rected

$$\Delta P = d^{n_1} l^{n_2} u^{n_3} \rho^{n_4} \mu^{n_5}$$

$$L^{n_1} L^{n_2} L^{n_3} T^{-n_3} M^{n_4} L^{-3n_4} M^{n_5} L^{-n_5} T^{-n_5}$$

$$ML^{-1}T^{-2} = L^{n_1+n_2+n_3-3n_4-n_5} M^{n_4+n_5} T^{-n_3-n_5}$$

For M $1 = n_4 + n_5$ --- (2)

L $-1 = n_1 + n_2 + n_3 - 3n_4 - n_5$ --- (3)

T $-2 = -n_3 - n_5$ --- (4)

For (2) $n_4 = 1 - n_5$ --- (5)

(4) $n_3 = 2 - n_5$ --- (6)

Sub (5) and (6) into (3)

$-1 = n_1 + n_2 + 2 - n_5 - 3 + 3n_5 - n_5$

$n_1 + n_2 + n_5 = 0$

$n_1 = -n_2 - n_5$ ---- (7)

From eqn (1)

$\Delta P = (d)^{n_1} (l)^{n_2} (u)^{n_3} (\rho)^{n_4} (\mu)^{n_5}$

$= d^{-n_2-n_5} l^{n_2} u^{2-n_5} \rho^{1-n_5} \mu^{n_5}$

$$\left(\frac{\Delta P}{\rho u^2}\right) = \left(\frac{l}{d}\right)^{n_2} \left(\frac{\mu}{\rho u d}\right)^{n_5}$$

$Cl_{2(g)} + 2NaOH_{(aq)} \longrightarrow NaCl_{(s)} + NaOCl_{(s)} + H_2O_{(l)}$

$850g$ $1150g$ 6049

No of moles of $Cl_2 = \frac{850g}{71g/mol} = 11.97moles$

No of moles of $NaOH = 1150g = 28.75moles$

The need 23.94 moles the No of moles was greater more than

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

No of moles of N_2 = 1

No of moles of H_2 = 3

No 1 moles of N_2 ⟶ 3 moles of H_2

~~24.39 moles of H_2 ⟶ ?~~

~~No of moles of N_2 = 24.39m~~

1 moles of N_2 ⟶ 3 moles of H_2

x ⟶ 12.19 moles of H_2

$x = \frac{12.19}{3} = 4.063$ moles

1 moles of N_2 ⟶ 3 moles of H_2

24.39 moles of N_2 ⟶ ?

No of mole of H_2 = 24.39 × 3 = 73.17 moles

Correctn

No of moles of N_2 = 1

No of moles of H_2 = 3

No of moles of N_2 = $\frac{\text{No of moles of } H_2}{3}$

$= \frac{24.39}{3} = 8.13$ moles

No of moles of H_2 = 3 No of moles of N

= 3(12.19)

36.37 mole

H_2 is limiting reagent since the amt of H_2 expected is less the No = hydrogen given was less than expected

It determines the yield of a reaction ... limiting reagent

b) Amt left = Given amt - amt needed
$= 28.75 - 23.94$
$= 4.81$ moles

Mass will be
N^o of moles × molar mass $= (4.81)(40)$
$= 192.4g$

% Excess $= \frac{\text{Mass left}}{\text{Initial Mass}} \times \frac{100}{1}$
$= \frac{192.4}{1150} \times 100$
$= 16.73\%$

c) 1 mole of $Cl_2 \longrightarrow$ 1 mole of NaOCl
71g of $Cl_2 \longrightarrow$ 74.5g of NaOCl
850g of $Cl_2 \longrightarrow x_g$
$x = \frac{74.5 \times 850}{71}$
$= 891.90g$

