AAQIL AHMED

JEE : THERMODYNAMICS

1) One mole of an ideal gas expands isothermally at 300K from 5L to 10L. Find the work done by the gas [$R = 8.31\ J mol^{-1} K^{-1}$]

ANSWER

$n = 1$
$T = 300K$
$V_1 = 5L$
$V_2 = 10L$

$$W = nRT \ln\left(\frac{V_2}{V_1}\right)$$

$$W = 1(8.31)(300)\ln 2$$

$$W \approx 1728 J$$

2) An ideal gas undergoes an adiabatic expansion from volume V to 2V. If initial pressure is P, find the final pressure.

Given, $\gamma = \frac{5}{3}$

ANSWER

$$PV^{\gamma} = \text{a constant}$$

$$P_1 V_1^{\gamma} = P_2 (2V_1)^{\gamma}$$

$$P_1 = P_2 2^{\gamma}$$

$$P_2 = \frac{P_1}{2^{\gamma}}$$

$$\boxed{P_2 = \frac{P_1}{2^{5/3}}}$$

CamScanner

3) A refrigerator works between 270K and 300K. Find the coefficient of performance (COP) of an ideal refrigator

ANSWER

$$COP = \frac{T_c}{T_h - T_c}$$

$$= \frac{270}{30}$$

$$= 9$$

Hazique Rizvi
2025-2026

Thermodynamics

Q In an adiabatic process, which of the following statements is true?

a) The internal energy of the gas decreases as the temperature increases

b) The molar heat capacity is zero

c) Work done by the gas equals the increase in internal energy

d) The molar heat capacity is infinite

Sol: option b) is correct

In an adiabatic process no heat is exchanged so,

$\delta Q = 0$

• The molar heat capacity for any process is defined by

$$C = \frac{\delta Q}{n \delta \bar{T}}$$

Since $\delta Q = 0$, even when $\delta \bar{T} \neq 0$, it follows that

$C_{adiabatic} = 0$

Q Assertion: With the increase in the pressure of an ideal gas, the volume falls off more rapidly in an isothermal process in comparison to the adiabatic process

Reason: In isothermal process, PV = constant, while in adiabatic process PV^{γ} = constant. Here γ is the ratio of specific heats, P is the pressure and V is the volume of the ideal gas.

Sol: $PV = n\bar{R}\bar{T}$

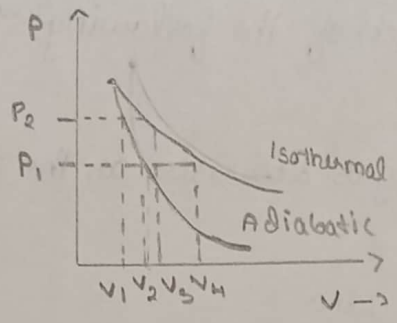
for isothermal process, T = constant

$\Rightarrow PV$ = constant

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

for an adiabatic process,

PV^{γ} = constant



We can see, for the same pressure increasement, $P_2 - P_1$,

$(V_4 - V_3) > (V_2 - V_1)$

volume falls of more rapidly in comparison to adiabatic process

∴ Both A and R are true and R is the correct explanation of A

Q The work done in an adiabatic process in an ideal gas depends upon only:

