YAKEEN NEET 2.0

2026

Thermodynamics & Thermochemistry

Physical Chemistry | Lecture -5

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Topics to be covered

1. Revision of Last Class
2. Poison ratio, q,w In different processes and numericals
3. Home work from Modules, Magarmach Practice Questions

Rules to Attend Class

1. Always sit in a peaceful environment with headphone and be ready with your copy and pen.
2. Never ever attend a class from in between or don't join a live class in the middle of the chapter.
3. Make sure to revise the last class before attending the next class & always complete your Magarmach Practice Questions.
4. Never ever engage in chat whether live or recorded on the topic which is not being discussed in current class as by doing so u can be blocked by the admin team or your subscription can be cancelled.

Rules to Attend Class

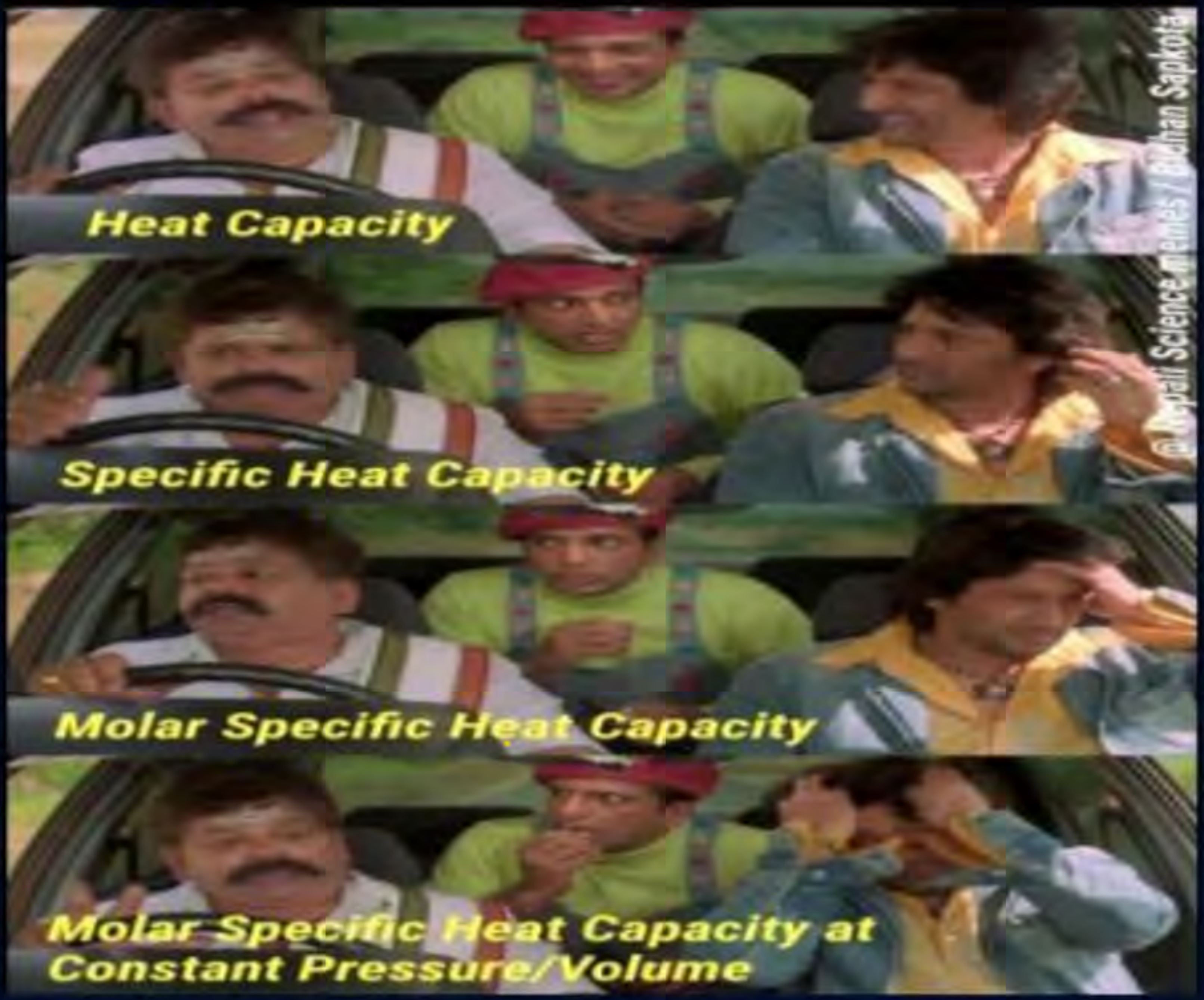
5. Try to make maximum notes during the class if something is left then u can use the notes pdf after the class to complete the remaining class.
6. Always ask your doubts in doubt section to get answer from faculty. Before asking any doubt please check whether same doubt has been asked by someone or not.


There is one big flaw in your Preparation that's name is Backlog ? What do we say to Backlog ?
NOT TODAY !!!

