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THERMODYNAMICS

O-I

(5) exp $W < 0$

comp $W > 0$

ice $\longrightarrow$ $H_2O(l)$ H_2O

compⁿ $W>0$ Bi

(7) P, V $2P, V$

$W = 0$

V to $2V$ P

$= -PV$

(3) s $\longrightarrow$ liq $\longrightarrow$ gas

Heat

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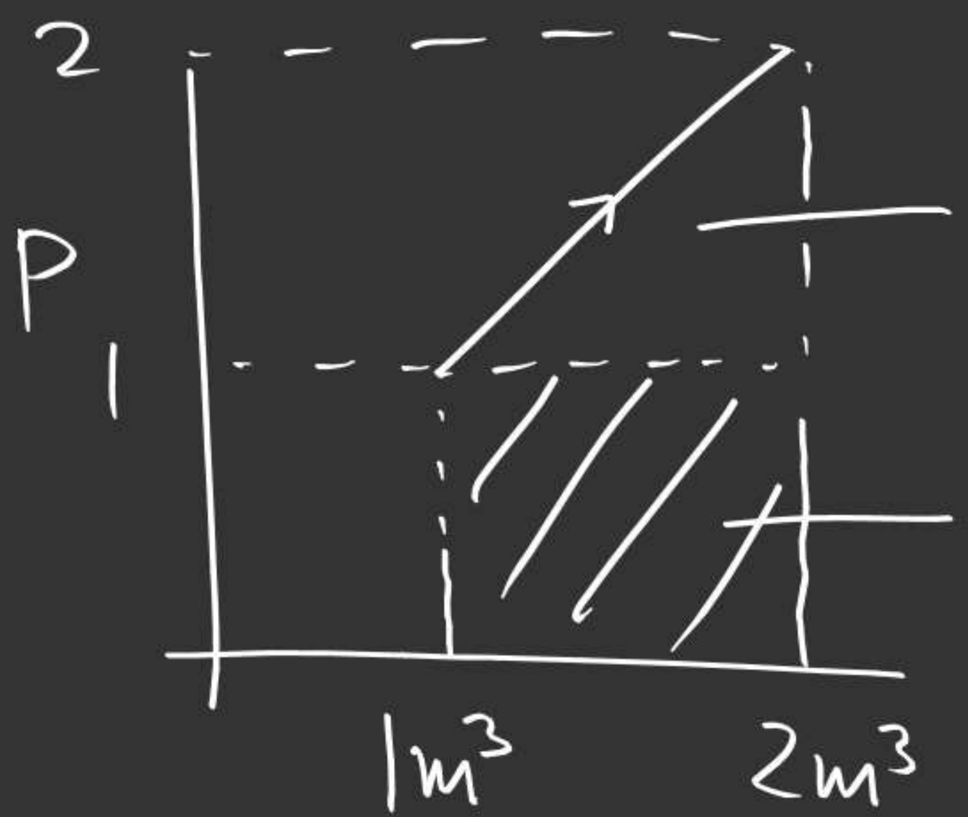
14

$Q = 200\,kJ$



$\frac{1}{2} \times 1 \times 1 \times 10^5 = 50\,kJ$

$10^5\,J = 100\,kJ$

$|W| = 150\,kJ$

$W = -150\,kJ$

$\Delta U = 200 - 150$

$= 50\,kJ$

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$$dU = q + w$$

$$\Delta U = Q + W$$

16

$$nC_v\Delta T = Q$$

n mol

fusion → (melting)

freezing

ΔH_{fusion}

$-\Delta H_{fusion} \times n$

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$q_p = \Delta H = -28$

$\underline{q_v = \Delta U}$

$\Delta H = \Delta U + \Delta n_g RT$

$-28\ \text{kcal} = \Delta U + \frac{1 \times 2 \times 300}{1000}$

$-28 = \Delta U + 0.6$

$\Delta U = -28.6$

$\underline{2X(s)} + \underline{2Y(s)} \rightarrow \underline{2C(l)} + D(g)$

$\Delta n_g = 1$

THERMODYNAMICS

$$C_2H_{4(g)} + HCl_{(g)} \longrightarrow C_2H_5Cl_{(g)} \quad \Delta H = -72.3\ kJ/mol$$