a) change in its pressure

b) change in its temperature

c) change in its specific heat

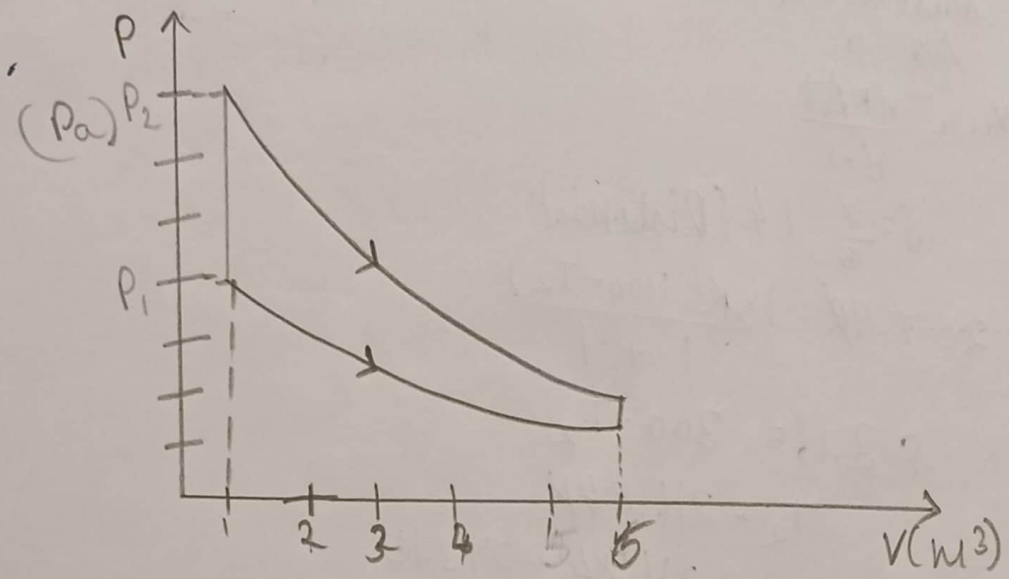
d) change in its volume

Sol: option B is correct

$\Delta W = -\Delta U = -n C_v \Delta T$

JEE Questions
Thermodynamics

Q.1) 10 mole of an ideal gas is undergoing the process shown in the figure. The heat involved in the process from P_1 to P_2 is 'α' J ($P_1 = 21.4$ Pa and $P_2 = 30$ Pa, $C_v = 21$ J/K.mol, $R = 8.3$ J/mol.K). The value of α is ____. [JEE Main 2026]



Ans :- (*) $\Delta T = T_2 - T_1$

$PV = nRT$

$\Delta T = \frac{P_2V}{nR} - \frac{P_1V}{nR} = \frac{(P_2 - P_1)V}{nR} \Rightarrow \frac{(8.3)(4)}{(10)(8.3)}$

$Q = n C_v (\Delta T)$

$Q \Rightarrow \frac{(10)(21)(8.3)(4)}{(10)(8.3)} \Rightarrow (21)(1) \Rightarrow \underline{\underline{21\ J}}$.

Q.2) One mole of an ideal diatomic gas expands from volume V to 2V isothermally at a temperature 27°C and does W J of work. If the gas undergoes same magnitude of expansion adiabatically from 27°C doing the same amount of work W, then its final Temperature is ____ °C. [$\log_e 2 = 0.693$] [JEE Main 2026]

Ans:- ⊛ $W_{iso} = nRT \ln \frac{V_2}{V_1}$ (2)

$T = 300K$

$\frac{V_2}{V_1} = \frac{2V}{V} = 2$

$\ln 2 = 0.693$

$W = 1 \times R \times 300 \times 0.693 \Rightarrow 207.9R$

For adiabatic Expansion;

$\Delta Q = 0$

$W_{adia} = \frac{nR\Delta T}{\gamma - 1}$

$\gamma = \frac{7}{5} = 1.4$ {Diatomic}

$207.9R = \frac{1 \times R(300 - T_2)}{1.4 - 1}$

$83.16 = 300 - T_2$

$T_2 = 216.84K$

$T(^\circ C) \Rightarrow 216.84 - 273.15$

$\therefore T \Rightarrow -56.31^\circ C$

Q.3) The volume of an ideal gas increases 8 times and temperature becomes (1/4)th of initial temperature during a reversible change. If there is no exchange of heat in this process ($\Delta Q = 0$) then identify gas from following options (Assuming gases are ideal):-

(A) NH_3 (B) O_2

(C) CO_2 (D) He

Ans:- (*) $\Delta Q = 0$; So, reversible adiabatic process.