Revision of Last Class

$\Delta H = \Delta U + P\Delta V$ or $\Delta n_g RT$ or $n R \Delta T$

Heat Capacity (C)



$C = \frac{\delta q}{dT}$

mass

Total system → C_P, C_V

1g → $C_{s,P}$, $C_{s,V}$

1 mole → $C_{P,m}$ ✓, $C_{V,m}$

1 mole

$$C_p = \frac{dH}{dT}$$

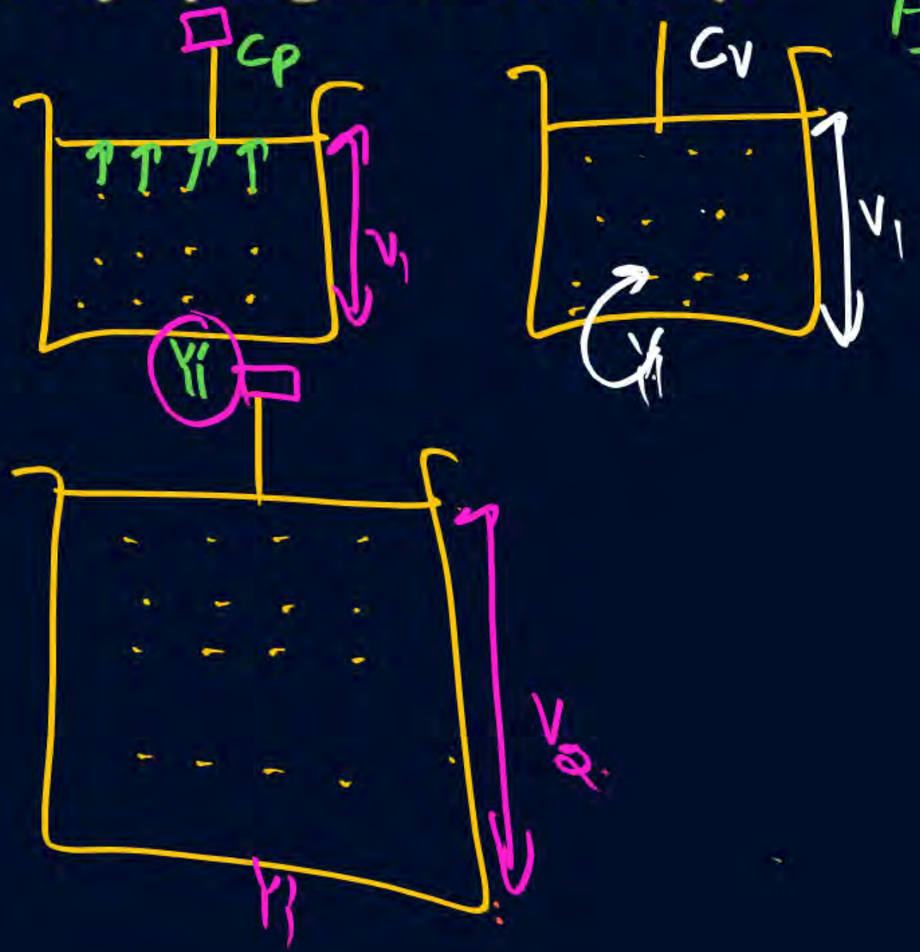
$$\Delta H = n C_{p,m} \Delta T$$

$$C_v = \frac{dU}{dT}$$

$$\Delta U = n C_{v,m} \Delta T$$

QUESTION

Why C_P is greater than C_V?



Ans :- at Constt. Pressure
Some heat waste in doing work
∴ More heat req. to raise temp. 1°C.

at Constt. Volume
all heat is used to inc. temp
∴ less heat req. to raise temp 1°C.

$$C_p - C_v = \frac{dH}{dT} - \frac{dU}{dT} = \frac{dH - dU}{dT} = \frac{dU + PdV - dU}{dT} = \frac{PdV}{dT} = nR$$

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$$\boxed{\begin{aligned} &C_p - C_v = nR \\ &C_{p,m} - C_{v,m} = R \end{aligned}}$$

$$C_p = n C_{p,m}$$

$$C_v = n C_{v,m}$$

$$n C_{p,m} - n C_{v,m} = nR$$

$$PV = nRT$$

$$PdV = nRdT$$

$$\frac{PdV}{dT} = nR$$

QUESTION – (NEET 2021)

Which one among the following is the correct option for right relationship between C_P and C_V for one mole of ideal gas?