Degree Conversion $= \frac{600g}{891.90g} = 0.67$

D) Yield $= \frac{600}{891.90} \times \frac{100}{1} = 67.27\%$

h) 5 moles of N_2

$N_2 + 3H_2 \longrightarrow 2NH_3$

Initially 12.19 24.39 -

Change $-x$ $-3x$ $+2x$

5 moles
N^o of moles of N_2 which reacted $= 12.19 - 5$
$= 7.19$ moles

N^o of moles of H_2 which reacted
$= 3(N^o$ of moles of $N_2)$
$= 3(7.19) = 21.57$ moles

N^o of moles of H_2 left $= 24.39 - 21.57$
$= 2.82$ moles

% Conversion $= \frac{21.57}{2.82} \times \frac{100}{1} = 7.64\%$
$= \frac{21.57}{24.39} \times 100 = 88.4\%$

Q1n 5

$CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$

If the water-gas shift reaction above proceeds to equilibrium at ... T°(K)

a) Use the mole fraction to derive the equilibrium constant expression (15y beginning with one mole of reactants

b) At $T = 1105K$, $K_y = 1.0$ & suppose the feed to the reactor contains 1.00 mol of CO, 2.00 mol of H_2O & the reaction mixture comes to equilibrium at 1105K, calc the equilibrium composition & the conversion of the limiting reagent

Soln

$$CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$$

$$K_y = \frac{[CO_2][H_2]}{[CO][H_2O]}$$

Initially	1	1	–	–
change	$-\alpha$	$-\alpha$	$+\alpha$	$+\alpha$
Eqm	$1-\alpha$	$1-\alpha$	$+\alpha$	$+\alpha$

of gas pressure w/

$$K_p = \frac{P_{CO_2} P_{H_2}}{P_{CO} P_{H_2O}}$$

$n_T = 1 - \alpha + 1 - \alpha + \alpha + \alpha$

$= 2$

$$K = \frac{\alpha^2}{(1-\alpha)}$$

b) $CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$

Initially	$1.00 - x$	2.00 moles	–	–
Change	$-x$	$-x$	$+x$	$+x$
at Eqm	$1.00 - x$	$2.00 - x$	$+x$	$+x$

Buckingham Method

$\Delta P = f(d, l, u, \rho, \mu)$

For us to know the number of dimensionless groups using the degree of freedom method

$K = n - 3$

$6 - 3 = 3 \Rightarrow \pi_1, \pi_2, \pi_3$

We choose from the list of basic quantities those of the simplest dimensions

$$\left.\begin{aligned} d &= L \\ u &= LT^{-1} \\ \rho &= ML^{-3} \end{aligned}\right\} \Rightarrow \begin{aligned} L &= d \\ T &= du^{-1} \\ M &= \rho d^3 \end{aligned}$$

Remaining quantities $\Delta P, l, \mu$

π_1: $\Delta P = ML^{-1}T^{-2}$

$\pi_1 = \Delta P (M^{-1} L T^2)$

$= \Delta P (\rho d^3)^{-1} (d) (du^{-1})^2$

$= \Delta P \rho^{-1} d^{-3} d\, d^2 u^{-2}$

$$\pi_1 = \frac{\Delta P}{\rho u^2}$$

π_2: $l = L$

$\pi_2 = l (L)^{-1}$

$= l (d)^{-1} \Rightarrow \pi_2 = \frac{l}{d}$

π_3: $\mu = ML^{-1}T^{-1}$

$\pi_3 = \mu (M^{-1} L T)$

$= \mu (\rho d^3)^{-1} (d) (du^{-1})$

$= \mu \rho^{-1} d^{-3} \cdot d \cdot d \cdot u^{-1}$

$$= \frac{\mu}{\rho d u}$$

method

$L \quad L \quad LT^{-1} \quad ML^{-3} \quad ML^{-1}T^{-1}$

$\Delta P = d^{n_1} l^{n_2} u^{n_3} \rho^{n_4} \mu^{n_5}$

$L^{n_1} L^{n_2} L^{n_3} T^{-n_3} M^{n_4} L^{-3n_4} M^{n_5} L^{-n_5} T^{-n_5}$

$ML^{-1}T^{-2} = L^{n_1+n_2+n_3-3n_4-n_5} M^{n_4+n_5} T^{-n_3-n_5}$

For M: $1 = n_4 + n_5$ --- (2)