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

So; $T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$

Given:- $V_2 = 8V_1$ and $T_2 = \frac{1}{4} T_1$

$$T_1 V_1^{\gamma-1} = \frac{1}{4}(T_1)(8V_1)^{\gamma-1}$$

$$1 = \frac{1}{4} \times 8^{\gamma-1}$$

$$4 = 8^{\gamma-1}$$

$$2^2 = 2^{3(\gamma-1)}$$

$$3(\gamma-1) = 2$$

$$\gamma - 1 = \frac{2}{3}$$

$$\gamma = \frac{5}{3}$$ {Monoatomic}

So, specific capacity is $\gamma = \frac{5}{3}$

So, monoatomic.

∴ (D) He

Thermodynamics

Q1. A system is taken from state A to state B along two different paths, ACB and ADB.
- Along path ACB, the heat absorbed is $Q = 60\,J$ and work done by the system is $W = 30\,J$.
- Along path ADB, the work done by the system is $W = 10\,J$.

What is the heat absorbed (Q) along path ADB?

Ans. Internal energy (U) is a state function.
∴ Change ΔU depends only on the initial and final states, not the path taken.

From path 1 (ACB),
using first law $\Delta U = Q - W$

$\Delta U = 60\,J - 30\,J$
$= 30\,J$

Applying to path 2 (ADB):
Since the endpoints are the same, ΔU must still be $30\,J$

$Q_{ADB} = \Delta U + W_{ADB}$
$Q_{ADB} = 30\,J + 10\,J$
$= 40\,J$

Q2. An ideal gas undergoes a cyclic process as shown in the P-V diagram below. The path consists of an isobaric expansion (AB), an isochoric cooling (BC), and an adiabatic compression (CA) back to the start. If the work done during the adiabatic process CA is $-40\,J$, and the net heat absorbed by the cycle is $20\,J$, what is the work done during the isobaric process AB? (Assume process BC involves no work).

Ans. Net change in a cycle, for any complete cycle, the total change in internal energy is zero.
$\Delta U_{total} = 0$)

First Law for a cycle is $Q_{net} = W_{net}$

$W_{net} = W_{AB} + W_{BC} + W_{CA}$

- $W_{BC} = 0$ (Isochoric process means $\Delta V = 0$)
- $W_{CA} = -40\,J$ (Given)

∴ For W_{AB},

$20\,J = W_{AB} + 0 + (-40\,J)$

$W_{AB} = 20\,J + 40\,J$

$= 60\,J$

Q3. One mole of a monatomic ideal gas ($\gamma = 5/3$) is heated at constant pressure. What fraction of the heat energy supplied is used to increase the internal energy of the gas?

Ans. Heat supplied at constant pressure, $Q = n C_p \Delta T$

Change in internal energy, $\Delta U = n C_v \Delta T$

The fraction is $\frac{\Delta U}{Q} = \frac{n C_v \Delta T}{n C_p \Delta T} = \frac{C_v}{C_p}$

Since $\gamma = \frac{C_p}{C_v}$

the ratio $\frac{C_v}{C_p}$ is $\frac{1}{\gamma}$

$\therefore$ Fraction $= \frac{1}{5/3}$

$= \frac{3}{5}$

For monatomic gas, $C_v = \frac{3}{2}R$ and $C_p = \frac{5}{2}R$

$\therefore$ This confirms the $\frac{3}{5}$ ratio.

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THERMODYNAMICS

Q.1 Water falls from a height of 200m into a pool. Calculate the rise in temperature of the water assuming no heat dissipation from the water in the pool.
($g = 10 m/s^2$; Specific Heat Capacity of water = 4200 J/kg

Ans PE = Heat gained

$$mgh = mS\Delta T$$

$$\Rightarrow \Delta T = \frac{gh}{S}$$

$$= \frac{2000}{4200}$$

$$\Rightarrow \Delta T = \frac{10}{21} \approx 0.48\,K$$

Q.2 Match List-I with List-II

List-I	List-II
(A) Isothermal	(i) $\Delta W = 0$
(B) Adiabatic	(ii) $\Delta Q = 0$
(C) Isobaric	(iii) $\Delta V \neq 0$
(D) Isovolumetric	(iv) $\Delta U = 0$

Ans (A) → (iv)
(B) → (ii)
(C) → (iii)
(D) → (i)