(A) $C_P - C_V = R$

(B) $C_P = R\,C_V$

(C) $C_V = R\,C_P$

(D) $C_P + C_V = R$

$C_P = 1 C_{P,m}$ $\quad C_{P,m} - C_{V,m} = R$

$C_V = 1 C_{V,m}$ $\quad C_P - C_V = R$

QUESTION – (AIIMS 2017)

$q_V = \Delta U$ $q_P = \Delta H$

The molar heat capacity of water at constant pressure is 75 J K^{-1} mol^{-1}. When 1 kJ of heat is supplied to 100 g of water, which is free to expand, the increase in temperature of water is:

$C_{P,m} = 75\ J\ K^{-1} mol^{-1}$ $\Delta T = ?$

(A) 6.6 K

(B) 1.2 K

(C) 2.4 K ✓

(D) 4.8 K

$q = 1000\ J = \Delta H = n C_{P,m} \Delta T$

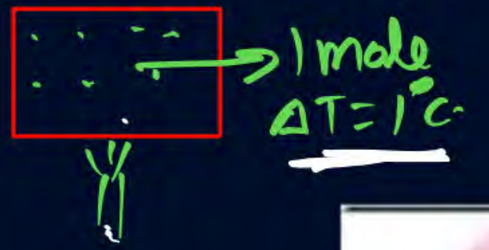
$w_{H_2O} = 100\ g$

$n_{H_2O} = \frac{100}{18} = 5.55$

$1000 = \frac{100}{18} \times 75 \times \Delta T$

$\Delta T = \frac{12}{5} = 2.4\ K$

Poison Ratio (γ)



$\frac{3}{2} \times \frac{25}{3} = 12.5\ J K^{-1} mol^{-1}$

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① $\gamma = \frac{C_{p,m}}{C_{v,m}}$

② γ tells us about atomicity of molecule

③ Monoatomic gas :- He, Ne, Ar, Kr, Xe etc.

$C_{v,m} = \frac{3}{2}R$, $C_{p,m} = \frac{3}{2}R + R = \frac{5}{2}R$

$\gamma = \frac{\frac{5}{2}R}{\frac{3}{2}R} = 1.66$

④ Diatomic gas :- O_2, N_2, Cl_2

$C_{v,m} = \frac{5}{2}R$, $C_{p,m} = \frac{5}{2}R + R = \frac{7}{2}R \Rightarrow \gamma = \frac{\frac{7}{2}R}{\frac{5}{2}R} = 1.4$

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⑤ O_3 (CH_4, CO_2)

Triatomic gas or Polyatomic gas

$C_{v,m} = 3R$, $C_{p,m} = 3R + R = 4R \Rightarrow \gamma = \frac{4R}{3R} = 1.33$

⑥ for mixture of gas $\Rightarrow \gamma_{mix.} = \frac{C_{p,m}\ mix.}{C_{v,m}\ mix.}$

$C_{v,m}\ mix. = \frac{n_1 C_{v_1} + n_2 C_{v_2}}{n_1 + n_2}$ | $C_{p,m}\ mix. = \frac{n_1 C_{p_1} + n_2 C_{p_2}}{n_1 + n_2}$

$C_{v,m}\ mix. = C_{v,m}$ of gas (if same moles & same atomicity gases are mixed)

$C_{p,m}\ mix. = C_{p,m}$ of gas (~~~~~~~~)

$\gamma_{mix} = \gamma$ of gas (~~~~~~~~)

QUESTION – (AIPMT 2012)

Equal volumes of two monoatomic gases, A and B, at same temperature and pressure are mixed. The ratio of specific heats (C_p/C_v) of the mixture will be:

A 0.83

B 1.50

C 3.3

D 1.67

Work, Enthalpy, Internal Energy & Heat in various Process

ln = natural log = $\log_e$

Isothermal Reversible Expansion of Ideal Gas

$\ln = 2.303 \log_{10}$

$\int \frac{dx}{x} = \ln x$

$$\delta w = -P_{ext} dV$$

$$P_{ext} \approx P_{int} = P_{gas}$$

$$PV = nRT \Rightarrow P_{gas} = \frac{nRT}{V}$$

$$\int \delta w = -nRT \int_{V_1}^{V_2} \frac{dV}{V}$$

$$w = -nRT [\ln V]_{V_1}^{V_2}$$

$$w = -nRT \ln \frac{V_2}{V_1}$$

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Isothermal Reversible expansion of Ideal gas:

① $w = -nRT\ln\left(\frac{V_2}{V_1} \text{ or } \frac{P_1}{P_2}\right)$

$= -2.303\, nRT \log\left(\frac{V_2}{V_1} \text{ or } \frac{P_1}{P_2}\right)$

② $\Delta U = nC_{v,m}\Delta T = 0$

$\Delta T = 0$

③ $q = -w$

④ $\Delta H = nC_{p,m}\Delta T = 0$

$\Delta T = 0$

⑤ Iso. Rev. Compression of Ideal gas: Sign Change

$PV = nRT$

$PV = K$

$P_1V_1 = K \mid P_2V_2 = K \Rightarrow P_1V_1 = P_2V_2$

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

$\Delta T = 0 \Rightarrow \Delta U = 0$

$\Delta U = q + w$

$\Delta U = 0$

$q = -w$

Isothermal Irreversible Expansion of Ideal Gas

$\Delta U = q + w$

$q = -w$

$w = -P_{ext}\,\Delta V$

$w = -P_{ext}(V_2 - V_1)$

$V_2 = \frac{nRT}{P_2}$

$V_1 = \frac{nRT}{P_1}$

$= -P_{ext}\left(\frac{nRT}{P_2} - \frac{nRT}{P_1}\right)$

$P_{ext} = P_2$

$= -nRT\left(\frac{P_{ext}}{P_2} - \frac{P_{ext}}{P_1}\right)$

$w = -nRT\left(1 - \frac{P_2}{P_1}\right)$

① $w = -nRT\left(1 - \frac{P_2}{P_1}\right)$

② $\Delta U = nC_{v,m}\Delta T = 0$

③ $\Delta H = nC_{p,m}\Delta T = 0$

④ $q = -w$

⑤ Isothermal irr. Compression of Ideal gases → sign change

Free Expansion of An Ideal Gas

(Vaccum $P_{ext} = 0$)