$$-72.3 = \Delta U + \frac{(-1) \times 2 \times 300 \times 8.314}{1000}$$

ΔU

$\frac{70}{28}$ $\quad$ 2 mol

$\boxed{\Delta U \times 2}$

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$\Delta H = \Delta U \qquad \Delta n_g = 0$

-185×3

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2

(i)

(iii)

(IV)

(V) — P

VI — T

(VII) — V

Heat

work

heat capacity

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4 $\quad CaCO_3(s) \longrightarrow CaO(s) + \underline{CO_2(g)}$

$\underline{exp} \qquad w<0$

6 $\quad W = -P_{ext}(V_2 - V_1)$

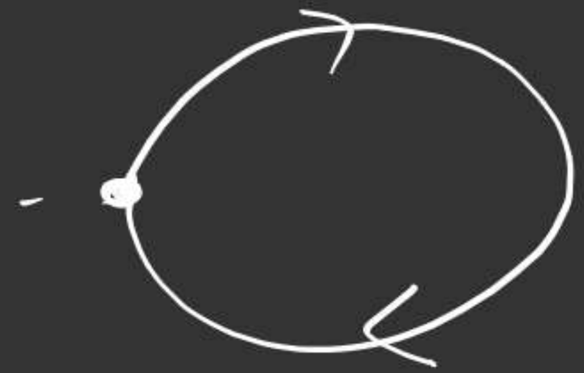
10

$$Q + W = 0$$

$$W = -Q$$

$$W = -24$$

magnitude 24



$$\Delta U = 0 = Q + W$$

$$20\,\text{cal} \times 4.2$$

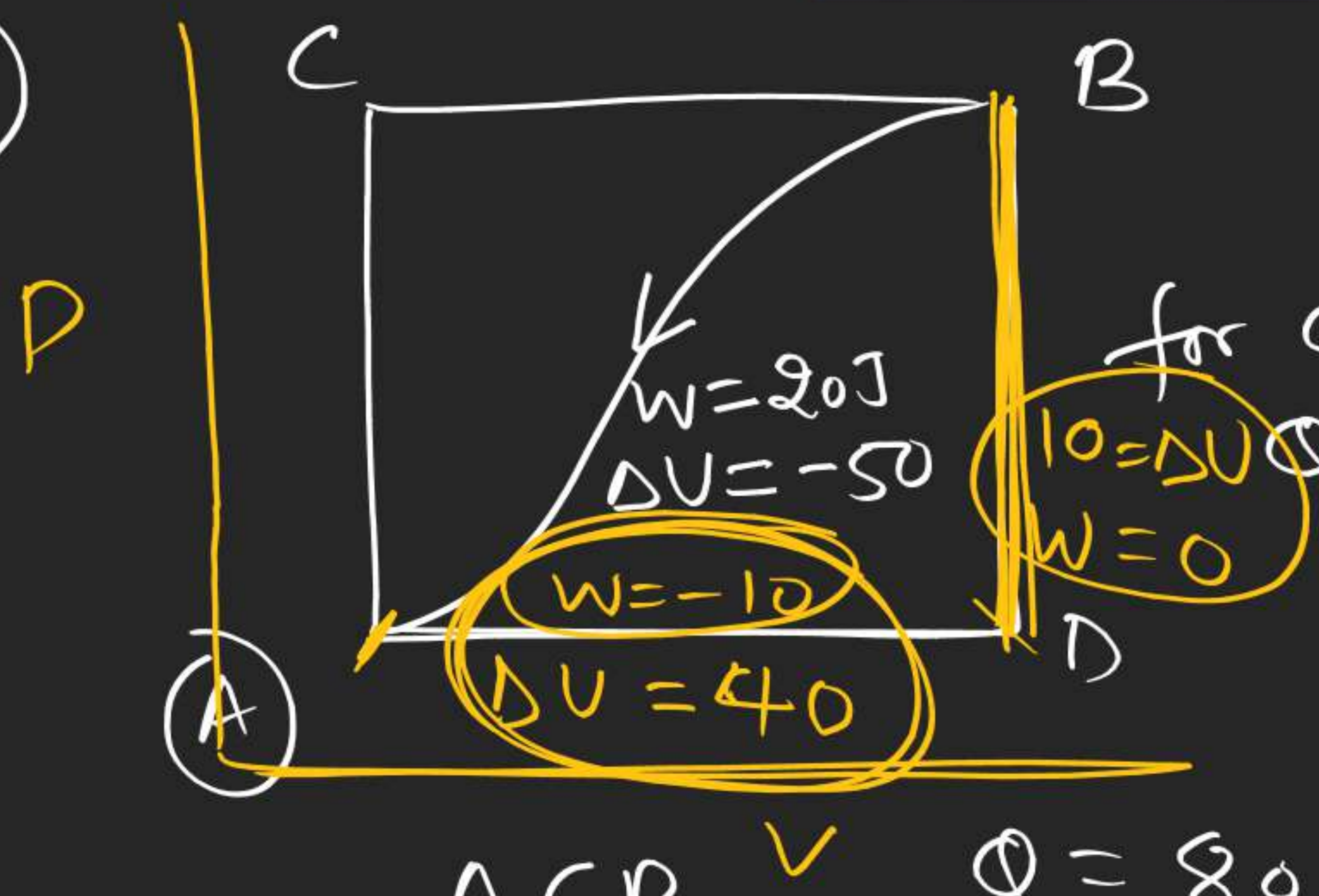
$$= 84\,J$$

$$-60$$

$$Q = 24$$

THERMODYNAMICS

(12)



$\underline{\underline{\Delta U_{AB} = 50\ J}}$

for curve path

$Q = \Delta U - W$

$= -50 - 20 = -70$

$\underline{ACB}$ $\quad Q = 80\ J \quad W = -30\ J \quad \Delta U = 50\ J$

ADB $\quad \Delta U = 50\ J \quad W = -10$

$Q = \Delta U - W$

$= 50 + 10$

$= 60$

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(14)

$$\Delta H = \Delta U + (P_2V_2 - P_1V_1)$$

$$= 30 \text{ atm. lit} + (20-6) \text{ atm}$$

$$=$$

(13)

$$Q_p = 180 \text{ kJ} = \Delta H$$

$$\Delta U = ?$$

$$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$$

34 ml 16 ml 20000 ml

$$\Delta U = Q + W$$

$$= 180 - 2$$

$$= 178$$

$$W = -1 \times \frac{(20000 + \cancel{16 - 34})}{1000}$$

$$= -20 \text{ bar.lit}$$

$$= -2000 \text{ J} = -2 \text{ kJ}$$

THERMODYNAMICS

18

$$\Delta H = \Delta U + (P_2V_2 - P_1V_1)$$

$$\Delta H - \Delta U = +500 \times 10^3 \, \underline{\text{bar}} \, (V_2 - V_1)$$