Q3. Two vessels A and B are of the same size and are at same temperature. 'A' contains 1g of H & B contains 1g of oxygen. P_A & P_B are the pressures of the gases in A and B respectively, then $\frac{P_A}{P_B}$ =

Ans $\frac{P_A V_A}{P_B V_B} = \frac{n_A R T_A}{n_B R T_B}$

Given, $V_A = V_B$; $T_A = T_B$

$\Rightarrow \frac{P_A}{P_B} = \frac{1/2}{1/32} = 16$

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13

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JEE - 2025-26

Thermodynamics

Q) An amount of mass 10^{-3} kg and temperature $-10^{\circ}C$ is transformed to vapour of temperature $110^{\circ}C$ by applying heat. The total amount of work required for conversion is,

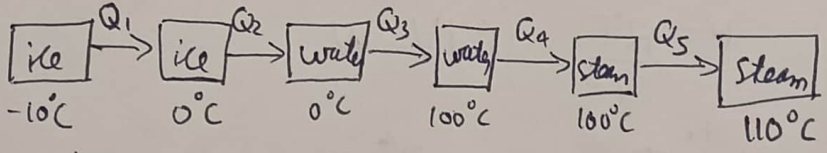
Given, specific heat capacity of ice $(c_{ice}) = 2100 J/kgK$, $C_{H_2O} = 4180 J kg^{-1}k^{-1}$

$L_{\substack{steam \\ ice}} = 3.35 \times 10^5 J kg^{-1}$ & $L_{steam} = 2.25 \times 10^6 J kg^{-1}$

$C_{steam} = 1920 J kg^{-1}k^{-1}$

(A) 3022 J (B) 3043 J (C) 3003 J (D) 3024 J

Sol.



Heat from temp $-10^{\circ}C$ to $0^{\circ}C \rightarrow Q = m S_i \Delta T = 10^{-3} \times 2100 \times 10$
$= 21 J$

Latent heat ice to water $\rightarrow Q_2 = m L_i = 10^{-3} \times 3.35 \times 10^5 = 335 J$

Heat from temp $0^{\circ}C$ to $100^{\circ}C \rightarrow Q_3 = m S_w \Delta T = 10^{-3} \times 4180 \times 100 = 418 J$

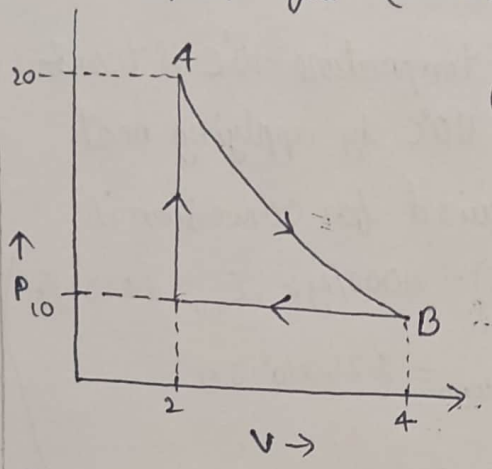
Latent heat water to steam $\rightarrow Q_4 = m L_{\substack{w \\ s}} = 10^{-3} \times 2.25 \times 10^6 = 2250 J$

Heat from temprat $100^{\circ}C$ to $110^{\circ}C \rightarrow Q_5 = m S_s \Delta T = 10^{-3} \times 1920 \times 10 = 19.2 J$

$Q_{net} = Q_1 + Q_2 + Q_3 + Q_4 + Q_5 = 3043 J$

(B) 3043 J

Q) A real gas within closed container at 27°C undrgoes cyclic moces as shown in figure. The gas obeys $PV^3 = RT$ equation for path A to B. The net work done in complete cycle. $(R = 8\ J\ mol^{-1}k^{-1})$



(A) -20J (B) 205J (C) 225J

(D) 20J

Sol:

for A to B:

$$PV^3 = RT$$

$$P = \frac{RT}{V^3} \Rightarrow \int P\,dV = W$$

$$W = \int_2^4 \frac{RT}{V^3} = RT\left[\frac{V^{-2}}{-2}\right]_2^4$$

$$W = -\frac{RT}{2} \times \left(\frac{1}{16} - \frac{1}{4}\right) = +\frac{3}{2} \times \frac{1}{16} \times RT = \frac{3}{2} \times \frac{1}{16} \times 8 \times 300$$

$$= 225\ J$$

(C) 225J

Q) A total of 48 J heat is given to one mole of He kept in cylender. The temp of He increases by 2°C. The work done by gas is: Given, $R = 8.3\ J k^{-1} mol^{-1}$

(A) 23.1 J (B) 48 J (C) 24.9 J (D) 72.9 J

Sol.