↓

Isothermal or adiabatic

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1. $w = -P_{ext} \cdot \Delta V = 0$
2. $\Delta U = 0$
3. $\Delta H = 0$
4. $q = 0$

Isochoric Process

$\Delta V = 0$

$W = 0$

$\Delta U = n C_{v,m} \Delta T$ ✓

$\Delta H = n C_{p,m} \Delta T$ ✓

Isobaric Process

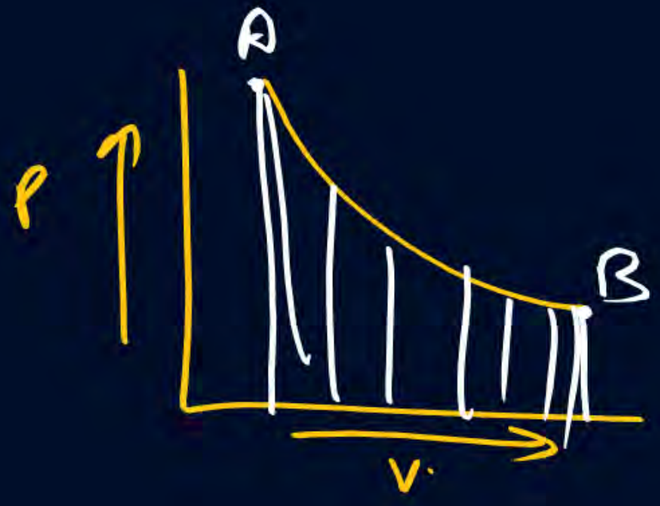
$\Delta U = n C_{v,m} \Delta T$

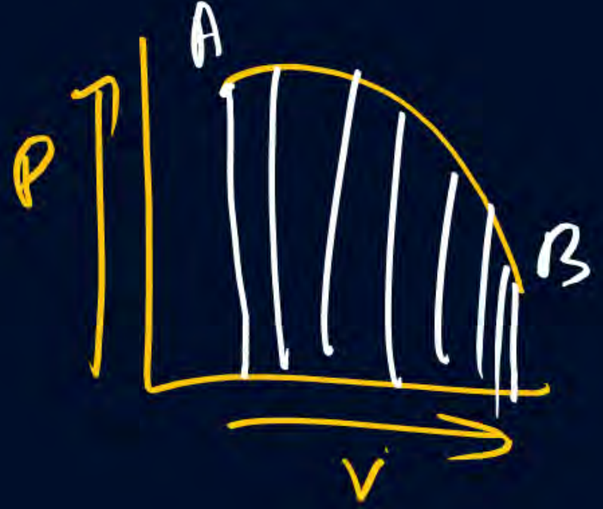
$\Delta H = n C_{p,m} \Delta T$

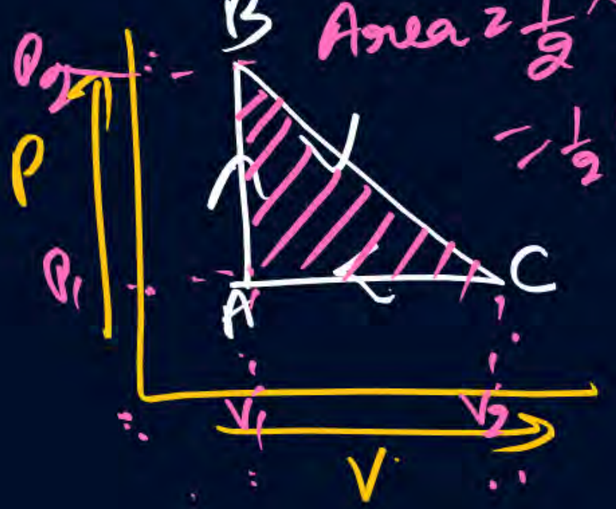
$W = -P_{ext} \cdot \Delta V$

#IIT

Work done in P-V graph = Area under the Curve





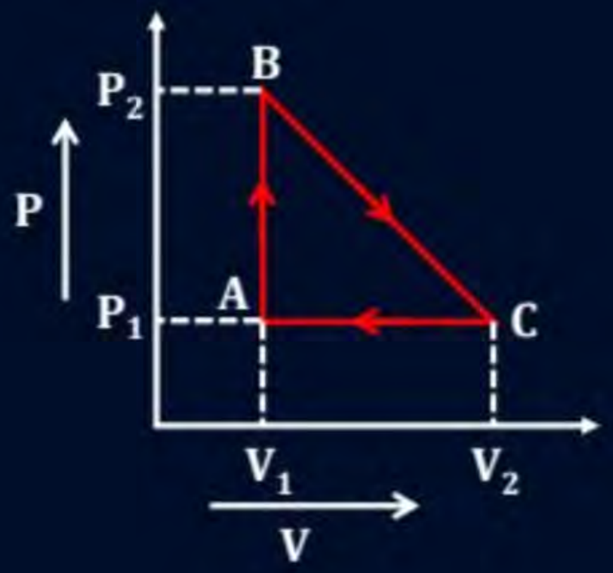


Area = $\frac{1}{2} \times AC \times AB$

