(A)

Class Worksheet 12

1) $A \rightleftharpoons B$

a) fwd rxn: $A \rightarrow B$ rvs rxn: $B \rightarrow A$

at eq'm

$r_{fwd} = r_{rvs}$

$K_{fwd}[A] = K_{rvs}[B]$

$K_{fwd} = 3.8 \times 10^{2}\ s^{-1}$

$K_{rvs} = 8.6 \times 10^{-1}\ s^{-1}$

$$\frac{K_{fwd}}{K_{rvs}} = \frac{[B]}{[A]} = k$$

$$K = \frac{3.8 \times 10^{2}}{8.6 \times 10^{-1}} = 4.42 \times 10^{2}$$

$K = 4.42 \times 10^{2}$

b) $[B] > [A]$

→ K is > 1 therefore fwd rxn ∴ products favoured

K_c | K_p

2

a) $3NO_{(g)} \rightleftharpoons N_2O_{(g)} + NO_{2(g)}$

$$K_c = \frac{[N_2O][NO_2]}{[NO]^3} \qquad K_p = \frac{P_{N_2O}\, P_{NO_2}}{P_{NO}^{\,3}}$$

b) $CH_{4(g)} + 2H_2S_{(g)} \rightleftharpoons CS_{2(g)} + 4H_{2(g)}$

$$K_c = \frac{[CS_2][H_2]^4}{[CH_4][H_2S]^2} \qquad K_p = \frac{P_{CS_2} \cdot P_{H_2}^{\,4}}{P_{CH_4}\, P_{H_2S}^{\,2}}$$

c) $$K_c = \frac{[CO]^4}{[Ni(CO)_4]} \qquad K_p = \frac{P_{CO}^{\,4}}{P_{Ni(CO)_4}}$$

d) $$K_c = \frac{[H_2O]^3}{[H_2]^3} \qquad K_p = \frac{P_{H_2O}^{\,3}}{P_{H_2}^{\,3}}$$

e) $$K_c = \frac{[NO_2]^4[O_2]}{[N_2O_5]^2} \qquad K_p = \frac{P_{NO_2}^{\,4}\, P_{O_2}}{P_{N_2O_5}^{\,2}}$$

3a) mostly reactants $K_c < 1$

b) mostly products $K_c > 1$

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4. $K_p = K_c (RT)^{\Delta n}$ Δn = mol prod − mol react

$K_p = (6.042)[(0.0831)(773)]^{-1}$ $R = 0.0831$

$= 6.54 \times 10^{-4}$

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5. $2\ SO_3\ (g) \rightleftharpoons 2\ SO_2\ (g) + O_2\ (g)$

a) $K_c = \dfrac{[SO_2]^2[O_2]}{[SO_3]^2}$ rvs $K_{c_2} = \dfrac{[SO_3]^2}{[SO_2]^2[O_2]}$

$\therefore K_{c\ rvs} = \dfrac{1}{K_c} = \dfrac{1}{2.4 \times 10^{-3}} = 417$

b) favours SO_3

$K_c < 1$ ∴ reactants favoured

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6 $SO_2\ (g) + \frac{1}{2} O_2\ (g) \rightleftharpoons SO_3\ (g)$ $K_c = 20.4$

a) $K_{c\ rvs} = \dfrac{1}{K_c} = \dfrac{1}{20.4} = 0.049$

b) K_c for $2\ SO_2\ (g) + O_2\ (g) \rightleftharpoons 2\ SO_3\ (g)$

$K_c = (K_{c_1})^2 = (20.4)^2 = 416.2$

c) $K_p = K_c (RT)^{\Delta n}$

$= (20.4)[(0.08314)(973)]^{-0.5}$

$K_p = 2.27$

7.

$$2HI_{(g)} \rightleftharpoons H_{2(g)} + I_{2(g)}$$

eq'm	3.53×10^{-3}	4.79×10^{-4}	4.79×10^{-4}

$$K_c = \frac{[H_2][I_2]}{[HI]^2}$$

$$= \frac{(4.77 \times 10^{-4})(4.77 \times 10^{-4})}{(3.53 \times 10^{-3})^2}$$

$$= 1.84 \times 10^{-2}$$

8.

$$2NO_{(g)} + Cl_{2(g)} \rightleftharpoons 2NOCl_{(g)}$$

P	.095	.171	.28

$$K_P = \frac{P_{NOCl}^2}{P_{NO}^2 P_{Cl_2}} = \frac{(0.28)^2}{(0.95)^2(0.171)} = 0.508$$

9.