By first law of thermodynamics:

$$\Delta Q = \Delta U + W$$

$\Delta Q = 48\ J$ (given)

$\Delta U = n C_v \Delta T$

$n = 1$ (given), $C_v = \frac{3}{2} R$ (mono atom gas), $\Delta T = 2$ (given)

$\Delta U = 1 \times \frac{3}{2} R \times 2 = \frac{3}{2} \times 8.3 \times 2 = 24.9\ J$

$\Delta Q = \Delta U + W$

$48 = 24.9 + W$

$\therefore W = 23.1\ J$

(A) 23.1 J

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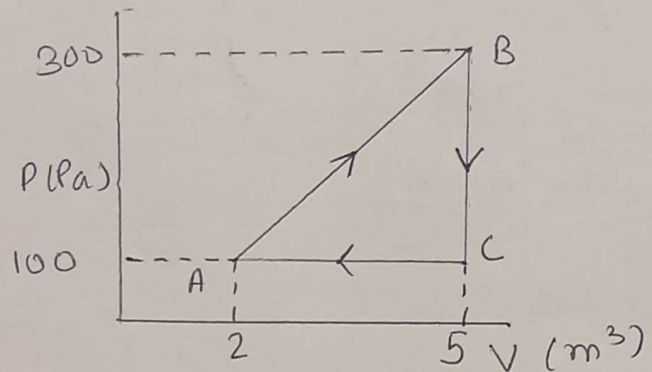
Thermodynamics

① A Thermodynamics system is taken through the cyclic process ABC as shown in the figure. The total work done by the system during the cyclic ABC is 300 J.



Ans:-

Cycle → A ↔ B ↔ C ↔ A

Work done = Area = $\frac{1}{2}$ × Length × Breadth

∴ Base = $V_C - V_A$ = (5-2) m^3 = 3 m^3

Height = $P_B - P_C$ = (300 - 100) Pa = 200 Pa

∴ Work Done = $\frac{1}{2} \times 3 \times 200$ = 300 J.

② A gas of certain mass filled in a closed cylinder at a pressure of 3.23 kPa has temperature 50°C. The gas is now heated to double its temperature. The modified pressure is 6460 Pa.

Ans:-

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$ | $P_1 = 3230$ Pa, $P_2 = ?$; $T_1 = 322$K; $T_2 = 2 \times T_1 = 646$K

∴ $P_2 = P_1 \times \frac{T_2}{T_1} = 3230 \times \frac{646}{323} = 6460$ Pa

③ The internal energy of air is $(4 \times 4 \times 3)\,m^3$ sized room at 1 atm. pressure will be 12 $\times 10^6$ J. (Consider air as diatomic molecule).

Ans:-

$V = 4 \times 4 \times 3 = 48\,m^3$

$U = n C_V T = n \frac{5RT}{2}$

$\Rightarrow nRT = PV.$

$\therefore U = \frac{5}{2} PV = \frac{5 \times 10^5 \times 48}{2} = 12 \times 10^6\,J$

CamScanner

THERMODYNAMICS

(Q) An ideal gas undergoes an isothermal reversible expansion from pressure P_1 to P_2. The work done is

(A) $nRT \ln \frac{P_1}{P_2}$ (B) $nRT(P_1 - P_2)$ (C) $\frac{nR(P_1 - P_2)}{T}$ (D) $nRT \ln \frac{P_2}{P_1}$