$= \frac{1}{2}(V_2 - V_1)(P_2 - P_1)$

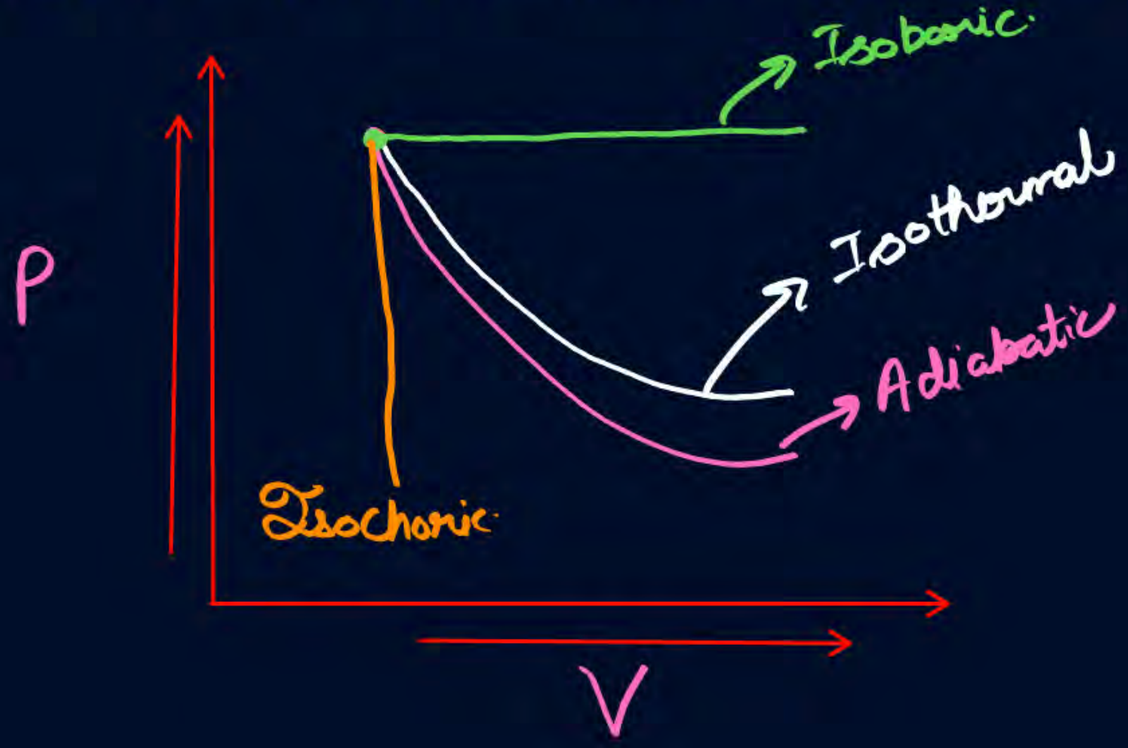
QUESTION

Work done in P – V graph



QUESTION

Work done in various different Process in P – V graph:



Isothermal

$PV = K$

$xy = K$

$P\,dV + V\,dP = 0$

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

Adiabatic

$PV^{\gamma} = K$

$\gamma > 1$

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

#MIT

BaTAch.

Iso Baric

Iso Thermal

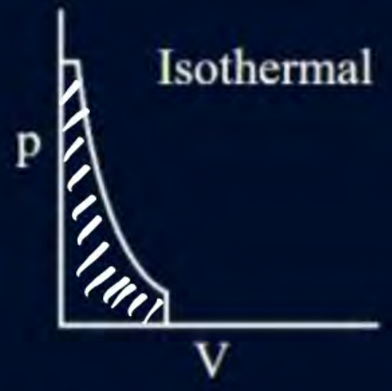
Adiabatic

Iso Chooric

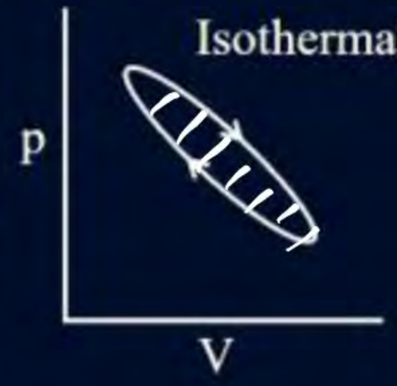
QUESTION – (NEET 2022)

Which of the following p-V curve represents maximum work done?

