Daily Tutorial Sheet-1	JEE Advanced (Archive)

1.(F) $R \times n$ is reversed and multiplied by $\frac{1}{2}$. So $\left(K_{eq}\right)_{new} = \sqrt{\frac{1}{K}}$

2.(K_c = 0.68)

	N_2	+ $3H_2$	$\rightleftharpoons$ $2NH_3$
Initial :	1.0	3.0	0
Equilibrium	$1-0.25$	$3-0.75$	0.05

$$[N_2] = \frac{0.75}{4}, [H_2] = \frac{2.25}{4}, [NH_3] = \frac{0.50}{4}$$

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{(0.50)^2}{(0.75)(2.25)^3} \times 16 = 0.468\, L^2\, mol^{-2}$$

Also for: $\frac{1}{2}N_2 + \frac{3}{2}H_2 \rightleftharpoons NH_3$

$$K_c^{'} = \sqrt{K_c} = 0.68$$

3.(F) Evaporation is an endothermic process.

4.(ABCD) $C_2H_4 + H_2 \rightleftharpoons C_2H_6, \Delta H = -32.7$ kcal

The above reaction is exothermic, increasing temperature will favour backward reaction, will increase the amount of C_2H_4. Decrease in pressure will favour reaction in direction containing more molecules (reactant side in the present case). Therefore, decreasing pressure will increase amount of C_2H_4.

Removing H_2, which is a reactant, will favour reaction in backwards direction, more C_2H_4 will be formed. Adding C_2H_6 will favour backward reaction and some of the C_2H_6 will be dehydrogenated to C_2H_4.

5.(1.86) $A_2(g) + B_2(g) \rightleftharpoons 2AB(g) \quad \Delta n = 0$

$$K = \frac{[AB]^2}{[A_2][B_2]} = \frac{(n_{AB})^2}{n_{A_2}.n_{B_2}} = \frac{(2x)^2}{(1-x)(2-x)}$$

$$\Rightarrow \quad 5 - 0 = \frac{4x^2}{x^2 - 3x + 2} \quad \Rightarrow \quad 23x^2 - 7x + 50 = 0$$

$$\Rightarrow \quad x = \frac{75 \pm \sqrt{75^2 - 4 \times 23 \times 50}}{46} = 0.93, 2.32$$

2.32 is not acceptable because x cannot be greater than 1,

Mole of AB = $2x = 2 \times 0.93 = 1.86$

6.(CD) $NaNO_3(s) \rightleftharpoons NaNO_2(s) + \frac{1}{2}O_2(g), \Delta H > 0$

$NaNO_3$ and $NaNO_2$ are in solid state, changing their amount has no effect on equilibrium. Increasing temperature favours forward reaction. Also, increasing pressure will favour backward reaction in which some $O_2(g)$ will combine with $NaNO_2(g)$ forming $NaNO_3$.

7.(T) Catalyst has no effect on thermodynamics of reaction.

8.(0.20 M)

$$SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g)$$

$1-x \quad 1-x \quad x \quad x$

$Q_c = 1 < K_c$, i. e. reaction proceed in forward direction to attain equilibrium.

$$16 = \left(\frac{x}{1-x}\right)^2 \Rightarrow x = 0.80$$

$$[NO] = 0.80M, [NO_2] = 0.20\,M$$

9.(K_α = 0.26 atm ; α = 0 .62)

$N_2O_4 \rightleftharpoons 2NO_2$ Total

$1-\alpha \quad 2\alpha \quad 1+\alpha$

p_i: $\frac{1-\alpha}{1+\alpha}p \quad \frac{2\alpha}{1+\alpha}p$

$$K_p = \frac{4\alpha^2}{1-\alpha^2}p = \frac{4.(0.25)^2}{1-(0.25)^2} = 0.26\,atm$$

When $p = 0.10\,atm$

$$0.26 = \frac{4\alpha^2(0.1)}{1-\alpha^2} \Rightarrow \alpha = 0.62$$

10. $\mathbf{SO_2 = \frac{2}{87}atm;\ O_2 = \frac{125}{87}atm;\ SO_3 = \frac{85}{87}atm}$

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

Initial p_i : $0 \quad 2 \quad 1$

Equilibrium p_i $2p \quad 2+p \quad 1-2p$

$$K_p = 900 = \frac{(1-2p)^2}{(2+p)(2p)^2}$$ [Ignoring p in comparison to 2]

$$p = \frac{1}{87}$$

Partial pressure of $SO_2 = 2p = \frac{2}{87}$ atm

Partial pressure of $O_2 = 2 + p = 2 + \frac{1}{87} = \frac{125}{87}atm$

Partial pressure of $SO_3 = 1 - 2p = 1 - 2\left(\frac{1}{87}\right) = \frac{85}{87}$ atm

11.(277.77M^{-2})

$CO_{(g)} + 2H_{2(g)} \rightleftharpoons CH_3OH_{(g)}$

Mole $0.2-0.10 \quad x-0.20 \quad 0.10 \Rightarrow$ Total moles $= x$

$$\Rightarrow \quad x = \frac{4.92\times 5}{0.082\times 600} = 0.5 \quad \Rightarrow \quad \text{moles of } H_2 \text{ at equilibrium} = x - 0.2 = 0.3$$

Partial pressures: $CO = \frac{9.1}{0.5}p, H_2 = \frac{0.3}{0.5}p,$

$$CH_3OH = \frac{0.1}{0.5}p$$

$$K_p = \frac{\frac{p}{5}}{\left(\frac{p}{5}\right)\left(\frac{3}{5}p\right)^2} = \frac{25}{9p^2} = \frac{25}{9(4.92)^2} = 0.10\,atm^{-2}$$

Concentrations: $[CO] = \frac{0.1}{5}M$, $[H_2] = \frac{0.3}{5}M$,

$[CH_3OH] = \frac{0.1}{5}M \quad \Rightarrow \quad K_c = \frac{(0.1/5)}{(0.1/5)(0.3/5)^2} = 277.77M^{-2}$

12.(CD) If inert gas is introduced at constant pressure, volume of container will have to be increased and this will favour the forward reaction. Also adding $PCl_5(g)$ at constant volume will favour forward reaction because $PCl_5(g)$ is a reactant.

13.(T) Rate of any reaction increases on rising temperature.

14.(12.315 atm)

$$\underset{0.15-0.08}{CO(g)} + \underset{x-0.16}{2H_2(g)} \rightleftharpoons \underset{0.08}{CH_3OH(g)}$$

Total moles at equilibrium $= x - 0.01$

$$x - 0.01 = \frac{8.5 \times 2.5}{0.082 \times 750} = 0.34\,,\ x = 0.35$$

(i) $K_p = 0.056$; $K_c = 213.33$

(ii) Pressure $= \frac{nRT}{V} = \frac{[0.15+0.35] \times 0.0821 \times 750}{2.5} = 12.315\,atm$

15.(No change)

Pressure has no effect on equilibrium constant.