Solution

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

$$P = \frac{nRT}{V}$$

So,

$$W = nRT \int_{V_1}^{V_2} \frac{dV}{V} = nRT \ln \frac{V_2}{V_1}$$

But $P_1V_1 = P_2V_2$

$$\frac{V_2}{V_1} = \frac{P_1}{P_2}$$

$$W = nRT \ln \frac{P_1}{P_2}$$

Option (A)

(Q) For a cyclic process, the net work done by the system is equal to

(A) change in internal energy (B) Heat absorbed

(C) Area enclosed by the PV curve (D) Zero

Solution

(C) Area enclosed by the PV curve

(Q) The molar heat capacity of an ideal gas in an isothermal process is

(A) 0 (B) ∞ (C) C_v (D) C_n

Solution

$$C = \frac{dQ}{dT}$$

In isothermal process $\Delta T = 0$ but heat Q is absorbed so, denomination = 0, numeration finite

$$C = \infty$$

Option (B)

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2025-26

Thermodynamics

Q.1 A carnot engine operating between temperature T_1 and T_2 has efficiency $\frac{1}{6}$. When T_2 is lowered by 62K, its efficiency increases to $\frac{1}{3}$. Then T_1 and T_2 are resp.

Ans: The efficiency of carnot engine

$$\eta = 1 - (T_2 / T_1)$$

$$\eta = \frac{1}{4}$$

$$T_2 / T_1 = 5/6$$

$$T_1 = 6T_2 / 5$$

$$\frac{1}{3} = (1 - (T_2 - 62 / T_1)(T_2 - 62 / T_1) = 1 - \left(\frac{1}{3}\right)$$

$$5(T_2 - 62) / 6T_2 = \frac{2}{3}$$

$$5T_2 - 310 = 4T_2 = T_2 = 310K$$

$$T_1 = \frac{(6 \times 310)}{5}$$

$$= 372K$$

Q·2 200 g water is heated from 40°C to 60°C. Ignoring the slight expansion of water, the change in its internal energy is close it

Ans: For isobaric process, $\Delta U = Q = ms\Delta T$

$m = 200g = 0.2kg$, $s \simeq 4184\ J/kg/K$

$\Delta T = 60°C - 40°C = 20°C$

$\Delta U = (0.2)(4184)(20) = 16736\ J$

$= 16.7\ KJ$

Q·3 An Ideal gas heat engine is operating between 227°C and 127°C. It absorbs 10^4 J of heat at a higher temperature. The amount of heat converted into work is.

$\eta = 1 (T_2/T_1)$

$\eta = 1 - (127+273)/(227+273) = 1 - (400/500) = \frac{1}{5}$

$W = \eta Q_1 = \frac{1}{5} \times 10^4$

$= 2000\ J$

2025-2026
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XI-A

Thermodynamics.

Q1. Ideal gas is taken through a cyclic process. The net heat supplied to the system is 200 J. What is the network done by gas.

Sol:

$\Delta U = 0$ (for cyclic)

$\Delta U = Q - W$

So $0 = Q - W \Rightarrow W = Q$.

$W = 200\,J$

Q2. One mole of an ideal gas expands at temperature 300K from volume V to 2V. Find work done.
($R = 8.314\,J/mol$).

Sol:

$W = nRT \ln\left(\frac{V_2}{V_1}\right)$

$W = 1 \times 8.314 \times 300 \times \ln(2)$

$W = 8.314 \times 300 \times 0.693$

$1.73 \times 10^3\,J$

Q3. Heat engine absorbs 600 J of heat and does 150 J of work. Find its efficiency.

