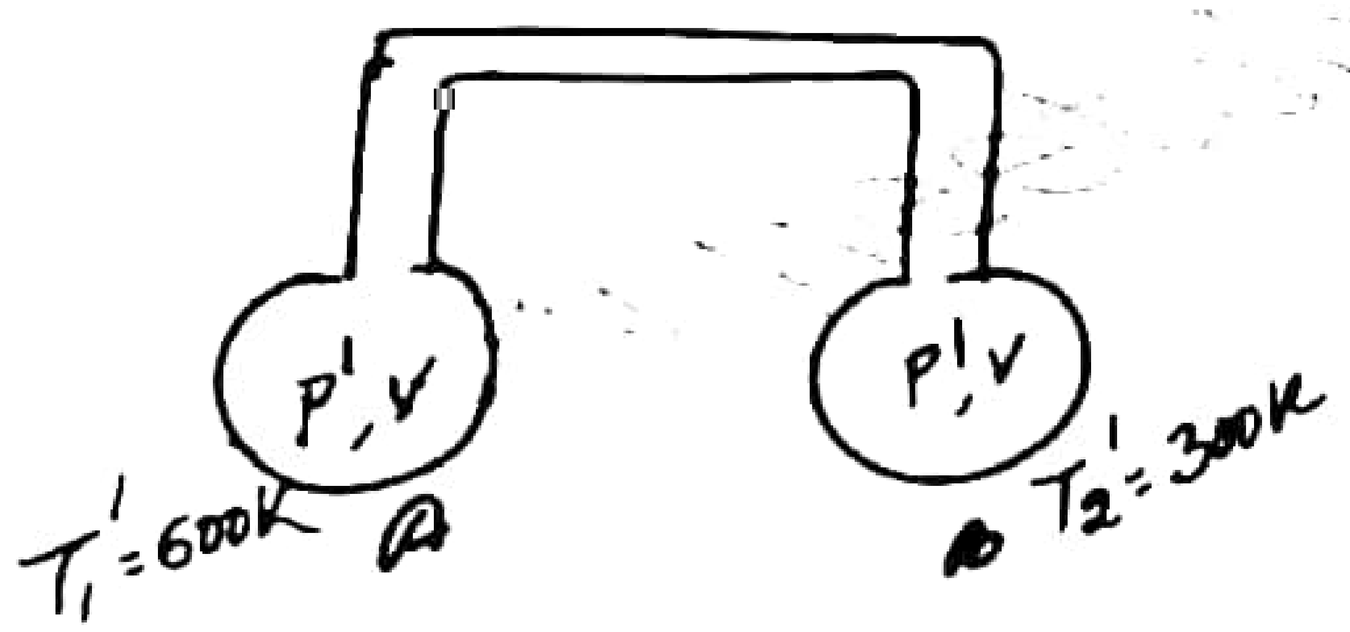
(A) 1 atm (B) 4/5 atm (C) 4/3 atm (D) 3/4 atm

$$n_1 + n_2 = n_1' + n_2'$$

$$\frac{2 \times 1 \times \cancel{V}}{\cancel{R} \times 300} = \frac{P' \times \cancel{V}}{\cancel{R}}\left(\frac{1}{600} + \frac{1}{300}\right)$$

$$\frac{2}{\cancel{300}} = \frac{P'}{\cancel{300}} \times \frac{3}{2}$$

$$\boxed{P' = \frac{4}{3}\,atm}$$



10.

At what temperature, r.m.s. velocity of O_2 molecules will be 1/3 of H_2 molecules at –3°C ?

(A) 90 K (B) 1167 °C (C) –3 K (D) 217°C

$$(V_{rms})_{O_2} = \sqrt{\frac{3R \times T}{32}}$$

$$(V_{rms})_{H_2} = \sqrt{\frac{3R \times 276}{2}}$$

$$V_{O_2} = \frac{1}{3}(V_{rms})_{H_2}$$

$$\sqrt{\frac{3RT}{32}} = \frac{1}{3}\sqrt{\frac{3R \times 276}{2}}$$

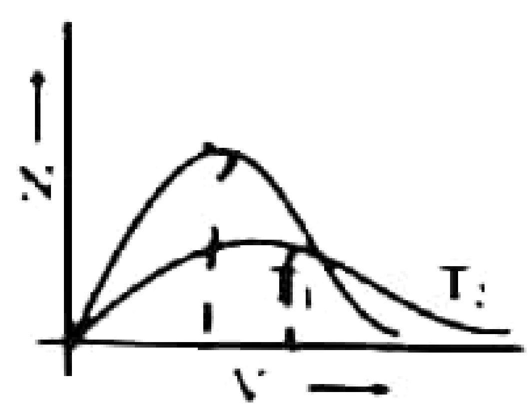
$$\frac{T}{\cancel{32}_{16}} = \frac{1}{9} \times \frac{276}{\cancel{2}}$$

$$T = 276 \times \frac{16}{9} = 490.6\,K$$

$$T = \underline{217^\circ C}$$

11.

Maxwell's velocity distribution curve is given for two different temperatures. For the given curves -



(A) $T_1 > T_2$ (B) $T_1 < T_2$ (C) $T_1 \leq T_2$ (D) $T_1 = T_2$

$(v_{mp})_2 > (v_{mp})_1$

$T_2 > T_1$

12.

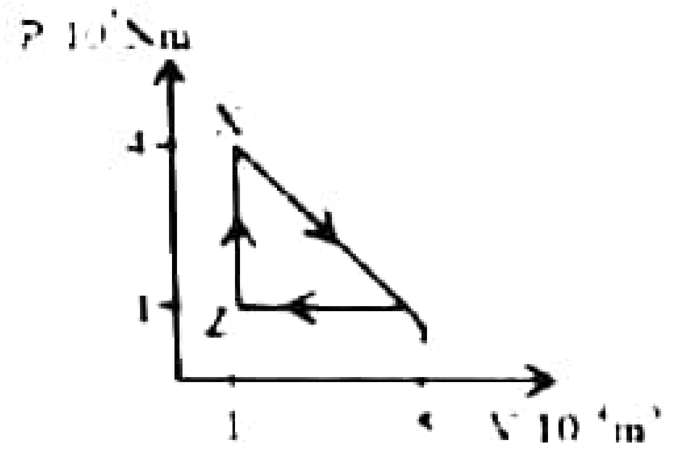
A gas molecule of mass m is incident normally on the wall of the containing vessel with velocity u. After the collision, magnitude of the change in momentum of the molecule will be –

(A) Zero (B) $(\frac{1}{2})$mu (C) 2 mu (D) mu

$\Delta p = 2mu$

13.

A mass of an ideal gas of volume V at pressure P undergoes the cycle of changes shown in the graph –



At which point is the gas coolest and hottest ?

Coolest	hottest
(A) X	Y
(B) Y	X
(C) Y	Z
(D) Z	Y

$PV \propto T$

$X = P_X V \propto 4 \propto T_X$

$Y = PV \propto 5 \propto T_Y$

$Z = PV \propto 1 \propto T_Z$

14.

