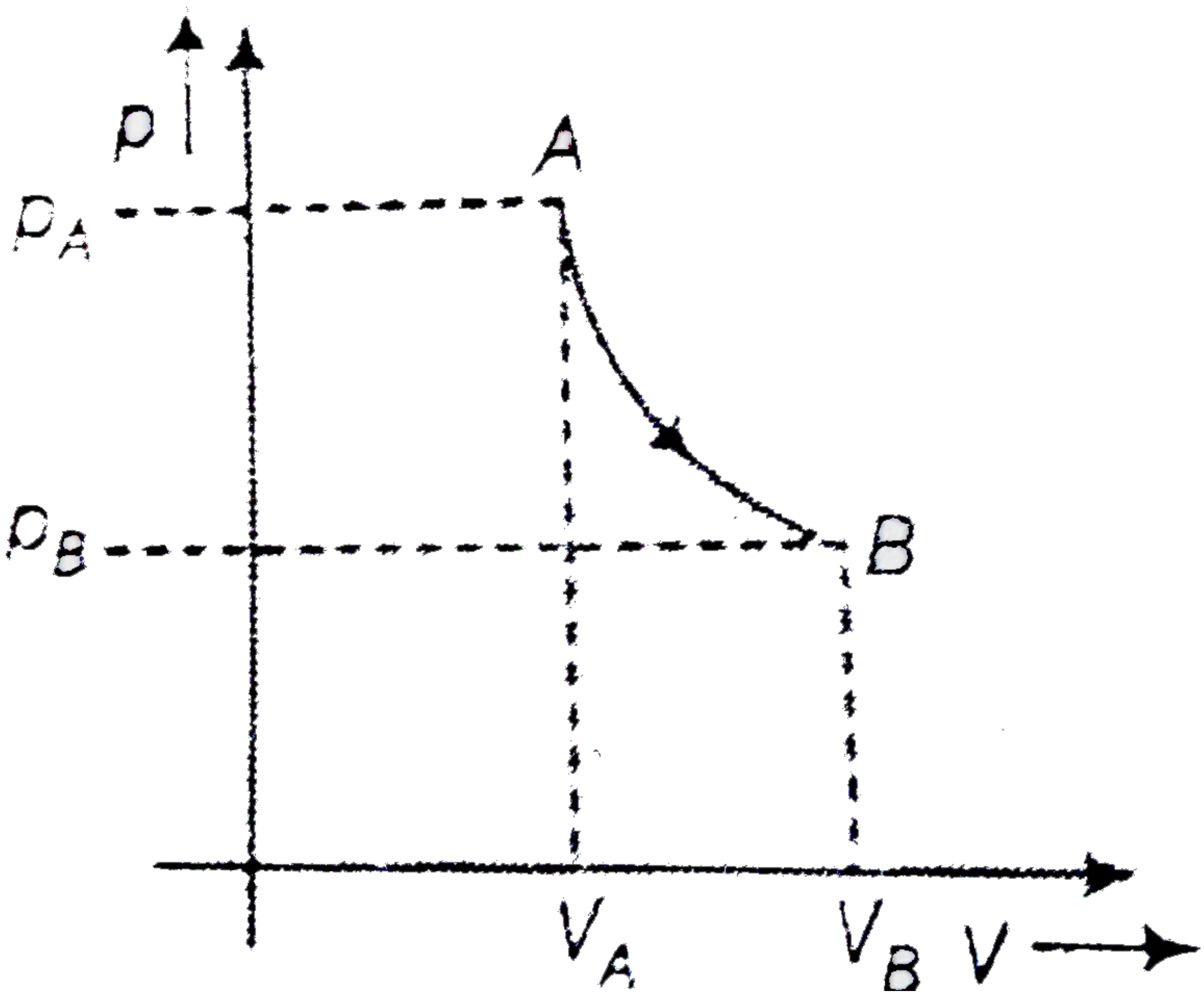
Q-1 - 18254204

Calculates the work done (W_{AB}) by the gas, if 5 moles of an ideal gas is carried by a quasi state isothermal process at 500K to twice its volume.



(A) 1500J

(B) 14407J

(C) 13380J

(D) 14890J

CORRECT ANSWER: B

Q-2 - 14927810

A closed gas cylinder is divided into two parts by a piston held tight. The pressure and volume of gas in two parts respectively are (P, 5V) and (10P, V). If now the piston is left free and the system undergoes isothermal process, then the volumes of the gas in two parts respectively are

(A) 2V,4V

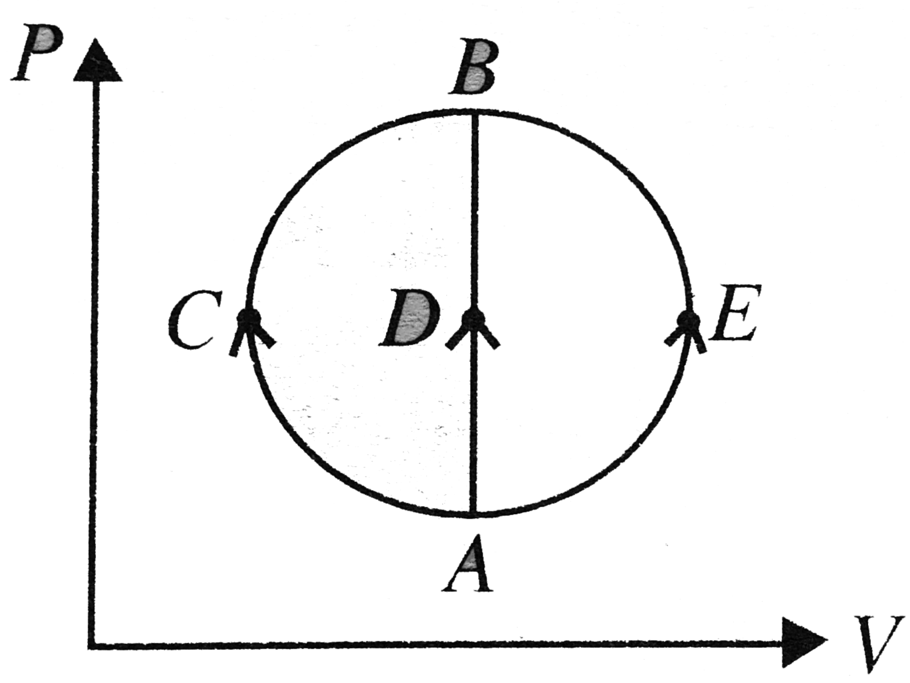
(B) 3V,3V

(C) 5v,V

(D) $\frac{10}{11}V\frac{20}{11}V$

Q-3 - 11446355

One mole of an ideal gas is taken from state A to state B by three different processes (a) ACB, (b) ADB and (c) AEB as shown in the $P-V$ diagram. The heat absorbed by the gas is



(A) greater in process (b) than in (a)

(B) the least in process (b)

(C) the same in (a) and (c)

(D) less in (c) than in (b)

CORRECT ANSWER: D

SOLUTION:

d. Heat absorbed by gas in three process is given by

$$Q_{ACB} = \Delta U + W_{ACB}$$

$$Q_{ADB} = \Delta U$$

$$Q_{AEB} = \Delta U + W_{AEB}$$

The change in internal erergy in all the three caese in same and W_{ACB} is positive, W_{AEB} is negative

Hence

$$Q_{ACB} > Q_{ABD}$$
$$> Q_{AEB}$$

Q-4 - 18254228

In a process PT=constant, if molar heat capacity of a gas is C=37.35 J/mol-K, then find the number of degrees of freedom of molecules in the gas.

(A) n=10

(B) n=5

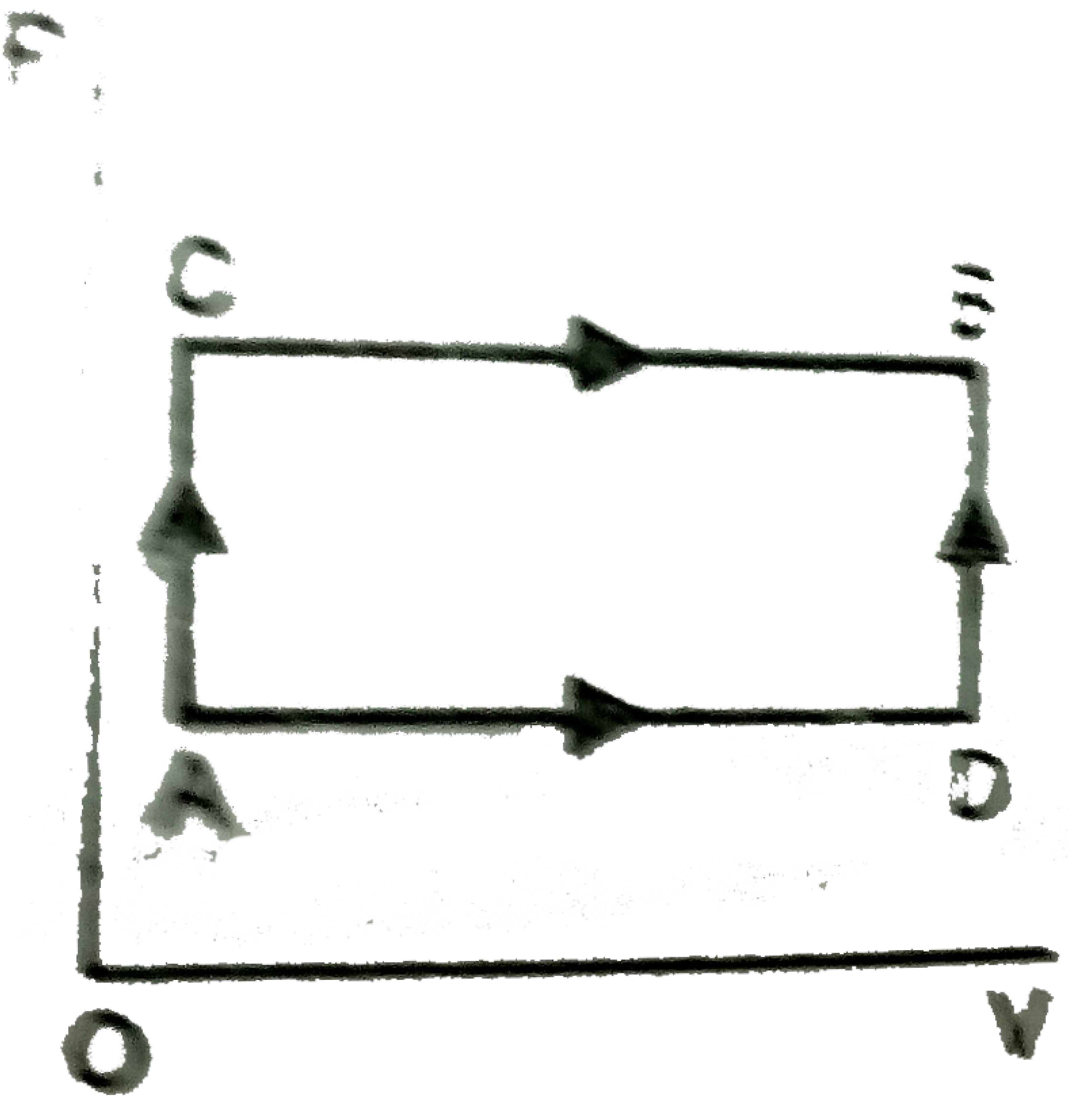
(C) n=6

(D) n=7

Q-5 - 14162684

In given figure, when a thermodynamic system is taken from state

A to state B via path ACB, 100 cal of heat given to the system and $60 cal$ work is done by the gas. Along the path ADB, the work done by the gas is $20 cal$. Find the heat flowing into the system in this case?



CORRECT ANSWER: $60 CAL$

SOLUTION:

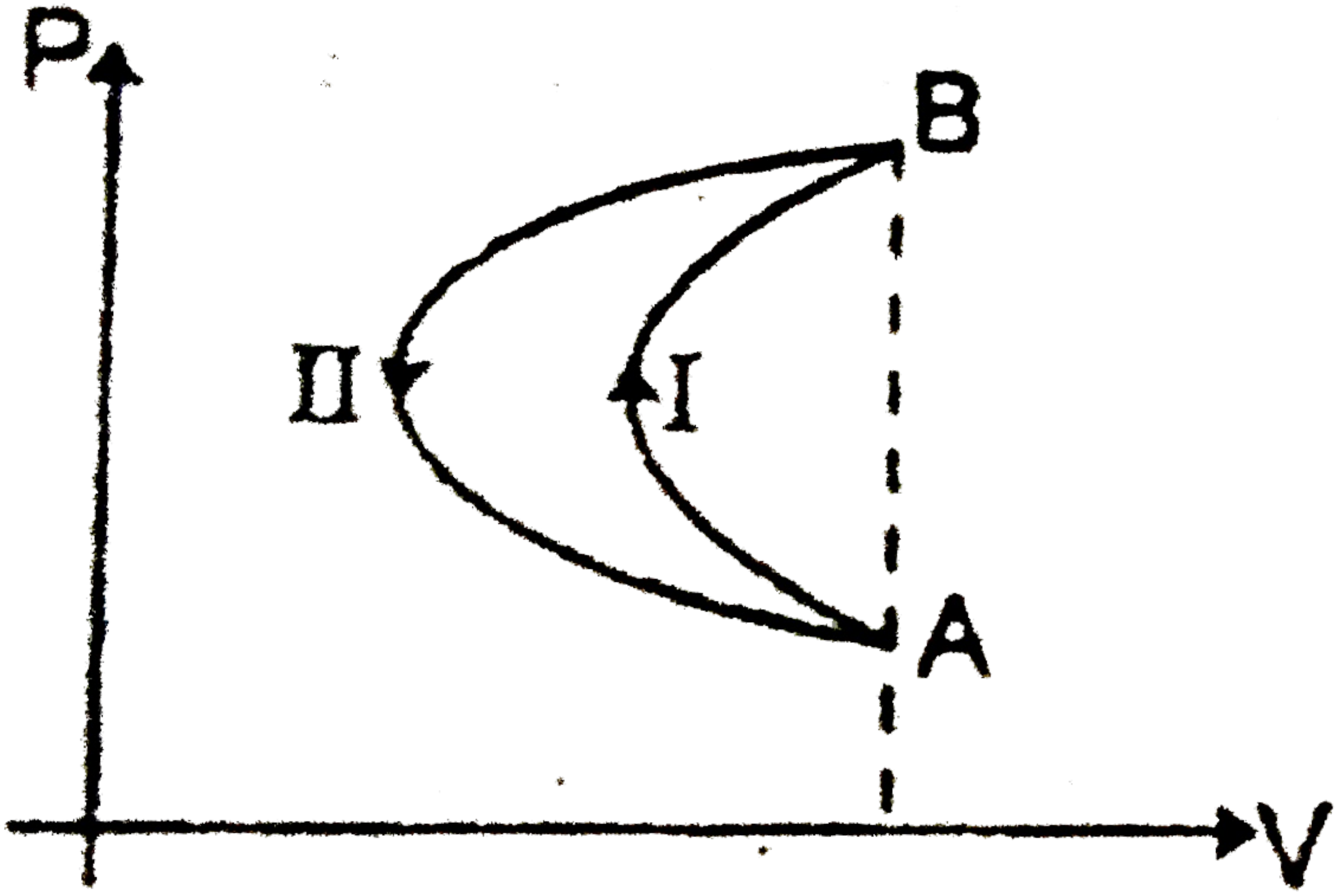
$$dQ = dU + dW$$
$$dU_1 = dQ_1 - dW_1$$
$$= 100 - 60 = 40 cal$$

$$dU_2 = dQ_2 - dW_2$$
$$= dQ_2 - 20 cal$$

$$dU_1 = dU_2$$
$$40 = dQ_2 - 20, dQ_2$$
$$= 60 cal$$

Q-6 - 14527707

In a cyclic process, a gas is taken from state A and B via path -I as shown in the indicator diagram and taken back to state A from state B via path-II. In the complete cycle