graphite $\longrightarrow$ diamond

$\frac{12 \text{ gm}}{2}$ $\frac{12 \text{ gm}}{3}$

$= 6 \text{ ml} = V_1$ $4 \text{ ml} = V_2$

6×10^{-3} $4 \times 10^{-3} =$

Cal
J
KJ
bar. lit

Calculation $Q, W, \Delta U$ & ΔH for various Process

(1) Isothermal process

$$Q = \cancel{n} C \Delta T$$

$dT = 0$ $(T = \text{Const})$

for ideal gas $U = f(T)$

$$\Delta U = 0$$

from 1st law $Q = -W$

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Work done

(i) Reversible

$$\ln x = 2.303 \log x$$

$$W = -\int P_{ext}\, dV$$

for a rev process

$$P_{ext} = P \pm dp$$

$$P_{ext} \simeq P$$

$$W = -\int P\, dV$$

$$W = -\int \frac{nRT}{V} dV$$

$$= -nRT \int \frac{dV}{V}$$

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

$$(P_1V_1 = P_2V_2 = nRT)$$

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

$$W = -P_1V_1 \ln \frac{P_1}{P_2}$$

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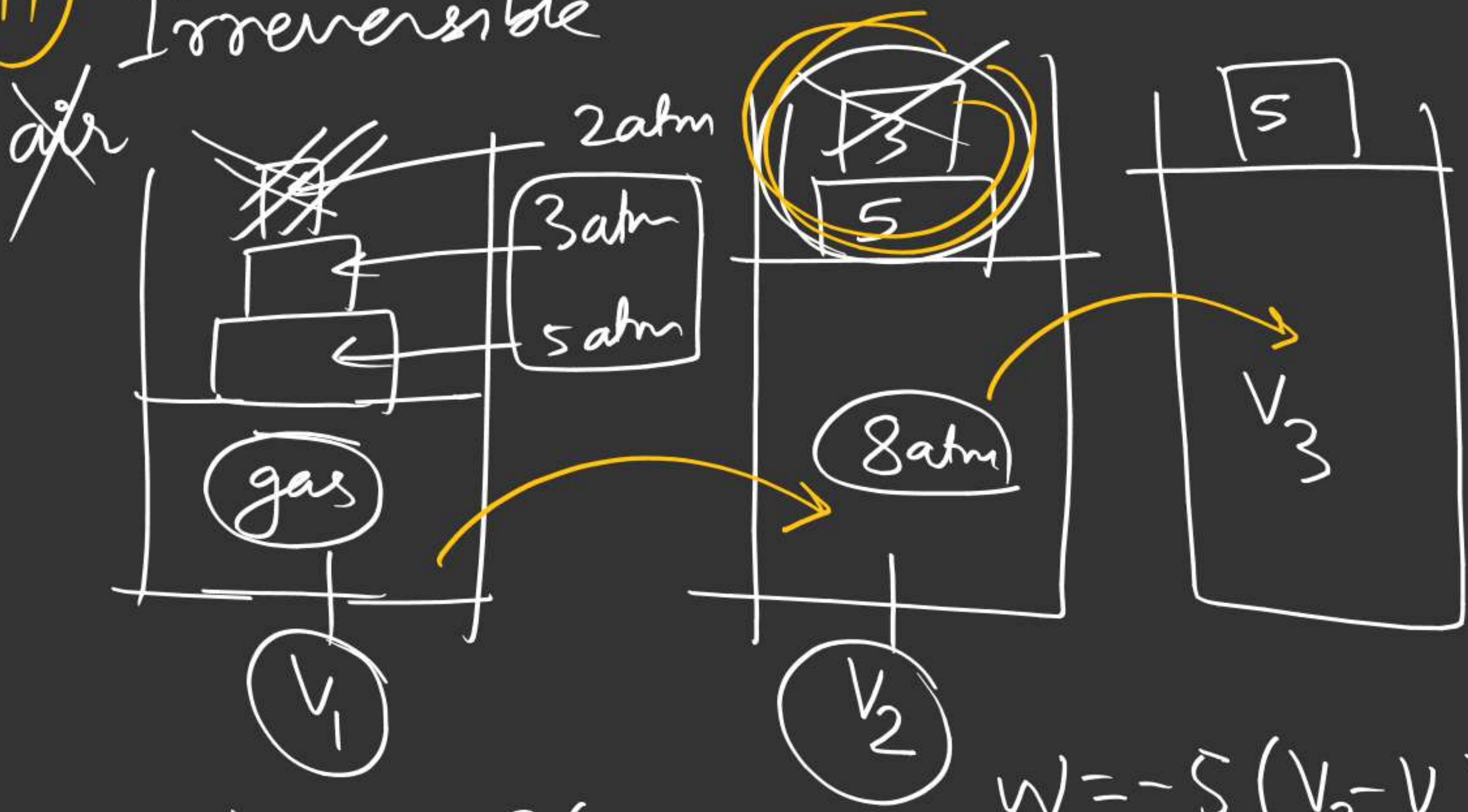
(II) Irreversible