An ideal gas whose adiabatic exponent is γ is expanded so that the amount of heat transferred to the gas is equal to the decrease of its internal energy. Molar heat capacity of the gas for this process is –

(A) $\frac{R}{1-\gamma}$ (B) $\frac{R}{\gamma-1}$ (C) R (D) $\frac{R}{2}$

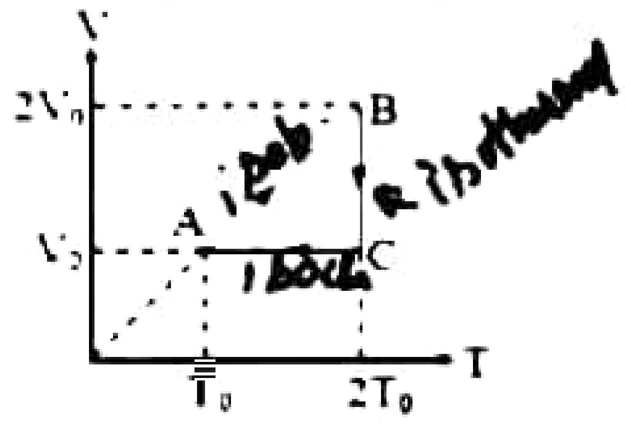
$\Delta Q = -\Delta U$

$n C \cancel{\Delta T} = -\cancel{n} C_V \cancel{\Delta T}$

$C_{given} = -\frac{R}{\gamma - 1} = \frac{R}{1-\gamma}$

15.

An ideal mono-atomic gas undergoes a cyclic process ABCA as shown in the figure. The ratio of heat absorbed is to heat rejected during process is –



(A) $\frac{5}{2\ln 2}$ (B) $\frac{5}{3}$ (C) $\frac{5}{4\ln 2+3}$ (D) $\frac{5}{6}$

$Q_{abs} = \frac{5}{2} nRT_0$

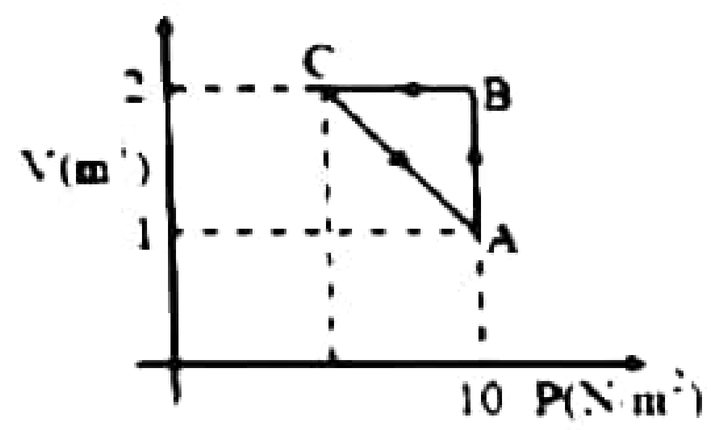
$Q_{rej} = \frac{nRT_0}{2}\left(4\ln 2+3\right)$

$$\boxed{\frac{Q_{abs}}{Q_{rej}} = \frac{5}{4\ln 2+3}}$$

	W	$\Delta U = \frac{f}{2} nR\Delta T$	$\Delta Q = \Delta U + W$
AB isobaric	$W = nR\Delta T$, $W_{AB} = nRT_0$	$\Delta U = \frac{3}{2} nRT_0$	$\Delta Q = \frac{5}{2} nRT_0$ [abs]
BC	$W = nRT \ln\frac{V_2}{V_1}$, $W = -2nRT_0 \ln 2$	$\Delta U = 0$	$\Delta Q = -2nRT_0 \ln 2$ [Rej]
CA	$W = 0$	$\Delta U = -\frac{3}{2} nRT_0$	$\Delta Q = -\frac{3}{2} nRT_0$ (Rej)

16.

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 $\underline{5\ J}$, the work done by the gas in the process C → A is –



(A) –5 J (B) – 10 J (C) – 15 J (D) – 20 J

$\Delta Q = +5\text{J}$

$W_{CA} = ?$

$\Delta Q = W$

$\Delta Q = W_{AB} + W_{BC} + W_{CA}$

$5 = 10\times 1 + 0 + W_{CA}$

$W_{CA} = \underline{-5\text{J}}$

17.

Statement - I : The specific heat of a gas in an adiabatic process is zero and in an isothermal process is infinite. Correct

Statement - II : Specific heat of gas is directly proportional to change in heat & inversely proportional to change in temperature. Correct

(a*) Both Statement-1 and Statement-2 are true
(b) Both Statement-1 and Statement-2 are false
(c) Statement-1 is true but Statement-2 is false.
(d) Statement-1 is false but Statement-2 is true.

$$C = \frac{\Delta Q}{nR\,\Delta T}$$

$C_{ad} = 0 \quad \big| \quad C_{iso} = \infty$

18.

8 A gas is expanded to double its volume by two different processes. One is isobaric and the other is isothermal. Let W_1 and W_2 be the respective work done, then –

(A*) $W_2 = W_1 \ln(2)$ (B) $W_2 = \frac{W_1}{\ln(2)}$

(C) $W_2 = \frac{W_1}{2}$ (D) data is insufficient

$A\,[P, V] \xrightarrow[W_1]{\text{isob.}} B\,[P, 2V]$

$A\,(P, V) \xrightarrow[W_2]{\text{isoth.}} C\,(\tfrac{P}{2}, 2V)$

$W_1 = P\Delta V = PV$

$W_2 = nRT \ln \frac{V_2}{V_1}$

$W_2 = PV \ln 2$

$\frac{W_1}{W_2} = \frac{1}{\ln 2}$

$$\boxed{W_2 = W_1 \ln 2}$$

19.

Heat is supplied to a diatomic gas at constant pressure. The ratio of $\Delta Q : \Delta U : \Delta W$ is –

(A) 5 : 3 : 2 (B) 5 : 2 : 3 (C) 7 : 5 : 2 (D) 7 : 2 : 5

$W_{isob} = nR\Delta T$

$\Delta U = \frac{5}{2} nR\Delta T$

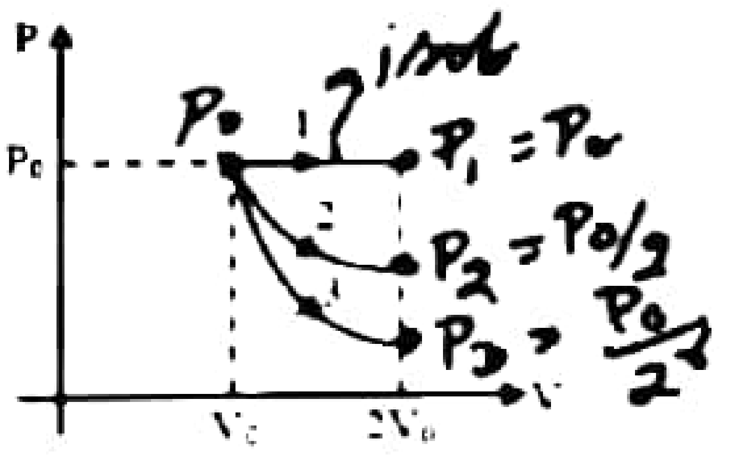
$\Delta Q = \frac{7}{2} nR\Delta T$

$\Delta Q : \Delta U : W = \frac{7}{2} : \frac{5}{2} : 1$

$= 7 : 5 : 2$

20.