(A) work is done by the gas

(B) heat is rejected by the gas

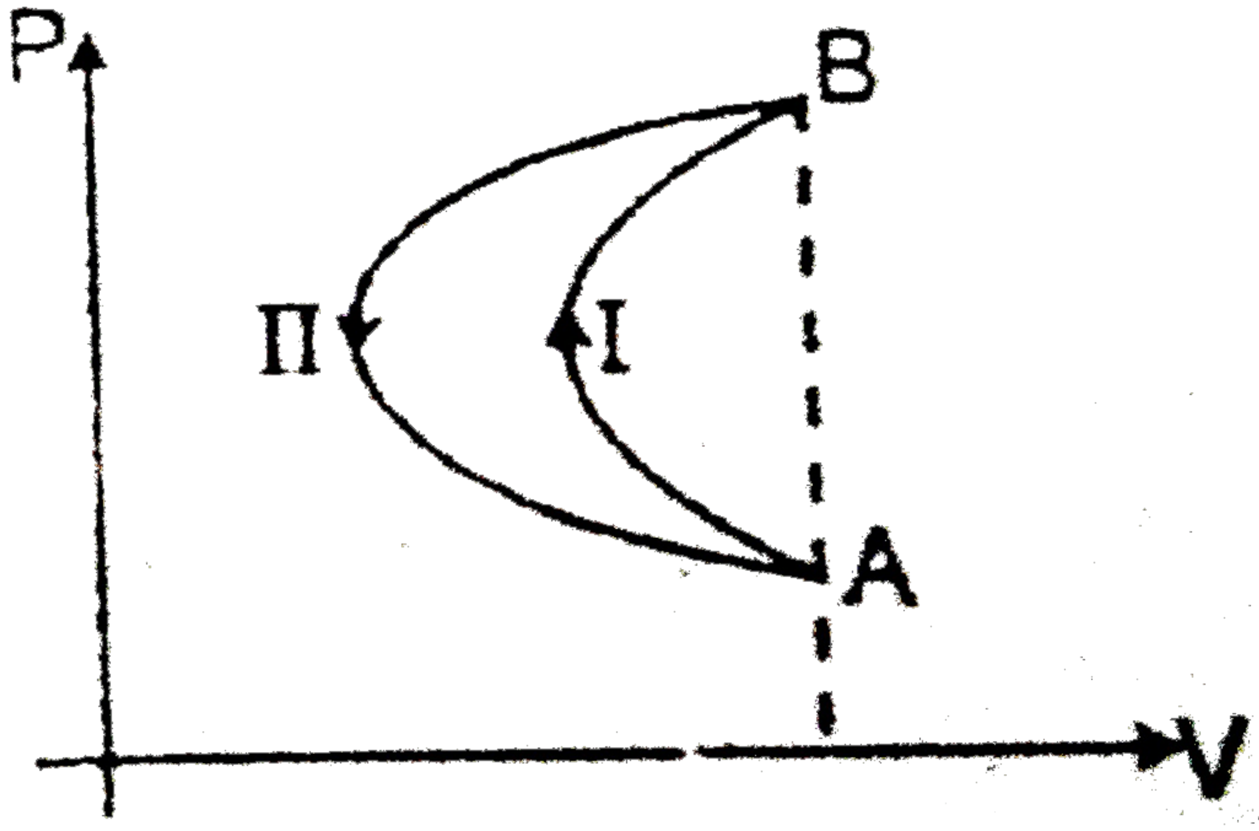
(C) no work is done by the gas.

(D) nothing can be said about work as data is insufficient

CORRECT ANSWER: B

SOLUTION:

As work done in state (II) is more than in state (I)



Q-7 - 13151941

An ideal gas is taken form the state $A(P, V)$ to the state $B\left(\frac{P}{2}, 2V\right)$ along a straight line path in the $P-V$ diagram.

Select the correct options

(i) The work done by the gas in the process A to B exceeds the work that would be done by it if the system were taken from A to B along the isotherm

(ii) In the $T-V$ diagram, the path AB becomes part of a hyperbola

(iii) In the $P - T$ diagram, the path AB becomes part of a hyperbola

(iv) In going from A to B, the temperature T of the first increases to maximum value and then decreases

(A) (i),(iii)

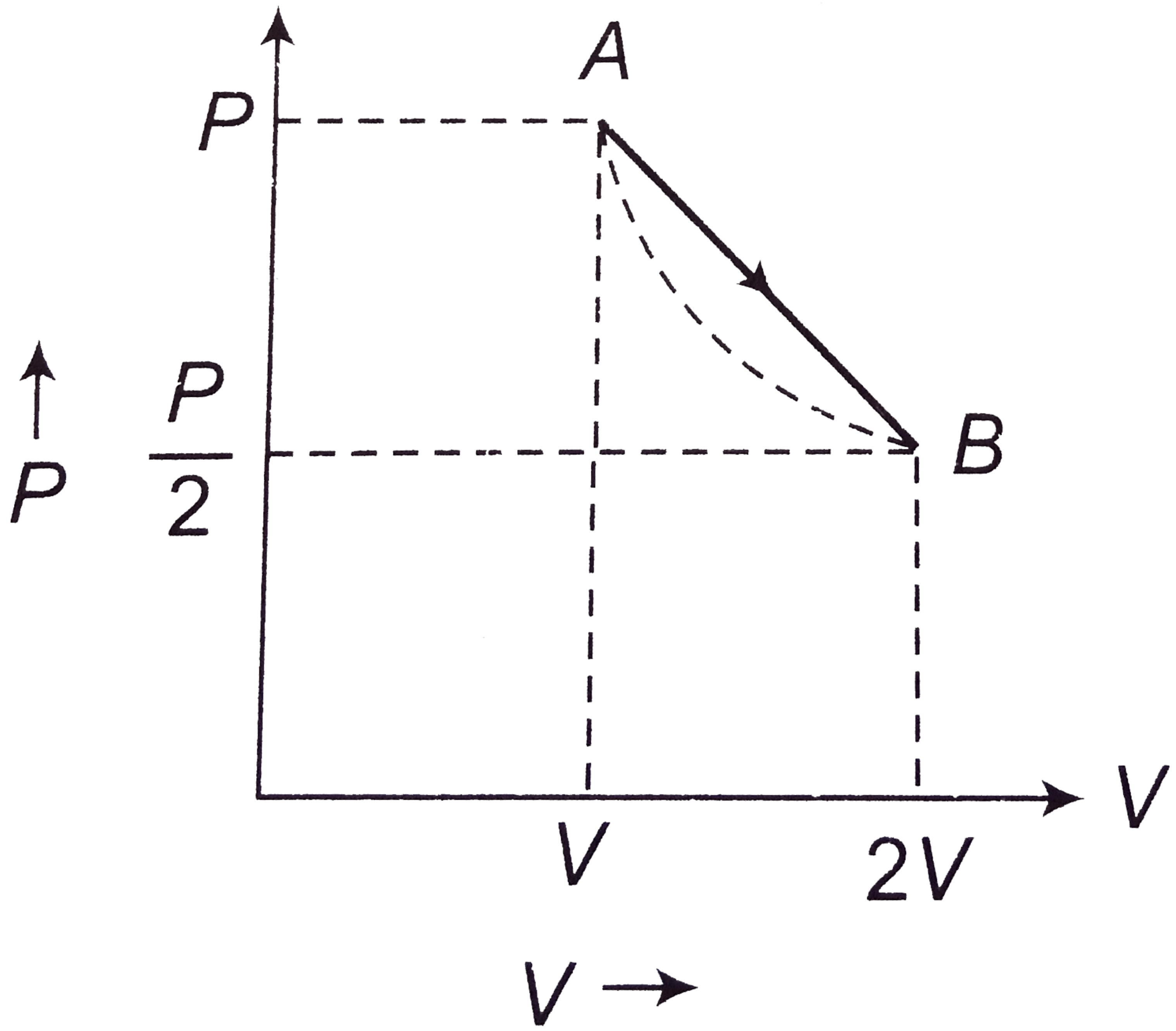
(B) (ii),(iii)

(C) (iii),(iv)

(D) (i),(ii),(iv)

CORRECT ANSWER: D

SOLUTION:



(i) The area below the process along $A \rightarrow B$ exeefs the

isotherm between A and B.

(ii) The equation of straight line AB is

$$P = -\frac{a}{nR}V^2$$

$$+\frac{b}{nR}V$$

T v/s V graph is parabola

(ii) is O.K.

(iii) $P = -aV + b$

$$P = -a\frac{nRT}{P} + b$$

$$P^2 = -anRT + bP$$

$$T = \frac{P^2}{anR} + bP$$

T v/s P graph is parabola (iii) is wrong.

(iv)

$$T = -\frac{a}{nR}V^2$$

$$+\frac{b}{nR}V$$

for T to be maximum

$$\frac{dT}{dV} = -\frac{a}{nR}.2V$$

$$+\frac{b}{nR} = 0$$

$$V = \frac{b}{2a}$$

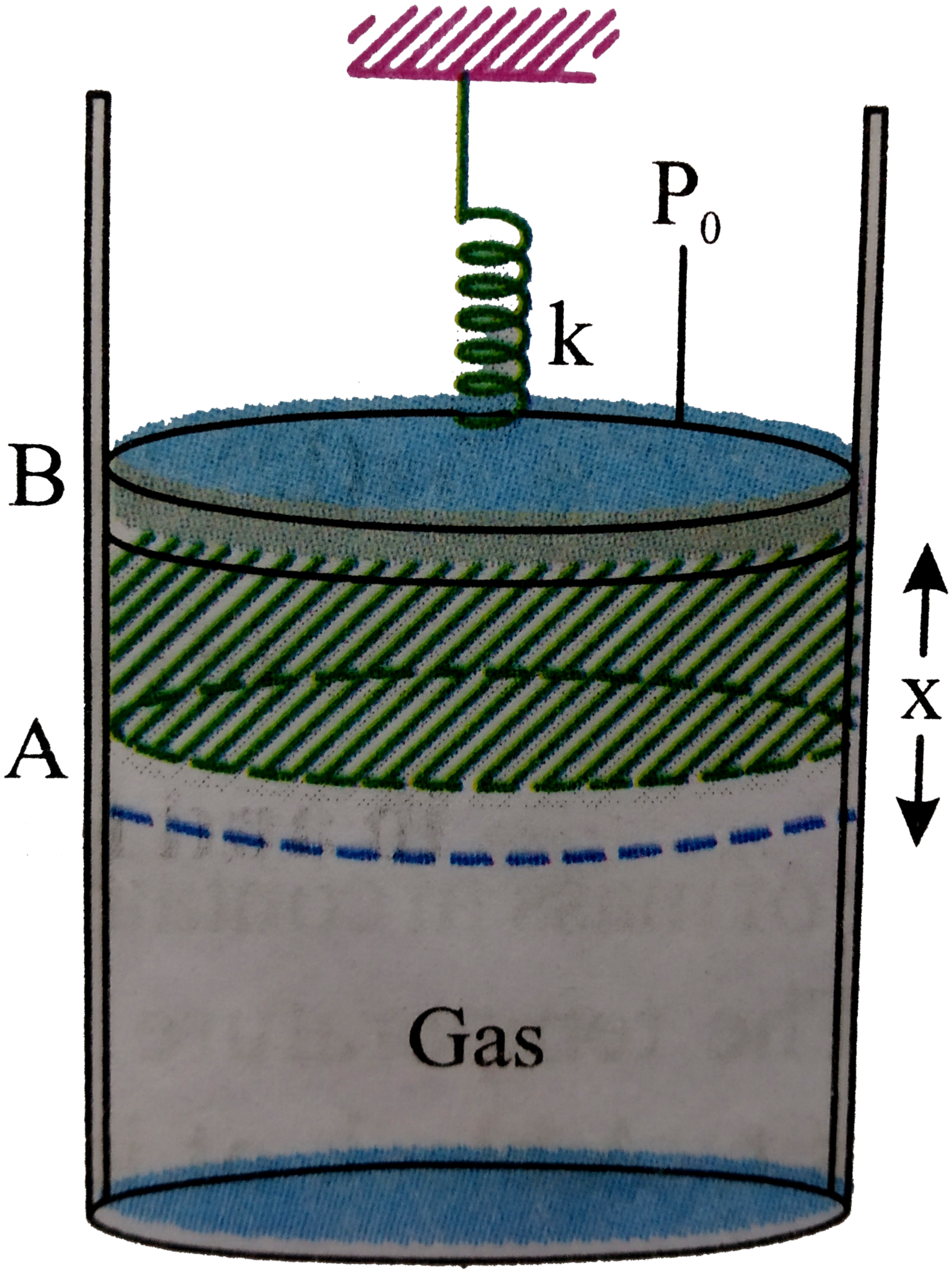
$$T_{\max} = -\frac{a}{nR}\left(\frac{b}{2a}\right)^2 + \frac{b}{nR} \cdot \frac{b}{2a}$$

$$= \frac{b^2}{4nRa}$$

(iv) is O.K.

Q-8 - 13078341

Two mole of an ideal monatomic gas are confined within a cylinder by a mass less spring loaded with a frictionless piston of negligible mass and crossectional area $4 \times 10^{-3} m^2$. The gas is heated by a heater for some time. During this time the gas expands and does $50J$ of work in moving the piston through a distance of 0.01m. The temperature of gas increases by 50k.



Change in internal energy of the gas is

(A) $1246.5J$

(B) $124.65J$

(C) $200J$

(D) $12.46J$

CORRECT ANSWER: A

SOLUTION:

When the gas is heated it expands $\&$ pushes the piston by x. If k is force constanat of spring and A is area of crossection of the piston. It P_0 is atmospheric pressure then at equilibrium of piston the pressure of the gas on the piston

$$P = P_0 + \frac{kx}{A}$$

The increas in the volume of the gas by samll movement of x of piston is

$$dv = Adx$$

$$W = \int_0^X Pdv$$

$$= P_0 Ax + \frac{1}{2}kx^2$$

Putting

$$A = 4 \times 10^{-3} m^2, x = 0.1m, W = 50J$$

.

$$P_0 = 1.013 \times 10^5 Nm^{-2}$$

in above equation

$$\therefore k = 1896 Nm^{-1}$$

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Q-9 - 9098426

Show a vertical cylindrical vesse seperated in two parts by a frictionless piston free to move along the length of vessel. The length of the cylilender is 90 cm and the piston divides the cylinder in the ratio of 5:4. Each of the two parts of the vessel contains 0.1 mole of an ideal gas. The temoerature of the gas is 300K in each part. Calculate the mass of the piston.(figure)

SOLUTION:

$Let l_1 \text{ and } l_2$ be the upper part and the lower part of the cylinder respectively. Clearly, $l_1 = 50cm$ and $l_2 = 40cm$. Let the pressures in the upper and lower parts be p_1 and p_2 respectively. Let the area of creoss section of the cylinder be A. The temperature in both parts is $T = 300K$.

Consider the equilbrium of the piston . the forces acting on the piston are

(a) its weight mg

(b) p_1 A downward, by the upper part of the gas

and (c) p_2 A upward, by the lower part of gas .