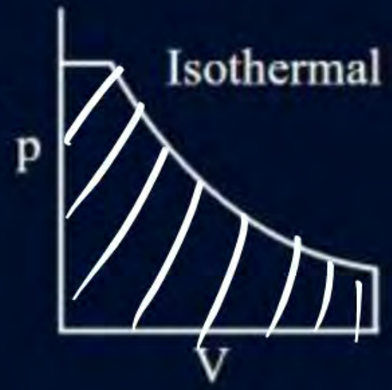
A



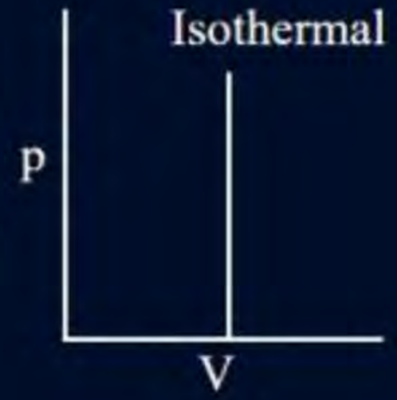
B



C



D



QUESTION – (AIIMS 2018, 27 May)

Assertion: In Free expansion, $\Delta U=0$

Reason: No work is done in free expansion.

A. If both Assertion and Reason are correct and the Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is correct but Reason is incorrect.

D. If both the Assertion and Reason are incorrect.

QUESTION – (NEET 2024)

The work done during reversible isothermal expansion of one mole of hydrogen gas at 25^0C from pressure of 20 atmosphere to 10 atmosphere is:
(Given R= 2.0 Cal K^{-1} Mol^{-1})

A. 0 calorie

B. – 413.14 calorie

C. 413.14 calorie

D. 100 calorie

$n = 1 (H_2)$

$T = 298\ K$

$P_1 = 20\ atm$

$P_2 = 10\ atm$

$R = 2\ Cal\ K^{-1}\ mol^{-1}$

$\log 2 = 0.3$

$$w = -2.3 \times 1 \times 2 \times 298 \log \frac{20}{10}$$

$$= -2.3 \times 596 \times 0.3$$

$$= -69 \times 596\ Cal$$

$$= -413.14\ Cal$$

QUESTION – (AIIMS 2018, 26 May)

$\log m^n = n \log m$

1 mole of an ideal gas expands isothermally and reversibly from 2 lit to 4 lit and 3 moles of same gas expand from 2 lit to x lit and doing same work, what is 'x'?

(A) $(8)^{1/3}$

(B) $(4)^{2/3}$

(C) 2

(D) 4

$n = 1$

$V_1 = 2\,L$

$V_2 = 4\,L$

$W = -nRT \ln \frac{V_2}{V_1}$

$n' = 3$

$V_1' = 2\,L$

$V_2' = x\,L$

$W' = -n'RT \ln \frac{V_2'}{V_1'}$

$+1 \times RT \ln \frac{4}{2} = +3RT \ln \frac{x}{2}$

$\ln 2 = \ln \left(\frac{x}{2}\right)^3$

$2 = \frac{x^3}{8}$

$x^3 = 16$

$x = (16)^{1/3}$

$= (4^2)^{1/3} = (4)^{2/3}$

QUESTION – (NEET 2019)

Under isothermal condition, a gas at 300 K expands from 0.1 L to 0.25 L against a constant external pressure of 2 bar. The work done by the gas is:
(Given that 1 L bar = 100 J)

(A) −30 J

(B) 5 kJ

(C) 25 J

(D) 30 J

$T = 300\ K$

$V_1 = 0.1\ L$

$V_2 = 0.25\ L$

$P_{ext} = 2\ bar$

Irr. Iso exp

$W = -P_{ext} \cdot \Delta V$

$= -2(V_2 - V_1)$

$= -2(0.25 - 0.1)$

$= -2 \times 0.15\ L\ bar$

$= -0.3\ L\ bar$

$= -0.3 \times 10^2\ J$

$= -30\ J$

QUESTION – (AIIMS 2011, 2013)

$\Delta T = 0$
$\Delta U = 0$

$\Delta U = q + w$
$q = -w$

Assertion: For an isothermal reversible process Q = –W i.e. work done by the system equals to the heat absorbed by the system.
Reason: Enthalpy change (ΔH) is zero for isothermal process.

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

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

(C) If Assertion is correct but Reason is incorrect.

(D) If both the Assertion and Reason are incorrect.