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



(A) $\Delta U_1 > \Delta U_2 > \Delta U_3$ (B) $\Delta U_1 < \Delta U_2 < \Delta U_3$

(C) $\Delta U_2 < \Delta U_1 < \Delta U_3$ (D) $\Delta U_2 < \Delta U_3 < \Delta U_1$

$$\Delta U = \frac{f}{2}\left[P_2V_2 - P_1V_1\right]$$

$$\Delta U = \frac{f}{2}\left(P_f\, 2V_0 - P_0V_0\right)$$

ANS THIS $\boxed{\Delta U_1 > \Delta U_2 > \Delta U_3}$

21.

One mole of an ideal gas undergoes a process $P = \dfrac{P_0}{1+\left(\dfrac{V_0}{V}\right)^2}$.

Here, P_0 and V_0 are constants. Change in temperature of the gas when volume is changed from $V = V_0$ to $V = 2V_0$ is –

(A) $-\frac{2P_0V_0}{5R}$ (B) $\frac{11P_0V_0}{10R}$ (C) $-\frac{5P_0V_0}{4R}$ (D) P_0V_0

Sol: $n = 1$ $P = \dfrac{P_0}{\left[1+\left(\frac{V_0}{V}\right)^2\right]}$

$\dfrac{RT}{V} = \dfrac{P_0}{\left[1+\left(\frac{V_0}{V}\right)^2\right]}$

$T = \dfrac{P_0V}{R\left[1+\left(\frac{V_0}{V}\right)^2\right]}$

$T_1 = \dfrac{P_0V_0}{R[1+1]}$

$T_1 = \dfrac{P_0V_0}{2R}$

$T_2 = \dfrac{2P_0V_0}{R\left[1+\left(\frac{1}{2}\right)^2\right]}$

$T_2 = \dfrac{8P_0V_0}{5R}$

$\Delta T = T_2 - T_1$

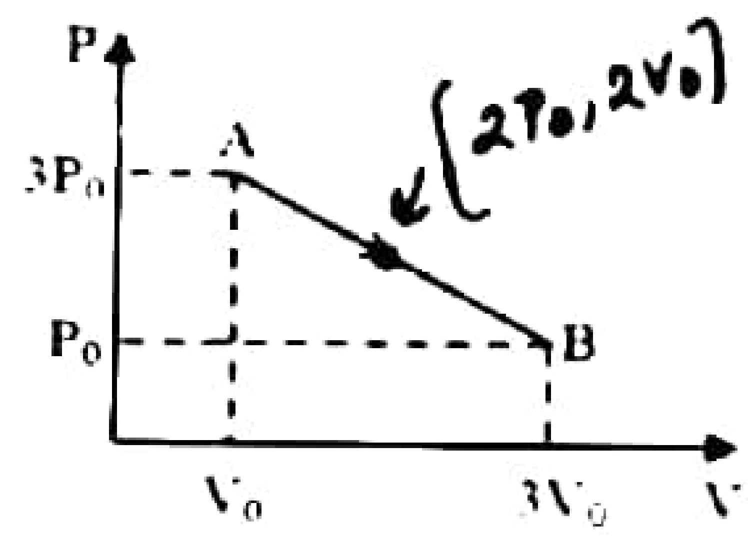
$= \left(\frac{8}{5} - \frac{1}{2}\right)\frac{P_0V_0}{R}$

$= \left(\frac{16-5}{10}\right)\frac{P_0V_0}{R}$

$= \frac{11P_0V_0}{10R}$

22.

n moles of an ideal gas undergoes a process A to B as shown. Maximum temperature of gas during the process is –



(A) $\frac{3P_0V_0}{nR}$ (B) $\frac{4P_0V_0}{nR}$ (C) $\frac{6P_0V_0}{nR}$ (D) $\frac{9P_0V_0}{nR}$

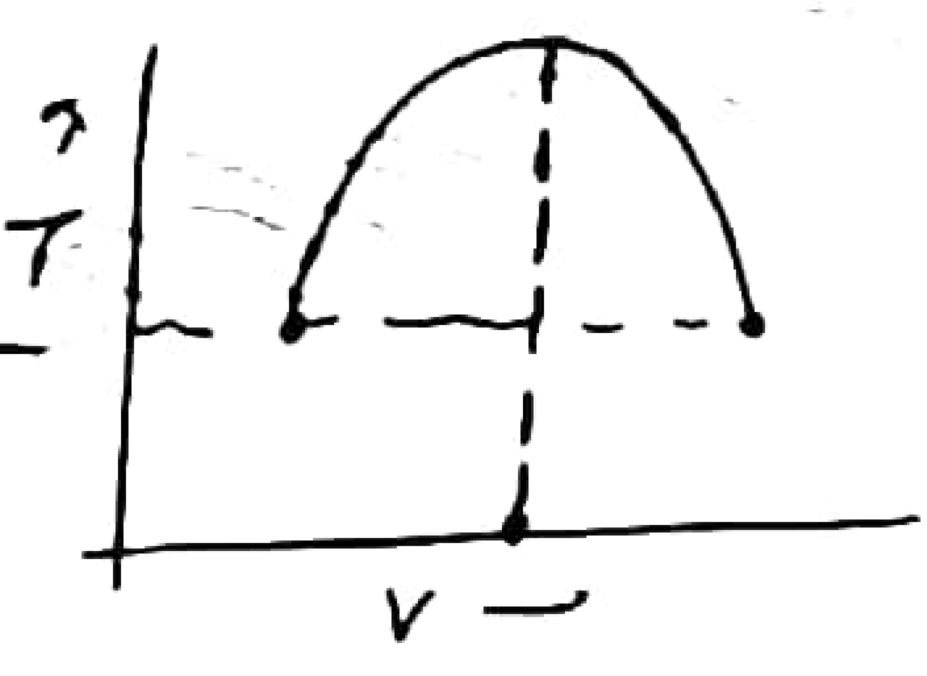
$PV = nRT$

$\boxed{T_{max} = \dfrac{4P_0V_0}{nR}}$

$P = -mV + C$

$\dfrac{nRT}{V} = -mV + C$

$\boxed{T = \dfrac{-mV^2}{nR} + \dfrac{CV}{nR}}$



23.

According to the first law of thermodynamics $\Delta Q = dU + \Delta W$, in an isochoric process–

(A) $\Delta Q = dU$ (B) $\Delta Q = \Delta W$ (C) $\Delta W = -dU$ (D) $\Delta W = dU$

24.

The heat energy given to a system in isothermal process is used in –

(A) Increasing the internal energy

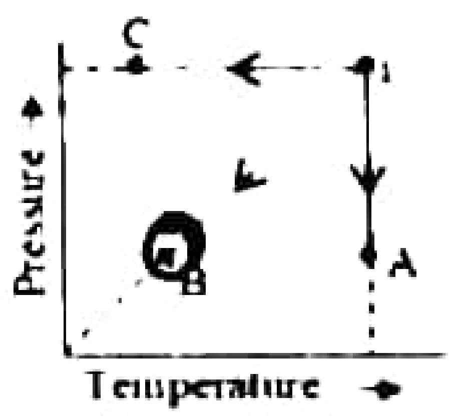
(B) Increasing temperature and doing external work

(C) Doing external work only

(D) Increasing internal energy, increasing temperature and doing external work

25.

In the figure shown here thermodynamic system goes from initial state i to three possible final states, A to B or C. Then the final state achieved by an isochoric process is –



(A) A (B) B (C) C (D) None

26.