Thus , $p_2 A = p_1 A + mg$ ....(i)

Using $pV = nRt$ for the upper and the lower parts

$p_1 l_1 A = nRT$ ...(ii)

and $p_2 l_2 A = nRT$ (iii)

Putting $p_1 A$ and $p_2 A$ from (ii)and(iii) into(i),

$$\frac{nRT}{l_2} = \frac{nRT}{l_1} + mg$$

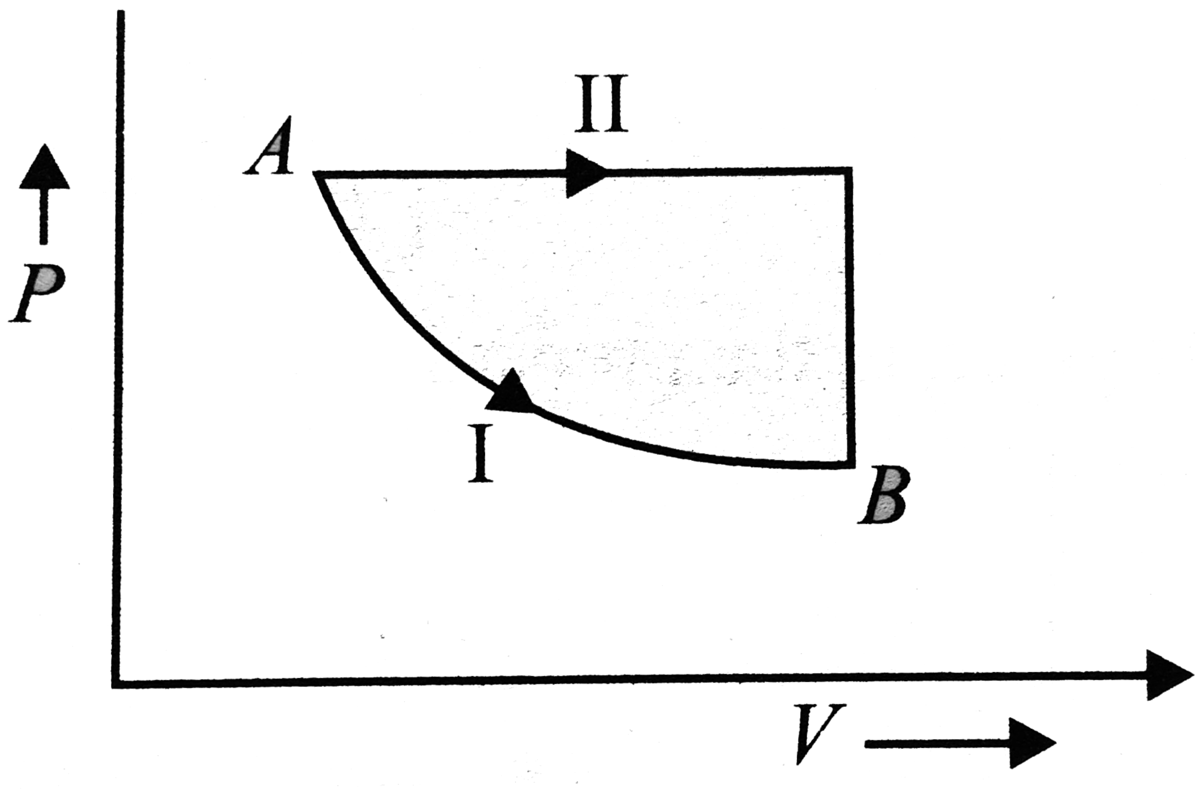
Thus, $m = \frac{nRT}{g}\left[\frac{1}{l_2} - \frac{1}{l_1}\right]$

$$= \frac{(0.1mol)\left(8.3JK^{-1}mol^{-1}\right)(300K)}{9.8ms^{-2}\left[\frac{1}{0.4m} - \frac{1}{0.5m}\right]}$$

$= 12.7kg.$

Q-10 - 11446503

A certain mass of is taken from an initial thermodynamics state A to another state B by process I and II. In process I for the gas does $5J$ of work and absorbs $4J$ of heat energy. In process II, the gas absorbs $5J$ of heat. The work done by the gas in process II is



CORRECT ANSWER: 6

SOLUTION:

For process I : $dQ = dU + dW$

$\Rightarrow 4 = dU + 5 \Rightarrow dU$

$= \; - 1$

For process II : $5 = dU + dW$

$\Rightarrow \; = \; - 1 + dW$

$\Rightarrow dW + dW$

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Q-11 - 10059190

A Carnot engine, whose efficiency is $40\ \%$, takes in heat from a source maintained at a temperature of 500K. It is desired to have an engine of efficiency $60\ \%$. Then, the intake temperature for the same exhaust (sink) temperature must be:

(A) efficiency of Carnot engine cannot be made larger than $50\ \%$

(B) $1200K$

(C) $750K$

(D) $600K$

CORRECT ANSWER: C

SOLUTION:

(c)

$$0.4 = 1 - \frac{T_2}{500} \text{ and }$$

$$0.6 = 1 - \frac{T_2}{T_1}$$

on solving we get $T_2 = 750K$

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Q-12 - 10966092

Assertion: Efficiency of a heat engine can't be greater than efficiency of Carnot engine.

Reason: Effieciency of any engine is never 100%

(A) (a) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

(B) (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(C) (c) If Assertion is true, but the Reason is false.

(D) (d) If Assertion is false but the Reason is true.

CORRECT ANSWER: D

SOLUTION:

For given temperature T_1 and T_2 efficiency of a heat engine can't be greater than efficiency of Carnot engine.

Q-13 - 16120505

In a thermodynamic process pressure of a fixed mass of a gas is changed in such a manner that the gas releases 30 joules of heat and 10 joules of work was done on the gas. If the initial internal energy of the gas was 30 joules , then the final internal energy will be

(A) 2 j

(B) -18 j

(C) $10j$

(D) $58j$

CORRECT ANSWER: C

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Q-14 - 12008878

Assuming that a domestic refrigerator can be regarded as a reversivle engine working between the temperature of melting ice and that of the atmosphere $(170C)$, calculate the energy which muct be supplied to freeze one kilogram of water already at $0C$.

CORRECT ANSWER: $2.092XX10^4J$

SOLUTION:

$$T_2 = 0C = 0 + 273$$
$$= 273K$$

$$T_1 = 17C = 17 + 273$$
$$= 290K$$

Heat required to be taken out to freeze $1kg$ of water

already at $0C$ is

$$Q_2 = mL = 1 \times 80,$$
$$000cals. = 80000$$
$$\times 4.2J$$

Cofficient of performance of refrigerator is

$$\frac{Q_2}{W} = \frac{T_2}{T_1 - T_2}$$
$$W = \frac{Q_2(T_1 - T_2)}{T_2}$$
$$= \frac{80000 \times 4.2(290 - 273)}{273}$$

$W = 2.092 \times 10^4 J$

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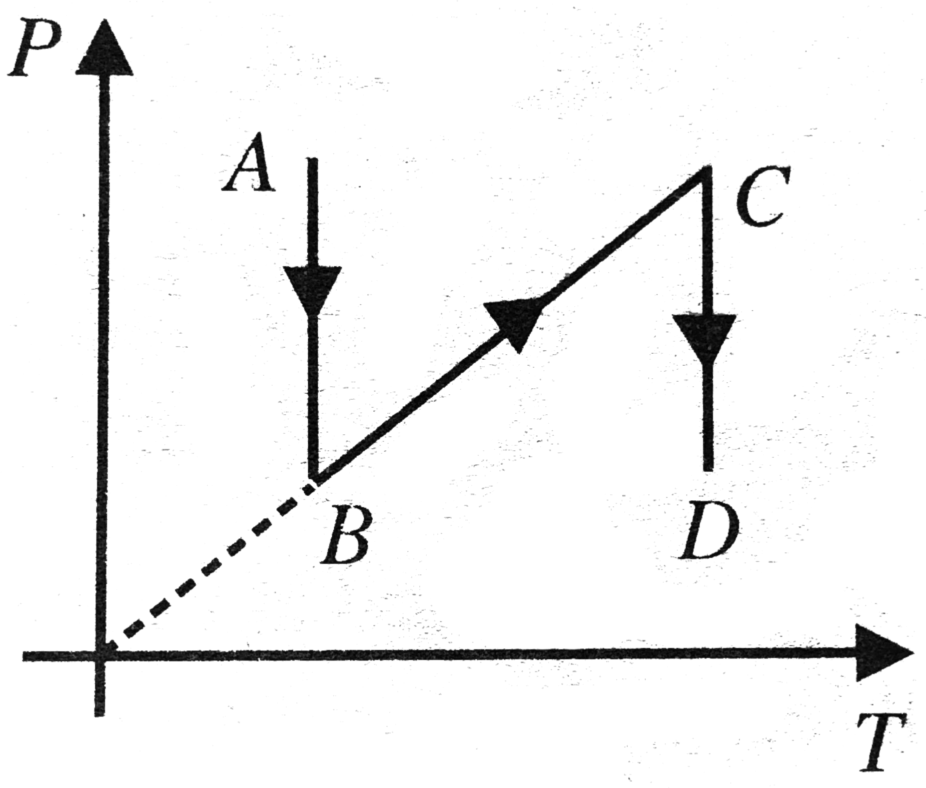
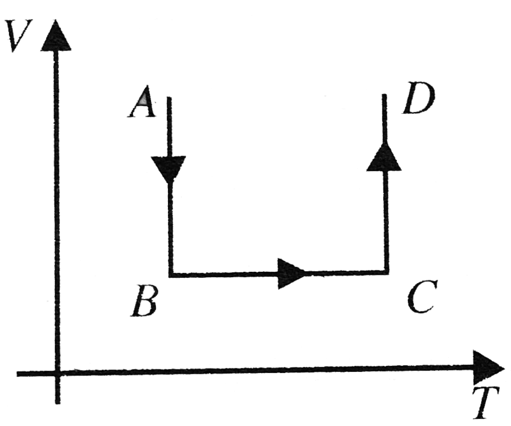
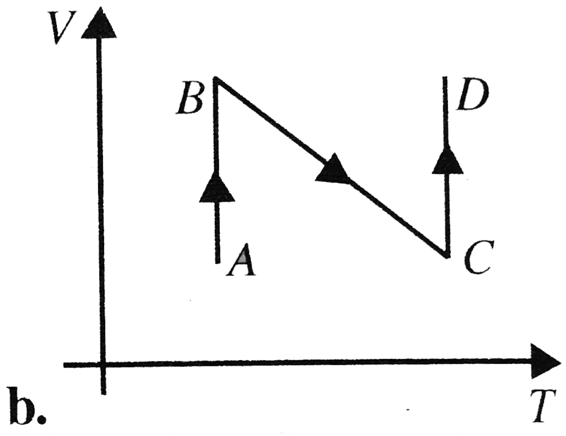
Q-15 - 11446357

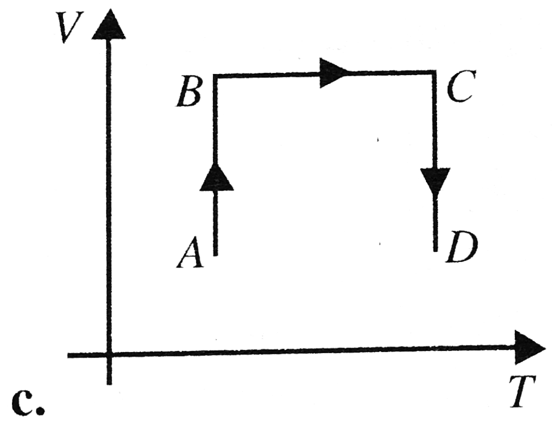
$P - T$ diagram is shown in Fig. Choose the corresponding $V - T$ diagram.

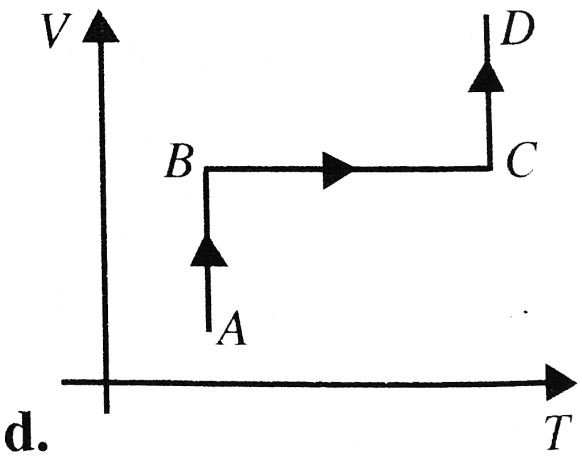


(A) a.



(B) 

(C) 

(D) 

CORRECT ANSWER: D

SOLUTION:

d. BC is isochoric :

$V_B > V_A, V_B = V_C, V_D > V_C$

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Q-16 - 10059003

A spherical black body with a radius of 12cm radiates 450W power at 500K. If the radius were halved and the temperature doubled, the power radiated in watt would be

(A) 225

(B) 450

(C) 900

(D) 1800

CORRECT ANSWER: D

SOLUTION:

(d) The energy radiated per second by a black body is given by Stefan's Law

$\frac{E}{t} = \sigma T^4 \times A,$ Where A is the surface area.

$$\frac{E}{t} = \sigma T^4$$

$$\times 4\pi r^2 \langle$$

$$'F \text{ or } asphare, A$$

$$= 4\pi r^2)$$

Case (i) :

$$\frac{E}{t} = 450, T = 500K,$$

$$r = 0.12m$$

$$\therefore 450$$

$$= 4\pi\sigma(500)^4(0.12)^2 \ldots$$

$$..(i)$$

Case (ii):

$$\frac{E}{t} = \ ?, T = 1000k, r$$

$$= 0.06m$$

$$\therefore \frac{E}{t}$$

$$= 4\pi\sigma(1000)^4(0.06)^2$$

$$\ldots\ldots (ii)$$

Dividing (ii) and (i), we get

$$\frac{E/t}{450}$$

$$= \frac{(1000)^4(0.06)^2}{(500)^4(0.12)^2}$$

$$= \frac{2^4}{2^2} = 4$$

$$\Rightarrow \frac{E}{t} = 450 \times 4$$

$$= 1800W$$

Q-17 - 12008906

The pressure of a gas is increased by 50 % at constant temperature.