Sol:

$$\eta = \frac{W}{Q_h}$$

$$\eta = \frac{150}{600} = 0.25 .$$

$\eta = 25\%$

CamScanner

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2025-26

Thermodynamics

Q. A Thermodynamic system is taken from an initial state A to another state B & back to A through a circular path. The work done by the system in one cycle is:

Sol: In a PV diagram, the work done in a cyclic process is numerically equal to the area enclosed by the loop. ∴ area of circle

Q. 5 moles of an ideal gas are kept at a constant volume. 100J of heat is supplied, raising the temp by 2K. What is the molar specific heat of the gas at constant pressure: [R = 8.3 J/mol·K] [JEE Main 2025]

Sol: $\Delta Q = n C_v \Delta T$

$\Delta Q = 100J$, $n = 5$ $\Delta T = 2K$

$100 = 5 \times C_v \times 2$

$C_v = 10 J/mol \cdot K$

For p (Mayer's Formula)

$C_p = C_v + R$

$C_p = 10 + 8.3$

$C_p = 18.3 J/mol \cdot K$

Q. If pressure of a gas is increased by 4 times & the temp. is doubled the mean free path (λ) becomes:
[JEE Main 2024]

Sol: Mean free path formula: $\lambda = \frac{RT}{\sqrt{2}\pi d^2 N_A P}$

$\lambda \propto \frac{T}{P}$

Temp → doubled = 2T

Pressure → increased 4 times = 4P

$\lambda' \propto 2T/4P$

$\lambda' \propto 1/2 (T/P)$

$\lambda' = \lambda/2$

Ans: $\lambda/2$

Q.) An ideal gas at Pressure 'P' and temperature 'T' is expanding such that $PT^3 = \text{constant}$. The coefficient of volume expansions of gas is —

(A) $2/T$ (B) $1/T$

(C) $3/T$ (D) $4/T$

Ans: $P = \frac{nRT}{V}$

$\left(\frac{nRT}{V}\right) T^3 = \text{constant}$

$\frac{T^4}{V} = \text{constant}$

$V = KT^4$

$\frac{dV}{dt} = 4KT^3 \frac{dT}{dt}$

$\gamma = \frac{1}{V}\frac{dV}{dt}$

$\boxed{\gamma = 4/T}$

Q.) Heat supplied to a diatomic gas at constant ~~Temperature~~ pressure. The ratio: $\Delta Q : \Delta U : \Delta W$ is —

Ans $f = 5$

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

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

$\Delta Q = n C_P \Delta T = n \frac{7}{2} R \Delta T$

$\Delta U = n C_V \Delta T = n \frac{5}{2} R \Delta T$

$\Delta W = nR\Delta T = n\left(\frac{2}{2}\right) R\Delta T$

$\Delta Q : \Delta U : \Delta W = \boxed{7:5:2}$.

Q.) A diatomic gas ($\gamma = 1.4$) does 100 J of work when it's expanded isobarically Then the heat given to the gas ___ J

Ans : $Q = \Delta U + W$

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

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

$W = n R \Delta T = 100 J$

$\Delta U = n C_V \Delta T = \frac{5}{2} \times 100 = 250 J$

$Q = 250 + 100 = \boxed{350 J}$

Saanvi Patel
2025-26

Thermodynamics

Q A Carnot engine operating between temperatures T_1 and T_2 has efficiency $\frac{1}{6}$, when T_2 is lowered by 62K, it efficiency increases to $\frac{1}{3}$. Then T_1 and T_2 are.

⇒ The efficiency of carnot engine,

$$\eta = 1 - \left(\frac{T_2}{T_1}\right) \qquad \frac{T_2}{T_1} = \frac{5}{6}$$

$$\boxed{\eta = \frac{1}{6}} \qquad T_1 = \frac{6T_2}{5} \longrightarrow (1).$$

T_2 is lowered by 62K ; efficiency become $\frac{1}{3}$

$$\eta = \left[1 - \left(T_2 - \frac{62}{T_1}\right)\right]\left[T_2 - \frac{62}{T_1}\right]$$

$$\frac{5(T_2 - 62)}{6T_2} = \frac{2}{3}$$

$$5T_2 - 310 = 4T_2$$

$$\boxed{T_2 = 310K} \longrightarrow \text{Ans}$$

$$T_1 = \frac{6 \times 310}{5}$$

$$\boxed{T_1 = 372K} \longrightarrow \text{Ans}$$

CamScanner

Q 100g of water is heated from 30°C - 50°C. Ignoring the slight expansion of the water, the change in its internal energy is.
(Specific heat of water is 4184 J/KgK)