A gas expands in a piston-cylinder device from V_1 to V_2, the process being described by $P = \frac{a}{V} + b$. Where P : Pressure and V: Volume The work done in process is –

(A) $a \ln \frac{V_1}{V_2} + b(V_2 - V_1)$ (B) $-a \ln \frac{V_2}{V_1} - b(V_2 - V_1)$

(C) $-a \ln \frac{V_1}{V_2} - b(V_2 - V_1)$ (D) $a \ln \frac{V_2}{V_1} + b(V_2 - V_1)$

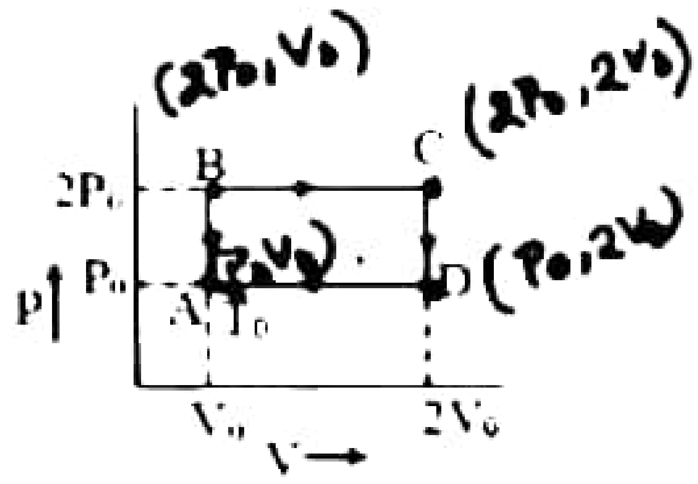
$$W = \int_{V_1}^{V_2} P\,dV$$

$$W = \int_{V_1}^{V_2} \frac{a}{V}\,dV + \int_{V_1}^{V_2} b\,dV$$

$$W = a \ln \frac{V_2}{V_1} + (V_2 - V_1)$$

27.

N moles of a monoatomic gas is carried round the reversible rectangular cycle ABCDA as shown in the diagram. The temperature at A is T_0. The thermodynamic efficiency of the cycle is–



(A) 15% (B) 50% (C) 20% (D) 25%

	w.d.	$\Delta U = \frac{3}{2}(P_2V_2 - P_1V_1)$	$\Delta Q = \Delta U + W$	
AB	0	$\Delta U = \frac{3}{2} \times P_0V_0$	$\Delta Q = \frac{3}{2} P_0V_0$	abs
BC	$2P_0V_0$	$\Delta U = \frac{3}{2}(2P_0V_0)$	$\Delta Q = 5P_0V_0$	
CD	0	$\Delta U = -\frac{3}{2}(2P_0V_0)$	$\Delta Q = -3P_0V_0$	rej
DA	$-P_0V_0$	$\Delta U = -\frac{3}{2}P_0V_0$	$\Delta Q = -\frac{5}{2}P_0V_0$	

$Q_R = \frac{11}{2} P_0V_0$

$Q_{abs} = \frac{13}{2} P_0V_0$

$\frac{Q_R}{Q_a} = \frac{11}{13}$

$\eta = 1 - \frac{Q_R}{Q_a}$

$\eta = \left(1 - \frac{11}{13}\right) \times 100$

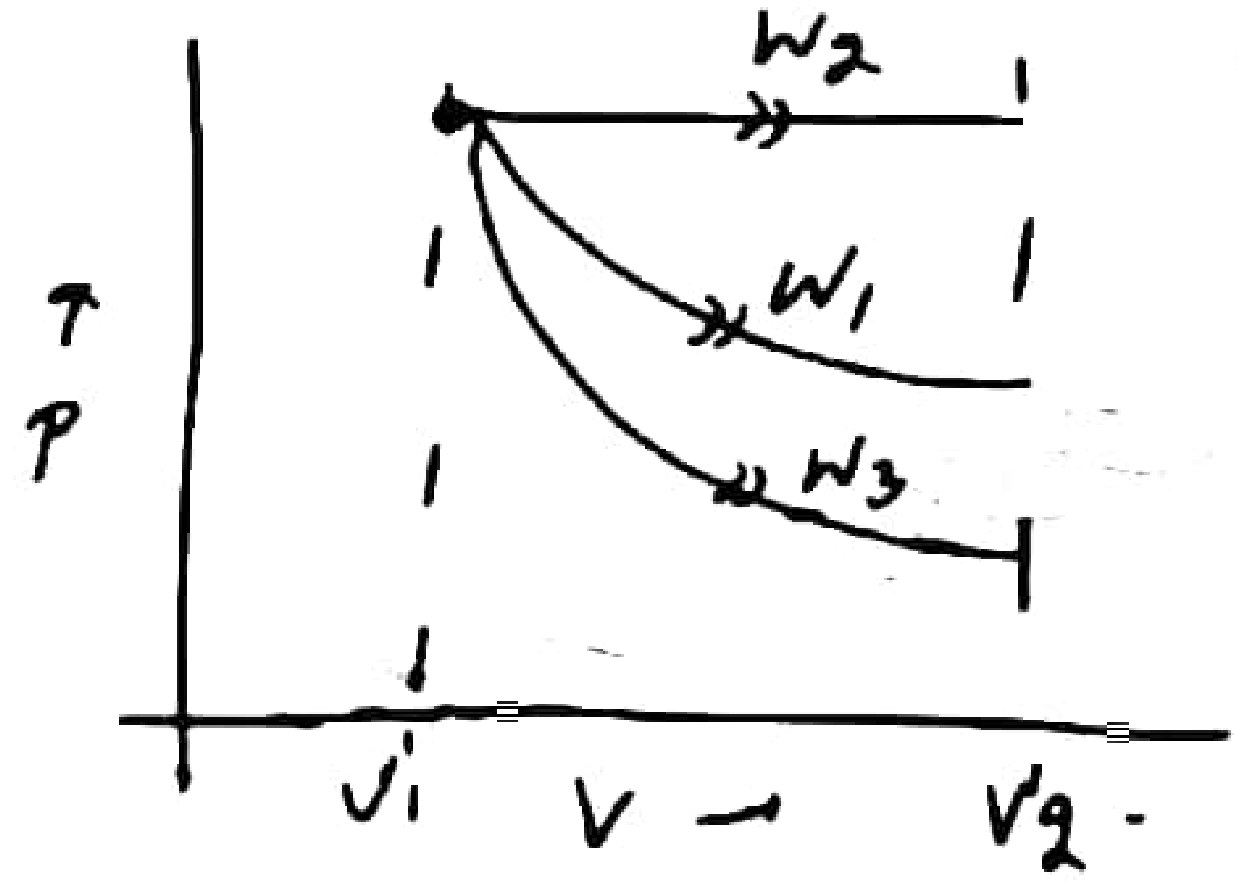
$= \frac{2}{13} \times 100 \simeq 15\ \%$

28.

Starting with the same initial conditions, an ideal gas expands from volume V_1 to V_2 in three different ways. The work done by the gas is W_1 if the process is purely isothermal, W_2 if purely isobaric and W_3 if purely adiabatic. Then –

(A) $W_2 > W_1 > W_3$ (B) $W_2 > W_3 > W_1$
(C) $W_1 > W_2 > W_3$ (D) $W_1 > W_3 > W_2$

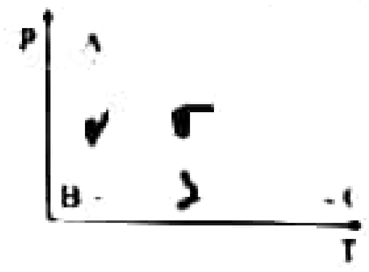
o/4



$W_2 > W_1 > W_3$

29.

