Ans1.

$$\Delta H_{rxn} = \sum v_i \, \Delta H_f^{P} - \sum v_i \, \Delta H_f^{R}$$

C−H = 414 KJ/mol

C−C = 347 KJ/mol

C−Cl = 377 KJ/mol

Cl−Cl = 243 KJ/mol

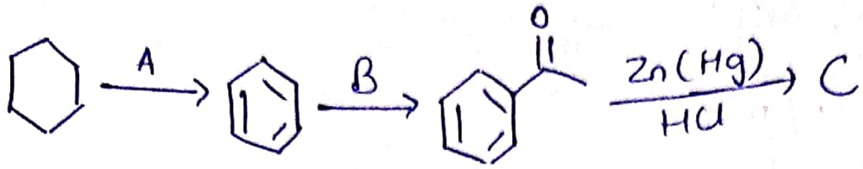
H−Cl = 431 KJ/mol

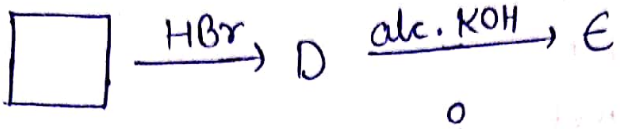
$$\Delta H = 5(C-H) + (C-Cl) + (Cl-Cl) - 4(C-H) - 2(C-Cl) - (H-Cl)$$
$$= 5 \times 414 + 377 + 243 - 4 \times 414 - 2 \times 377 - 431$$
$$= -757 \text{ KJ/mol}$$

Ans2.

| Bulk Polymerization | Solution Polymerization |
|---|---|
| • Due to absence of solvent the mixture becomes highly viscous which cause difficulty in stirring. | • Due to presence of solvent, the mixture is not so much viscous therefore can be stirred easily. |
| • Due to high viscosity, chain termination is difficult | • Chain termination is easier. |
| • We obtain polymer of high molecules wt. distribution. | • No molecular distribution. Almost same type of polymer are made. |
| • The reaction is too vigorous that sometimes lead to explosion area. | • Presence of solvent enables dissipation of heat so chances of explosion are reduced. |
| • Polymer of high quality is obtained. | • Polymer are not pure. |
| • No seperation is required. | • Seperation of solvent and polymer is needed. |
| • We are not using any solvent so process is economical. | • Not so economical. |

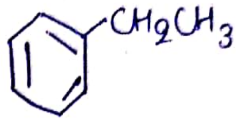
Ans 3.

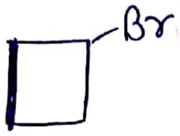


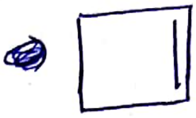




A ⇒ $CrO_3$ / Pt
600°C

B ⇒ $CH_3-\overset{O}{\overset{\|}{C}}-Cl$ + Anhy. $AlCl_3$

C ⇒ 


D ⇒ 


E ⇒ 

Ans 4.

$K_2 = 10000\ s^{-1}$
$K_1 = 4500\ s^{-1}$
$Ea = 58000\ J/mol$
$T_1 = 1°C = 274\ K$
$R = 8.314$

$$\log\left[\frac{K_2}{K_1}\right] = \frac{Ea}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$$\log\left[\frac{10000}{4500}\right] = \frac{58000}{2.303 \times 8.314}\left[\frac{1}{274} - \frac{1}{T_2}\right]$$

$$0.347 = 3019.22\left[\frac{1}{274} - \frac{1}{T_2}\right]$$

$$T_2 = 286.53\ K$$

Ans 5.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

| | $PCl_5$ | $PCl_3$ | $Cl_2$ |
|---|---|---|---|
| moles at t=0 | 0.1 | 0 | 0 |
| at t=t | $0.1 - x$ | $x$ | $x$ |

$$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]}$$

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$$K_c = \frac{[x/5][x/5]}{\left[\frac{0.1-x}{5}\right]} \qquad \left\{ c = \frac{\text{moles}}{\text{volume}} \right\}.$$

$$1.8 \times 5 = \frac{x^2}{0.1-x}$$

$$9 = \frac{x^2}{0.1-x}$$

$$x^2 + 9x - 0.9 = 0$$

$$x = \frac{-9 \pm \sqrt{81+3.6}}{2}$$

$$x = \frac{-9 \pm 9.19}{2}$$

$$x = \frac{-9+9.19}{2}, \quad x = \frac{-9-9.19}{2} \text{ (Not valid)}$$

$$\boxed{x = 0.095}$$

$$[PCl_5] = \frac{0.1-0.095}{5} = \frac{0.005}{5} = 0.001 \text{ mol/L or M}$$

$$[PCl_3][Cl_2] = \frac{0.095}{5} = 0.019 \text{ mol/L or M}$$

Ans 6.