QUESTION – (AIIMS 2010)

One mole of an ideal gas at 300 K is expanded isothermally from an initial volume of 1 litre to 10 litres. The value of ΔU for this process is:
($R = 2$ cal mol^{-1} K^{-1})

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

$\Delta U = 0$
$\Delta T = 0$

(A) 163.7 cal

(B) zero

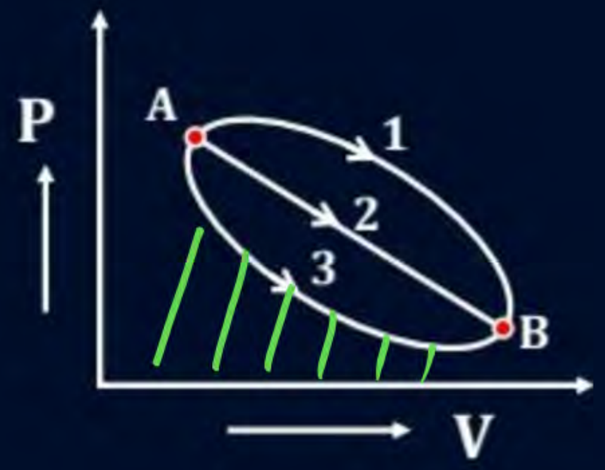
(C) 138.1 cal

(D) 9 litre atm

QUESTION

A given mass of gas expansion reversibly from state A to state B by three path 1, 2 and 3. Compare work done in the three paths.

$W_1 > W_2 > W_3$



Q. JEE advance:
2 moles of Ideal gas expand isothermally & reversibly from 1L to 10L at 300K. what is enthalpy change.

$\Delta H = n C_{p,m} \Delta T$

(a) 4.98 KJ

(b) 11.47 KJ

(c) −11.47 KJ

(d) 0 KJ

JEE Mains.

Q. A piston filled with 0.04 mol of Ideal gas expands reversibly from 50ml to 375ml at constt. T of 37°C. As it does so, it absorbs 208 J of Heat. Value of q & w

$C_R = 8.314\ J\ K^{-1}\ mol^{-1}$

$\ln 7.5 = 2.01$

Rev. Iso. exp.

$n = 0.04$

$V_1 = 50ml$

$V_2 = 375ml$

$T = 310K.$

$q = 208\ J$

$q = -w$

$w = -208\ J$

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

(a) $q = +208J,\ w = -208J$

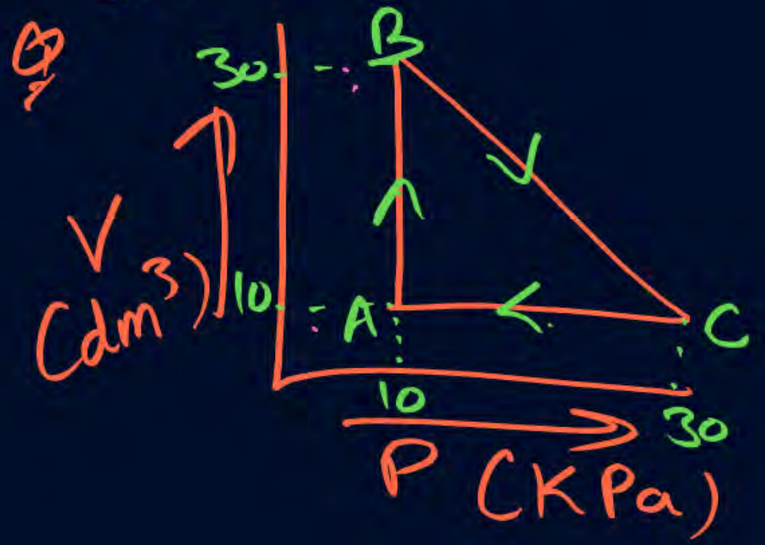
(b) $q = -208\ J,\ w = -208\ J$

(c) $q = -208J,\ w = +208J$

(d) None of these.

JEE mains 2024

Q



Total work done

$$W = \frac{1}{2} AC \times AB$$

$$= \frac{1}{2} \times 20000 \times \frac{20}{1000}$$

$$= 200\ J$$

$20\ dm^3$

$\frac{20}{1000}\ m^3$

Magarmach Practice Questions (MPQ)

QUESTION – [NCERT : PL-142 | JEE Mains April 4, 2025 (1)]

One mole of an ideal gas expands isothermally and reversibly from 10 dm^3 to 20 dm^3 at 300 K. ΔU, q and work done in the process respectively are : Given: R = 8.3 JK^{-1} and mol^{-1}

In 10 = 2.3

log 2 = 0.30

log 3 = 0.48

(A) 0,21.84 kJ, –1.26 kJ

(B) 0, –17.18 kJ, 1.718 J

(C) 0,21.84 kJ, 21,84 kJ

(D) 0,1.78 kJ,–1.718 kJ

QUESTION* – (NCERT Exemplar)

For an ideal gas, the work of reversible expansion under isothermal condition can be calculated by using the expression $w = -nRT\ln\frac{V_f}{V_i}$. A sample containing 1.0 mole of an ideal gas is expanded isothermally and reversibly to ten times of its original volume, in two separate experiments. The expansion is carried out at 300 K and at 600 K respectively. Choose the correct option.

A Work done at 600 K is 20 times the work done at 300 K.

B Work done at 300 K is twice the work done at 600 K.