The PT diagram for an ideal gas is shown in figure, where AC is an adiabatic process. The corresponding PV diagram is–



AB :→ isoth = $PV = \text{Const}$

$P(\downarrow)$ $V(\uparrow)$

BC isobaric: $V \propto T$

$T(\uparrow)$ $V(\uparrow)$

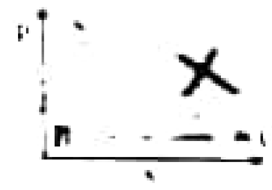
CA: Adiabatic

$PV^{\gamma} = \text{Const}$

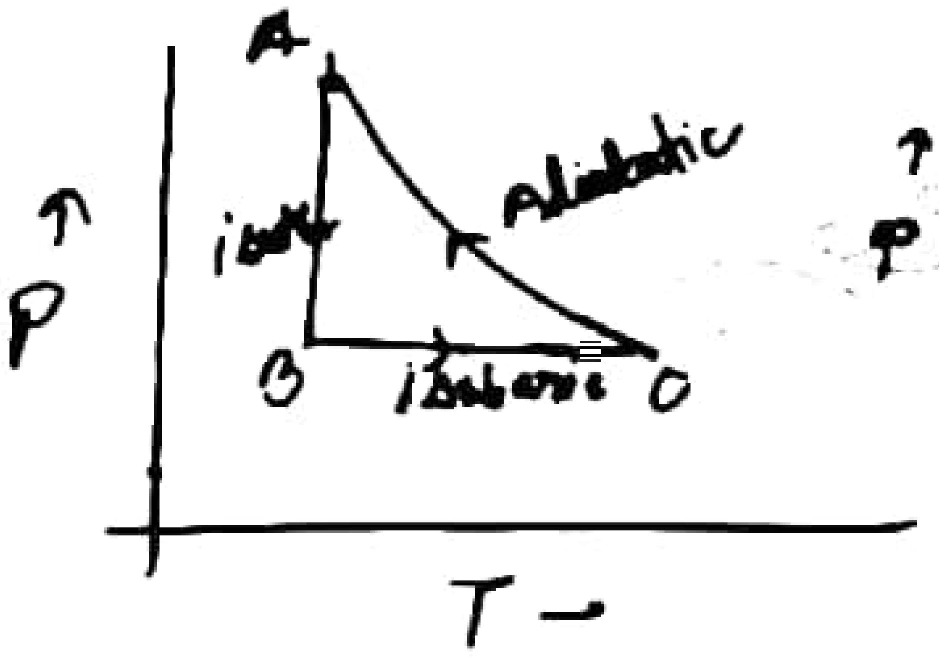
$P(\uparrow)$ $V(\downarrow)$

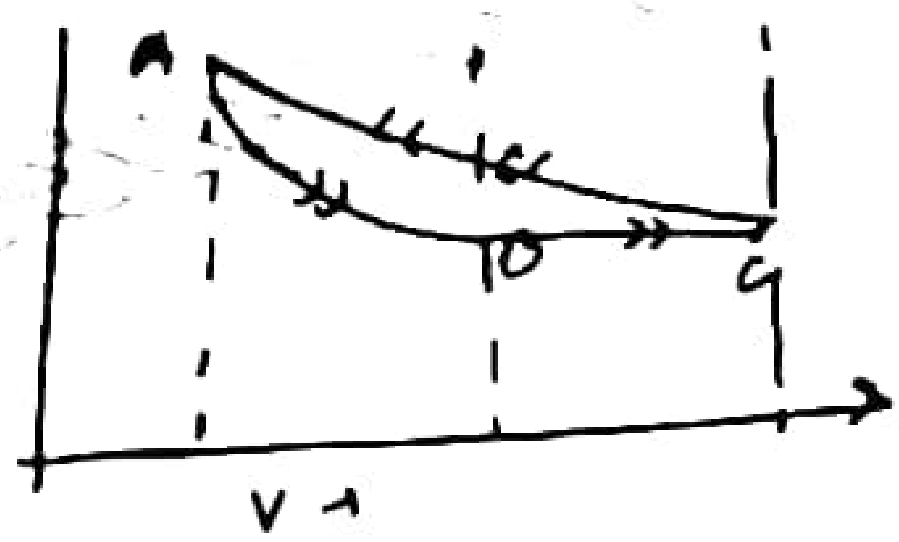
(A) 

(B)  X

(C)  X

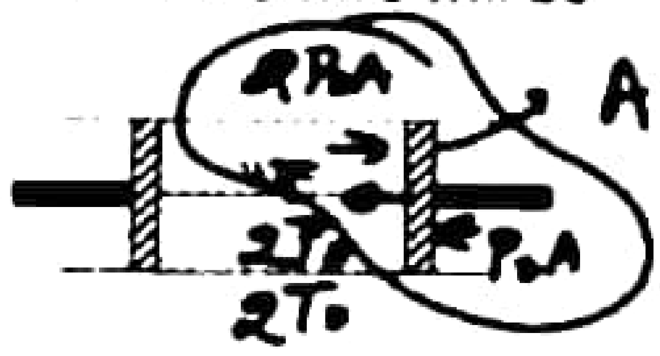
(D) none is correct





30.

A cylindrical tube of uniform cross-sectional area A is fitted with two air tight frictionless pistons. The pistons are connected to each other by a metallic wire. Initially the pressure of the gas is P_0 and temperature is T_0. Atmospheric pressure is also P_0. Now the temperature of the gas is increased to $2T_0$, the tension in the wire will be –



(A) $2P_0A$ (B) P_0A (C) $\frac{P_0A}{2}$ (D) $4P_0A$

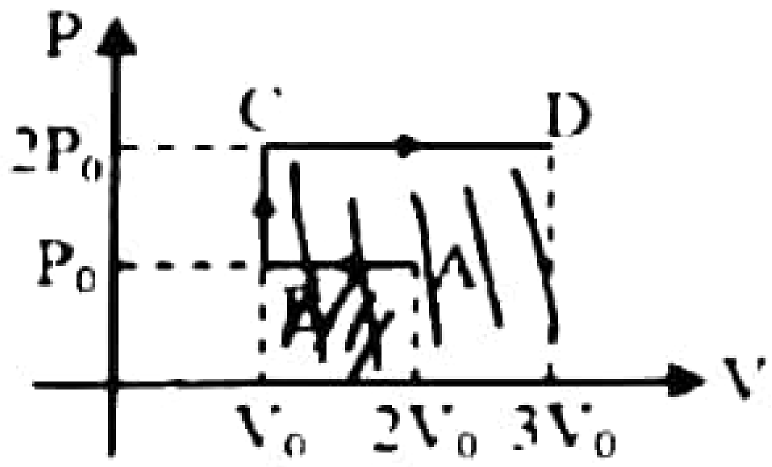
Sol^n

$P_0A + T = 2P_0A$

$\boxed{T = P_0A}$

31.