$$M_n = \frac{\Sigma N_i M_i}{\Sigma N_i} = \frac{100 \times 1000 + 200 \times 2000 + 300 \times 5000}{100 + 200 + 300}$$

$$\boxed{M_n = 3.33 \times 10^3}$$

$$M_w = \frac{\Sigma N_i M_i^2}{\Sigma N_i M_i} = \frac{100 \times (1000)^2 + 200 \times (2000)^2 + 300 \times (5000)^2}{100 \times 1000 + 200 \times 2000 + 300 \times 5000}$$

$$\boxed{M_w = 4.2 \times 10^3}$$

$$PDI = \frac{M_w}{M_n} = 1.26$$

Ans 7.

Overall reaction : $2N_2O_5 \rightarrow 4NO_2 + O_2$

Mechanism : $N_2O_5 \xrightarrow{k_1} NO_3 + NO_2$

$NO_3 + NO_2 \xrightarrow{k_2} N_2O_5$

$NO_3 + NO_2 \xrightarrow{k_3} NO + NO_2 + O_2$

$NO_3 + NO \xrightarrow{k_4} 2NO_2$

$$\frac{d[NO_2]}{dt} = k_1[N_2O_5] - k_2[NO_3][NO_2] - k_3[NO_3][NO_2] + k_4[NO_3][NO_2]$$

$$= k_1[N_2O_5] + k_4[NO_3][NO_2] - (k_3+k_2)[NO_3][NO_2] \quad - (1)$$

$$\frac{d[NO_3]}{dt} = 0 = k_1[N_2O_5] - k_2[NO_3][NO_2] - k_3[NO_3][NO_2]$$

$$[NO_3] = \frac{k_1[N_2O_5]}{(k_2+k_3)[NO_2]} \quad (2)$$

from (1) & (2)

$$\frac{d[NO_2]}{dt} = \cancel{k_1[N_2O_5]} + \frac{k_4 \cdot k_1[N_2O_5][NO]}{(k_2+k_3)[NO_2]} - \cancel{\frac{(k_2+k_3)\,k_1[N_2O_5][NO_2]}{(k_2+k_3)[NO_2]}}$$

$$= \frac{k_4 \cdot k_1[N_2O_5][NO_2]}{(k_2+k_3)[NO_2]} \quad - (3)$$

$$\frac{d[NO]}{dt} = 0 = k_3[NO_3][NO_2] - k_4[NO_3][NO]$$

$$[NO] = \frac{k_3}{k_4}[NO_2]. \quad - (4)$$

from (3) & (4)

$$\frac{d[NO_2]}{dt} = \frac{k_4 \cdot k_1[N_2O_5]}{(k_2+k_3)[NO_2]} \cdot \frac{k_3}{k_4}[NO_2]$$

$$\boxed{\frac{d[NO_2]}{dt} = \left(\frac{k_3 k_1}{k_2+k_3}\right)[N_2O_5]}$$

Ans 8

1(i) Composition of components | Volume of $O_2$ needed

| Composition of components | Volume of $O_2$ needed |
|---|---|
| $H_2$ (30%) $= 0.3 m^3$ | $0.3 \times 0.5 = 0.15 m^3$ |
| $CH_4$ (5%) $= 0.05 m^3$ | $0.05 \times 0.2 = 0.1 m^3$ |
| $CO$ (20%) $= 0.2 m^3$ | $0.2 \times 0.5 = 0.1 m^3$ |
| | Total $= 0.35 m^3$ |
| $O_2$ (5%) $= 0.05 m^3$ | less $O_2$ in fuel gas $= -0.05 m^3$ |
| | Net $O_2$ needed $= 0.3 m^3$ |
| | $= 300 L$ |