The decrease in volume will be nearest to

(A) $66\ \%$

(B) $33\ \%$

(C) $17\ \%$

(D) $8\ \%$

CORRECT ANSWER: B

SOLUTION:

Let initial pressure, $P_1 = P, V_1 = V$

Final pressure, $P_2 = P + 50\ \%\ P$

$$P = \frac{3}{2}P, V_2 = \ ?$$

As temperature is constant $P_1V_1 = P_2V_2$

or

$$V_2 = \frac{P_1V_1}{P_2} = \frac{PV}{3P/2}$$

$$= \frac{2}{3}V$$

$\therefore$ Decrease in volume $= V - \frac{2}{3}V = \frac{V}{3}$

% decrease in volume $= \frac{V/3}{V} \times 100$

$= 33.3\,\% \approx 33\,\%$

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Q-18 - 11446343

Internal energy of n_1 mol of hydrogen of temperature T is equal to the internal energy of n_2 mol of helium at temperature $2T$. The ratio n_1/n_2 is

(A) $\frac{3}{5}$

(B) $\frac{2}{3}$

(C) $\frac{6}{5}$

(D) $\frac{3}{7}$

CORRECT ANSWER: C

SOLUTION:

c. Internal energy of n moles of an ideal gas at

temperature ture $T$is given by

$$U = \frac{f}{2} mRT \text{ (f = degrees of freedom)}$$

$$U_1 = U_2$$

$$f_1 n_1 T_1 = f_2 n_2 T_2$$

$$\therefore \frac{n_1}{n_2} = \frac{f_2 T_2}{f_1 T_1}$$

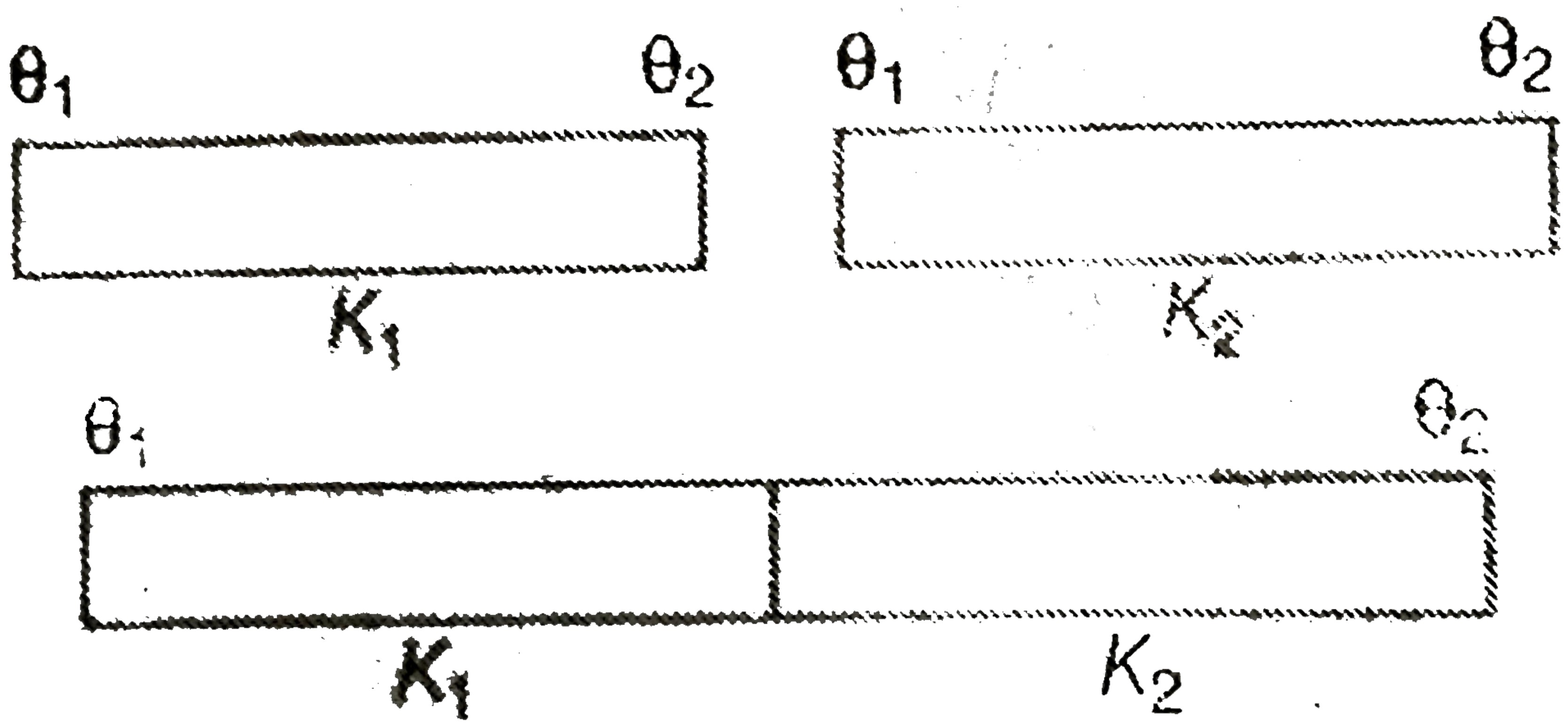
$$= \frac{3 \times 2}{5 \times 1} = \frac{6}{5}$$

Here, $f_2 =$ degrees of freedom of $He = 3$

and $f_1 =$ degrees of freedom of $H_2 = 5$

Q-19 - 17817921

Rate of heat flow through two conducting rods of identiclal dimensions having thermal conductivities K_1 and K_2 and Q_1 and Q_2 when their ends are maintained at the same difference of temperature individually. When the two rods are joined in series with their ends maintained at the same temperature difference (as shown in the figure), the rate of heat flow will be



(A) $\dfrac{Q_1 + Q_2}{2}$

(B) $\dfrac{K_1 Q_2 + K_2 Q_1}{K_1 + K_2}$

(C) $\dfrac{K_1 Q_1 + K_2 Q_2}{K_1 + K_2}$

(D) $\dfrac{Q_1 Q_2}{Q_1 + Q_2}$

CORRECT ANSWER: D

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Q-20 - 11446380

The ratio of pressure of the same gas in two containers in $\frac{n_1 T_1}{n_2 T_2}$ where n_1 & n_2 are the number of moles and T_1 & T_2 are respective temperatures. If the containers are now joined find the ratio of pressure to the pressure :

(A) $\frac{P_1 T_2 + P_2 T_1}{2 T_1 T_2}$

(B) $\frac{P_1 T_1 + P_2 T_1}{T_1 T_2}$

(C) $\frac{P_1 T_1 + P_2 T_2}{2 T_1 T_2}$

(D) none of these

CORRECT ANSWER: A

SOLUTION:

a. Given $\frac{P_1}{P_2} = \frac{n_1 T_2}{n_2 T_2}$

$P \propto nT$. It implies that volume of both containers is same. After mixing.

$$P(2V) = (n_1 + n_2)RT$$

$$= \left(\frac{P_1 V}{RT_1} + \frac{P_2 V}{RT_2}\right)RT$$

$$P/T = \frac{1}{2}\left(\frac{P_1}{T_1} + \frac{P_2}{T_2}\right)$$

$$= \frac{1}{2}\left(\frac{P_1 T_2 + P_2 T_2}{T_1 T_2}\right)$$

Q-21 - 14625015

In a thermodynamic process, pressure of a fixed mass of gas is changed in such manner that the gas releases 30 joule of heat and 18 joule of work was done on the gas. If the initial internal energy of the gas was 60 joule, then the final internal energy is $8x$ joule. find the value of x

---

CORRECT ANSWER: 6

SOLUTION:

It is given that, initial internal energy $U_i = 60J$ gas releases 30 J of heat and 18 J of work is done on the gas $\Rightarrow$ in the whole, the gas loses 12 J energy $\Rightarrow$ its internal energy will decreases by 12 J, hence final internal energy is.

$U_f = 60 - 12 \Rightarrow U_f$
$= 48J$

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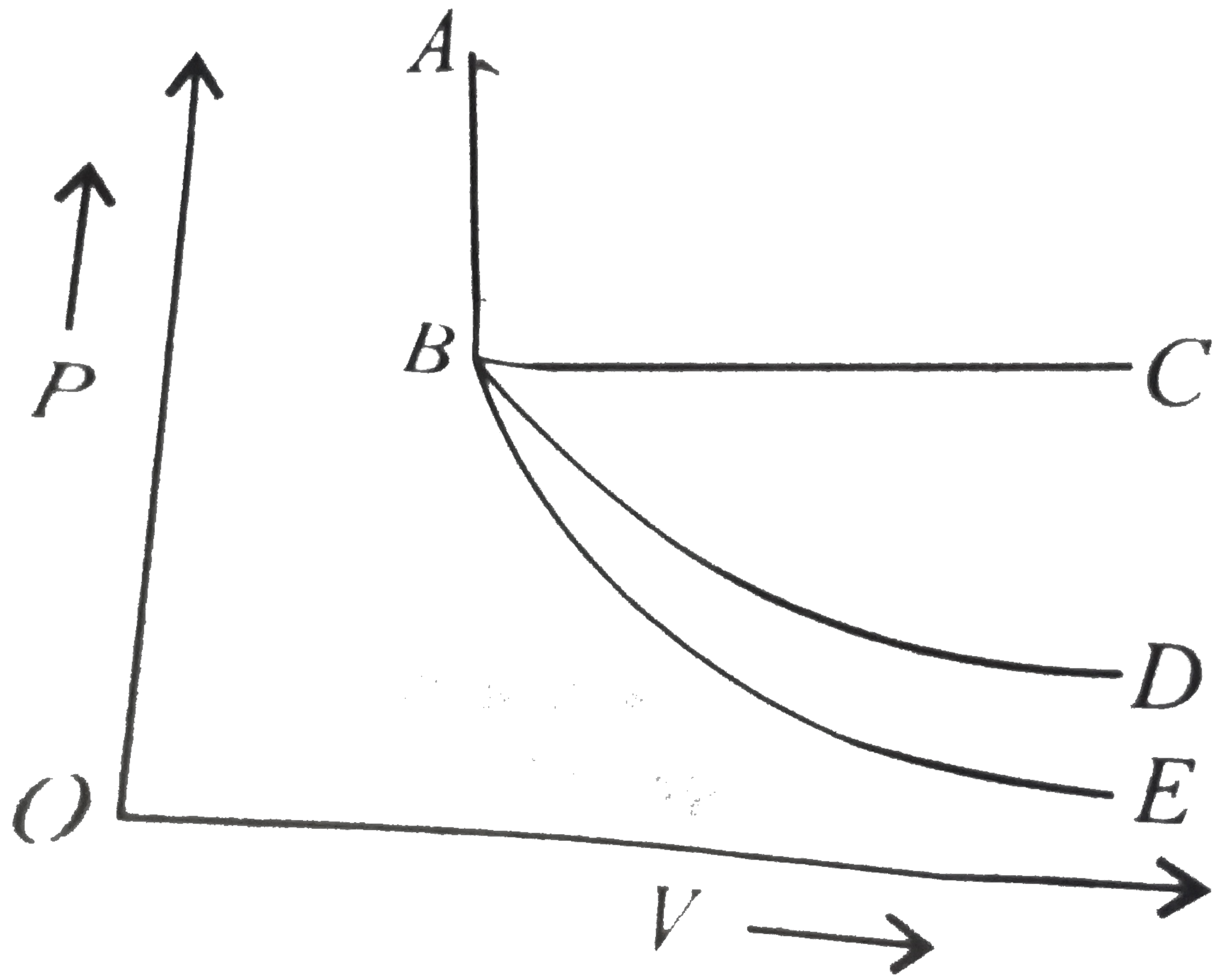
Q-22 - 11035157

In $P-V$ diagram shown below,



(A) AB represents adiabatic process.

(B) AB represents isothermal process.

(C) AB represents isobaric process.

(D) AB represents isochoric process.

SOLUTION:

In AB process, volume does not change hence it is isochoric process.

Q-23 - 13078069

A spherical black body of radius r radiated power P at temperature T when placed in surroundings at temprature $T_0(< \quad < T)$ If R is the rate of colling .

(A) $P\alpha(T - T_0)$

(B) PaT^4

(C) $P\alpha r^2$

(D) $R\alpha\frac{1}{r}$

CORRECT ANSWER: C::D

SOLUTION:

$Ra(T - T_0)$and$P = \sigma A(T^4 - T_0^4)$

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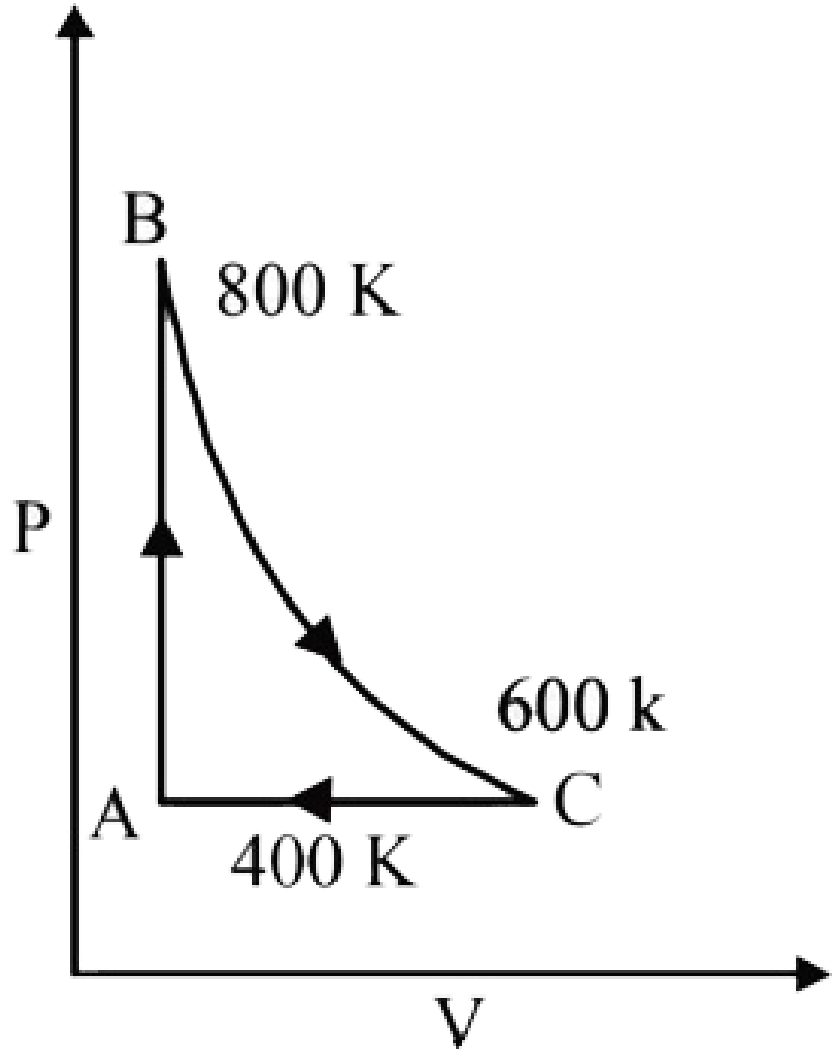
Q-24 - 10059197

One mole of a diatomic ideal gas undergoes a cyclic process ABC as shown in figure. The process BC is adiabatic. The temperature at A,B and C are 400K, 800K and 600K respectively. Choose the correct statement:



(A) The change in internal energy in whole cyclic process is 250R.

(B) The change in internal process CA is 700R.

(C) The change in internal energy in the process AB is -350R.

(D) The chang in internal energy in the process BC is -500R.

CORRECT ANSWER: D

SOLUTION:

(d) In cyclic process, change in total internal energy is zero.

$$\Delta U_{cyclic} = 0$$

$$\Delta U_{BC} = nC_v \Delta T = 1 \times \frac{5R}{2} \Delta T$$

Where, C_V =molar specific heat at constant volume.