P V diagram of an ideal gas is shown in figure. Work done by the gas in the process ABCD is –



(A) $4P_0V_0$ (B) $2P_0V_0$ (C) $3P_0V_0$ (D) P_0V_0

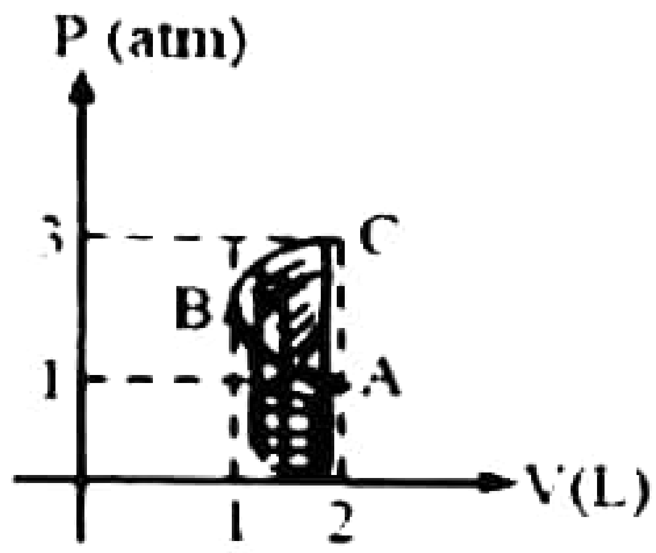
$W_{AB} = -P_0V_0$ $W_T = 3P_0V_0$

$W_{BC} = 0$

$W_{CD} = +4P_0V_0$

32.

In the P V diagram shown in figure ABC is a semicircle. The work done in the process ABC is -



(A) zero (B) $\frac{\pi}{2}$ atm-L (C) $-\frac{\pi}{2}$ atm-L (D)4 atm-L

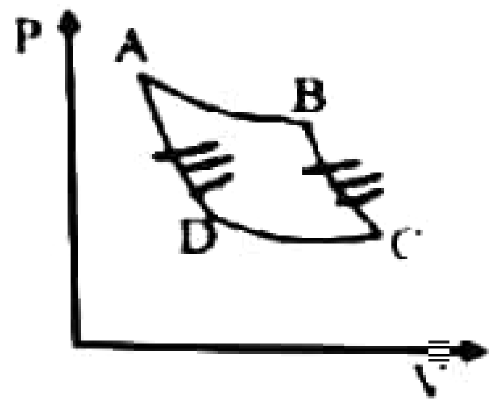
$W_{ABC} = +$ area of semicircle

$= \frac{\pi}{2} r_1 r_2 = \frac{\pi}{2} \times 1 \times 1$ atm $\times$ L

$= \frac{\pi}{2}$ atm - L

33.

The pressure volume graph of an ideal gas cycle is shown in the fig. The adiabatic process is described by



(A) AB and BC (B) AB and CD

(C*) AD and BC (D) BC and CD

34.

A carnot engine works between ice point and steam point. It is desired to increase efficiency by 20%, by changing temperature of sink to –

(A*) 253 K (B) 293 K (C) 303 K (D) 243 K

$$\eta = 1 - \frac{273}{373} = \frac{100}{373} \quad \text{—(1)}$$

$$\eta\left(1 + \frac{\cancel{20}}{\cancel{100}}\right) = 1 - \frac{(273 + \Delta T)}{373}$$

$$\eta \times \frac{6}{5} = \frac{100 - \Delta T}{373} \quad \text{—(2)}$$

$$\frac{\cancel{5}}{6} = \frac{\overset{20}{\cancel{100}}}{100 - \Delta T}$$

$$100 - \Delta T = 120$$

$$\boxed{\Delta T = -20\,K}$$

$$T_{Sink} = 273 - 20 = 253\,K$$

35.

An ideal gas heat engine operates Carnot cycle between 227°C and 127°C. It absorbs 6×10^4 calories at the higher temperature. The quantity of heat converted into work is equal to-

(A) 4.8×10^4 cal (B) 3.5×10^4 cal

(C) 1.6×10^4 cal (D) 1.2×10^4 cal

$$\frac{Q_R}{Q_a} = \frac{T_{si}}{T_{so}}$$

$$\frac{Q_R}{6 \times 10^4} = \frac{400}{500}$$

$$Q_R = \frac{24 \times 10^4}{5}$$

$$Q_R = 4.8 \times 10^4 \text{ cal}$$

$$W = Q_a - Q_R$$

$$W = 6 \times 10^4 - 4.8 \times 10^4$$

$$= 1.2 \times 10^4 \text{ cal}$$

36.

A carnot engine takes operating between source and sink has efficiency 25%, when temperature of both source and sink is increased by 100°C new efficiency becomes 20% .Find temperature of source and sink-

(A) 400K ,300K (B) 500K,400K (C) 400°C, 300°C (D) none of these

$$\eta = 1 - \frac{T_{si}}{T_{so}}$$

$$\frac{1}{4} = 1 - \frac{T_{si}}{T_{so}}$$

$$\frac{T_{si}}{T_{so}} = \frac{3}{4} \quad -(1)$$

$$\frac{20}{100} = \frac{1}{5} = 1 - \frac{(T_{si}+100)}{(T_{so}+100)}$$

$$\frac{T_{si}+100}{T_{so}+100} = \frac{4}{5}$$

$$5T_{si} + 500 = 4T_{so} + 400$$

$$5 \times \frac{3}{4} \times T_{so} - 4T_{so} = -100$$

$$-\frac{T_{so}}{4} = -100$$

$$T_{so} = 400\text{K}$$

$$T_{si} = 300\text{K}$$

37.

A Carnot engine, having an efficiency of $\eta = 1/10$ as heat engine, is used as a refrigerator. If the work done on the system is 10 J, the amount of energy absorbed from the reservoir at lower temperature is

(A) 99 J (B) 90 J (C) 1 J (D) 100 J

Sol^n

$$K = \frac{1}{\eta} - 1$$

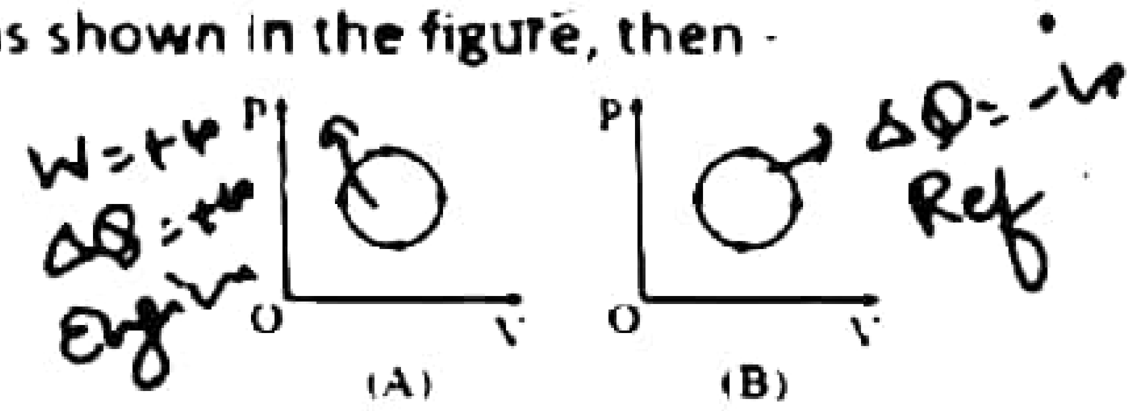
$$K = 10 - 1 = 9$$

$$K = \frac{Q_{abs}}{W}$$

$$9 = \frac{Q_a}{10} \qquad \boxed{Q_a = 90\,J}$$

38.