$$W = -\int_{V_1}^{V_2} P_{ext}\, dV$$

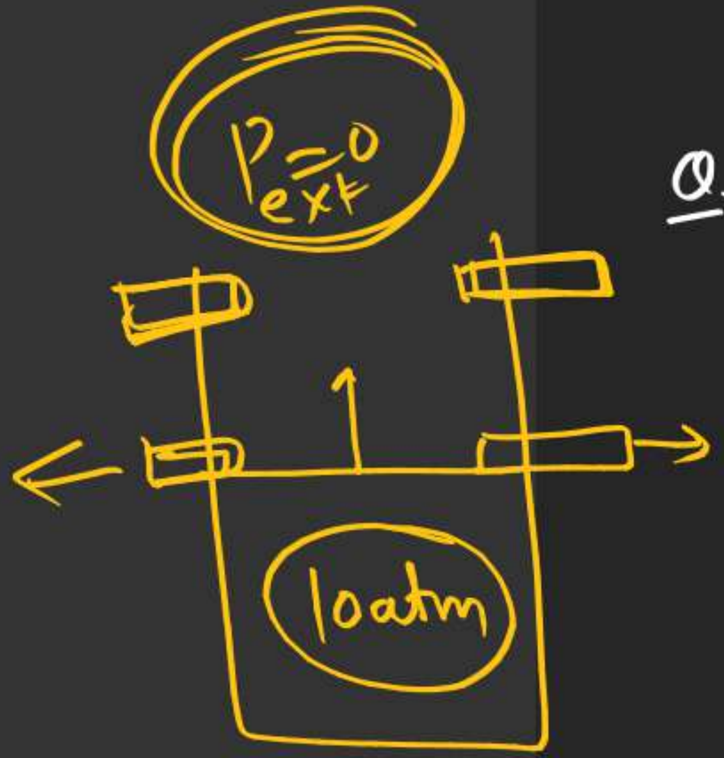
$$= -P_{ext} \int_{V_1}^{V_2} dV$$

$$\boxed{W = -P_{ext}(V_2 - V_1)}$$

$$W_{I} = -8(V_2 - V_1)$$

$$W_{II} = -5(V_3 - V_2)$$

THERMODYNAMICS



Q. Calculate W for 1mol ideal gas undergoing isothermal expansion from 10 atm to 1 atm at 300K.

P_{ext}

If the process is carried out $\ln x = 2.3 \log x$

(i) Reversibly → $W = -2.3\, nRT \log \frac{P_1}{P_2}$

$= -2.3 \times 1 \times R \times 300 \log \frac{10}{1}$

$= -690R$

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

$= -1\left(\frac{1}{1} - \frac{1}{10}\right) \times 1 \times R \times 300 = -270R$

(iii) free expansion → $W = -0(V_2 - V_1)$

$= 0$

$Q = ?$

(i) $Q = 690R$

(ii) $Q = 270R$

(iii) $Q = 0$

$\Delta U = 0$

$\Delta H = 0$

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THERMODYNAMICS

Calculate w for 1 mol ideal gas undergoing compⁿ form 1 atm to 10 atm at 300 K.

(I) Reversibly → $W = -2.3 \times 1 \times R \times 300 \log \frac{1}{10}$

$= 690R$

$P_1V_1 = P_2V_2$

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

$= -10\left(\frac{1}{10} - \frac{1}{1}\right) R \times T$

$= 2700R$

isothermal exp or $comp^n$ against
Const external pressure → irrereversible

0-I 24-28

S-1 19-27