

Law of equilibrium and Equilibrium constant

21. (a) $K = \frac{[NH_3]^2}{[N_2][H_2]^3}$

22 (b) $K_c = [NOCl]^2 / ([NO]^2 [Cl_2])$

Explanation:

For a general reaction $aA + bB \rightleftharpoons cC$,

$$K_c = \frac{[C]^c}{([A]^a [B]^b)}$$

Here, $a = 2$ (for NO), $b = 1$ (for Cl_2), $c = 2$ (for NOCl).

So, $K_c = [NOCl]^2 / ([NO]^2 [Cl_2])$.

23. (d) $A + B \rightleftharpoons C + D$

$$\begin{array}{cccc} x & x & 0 & 0 \end{array}$$

$$\begin{array}{cc} 2x & 2x \end{array}$$

$$K_c = \frac{[C][D]}{[A][B]} = \frac{2x \cdot 2x}{x \cdot x} = 4$$

24. (d) $N_2O_4 \rightleftharpoons 2NO_2$

$$\begin{array}{c} 1 \\ (1-\alpha) \end{array}$$

$$\begin{array}{c} 0 \\ 2\alpha \end{array}$$

$$\text{total mole at equilibrium} = (1 - \alpha) + 2\alpha = 1 + \alpha$$

25. (b) $K = \frac{[C_2H_6]}{[C_2H_4][H_2]} = \frac{[\text{mole / litre}]}{[\text{mole / litre}][\text{mole / litre}]}$

$$= \text{litre/mole. or litre mole}^{-1}.$$

26. (b) mol litre^{-1}

Explanation:

For the reaction $2SO_2 + O_2 \rightleftharpoons 2SO_3$,

$$K_c = [SO_3]^2 / ([SO_2]^2 [O_2])$$

Each concentration term has unit mol L^{-1} .

So, units of $K_c = (\text{mol L}^{-1})^2 / ((\text{mol L}^{-1})^3)$



$$= \text{mol}^2 \text{L}^{-2} / \text{mol}^3 \text{L}^{-3}$$

$$= \text{mol}^{-1} \text{L}^1 \text{ or } \text{mol L}^{-1}.$$

27. (c) $K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} = \frac{\frac{0.2}{10} \times \frac{0.2}{10}}{[0.1/10]} = 0.04 .$

28. (b) $K_c = \frac{[HI]^2}{[H_2][I_2]}; \quad 64 = \frac{x^2}{0.03 \times 0.03}$

$$x^2 = 64 \times 9 \times 10^{-4}$$

$$x = 8 \times 3 \times 10^{-2} = 0.24$$

x is the amount of HI at equilibrium amount of I₂ at equilibrium will be

$$0.30 - 0.24 = 0.06$$

29. (c) $K_c = \frac{K_f}{K_b}$

$$K_f = K_c \times K_b = 1.5 \times 7.5 \times 10^{-4} = 1.125 \times 10^{-3}$$



Initial conc.	1	3	0
at equilibrium	1-0.81	3-2.43	1.62
	0.19	0.57	

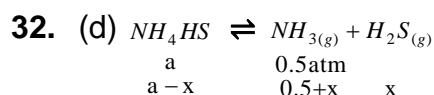
No. of moles of $N_2 = \frac{28}{28} = 1 \text{ mole}$

No. of moles of $H_2 = \frac{6}{2} = 3 \text{ mole}$

No. of moles of $NH_3 = \frac{27.54}{17} = 1.62 \text{ mole}$

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{[1.62]^2}{[0.19][0.57]^3} = 75$$

31. (b) $K_c = \frac{[YX_2]}{[X]^2[Y]} = \frac{2}{4 \times 4 \times 2} = \frac{1}{16} = 0.0625 .$

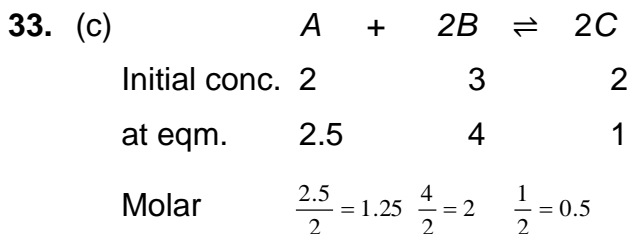


Total pressure = 0.5 + 2x = 0.84

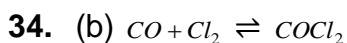


i.e., $x = 0.17$

$$K_p = P_{NH_3} \cdot P_{H_2S} = (0.67) \cdot (0.17) = 0.1139$$



$$K = \frac{[0.5]^2}{[1.25] \times [2]^2} = 0.05$$



$$[CO] = \frac{0.1}{0.5}, [Cl_2] = \frac{0.1}{0.5}, [COCl_2] = \frac{0.2}{0.5}$$

$$= \frac{[COCl_2]}{[CO][Cl_2]} = 0 \frac{\frac{0.2}{0.5}}{\frac{0.1}{0.5} \times \frac{0.1}{0.5}} = \frac{2}{5} \times 25 = 10$$



at equilibrium $a \quad a \quad 2a \quad 2a$

$$K = \frac{2a \times 2a}{a \times a} = 4$$



Initial conc.	4.5	4.5	0
	x	x	$2x$

from question $2x = 3$

$$x = \frac{3}{2} = 1.5$$

So conc. at eqm. $4.5 - 1.5$ of H_2

$= 4.5 - 1.5$ of I_2 and 3 of HI

$$K = \frac{[HI]^2}{[I_2][H_2]} = \frac{3 \times 3}{3 \times 3} = 1.$$



37. (c) $K = \frac{[H_2]^2[S_2]}{[H_2S]^2} = \frac{[0.10]^2[0.4]}{[0.5]^2} = 0.016$

38. (a) $K_p = \frac{[P_{CO}]^2[P_{O_2}]}{[P_{CO_2}]^2} = \frac{[0.4]^2 \times [0.2]}{[0.6]^2} = 0.0888$.

39. (d) $K_f = 1.1 \times 10^{-2}$; $K_b = 1.5 \times 10^{-3}$

$$K_c = \frac{K_f}{K_b} = \frac{1.1 \times 10^{-2}}{1.5 \times 10^{-3}} = 7.33$$
 .

40. (a) $2HI \rightleftharpoons H_2 + I_2$
 $\begin{matrix} 100 & & 0 & 0 \\ 50 & & 25 & 25 \end{matrix}$

$$\frac{[H_2][I_2]}{[HI]^2} = \frac{25 \times 25}{50 \times 50} = 0.25$$
 .