If the P V diagrams of two thermodynamics devices working in a cyclic process are as shown in the figure, then -



(A) (B)

(A) A is a heat engine, B is a heat pump/refrigerator

(B) B is a heat engine, A is a heat pump/refrigerator

(C) both A and B are heat engines

(D) both A and B are heat pumps/refrigerator

Engine

$Q_a > Q_R$

$\Delta Q = +ve$

Ref

$Q_a < Q_R$

$\Delta Q = -ve$

39.

Q.39 Three samples of the same gas A, B and C ($\gamma = 3/2$) have initially equal volume. Now the volume of each sample is doubled. The process is adiabatic for A isobaric for B and isothermal for C. If the final pressure are equal for all three samples, the ratio of their initial pressures are

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

$[P_1, V] \xrightarrow[A]{adiab(\gamma = 3/2)} [P, 2V]$

$P_1 V^{3/2} = P(2V)^{3/2}$

$P_1 = P \cdot 2^{3/2} = 2\sqrt{2}P$

$P_2 = P$

$(P, V) \xrightarrow[B]{isob} (P, 2V)$

$P_3 = 2P$

$\boxed{P_1 : P_2 : P_3 = 2\sqrt{2} : 1 : 2}$

$(2P, V) \xrightarrow[C]{isoth} (P, 2V)$

40.

Suppose ideal gas equation follows VP^3 = constant. Initial temperature and volume of the gas are T and V respectively. If gas expand to 27V then its temperature will become -

(A) T (B*) 9T (C) 27 T (D) T/9

$P^3 V = Const$

Initial (T, V) Final $(T', 27V)$

$\left(\frac{T}{V}\right)^3 V = Const$

$\frac{T^3}{V^2} = Const$

$T^3 \propto V^2$

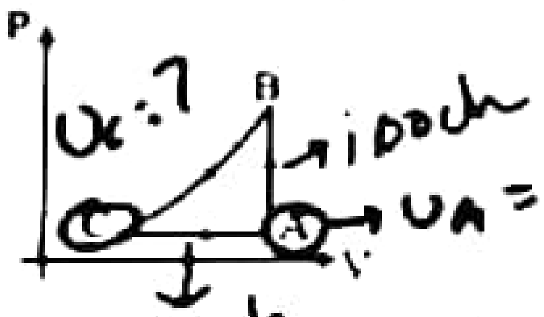
$\left(\frac{T}{T'}\right)^3 = \left(\frac{V}{27V}\right)^2$

$T' = T(27)^{2/3}$

$T' = 3^2 T = 9T$

41.

A sample of an ideal gas is taken through a cycle as shown in figure. It absorbs 50 J of energy during the process AB, no heat during BC, rejects 70 J during CA. 40 J of work is done on the gas during BC. Internal energy of gas at A is 1500 J, the internal energy at C would be :



(A) 1590 J (B) 1620 J (C) 1540 J (D) 1570 J

	W	ΔU	ΔQ
AB	0	+50J	50J
BC	−40J	+40J	0
CA	+20J	$\Delta U_{CA} = -90J$	−70J

$\Delta Q = \Delta U + W \Rightarrow 0 = \Delta U - 40$
$\Delta U_{BC} = 40J$

$\Delta U_{CA} = -90J$
$U_A - U_C = -90J$
$1500 - U_C = -90$
$\boxed{U_C = 1590J}$

42.

.2 Pressure P, volume V and temperature T of a certain material are related by $P = \frac{\alpha T^2}{V}$. Here, α is a constant. The work done by the material when temperature changes from T_0 to $2T_0$ while pressure remains constant is -

(A) $6\alpha T_0^2$ (B) $\frac{3}{2}\alpha T_0^2$ (C) $2\alpha T_0^2$ (D) $3\alpha T_0^2$

$W = P\Delta V = P(V_2 - V_1)$

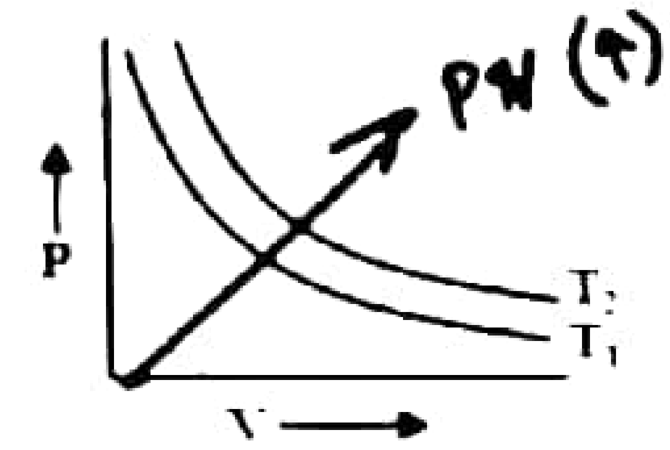
$PV = \alpha T^2$

$W = PV_2 - PV_1 = \alpha T_2^2 - \alpha T_1^2$

$W = \alpha(4T_0^2 - T_0^2) = \underline{3\alpha T_0^2}$

43.

The fig presents pressure P verses volume V graphs for a certain mass of a gas at two constant temperatures T_1 and T_2. Which of the inferences given below is correct ?



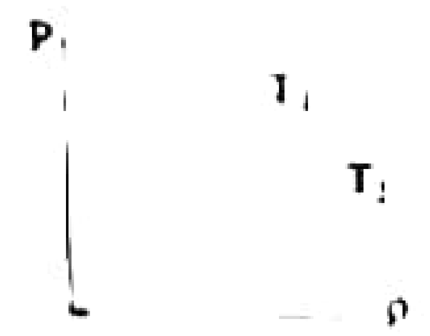
$PV (\uparrow) \propto T (\uparrow)$

$T_2 > T_1$

(A) $T_1 = T_2$ (B) $T_1 > T_2$ (C) $T_1 < T_2$ (D) None of the above.

44.

The Fig shows graphs of pressure versus density for an ideal gas at two temperatures T_1 and T_2. Then from the graph -



(A) $T_1 = T_2$ (B) $T_1 > T_2$

(C) $T_1 < T_2$ (D) nothing can be predicted

$P = \frac{\rho R T}{M}$

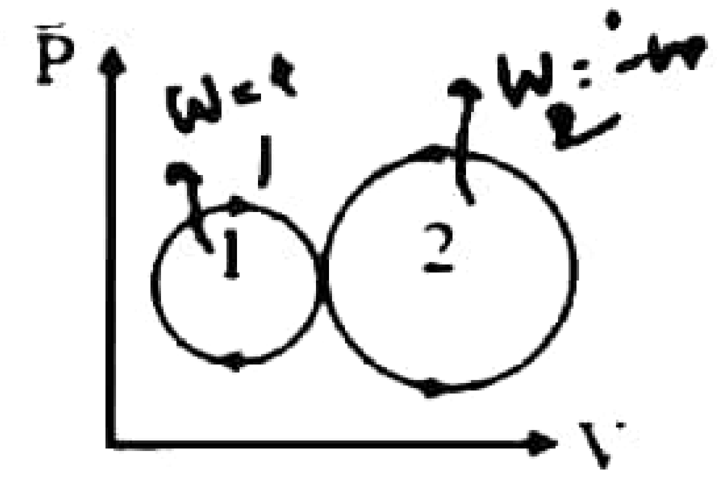
$P \propto \rho$

slope $= \frac{RT}{M}$

$T_1 > T_2$

45.