For BC, $\Delta T = -200K$

$$\therefore \Delta U_{BC} = -500R$$

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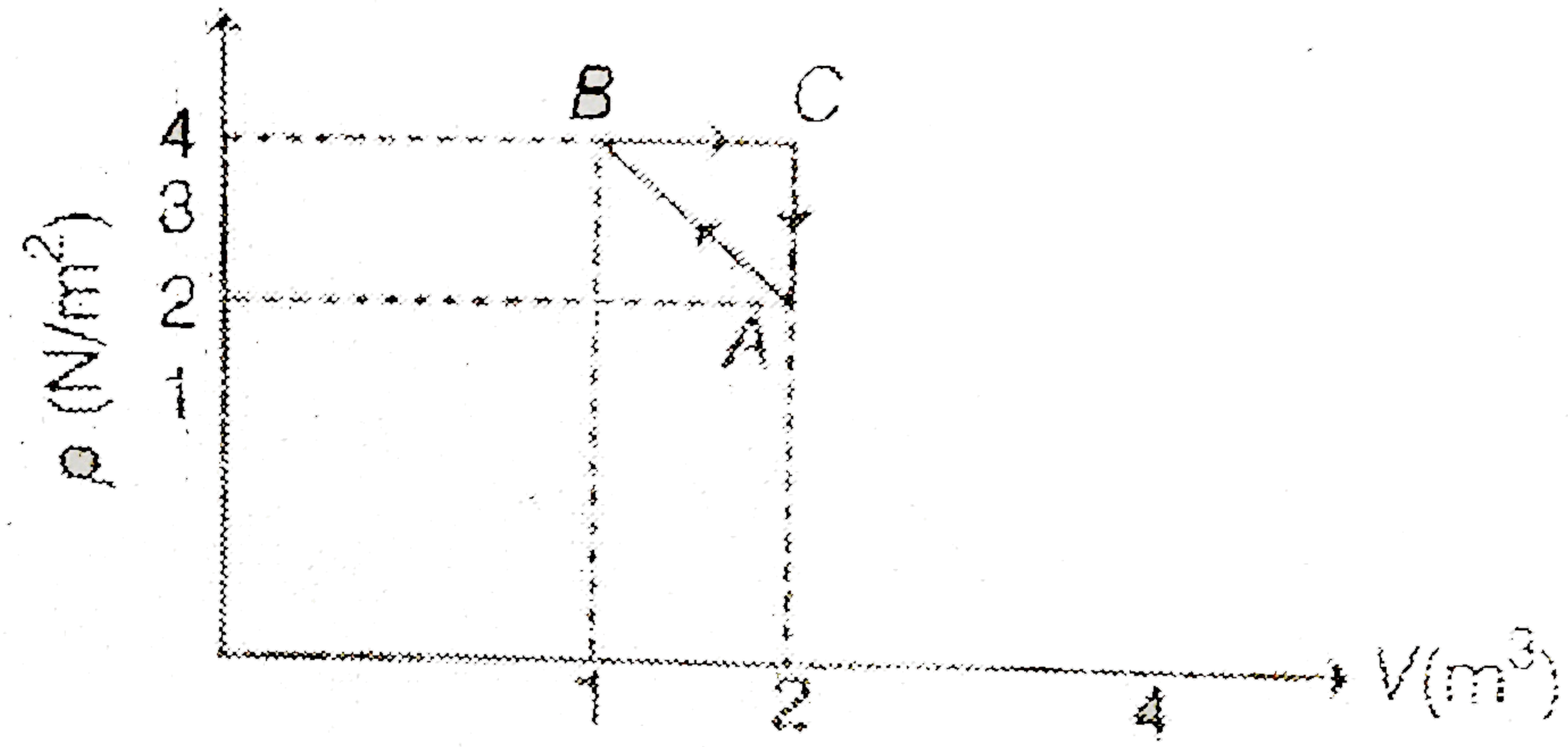
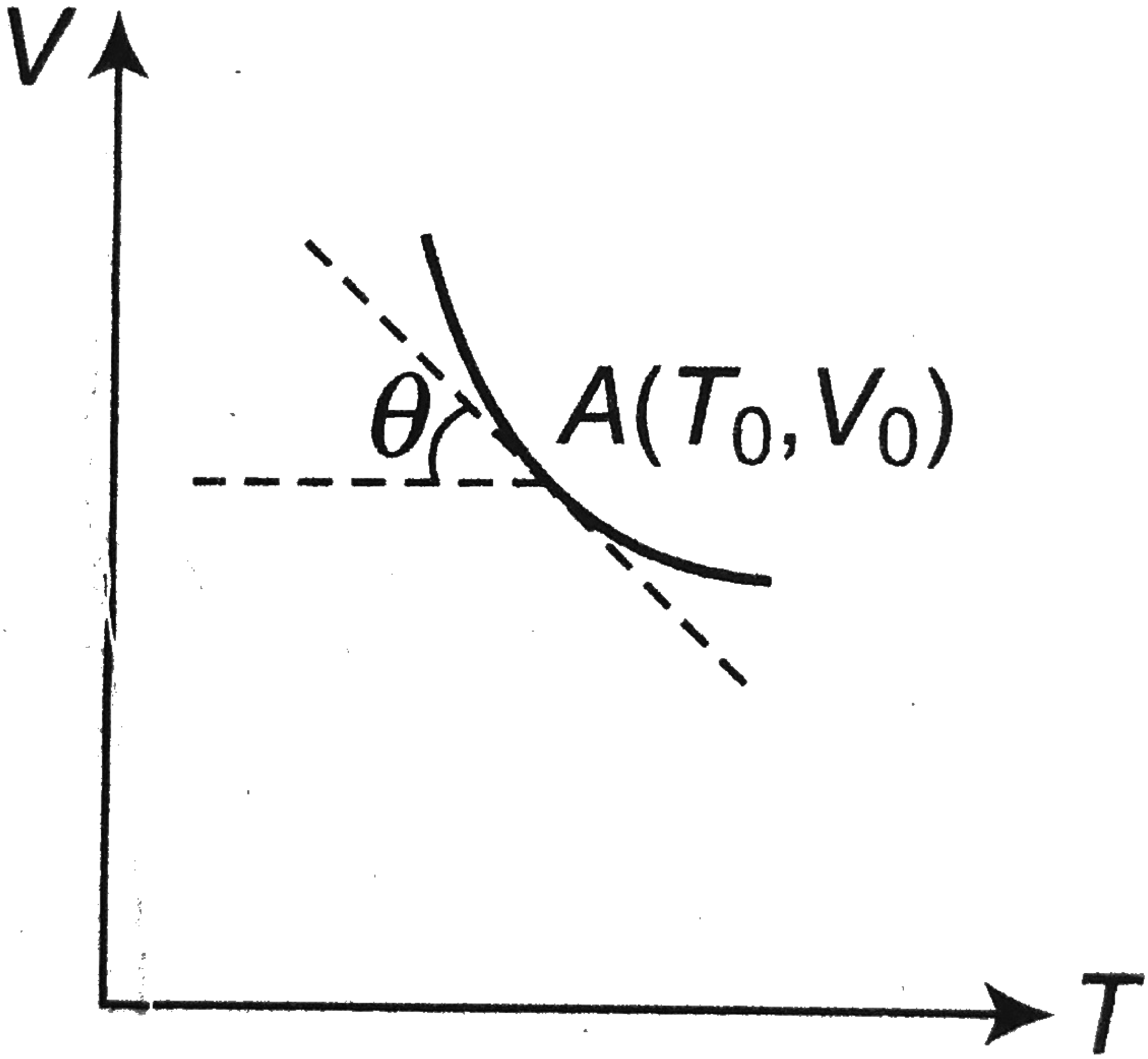
Q-25 - 17818236

Corresponding to the process shown in figure, the heat given to the gas in the process ABCA is $(0.2x)J$. Find value of x.



Q-26 - 11797036

A gas is undergoing an adiabatic process. At a certain stage A, the values of volume and temperature (V_0, T_0). From the details given in the graph, find the value of adiabatic constant γ



(A) $\dfrac{V_0}{T_0 \tan\theta} + 1$

(B) $\dfrac{V_0 \tan\theta}{T_0 + 1}$

(C) $\dfrac{V_0 \tan^2\theta}{T_0} + 1$

(D) $\dfrac{V_0}{T_0} + \tan\theta$

CORRECT ANSWER: A

SOLUTION:

We have, for an adiabatic process, in relation wiht temperature and volume

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

Differentiating with respect to T

$V^{\gamma-1}.1 + T$

$.(\gamma-1)V^{\gamma-1}$

$$= \frac{V_0}{T_0 \tan\theta}$$

$$\gamma = \frac{V_0}{T_0 \tan\theta} + 1.$$

Q-27 - 11446253

Energy of all molecules of a monatomic gas having a volume V and pressure P is $3/2PV$. The total translational kinetic energy of all molecules of a diatomic gas at the same volume and pressure is

(A) $1/2PV$

(B) $3/2PV$

(C) $5/2PV$

(D) $3PV$

CORRECT ANSWER: B

SOLUTION:

b. Energy of 1 mol of gas

$$= \frac{f}{2}RT = \frac{f}{2}PV$$

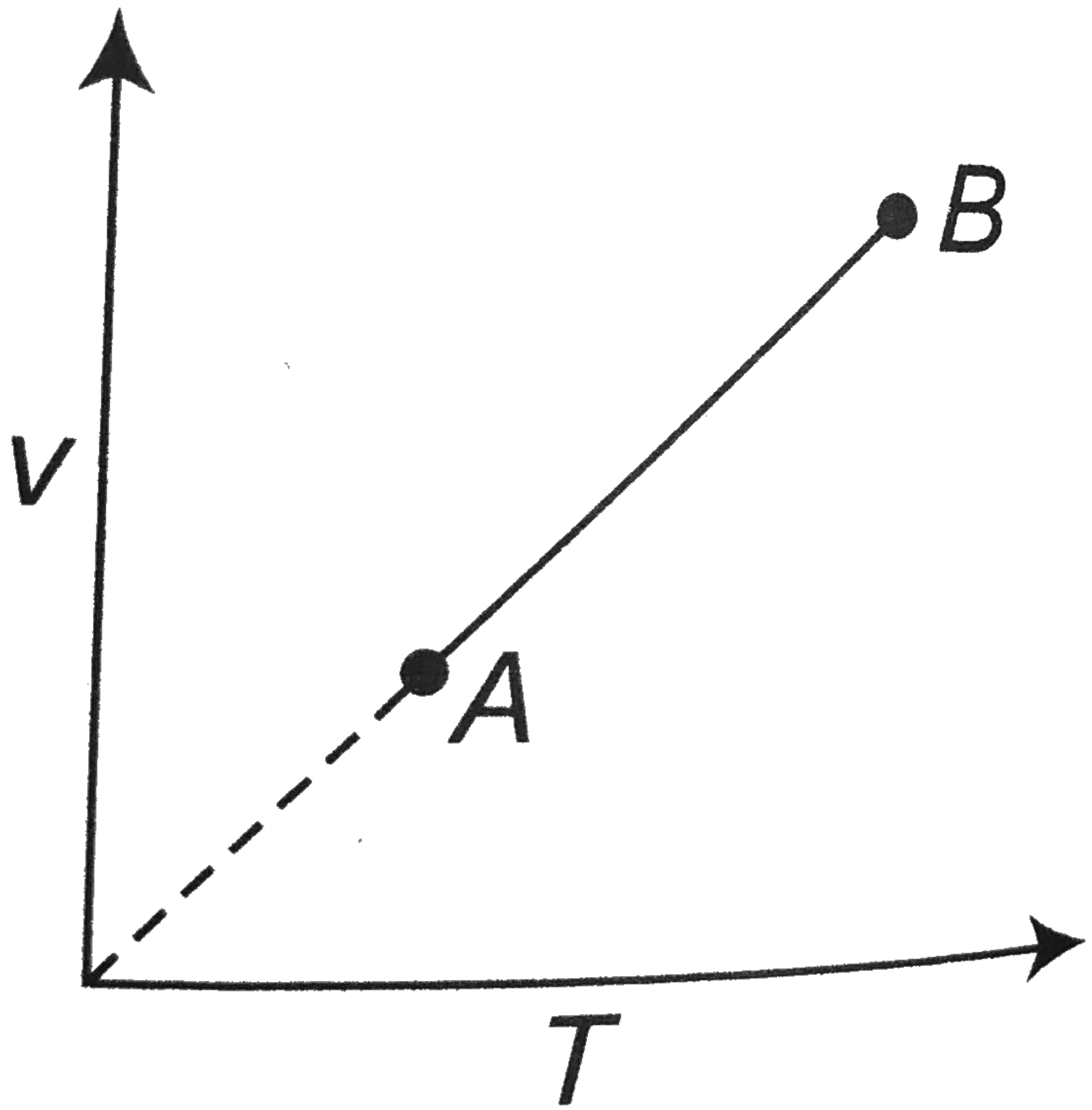
where $f =$ degree of freedom

Monatomic or diatomic gases possess equal degree of freedom for translational motion and that is equal to 3, i.e., $f = 3$

$$\therefore E = \frac{3}{2}PV$$

Q-28 - 11796917

An ideal monoatomic gas undergoes the process AB as shown in the figure. If the heat supplied and the work done in the process are ΔQ and Delta W$respectively. The ratio$DeltaQ : DeltaW` is



(A) 2.50

(B) 1.67

(C) 0.67

(D) 0.40

CORRECT ANSWER: A

SOLUTION:

(P= constant)

$$\frac{\Delta Q}{\Delta W} = \frac{nC_P \Delta T}{nR\Delta T}$$

$$= \frac{C_P}{R} = \frac{5}{2}$$

.

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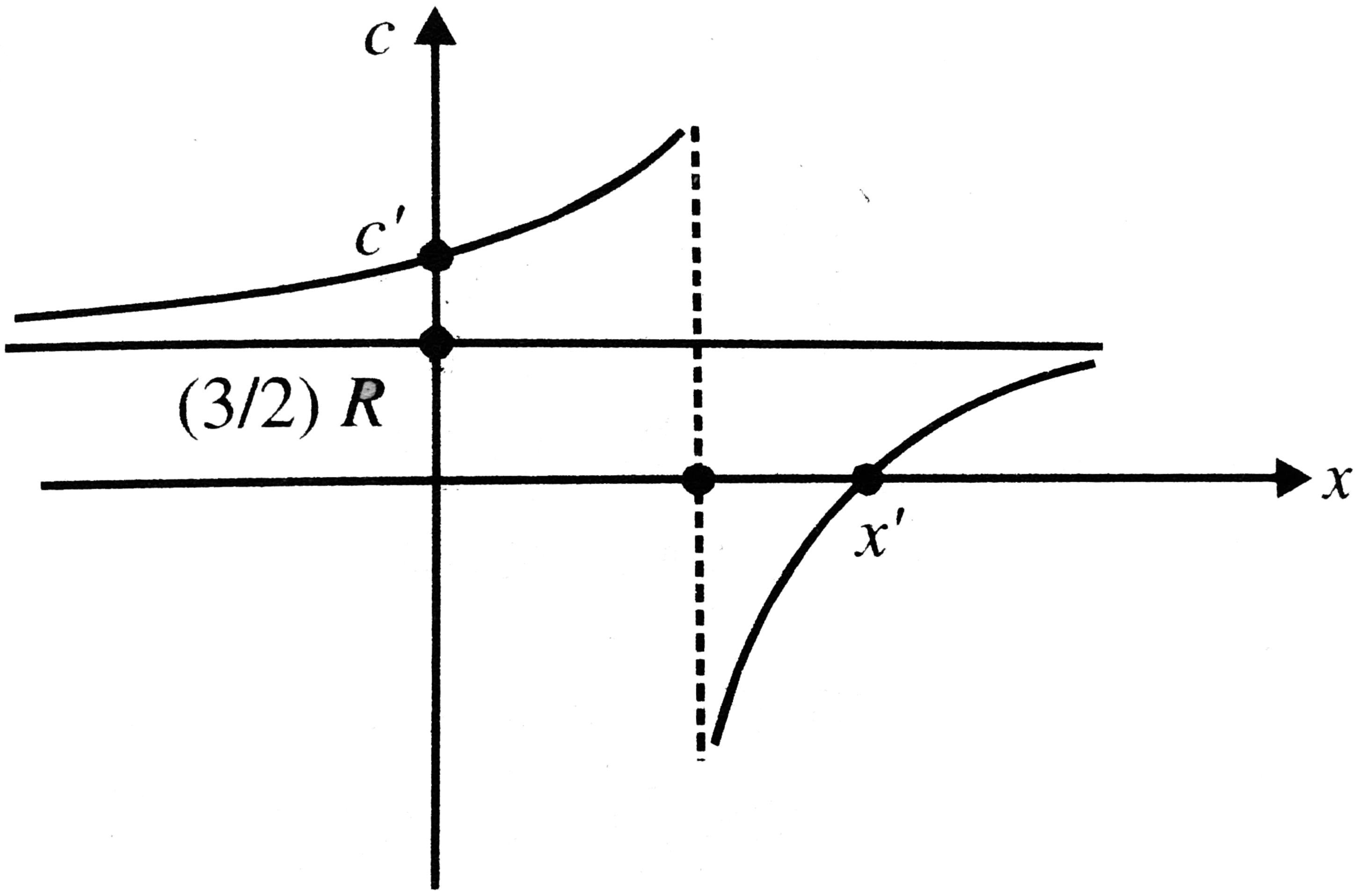
Q-29 - 11446299