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

I	.1	.05	0	.08
C	$-x$	$-x$	$+x$	$+x$
E	$.1-x$	$.05-x$	x	$.08+x$

$[H_2O]_{eq'm} = 0.0856 = 0.08 + x$

$x = 0.0056$

$[CO]_{eq'm} = 0.0056 mol/L$

$[CO_2]_{eq'm} = 0.1 - x = 0.0944 mol/L$

$[H_2]_{eq'm} = 0.05 - x = 0.0444 mol/L$

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

$$= \frac{(0.0856)(0.0056)}{(0.0944)(0.0444)}$$

$$= 1.14 \times 10^{-1}$$

$K_c \rightarrow$ cannot be calculated
require temp

10. a) $K_c \rightarrow$ at eq'm

$Q \rightarrow$ not necessarily at eq'm

b) $Q < K$

$\rightarrow$ shift towards products

c) $Q = K$

$\rightarrow$ at eq'm

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11. $COCl_{2\,(g)} \rightleftharpoons CO_{(g)} + Cl_{2\,(g)} \qquad K_c = 2.19 \times 10^{-10}$

$$Q = \frac{[CO][Cl_2]}{[COCl_2]}$$

a) $$Q = \frac{(3.31 \times 10^{-6})(6.62 \times 10^{-6})}{(2 \times 10^{-3})} = 1.10 \times 10^{-8}$$

$Q > K_c$ shift left

b) $$Q = \frac{(1.1 \times 10^{-1})(2.25 \times 10^{-6})}{(4.5 \times 10^{-2})} = 5.50 \times 10^{-12}$$

$Q < K_c$ shift right

c) $$Q = \frac{(1.48 \times 10^{-6})(1.48 \times 10^{-6})}{(0.01)} = 2.19 \times 10^{-10}$$

$Q = K_c$ at eq'm no shift

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12. $SO_2Cl_{2\,(g)} \rightleftharpoons SO_{2\,(g)} + Cl_{2\,(g)}$

	SO_2Cl_2	SO_2	Cl_2
eq'm	0.108	0.052	x

$K_c = 0.078$

$$K_c = \frac{[SO_2][Cl_2]}{[SO_2Cl_2]}$$

$$0.078 = \frac{(0.052)(x)}{(0.108)}$$

$$x = 0.162$$

$[Cl_2]_{eq'm} = 0.162 \frac{mol}{L}$

(F)

13.

$2NO_{(g)} \rightleftharpoons N_{2(g)} + O_{2(g)}$

	$2NO_{(g)}$	$N_{2(g)}$	$O_{2(g)}$
I	.2	0	0
C	$-2x$	$+x$	$+x$
E	$.2-2x$	x	x

$$K_c = \frac{[N_2][O_2]}{[NO]^2} = \frac{(x)(x)}{(.2-2x)^2} = 2.4 \times 10^3$$

$$\frac{x}{.2-2x} = 49.0$$

$$x = 49.0(.2-2x)$$

$$x = 9.798 - 98x$$

$$99x = 9.798$$

$$x = 0.0990$$

$$[N_2]_{eq'm} = [O_2]_{eq'm} = 0.0990 \frac{mol}{L}$$

$$[NO] = .2-2x = 2.06 \times 10^{-3} \frac{mol}{L}$$

14.

$2\,NOBr_{(g)} \rightleftharpoons 2\,NO_{(g)} + Br_{2(g)}$

eq'm

$P_{NOBr} = P_{NO}$

$P_{Br_2} = x$

$$K_p = \frac{(P_{NO})^2 P_{Br}}{(P_{NOBr})^2}$$

$$0.416 = \frac{(x)^2 P_{Br_2}}{(x)^2}$$

$$P_{Br_2} = 0.416$$

15.

	$I_{2(g)}$	+ $Br_{2(g)}$	$\rightleftharpoons$	$2IBr_{(g)}$
I	0	0		.5
C	+x	+x		-2x
E	x	x		.5-2x

$$K_c = \frac{[IBr]^2}{[I_2][Br_2]}$$

$$280 = \frac{(.5-2x)^2}{(x)(x)}$$

$$\sqrt{280} = \frac{.5-2x}{x}$$

$$16.73x = .5-2x$$

$$18.73x = .5$$

$$x = 0.0267$$

$[I_2]_{eq'm} = [Br_2]_{eq'm} = 0.0267 \frac{mol}{L}$

$[IBr]_{eq'm} = .5-2x = 0.447 \frac{mol}{L}$

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16 $A \rightleftarrows B \quad \Delta H > 0$

a) no effect

b) no effect

c) ↓T rvs rxn favoured as it is exothermic

∴ [ ] reactants ↑
[ ] products ↓

∴ K_c will decrease

d) no effect