L: $-1 = n_1 + n_2 + n_3 - 3n_4 - n_5$ --- (3)

T: $-2 = -n_3 - n_5$ --- (4)

b) $CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$

Initially	$1.00 - x$	2.00 moles	–	–
Change	$-x$	$-x$	$+x$	$+x$
at Eqm	$1.00 - x$	$2.00 - x$	$+x$	$+x$

$$K_y = \frac{[CO_2][H_2]}{[CO][H_2O]}$$

$$K_y = \frac{x^2}{(1.00-x)(2.00-x)}$$

$$1.0 = \frac{x^2}{(1.00-x)(2.00-x)}$$

$$1.0 = \frac{x^2}{(2-x-2x+x^2)}$$

$$1.0 = \frac{x^2}{2-3x+x^2}$$

$$1.0 = \frac{x^2}{x^2-3x+2}$$

$$= x^2 = x^2-3x+2$$

$$-3x+2=0$$

$$\frac{2}{3} = \frac{3x}{3} = x = 2/3 = 0.67$$

No of moles of CO $= 1.00 - 0.67 = 0.33$

No of moles of $H_2O = 2.00 - 0.67 = 1.33$

No of moles of $CO_2 = 0.67$ moles

No of moles of $H_2 = 0.67$ moles

Buckingham Method

$\Delta P = f(d, l, u, \rho, \mu)$

For us to know the number of dimensionless groups using the degree of freedom method

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Remaining quantities $\Delta P, l, \mu$

π_1: $\Delta P = ML^{-1}T^{-2}$

$\pi_1 = \Delta P (M^{-1} L T^2)$

$\Delta P (\rho d^3)^{-1} (d) (du^{-1})^2$

$\Delta P \rho^{-1} d^{-3} d d^2 u^{-2}$

$$\pi_1 = \frac{\Delta P}{\rho u^2}$$

π_2: $l = L$

$\pi_2 = l(L)^{-1}$

$= l(d)^{-1} \Rightarrow \pi_2 = \frac{l}{d}$

π_3: $\mu = ML^{-1}T^{-1}$

$\pi_3 = \mu(M^{-1} L T)$

$= \mu(\rho d^3)^{-1}(d)(du^{-1})$

$\mu \rho^{-1} d^{-3} \cdot d \cdot d \cdot u^{-1}$ $= \dfrac{\mu}{\rho d u}$

Buckingham Method

$\Delta P = f(d, l, u, \rho, \mu)$

For us to know the number of dimensionless groups using the degree of freedom method

$K = n - j$

$6 - 3 = 3 \Rightarrow \pi_1, \pi_2, \pi_3$

We chose from the list of basic quantities those of the simplest dimensions

$l_{2(g)} + 2NaOH_{(aq)} \longrightarrow NaCl_{(s)} + NaOCl_{(s)} + H_2O_{(l)}$

50g 1150g 600g

° of moles of $Cl_2 = \frac{850g}{71g/mol} = 11.97$moles

° of moles of $NaOH = \frac{1150g}{40g/mol} = 28.7$moles

You need 23.94moles the N° moles was given more than what was needed.

$\frac{N^{o} \text{ of moles of } Cl_2}{N^{o} \text{ of moles of } NaOH} = \frac{1}{2}$

N° of moles of NaOH = 2× N° of moles of Cl_2

$= 2(11.97)$

$= 23.94$moles

The N° of moles of NaOH given was more than the one required needed for the experiment so NaOH is in excess

N° of moles of $Cl_2 = \frac{N^{o} \text{ of moles of } NaOH}{2}$

$= \frac{28.75}{2} = 14.375$mol

The N° of moles given (11.97) was less than the one needed for the experiment So since it is less therefore Cl_2 is a limiting reagent.

When Cl_2 and NaOH will be reacted Cl_2 will be used up finished first and NaOH will remain small