One mole of an ideal gas is taken along the process in which

PV' = constant. The graph shown represents the variation of molar heat capacity of such a gas with respect to x. The value of c' and $x'c$ respectively, are given by



(A) $\frac{5}{2}R, \frac{5}{2}$

(B) $\frac{5}{2}R, \frac{5}{3}$

(C) $\frac{7}{2}R, \frac{7}{2}$

(D) $\frac{5}{2}R, \frac{7}{5}$

CORRECT ANSWER: B

SOLUTION:

b. At $x = \infty, C = \frac{3}{2}R$

from $PV^x =$ constant

and $P^{1/x}V =$ another constant

so at $x = \infty, V =$ constant

hence $C = C_v = \frac{3}{2}R$

and then $C_P = C_v + R = \frac{5}{2}C$

at $x = 0, P =$ constant and $C = C'$

hence $C' = C_P = \frac{5}{2}R$

at $x = x', C = 0$, so the process is adiabatic, hence

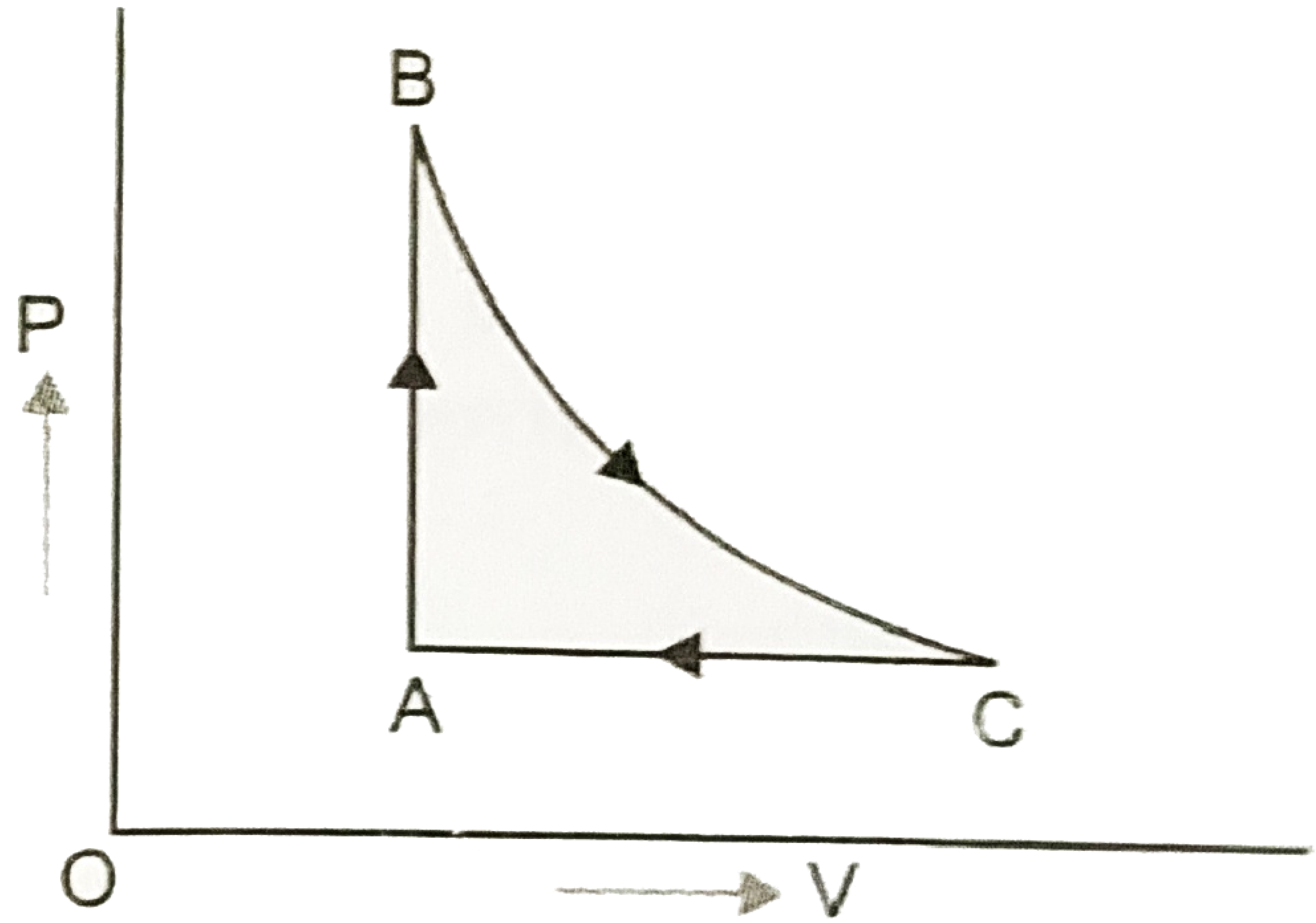
$x' = \frac{C_P}{C_v} = \frac{5}{3}$

Q-30 - 12008773

Gas with in a chamber, passes through the cycle shown in (figure).

Determine the net heat added to the system during process AB is

$Q_{AB} = 20J$. No heat is transferred during process BC and net work done during the cycle is $15J$



SOLUTION:

According to first law of thermodynamics.

In process CA,

$dQ_{CA} = dU_{CA}$
$+ dW_{CA}$

In process AB

$dQ_{AB} = dU_{AB}$
$+ dW_{AB}$

, and

In process BC

$dQ_{BC} = dU_{BC}$
$+ dW_{BC}$

Adding the three equations, we get

$dQ_{CA} + dQ_{AB} + dQ_{BC}$
$= (dU_{CA} + dU_{AB}$
$+ dU_{BC})$

$+ (dW_{CA} + dW_{AB}$
$+ dW_{BC}$

....(i)

As the process is cyclic,

$dU = dU_{CA} + dU_{AB}$
$+ dU_{BC} = 0$

From (i)

$dQ_{CA} + 20 + 0 = 0$
$+ 15$

$dQ_{CA} = 15 - 20 =$
$- 5J$

This is the net heat added to the system.

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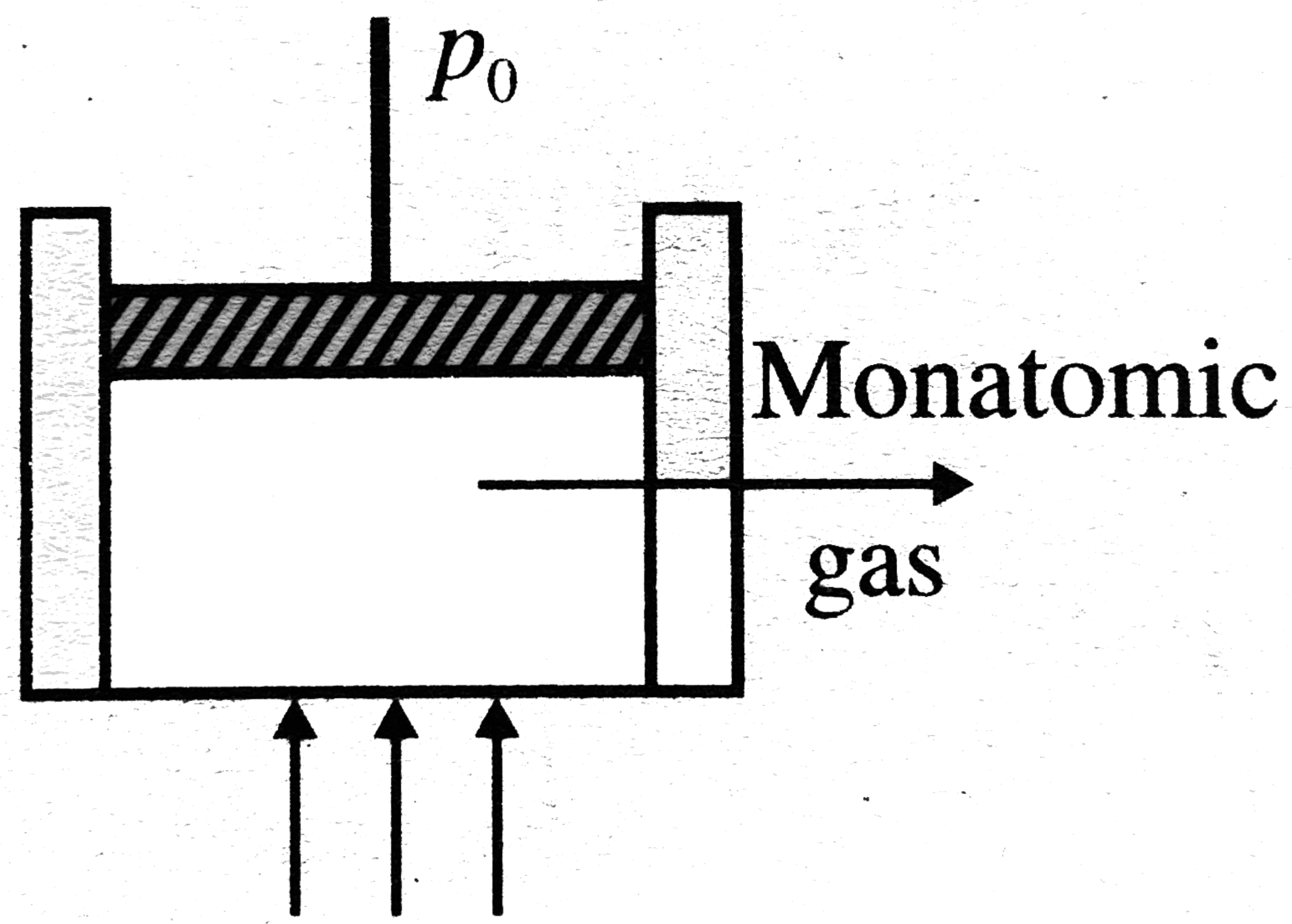
Q-31 - 11446292

If $50cal$ of heat is supplied to the system containing $2mol$ of an ideal monatomic gas, the rise in temperature is

$(R = 2cal / mol - K)$



(A) $50K$

(B) $5K$

(C) $10K$

(D) $20K$

CORRECT ANSWER: B

SOLUTION:

b. $\frac{C_v}{C_P} \times Q = nC_V dT$

$$dT = \frac{Q}{nC_P}$$

$$= \frac{50}{2 \times \frac{5}{2} \times R} = 5K$$

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Q-32 - 16120102

A thermodynamic system goes from states (i) P_1V to $2P_1$, V (ii) P , V to P , 2 V . Then work done in the two cases is

(A) Zero zero

(B) Zero, PV_1

(C) PV_1,Zero

(D) PV_1, P_1V_1

CORRECT ANSWER: B

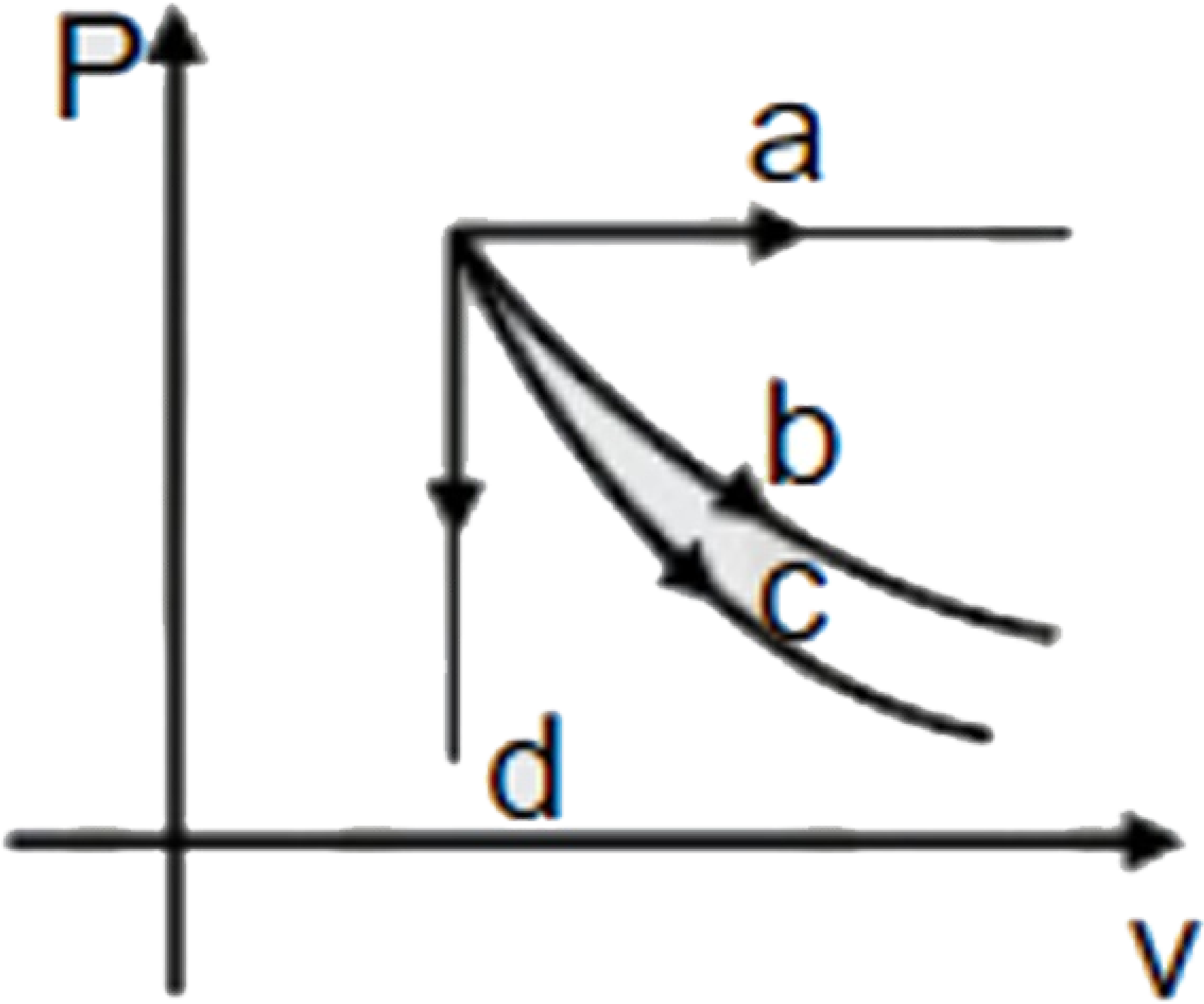
Q-33 - 12008841

Calculate net work done by the gas whose thermodynamical behaviour is represented by right angled triangle ABC on $P-V$ diagram. The $P-V$ diagram co-ordinates are : $A(20, 6)$, $B(10, 12)$ and $C(10, 6)$ where P is in Nm^{-2} and V is in m^3

CORRECT ANSWER: $30J$

Q-34 - 9407418

The pressure v/s volume graph of an ideal gas is given different thermodynamics process which of the following option relevant in order : (Isochoric, isobaric, isothermal, adiabatic)



(A) d,a,b,c

(B) a,d,c,b

(C) `a,c,d,b

(D) a,b,c,d

CORRECT ANSWER: A

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Q-35 - 11446333

Four moles of hydrogen, 2 moles of helium and 1 mole of water form an ideal gas mixture. What is the molar specific heat at constant pressure of mixture ?