Volume of air required for $1 m^3$ of gas using 50% excess air

$$= 300 \times \frac{100}{21} \times \frac{150}{100}$$

$$= 2142.8 L$$

Hence, weight of air actually supplied per $m^3$ of the gas

$$= 2142.8 L \times \left(\frac{1 \text{ mol}}{22.4 L}\right) \times \left(\frac{28.97 gm}{mol}\right)$$

$$= 2771 \text{ gm}$$

Ans 8 1(ii) $x = w_1 = 1.6 g$

$w_2 = 1.42 g$

$w_3 = 0.98 g$

$w_4 = 0.41 g$

$$\% \text{ moisture} = \frac{w_1 - w_2}{x} \times 100 = \frac{1.6 - 1.42}{1.6} \times 100$$

$$= 11.25 \%$$

$$\% \text{ Vm} = \frac{w_2 - w_3}{x} \times 100 = \frac{1.42 - 0.98}{1.40} \times 100$$

$$= 27.5 \%$$

$$\% \text{ ash} = \frac{w_4}{x} \times 100 = \frac{0.41}{1.6} \times 100 = 25.625 \%$$

Fixed Carbon $= 100 - \%$ (Moisture + Vm + ash)

$= 100 - \%\ (11.25 + 27.5 + 25.625)$

$= 35.625\ \%$

Q8 2(i) weight of fuel $(x)$ = (weight of the crucible + fuel) − (weight of crucible)

$= 3.58 - 2.34$

$x = 1.24g$

$A = 650g$

$W = 2200g$

$T_2 - T_1 = 4.24°C$

$CC = 0.048°C$

$AC = 60cal$

$$GCV = \frac{\{(A+W) \times S_W \times (T_f - T_i + C.C)\} - \{F.C + \text{Cotton Correction} + AC\}}{x}$$

$$= \frac{\{(650+2200) \times 1 \times (4.24 + 0.048)\} - 60}{1.24}$$

$$\boxed{GCV = 9807.097\ cal/g}$$

$\%\ H = 4\%$

$GCV = NCV + 0.09H \times 587$

$NCV = GCV - (0.09H \times 587)$

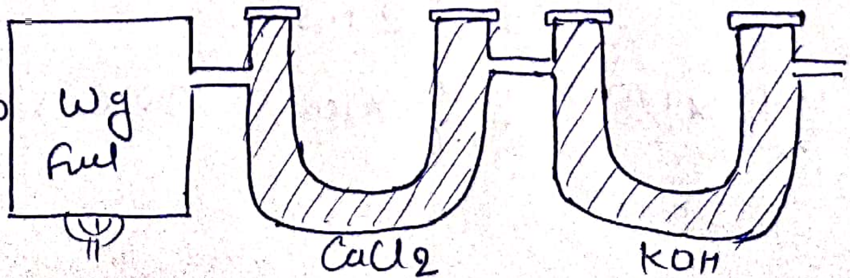
$NCV = 9807.097 - (0.09 \times 4 \times 587)$

$$\boxed{NCV = 9595.777\ cal/g}$$

Ans 8 2(ii)

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$

$C + O_2 \rightarrow CO_2$



before passing the gas $\begin{cases} \text{wt of U-tube with } CaCl_2 = w_1\, g \\ \text{wt of U-tube with } KOH = w_2\, g \end{cases}$

After passing the gas ($CO_2$, $H_2O$) $\begin{cases} \text{wt of } CaCl_2 \text{ U-tube} = w_3\, g \\ \text{wt of KOH tube} = w_4\, g \end{cases}$

$$CaCl_2 + 7H_2O \longrightarrow CaCl_2 \cdot 7H_2O$$

$$2KOH + CO_2 \longrightarrow K_2CO_3 + H_2O$$

$$\% \, H = \frac{\text{increase in wt(g) } CaCl_2 \text{ tube}}{w} \times \frac{2}{18} \times 100$$

$$\% \, C = \frac{\text{increase in wt(g) KOH tube}}{w} \times \frac{12}{44} \times 100$$