C Work done at 600 K is twice the work done at 300 K.

D $\Delta U = 0$ in both cases.

QUESTION

The value of enthalpy change (ΔH) for the reaction:

$CH_3OH(l) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(l)$

at 27°C is –1366.5 kJ mol^{-1}. The value of internal energy change for the above reaction at this temperature will be

A –1371.5 kJ

B –1369.0 kJ

C –1364.0 kJ

D –1361.5 kJ

QUESTION

Work done during isothermal reversible expansion of one mole of an ideal gas from 10 atm to 1 atm at 300 K is:

A 4938.8 J

B 4138.8 J

C –5744.1 J

D –6257.2 J

QUESTION* – (NCERT Exemplar)

Consider the following reaction between zinc and oxygen and choose the correct options out of the options given below:

$2\,Zn(s) + O_2(g) \rightarrow 2\,ZnO(s)$; $\Delta H = -693.8\ kJ\ mol^{-1}$

(A) The enthalpy of two moles of ZnO is less than the total enthalpy of two moles of Zn and one mole of oxygen by 693.8 kJ.

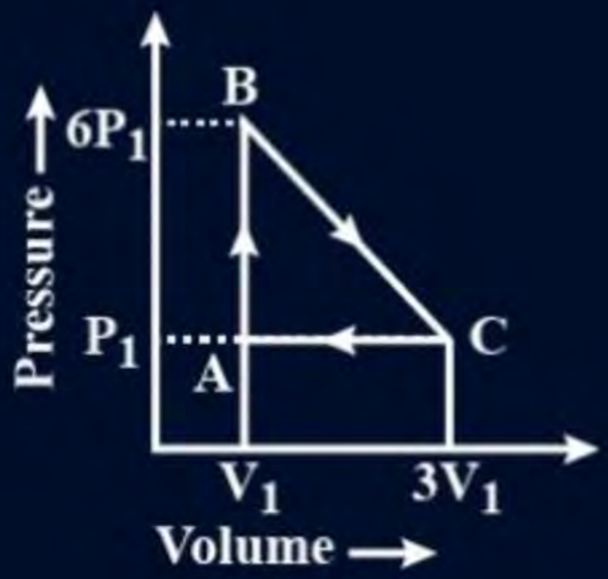
(B) The enthalpy of two moles of ZnO is more than the total enthalpy of two moles of Zn and one mole of oxygen by 693.8 kJ.

(C) 693.8 kJ mol^{-1} energy is evolved in the reaction.

(D) 693.8 kJ mol^{-1} energy is absorbed in the reaction.

QUESTION

An ideal gas is taken around the cycle ABCA as shown in P – V diagram. The net work done during the cycle is equal to:



A $12P_1V_1$

B $6P_1V_1$

C $5P_1V_1$

D P_1V_1

QUESTION [JEE Main 2019, 10 Jan. Shift-II]

An ideal gas undergoes isothermal compression from $5m^3$ to $1\ m^3$ against a constant external pressure of $4\ Nm^{-2}$. Heat released in this process is used to increase the temperature of 1mole of Al. If molar heat capacity of Al is 24 J $mol^{-1}K^{-1}$, the temperature of Al increases by

(A) 3/2 K

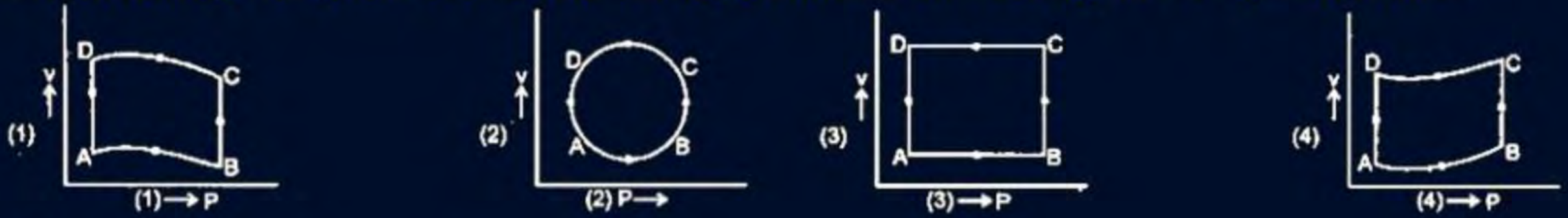
(B) 1 K

(C) 2 K

(D) 2/3 K

QUESTION

In diagram (1 to 4), variation of volume with changing pressure is shown. A gas is taken along the path ABCD. The change in internal energy of the gas will be:



A Positive in all the case (1) to (4)

B Positive in cases (1), (2), (3) but zero in case (4)

C Negative in cases (1), (2), (3) but zero in case (4)

D Zero in all the case

QUESTION

The difference between ΔH and ΔU ($\Delta H - \Delta U$), when the combustion of one mole of heptane (l) is carried out at a temperature T, is equal to

A $-4\ RT$

B $3\ RT$

C $4\ RT$

D $-3\ RT$

THANK YOU