(A) $\frac{16}{7}R$

(B) $\frac{7R}{16}$

(C) R

(D) $\frac{23}{7}R$

CORRECT ANSWER: D

SOLUTION:

d. C_v for hydrogen $= 5R/2, C_V$ for helium

$= 3R/2, C_v$ for water vapour $= 6R/2$

$\therefore (C_v)_{\max}$

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

$$= \frac{16R}{7}$$

$\therefore C_P + C_v + R$

$$= \frac{16R}{7} + R = \frac{23R}{7}$$

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Q-36 - 14162699

Internal energy of two moles of an ideal gas at a temperature of $127 C is 1200 R$. Then find the molar specific heat of the gas at constant pressure?

CORRECT ANSWER: $2.5R$

SOLUTION:

$U = 1200R = nCvT$

$1200R = 2Cv \times 400$

$C_V = \frac{3}{2}R \therefore C_P = R$

$+ \frac{3}{2}R = 2.5R$

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Q-37 - 11446381

In an isobaric process, $\Delta Q = \frac{K\gamma}{\gamma - 1}$ where $\gamma = C_P / C_V$. What is K?

(A) Pressure

(B) Volume

(C) ΔU

(D) ΔW

CORRECT ANSWER: D

SOLUTION:

d.

$$\Delta Q = \frac{K\gamma}{\gamma - 1}$$

$$= \frac{KC_P / C_V}{(C_P / C_V) - 1}$$

$$= \frac{KC_P}{C_P - C_V}$$

$$= \frac{K(nC_P\Delta T)}{(nC_P\Delta T - nC_v\Delta T)}$$

$$= \frac{K\Delta Q}{(\Delta Q - \Delta U)}$$

$$= \frac{K\Delta Q}{\Delta W}$$

or $1 = \frac{K}{\Delta w} \Rightarrow K = \Delta W$

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Q-38 - 14798319

One mole of a perfect gas in a cylinder fitted with a piston has a pressure P, volume V and temperature T. if the temperature is increased by 1K keeping pressure constant, the increase in volume is

(A) $\frac{2V}{273}$

(B) $\frac{V}{91}$

(C) $\frac{V}{273}$

(D) V

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Efficiency of a Carnot engine is 50 $\%$ when temperature of outlet is $500K$. In order to increase efficiency up to 60 $\%$ keeping temperature of intake the same what is temperature of outlet?

(A) $200K$

(B) $400K$

(C) $600K$

(D) $800K$

CORRECT ANSWER: B

SOLUTION:

$$\eta = 1 - \frac{T_2}{T_1} \Rightarrow \frac{1}{2} = 1$$

$$- \frac{500}{T_1} \Rightarrow \frac{500}{T_1} = \frac{1}{2}$$

$$\frac{60}{100} = 1 - \frac{T'_2}{T_1} = \frac{2}{5}$$

Dividing equation (i) and (ii) ,

$$\frac{500}{T'_2} = \frac{5}{4} \Rightarrow T_2$$
$$= 400K$$

.

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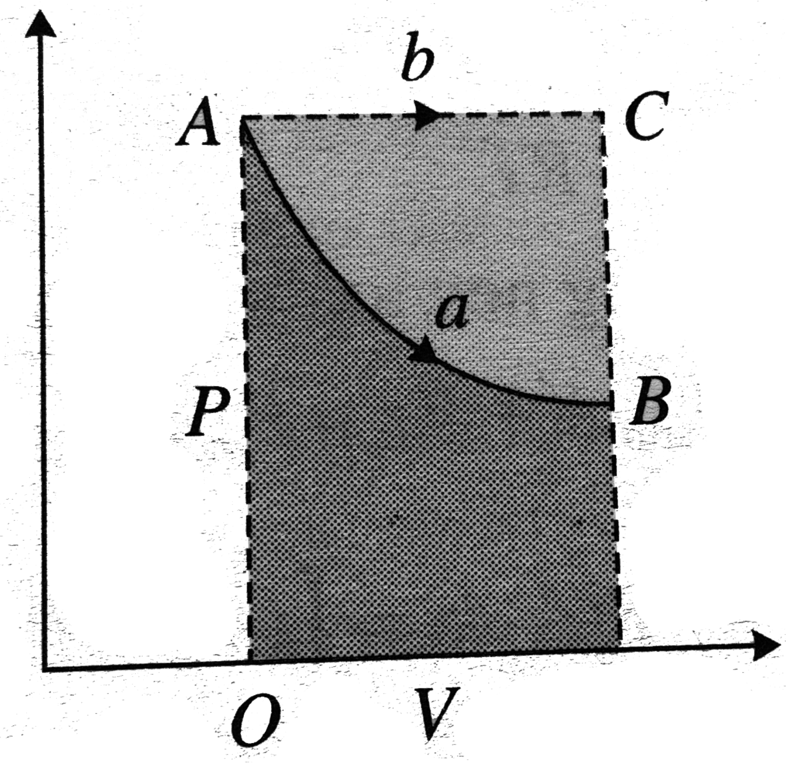
Q-40 - 11446106

A quantity of gas occupies an initial volume V_0 at pressure p_0 and temperature T_0. It expands to a volume V (a) constant temperature and (b) constant pressure. In which case does the gas do more work ?



SOLUTION:

The work done is givne by the area between the P-V plot and the V-axis. Here, the area between the P-V plot and the V-axis is less in the case (a) than in the case (b). Hence, the work done at constant pressure is greater than the work done at constant temperature.

Q-41 - 13078401

An ideal monoatomic gas indergoes a pressure pV_n=constant. The adiabatic constant for gas is y. During the process, volume of gas increases from V_0 to rV_0 and pressure decreases for p_0 to $\frac{p_0}{2r}$ Based on above information, answer the following questios :

The molar heat capacity of the gas for the process is

(A) $\frac{R(n-\gamma)}{(n-1)(\gamma-1)}$

(B) $\frac{R(n-1)}{(n-\gamma)(\gamma-1)}$

(C) $\frac{R}{\gamma-1}$

(D) $\frac{R}{n-1}+\frac{R}{\gamma}$

CORRECT ANSWER: A

SOLUTION:

$$C = C_v + \frac{R}{1-n}$$
$$= \frac{R}{\gamma - 1} - \frac{R}{n-1}$$
$$= \frac{R(n-\gamma)}{(\gamma-1)(n-1)}$$

Q-42 - 17818171

The internal energy of a gas is given by U = 3 pV. It expands from V_0 to $2V_0$ against a constant pressure p_0.

The heat absorbed by the gas in the process is

(A) p_0V_0

(B) $2p_0V_0$

(C) $3p_0V_0$

(D) $4p_0V_0$

CORRECT ANSWER: D

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Q-43 - 16120219

A polyatomic gas $\left(\lambda = \frac{4}{3}\right)$ is compressed to $\frac{1}{8}$ of its voulme Adiabatically. If initial pressure is P_0, Its mew perssure will be

(A) $8P_0$

(B) $16P_0$

(C) $6P_0$

(D) $2P_0$

CORRECT ANSWER: B

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Q-44 - 10059040

Two moles of ideal helium gas are in a rubber balloon at 30^{C}. The balloon is fully expandable and can be assumed to require no energy in its expansion. The temperature of the gas in the balloon is slowly changed to 35^{C}. The amount of heat required in raising the temperature is nearly (take R $= 8.31J/mol.K$)

(A) $62J$

(B) $104J$

(C) $124J$

(D) $208J$

CORRECT ANSWER: D

SOLUTION:

(d) The heat is supplied at constant pressure.

Therefore ,

$$Q = nC_p\Delta t$$

$$= 2\left[\frac{5}{2}R\right] \times \Delta t = 2$$

$$\times \frac{5}{2} \times 8.31 \times 5$$

$$= 208J$$

$$\left\langle 'C_p = \frac{5}{2}Rf \text{ or } \right.$$

$$mono - a$$

$$\left. \rightarrow micgas \right)$$

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Q-45 - 11446259

A monatomic gas expands at constant pressure on heating. The percentage of heat supplied that increases the internal energy of the gas and that is involed in the expansion is

(A) $75\,\%$, $25\,\%$

(B) $25\,\%$, $75\,\%$

(C) $60\,\%$, $40\,\%$

(D) $40\,\%$, $60\,\%$

CORRECT ANSWER: C

SOLUTION:

c. Fraction of energy supplied for increment in internal

energy

$= 1/\gamma = 3$

$/5(as\gamma = 5/3$

for monatomic gas)

Therefore, percentage energy $= 30/5 = 60\,\%$.

Fraction of energy supplied for external work done

$$= 1 - \frac{1}{\gamma} = \frac{\gamma - 1}{\gamma}$$

$$= \frac{\frac{5}{3} -}{\frac{5}{3}} = \frac{5}{3}$$

$\therefore$ Percentage energy

$$= \frac{2}{3} \times 100\,\% = 40$$

$\%$

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Q-46 - 10966041

When an ideal diatomic gas is heated at constant pressure, the fraction of the heat energy supplied, which increases the internal energy of the gas, is

(A) $\frac{2}{5}$

(B) $\frac{3}{5}$

(C) $\frac{3}{7}$

(D) $\frac{5}{7}$

CORRECT ANSWER: D

SOLUTION:

The desired fraction is

$$f = \frac{\Delta U}{\Delta Q} = \frac{nC_V \Delta T}{nC_p \Delta T}$$

$$= \frac{C_V}{C_p} = \frac{1}{\gamma}$$

or $f = \frac{5}{7}$ (as $\gamma = \frac{7}{5}$)

Therefore, the correct option is (d).

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Q-47 - 11446277

Two sample A and B of a gas initially at the square at the same pressure and temperature are compressed from volume V to $V/2$

(A isothermally and B adiabatically). The final pressure of A is

(A) greater than the final pressure of B

(B) equal to the final pressure of B

(C) less than final pressure of B

(D) twice the final pressure of B

CORRECT ANSWER: C

SOLUTION:

c. For isothermal process

$$P_1 V = P'_2 \frac{V}{2} \Rightarrow P'_2 = 2P_1$$

For adabatic process

$$P_1 V^\gamma = P_2 \left(\frac{V}{2}\right)^\gamma \Rightarrow P_2 = 2^\gamma P_1$$

Since $\gamma > 1, P_2 > P'_2$

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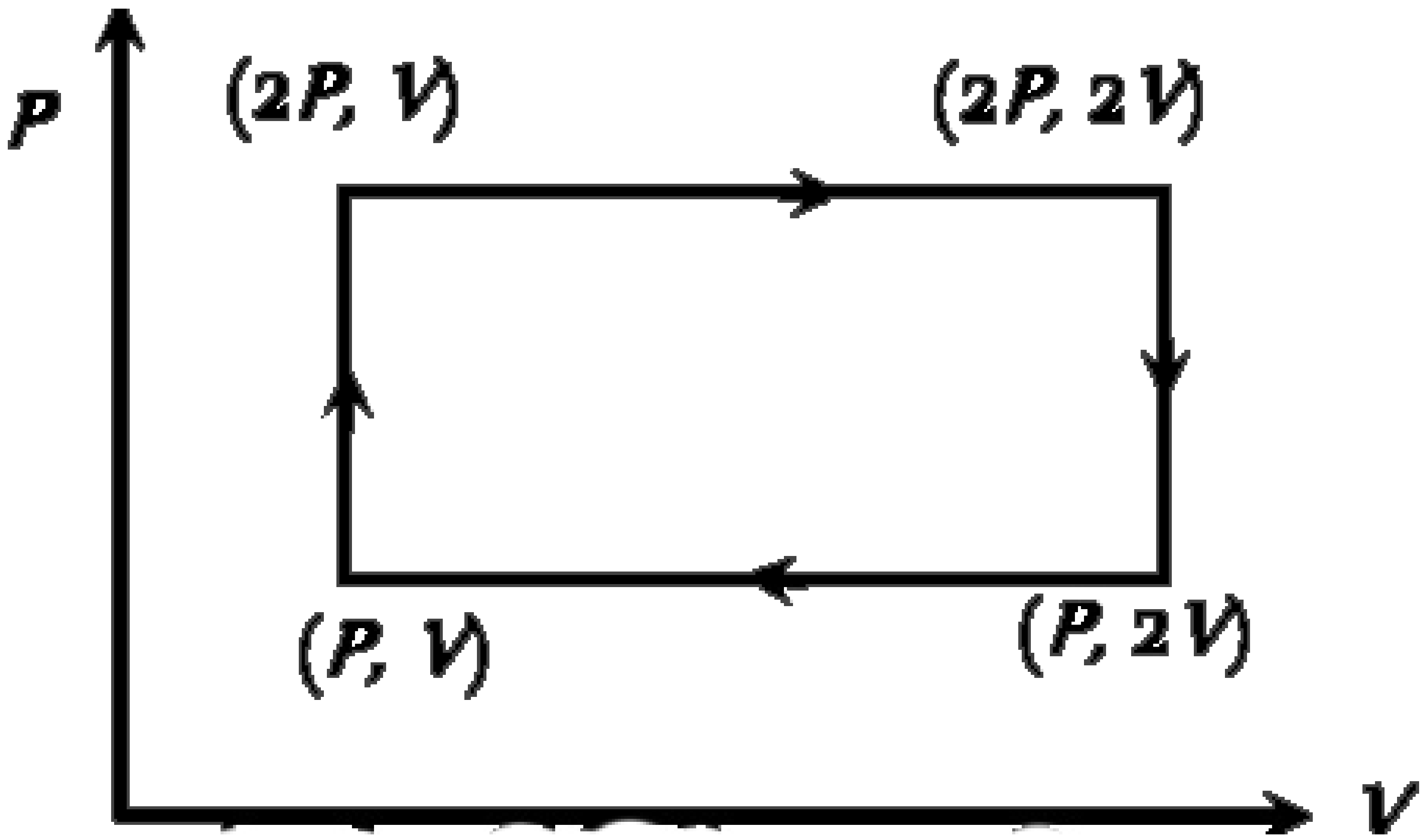
Q-48 - 16120412

Work done in the given P - V diagram in the cyclic process is



(A) 2p

(B) 2PV

(C) PV/2

(D) 3pv

CORRECT ANSWER: A

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Q-49 - 13151889

A heat engine operates between a cold reservoir at temperature $T_2 = 300K$ and a hot reservoir at temperature T_1. It takes 200 J of heat from the hot reservoir and delivers 120 J of heat from the hot reservoir and delivers 120 J of heat to the cold reservoir in a cycle. What could be the minimum temperature of the hot reservoir?

SOLUTION:

$$W = Q_1 - Q_2 = 200 - 120 = 80J$$

$$\eta = \frac{W}{Q_1} = \frac{80}{200} = 0.40$$

$$\eta_{\max} = 1 - \frac{T_2}{T_1} = 1 - \frac{300}{T_1}$$

$$\eta \leq \eta_{mex}$$

$$0.40 \leq \left(1 - \frac{300}{T_1}\right)$$

$$\frac{300}{T_1} \leq 0.6$$

$$T_1 \geq 500$$

$$(T_1)_{\min} = 500K$$

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Q-50 - 18931014

5 moles of oxygen are heated at constant volume from $10C$ to $20C$.

The change in internal energy of a gas.

$[C_P = 7.03 cal mol^{-1} deg^{-1}$ and $R = 8.3 J mol^{-1} deg^{-1}]$

(A) 125 cal

(B) 252 cal

(C) 50 cal

(D) 500 cal

CORRECT ANSWER: B

SOLUTION:

$$C_P - C_V = R, q$$
$$= nC_V \Delta T$$

since

$$W = 0 \quad \Delta U = q$$
$$+ W, \Delta U = q$$

Q-51 - 11796963

An ideal heat engine working between temperature T_1 and T_2 has an efficiency η, the new efficiency if both the source and sink temperature are doubled, will be

(A) $\frac{\eta}{2}$

(B) η

(C) 2η

(D) 3η

CORRECT ANSWER: B

SOLUTION:

In first case , $\eta_1 = \frac{T_1 - T_2}{T_1}$

in second case

$$\eta_2 = \frac{2T_1 - 2T_2}{2T_1}$$

$$= \frac{T_1 - T_2}{T_1} = \eta$$

.

