Law of equilibrium and Equilibrium constant

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

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

Explanation:

For a general reaction aA + bB ⇌ cC,

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

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

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

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

$x \quad x \quad 0 \quad 0$

$2x \quad 2x$

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

24. (d) $\underset{(1-\alpha)}{\overset{1}{N_2O_4}} \rightleftharpoons \underset{2\alpha}{\overset{0}{2NO_2}}$

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

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

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

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

Explanation:

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

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

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

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

= mol² L⁻² / mol³ L⁻³

= **mol⁻¹ L¹** or **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) $K_c = \frac{[HI]^2}{[H_2]\,[I_2]}$; $64 = \frac{x^2}{0.03 \times 0.03}$

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

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

x is the amount of *HI* at equilibrium amount of I_2 at equilibrium will be

$0.30 - 0.24 = 0.06$

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

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

30. (a) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

Initial conc. 1 3 0

at equilibrium 1-0.81 3-2.43 1.62

0.19 0.57

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

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

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

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

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

32. (d) $NH_4HS \rightleftharpoons NH_{3(g)} + H_2S_{(g)}$

a

a − x 0.5atm

0.5+x x

Total pressure $= 0.5 + 2x = 0.84$

i.e., $x = 0.17$

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

33. (c)

	A	+	$2B$	$\rightleftharpoons$	$2C$
Initial conc.	2		3		2
at eqm.	2.5		4		1
Molar	$\frac{2.5}{2} = 1.25$		$\frac{4}{2} = 2$		$\frac{1}{2} = 0.5$

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

34. (b) $CO + Cl_2 \rightleftharpoons COCl_2$

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

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

35. (a) $A + B \rightleftharpoons C + D$

at equilibrium a a $2a$ $2a$

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

36. (a) $H_2 + I_2 \rightleftharpoons 2HI$

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) $\underset{\substack{100 \\ 50}}{2HI} \rightleftharpoons \underset{\substack{0 \\ 25}}{H_2} + \underset{\substack{0 \\ 25}}{I_2}$

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