$\Rightarrow \Delta q = ms\Delta T$

$m = 100g = 100 \times 10^{-3} kg$

$s = 4184\ J/kgK$

$\Delta T = (50 - 30) = 20°C$

$\Delta q = 100 \times 10^{-3} \times 4184 \times 20$

$\Delta q = 8.4 \times 10^{3} J$

$\Delta q = \Delta U + \Delta W$

change in internal energy

$\Delta U = \boxed{\Delta q = 8.4\ kJ}$ ⟵ Ans

Q The work of 146 kJ is performed in order to compress one-kilo mole of gas adiabatically and in this process the ~~the~~ temperature of the gas increases by 7°C. The gas is (R = 8.3 J/K mol

$\Rightarrow \Delta q = \Delta W + \Delta U$

$0 = \Delta U + \Delta W \rightarrow \Delta U = -\Delta W \rightarrow nC_v\Delta T = -\Delta W$

$C_v = -\Delta W / n\Delta T = \dfrac{[-146 \times 10^3]}{(1 \times 10^3) \times 7} = 20.8\ J/mol\,K$

$\therefore$ Gas is diatomic ⟵ Ans

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2025-2026

Q1) A lead bullet when stopped by a target, just melts. If 25% of heat is absorbed by the target then the velocity of bullet will be if its initial temperature is 27°C. Melting point of lead = 327°, specific heat of lead = 0.03 cal/gm/°C, latent heat of fusion of lead = 6 cal/gm.

A) $Q = \frac{W}{J}$

$$mL + ms(q_2 - q_1) = \frac{mv^2}{2J} \times \frac{75}{100}$$

$$\frac{75v^2}{2 \times 4.2 \times 10^7} = 6 + 0.03\,(327 - 27)$$

$$v^2 = 16.8 \times 10^8\ (cm/s)^2$$

$$v = 4.098 \times 10^4\ cm/s$$

∴ Velocity of bullet initially at 27°C was 4.098×10^4 cm/s

Q2) A gas is taken from state A to B along two different paths, calculate work done in (i) and difference from (ii) without calculating?

i) Isobaric expansion at $P = 2 \times 10^5$ Pa from $V = 1m^3$ to $V = 3m^3$

ii) First isochoric, then isobaric expansion at lower pressure.

A) Work in Path 1 (isobaric):

$$W = P\Delta V = 2 \times 10^5 (3 - 1)$$

$$= 4 \times 10^5\ J\ //$$

Work = Area under PV curve

Path 2 occurs partly at lower pressure

⇒ Area under curve is smaller

∴ Work in Path 2 is less than 4×10^5 J //

Q3) An ideal gas undergoes following cycle:

A → B: Isothermal expansion at T = 400 K, volume doubles

B → C: Isochoric cooling to T = 200 K

C → A: Isobaric compression back to initial state

Given, n = 1, R = 8.314

Find net work done in the cycle.

A) Work in $A \to B$ (Isothermal)

$$W_{AB} = nRT\ln\left(\frac{V_B}{V_A}\right)$$

$$= 1 \times 8.314 \times 400 \times \ln(2)$$

$$= 332.6 \times 0.0693$$

$$\sim 3304\ J$$

Work in $B \to C$ (Isochoric)

$$W_{BC} = 0$$

Work in $C \to A$ (Isobaric)

At A:

$$P_A V_A = nRT_A = 8.314 \times 400$$

At C:

$$P_A V_C = 8.314 \times 200$$

Isobaric $\Rightarrow$ Pressure is constant

$$P_C = \frac{8.314 \times 200}{V_B}$$

$$P_C = \frac{8.314 \times 200}{2V_A}$$

Work:

$$W_{CA} = P(V_A - V_B)$$

$$= \frac{8.314 \times 200}{2V_A}(V_A - 2V_A)$$

$$= 8.314 \times 100(-1)$$

$$= -831.4\ J$$

Net Work:

$$W_{net} = 2304 + -831.4\ J$$

$$= 1472.6\ J //$$

$\therefore$ Net Work of the cycle $= 1.9726 \times 10^3$ //