In the following indicator diagram the net amount of work done will be-

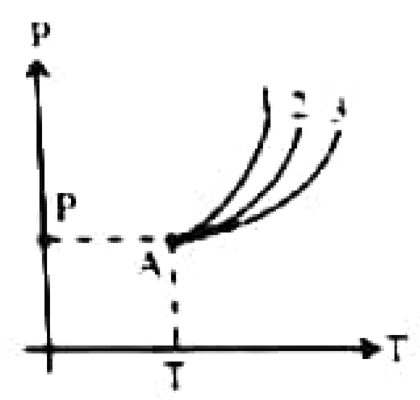


(A) positive ~~(B)~~ negative (C) zero (D) infinity

$$\boxed{W_T = -ve}$$

46.

The curves shown represent adiabatic curves for monoatomic, diatomic & polyatomic (4 3) gases. The slopes for curves 1,2,3 respectively at point A are



(A) $2.5\frac{P}{T}, 3.5\frac{P}{T}, 4.5\frac{P}{T}$ (B) $2.5\frac{P}{T}, 3\frac{P}{T}, 4\frac{P}{T}$

(C) $2.5\frac{P}{T}, 3.5\frac{P}{T}, 4\frac{P}{T}$ (D) $4\frac{P}{T}, 3.5\frac{P}{T}, 2.5\frac{P}{T}$

$\gamma_{mon} = \frac{5}{3}$, $\gamma_D = \frac{7}{5}$, $\gamma_{pol} = \frac{4}{3}$

$P^{1-\gamma}T^{\gamma} = const \Rightarrow P\,T^{\frac{\gamma}{1-\gamma}} = const$

$\frac{dP}{dT}T^{\gamma/1-\gamma} + \frac{\gamma}{1-\gamma}\cdot T^{\frac{\gamma}{1-\gamma}-1} \times P = 0$

$\frac{dP}{dT}\cancel{T^{\gamma/1-\gamma}} + \frac{\gamma}{1-\gamma} \times \cancel{T^{\gamma/1-\gamma}} \times \frac{P}{T} = 0$

$\frac{dP}{dT} = -\frac{\gamma}{1-\gamma} \times \frac{P}{T} = \frac{\gamma}{(\gamma-1)} \times \frac{P}{T}$

Mono $\frac{dP}{dT} = \frac{\frac{5}{\cancel{3}}}{\frac{2}{\cancel{3}}} \times \frac{P}{T} = 2.5\frac{P}{T}$

Diat $\frac{dP}{dT} = \frac{7}{2}\frac{P}{T} = 3.5\frac{P}{T}$

Poly $\frac{dP}{dT} = 4\frac{P}{T}$

47.

Heat is supplied to a diatomic gas at constant pressure. The ratio of ΔQ : ΔU : ΔW is –

(A) 5 : 3 : 2 (B) 5 : 2 : 3 (C*) 7 : 5 : 2 (D) 7 : 2 : 5

$$\Delta Q : \Delta U : W = nC_p\Delta T : nC_v\Delta T : nR\Delta T$$
$$= C_p : C_v : R$$
$$= \frac{7}{2}R : \frac{5}{2}R : R$$
$$= 7 : 5 : 2$$

48.

The equation of process of a diatomic gas is $P^2 = \alpha^2 V$, where α is a constant. Then choose the correct option-

(A) Work done by gas for a temperature change T is $\frac{2}{3}\alpha$ nRT ✗

(B*) The change in internal energy is $\frac{5}{2}$ nRT for a temperature change T ✓

(C) Specific heat for the process is $\frac{19}{9}$R ✗

(D) The change in internal energy for a temperature change T is $\frac{5}{2}\alpha$nRT ✗

$$P^2 = \alpha^2 V$$
$$P^2 V^{-1} = \text{Const}$$
$$P V^{-1/2} = \text{Const.}$$
$$P V^{a} = \text{Const}$$
$$a = -\frac{1}{2}$$

$$W = \frac{nR\Delta T}{1-a} = \frac{nR \times T}{\frac{3}{2}} = \frac{2}{3}nRT$$

$$\Delta U = \frac{f}{2}nR\Delta T = \frac{5}{2}nRT$$

$$C_{process} = C_v + \frac{R}{1-a} = \frac{5R}{2} + \frac{R}{1+\frac{1}{2}}$$
$$= \frac{5R}{2} + \frac{2}{3}R = \frac{19R}{6}$$

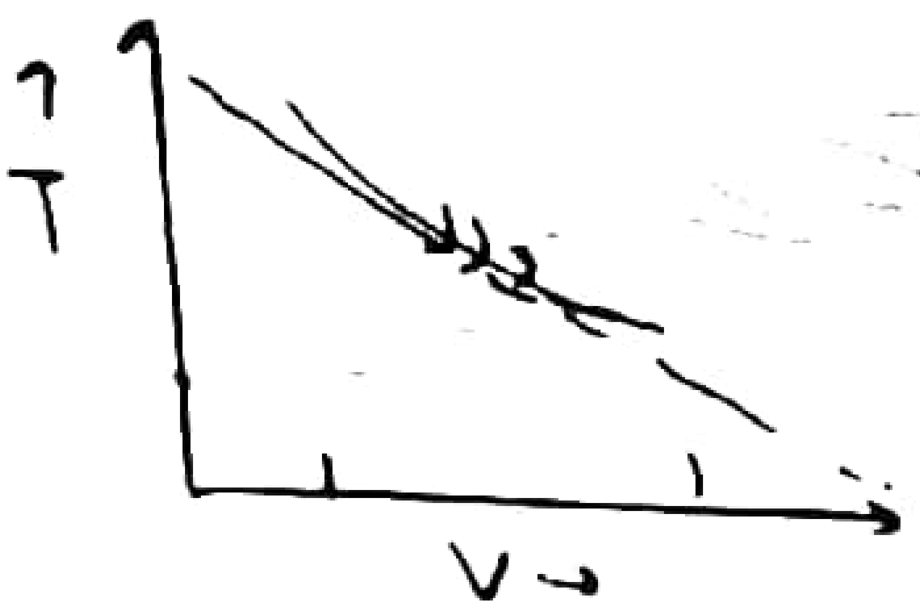
49.

Statement-1 : On a T-V graph (T on y-axis), the curve for adiabatic expansion would be a monotonically decreasing curve. Correct

Statement-2 : The slope of an adiabatic process represented on T-V graph is always -ve. Incorrect

(a) Both Statement-1 and Statement-2 are true
(b) Both Statement-1 and Statement-2 are false
(c) Statement-1 is true but Statement-2 is false.
(d) Statement-1 is false but Statement-2 is true.

$TV^{\gamma-1} = const$



50.

Match the column

	Column I		Column II
(A)	Adiabatic expansion → S	(P)	No work done
(B)	Isobaric expansion → R	(Q)	Constant internal energy
(C)	Isothermal expansion → Q	(R)	Increase in internal energy
(D)	Isochoric process → P	(S)	Decrease in internal energy

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

A) $\Delta Q = 0$
$\Delta U = -W$
$W = +w$
$\Delta U = -w$

B) $W = +w$
$\Delta U = +w$

C) $\Delta U = 0$
$U = const$