Statement-1 : A Carnot engine working between $100K$ and $400K$ has an efficiency of $75\ \%$

Statement-2 : It follows from $\eta = 1 - \frac{T_2}{T_1}$

(A) If both, Assertion and Reason are true and Reason is the correct explanation of the Asserrion.

(B) If both,Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

(C) If Assertion is true but the Reason is false.

(D) If both, Assertion and Reason are false.

CORRECT ANSWER: A

SOLUTION:

$$\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{100}{400} = \frac{3}{4} = 75\ \%$$

Both the statements are true and statement-2 is correct explanation of statement-1

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Q-53 - 14927810

A closed gas cylinder is divided into two parts by a piston held tight. The pressure and volume of gas in two parts respectively are (P, 5V) and (10P, V). If now the piston is left free and the system undergoes isothermal process, then the volumes of the gas in two parts respectively are

(A) 2V,4V

(B) 3V,3V

(C) 5v,V

(D) $\frac{10}{11}V\frac{20}{11}V$

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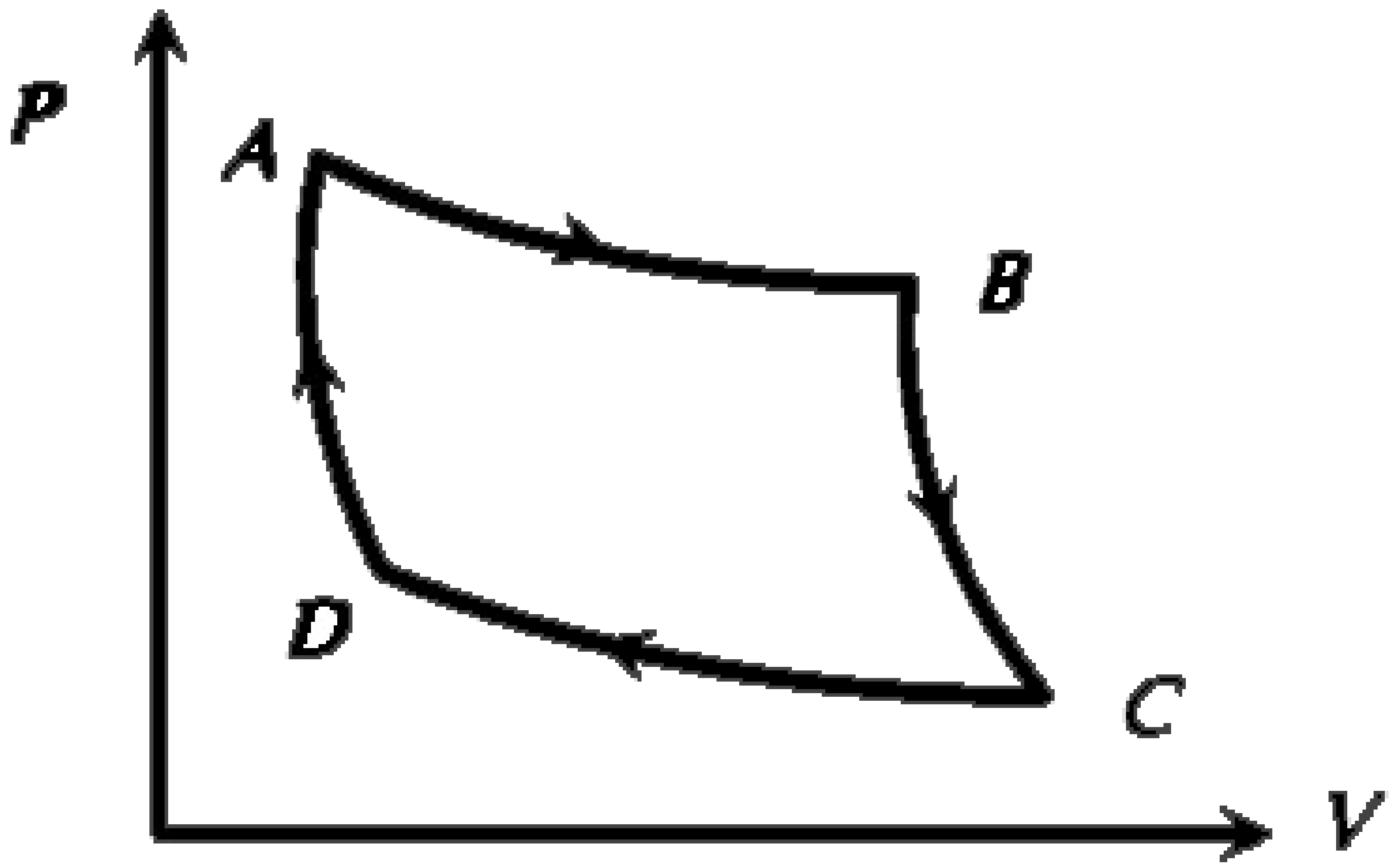
Q-54 - 16120423

The P - V graph of an ideal gas cycle is shown here as below. The adiabatic process is described by



(A) AB and BC

(B) AB and CD

(C) BC and DA

(D) BC and CD

CORRECT ANSWER: C

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Q-55 - 12009009

During adiabatic expension of $10 moles$ of a gas , internal energy decrease, by $700J$. Work done during the process is $\times x10^2 J$. What is x?

SOLUTION:

From firsrt law of thermodynamics, $dQ = dU + dW$

In adiabatic expression, $dQ = 0$

$\therefore dW = -dU = -(-700J) = 700J$

$= 7 \times 10^2 J$

$\therefore X = 7$

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Q-56 - 16120367

The temperature of a hypothetical gas increases to $\sqrt{2}$ times when compressed adiabatically to half the volume. Its equation can be written as

(A) $PV^{3/2} =$ constant

(B) $PV^{5/2} =$ constant

(C) $PV^{7/3} =$ constant

(D) $PV^{4/3} =$ constant

CORRECT ANSWER: A

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Q-57 - 11446287

An ideal gas expands in such a manner that its pressure and volume can be related by equation $PV^2 =$ constant. During this process, the gas is

(A) heated

(B) cooled

(C) neither heated nor cooled

(D) first heated and then cooled

CORRECT ANSWER: B

SOLUTION:

b. For an isothermal process, $PV =$ constant and for the given process $PV^2 =$ constant.

Therefore has is cooled because volume expands by a greater exponent than is in an isothermal porcess.

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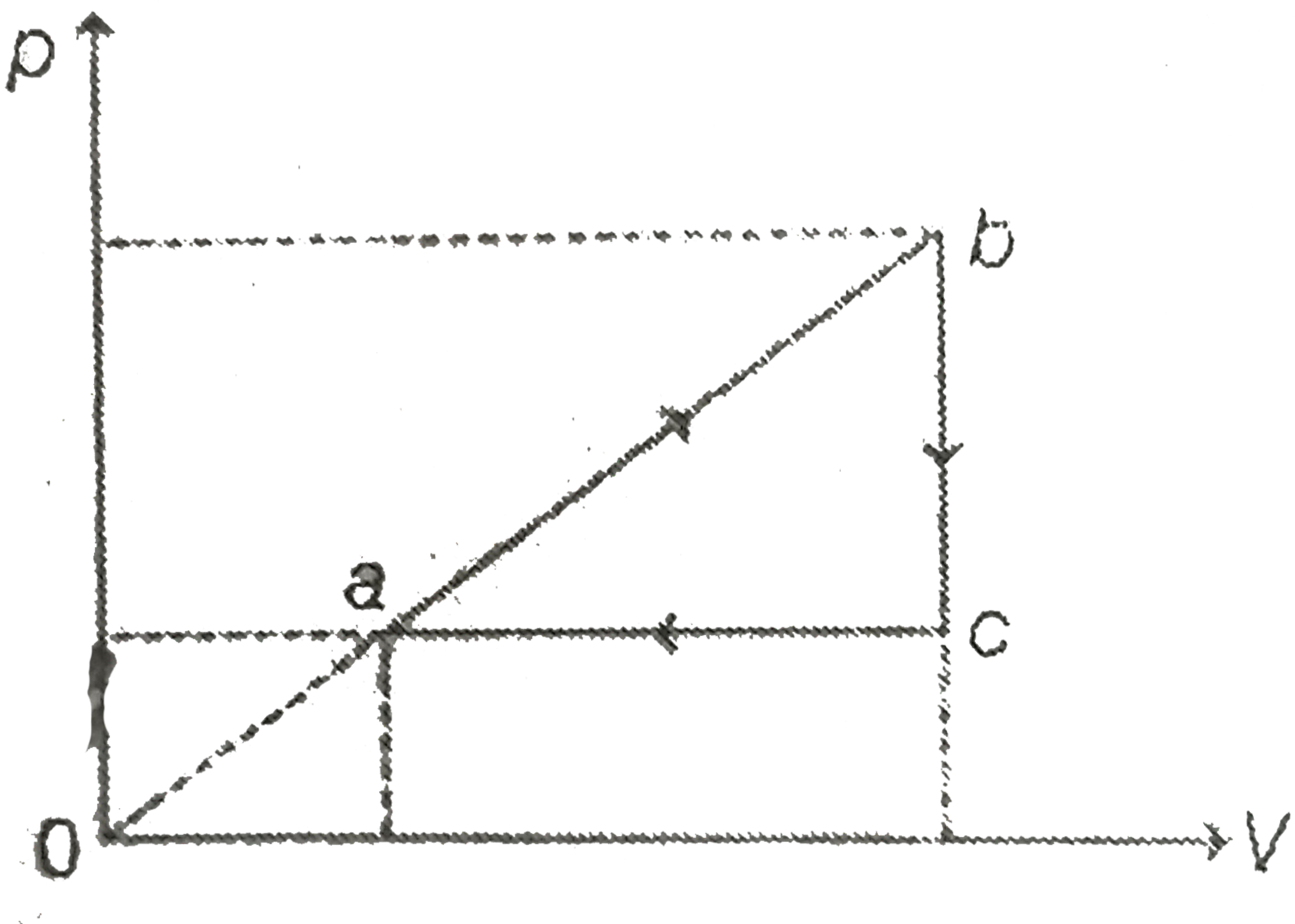
Q-58 - 17818088

Figure illustrates a cycle conducted with n moles of an ideal gas. In the states a and b the gas temperatures are T_a and T_b respectively. Temperature of the gas in the state C is ltbr)



(A) $\sqrt{T_a T_b}$

(B) $T_a + T_b$

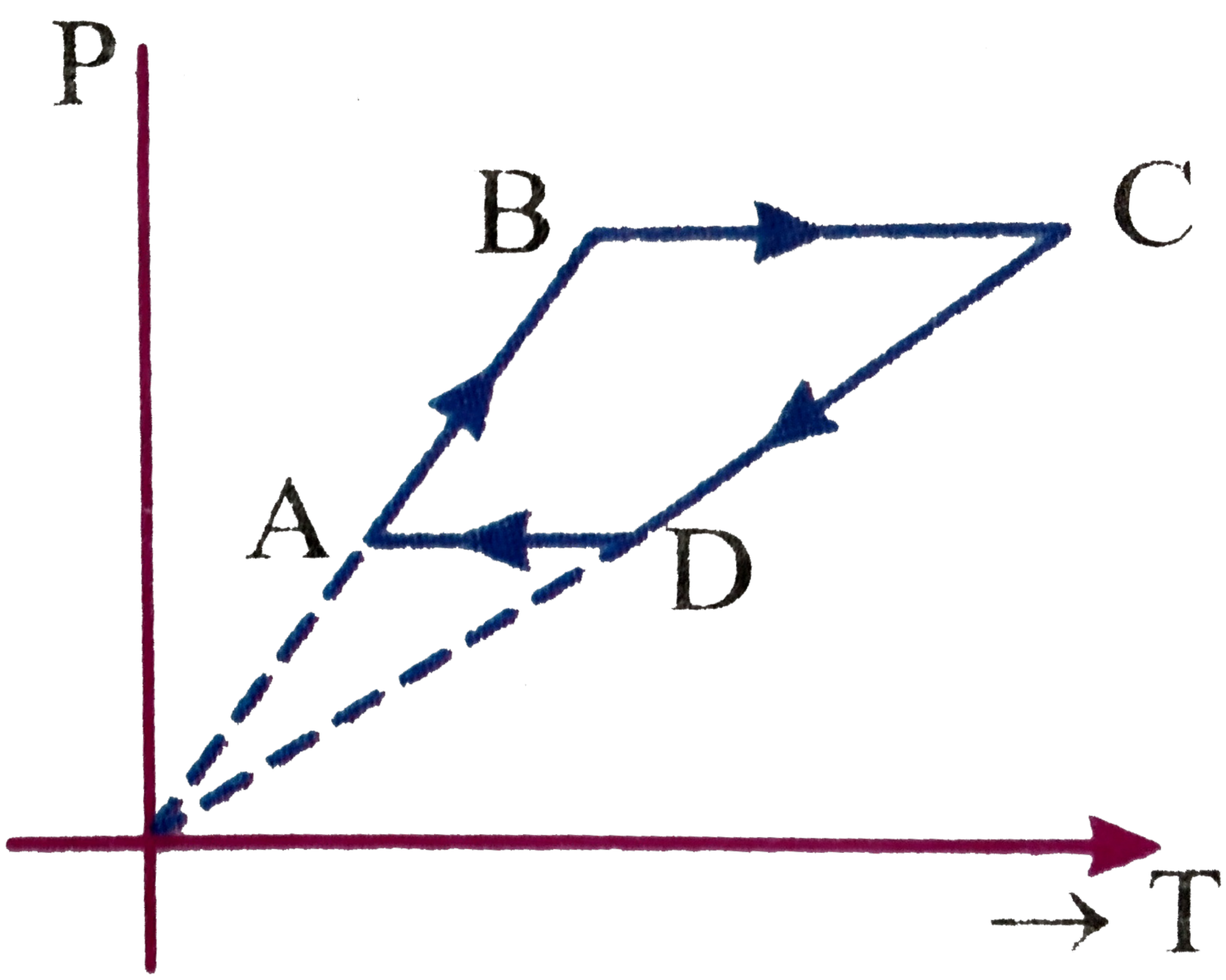
(C) $\frac{T_a T_b}{T_a + T_b}$

(D) $(T_a + T_b)/2$

CORRECT ANSWER: A

Q-59 - 13078299

3 moles of an ideal mono atomic gas performs a cycle as shown in fig. If gas temperature $T_A = 400K$ $T_B = 800K, T_C = 2400K$, and $T_D = 1200K$. Then total work done by gas is



(A) $2400R$

(B) $1200R$

(C) $2000R$

(D) Zero

CORRECT ANSWER: A

SOLUTION:

$$W_{BA} = W_{CD}$$
$$= 0(V = const)$$

$$\left.\begin{aligned} W_{BC} &= 3R \quad (T_c - T_B) \\ W_{DA} &= 3R \quad (T_A - T_D) \end{aligned}\right\} P$$
$$= const$$

.

$$\therefore W = 3R(T_A + T_c$$
$$- T_B - T_D) = 2400R$$

Q-60 - 16120225

In an adiabatic expansion of a gas initial and final temperatures are T_1 and T_2 respectively, then the change in internal energy of the gas is

(A) $\frac{R}{\lambda}(T_2 - T_1)$

(B) $\frac{R}{\lambda - 1}(T_1 - T_2)$

(C) $R(T_1 - T_2)$

(D) Zero

CORRECT ANSWER: A