1 $2SO_2 + O_2 \rightleftharpoons 2SO_3$

[Eqm] 0.230 1.370 0.920

$K_c = \dfrac{[SO_3]^2}{[SO_2]^2[O_2]}$

$= \dfrac{0.920^2}{0.230^2 \times 1.370}$

$= \underline{\underline{11.7 \text{ mol}^{-1}\text{dm}^3}}$ (3sf)

2 $2A + B_2 \rightleftharpoons 2AB$

[Eqm] 0.0200 0.100 0.400

$K_c = \dfrac{[AB]^2}{[A]^2[B_2]}$

$= \dfrac{0.400^2}{0.0200^2 \times 0.100}$

$= \underline{\underline{4000 \text{ mol}^{-1}\text{dm}^3}}$ (3sf)

3 $PCl_5 \rightleftharpoons Cl_2 + PCl_3$

Eqm 0.00420 0.0400 0.0400

[Eqm] $\frac{0.00420}{2.00}$ $\frac{0.0400}{2.00}$ $\frac{0.0400}{2.00}$

$= 0.00210$ $= 0.0200$ 0.0200

$K_c = \dfrac{[PCl_3][Cl_2]}{[PCl_5]}$

$= \dfrac{0.0200 \times 0.0200}{0.00210}$

$= \underline{\underline{0.190 \text{ mol dm}^{-3}}}$ (3sf)

4 $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

Start 2.00 - -

Change -1.20 +1.20 +1.20

Eqm 0.80 1.20 1.20

[Eqm] $\frac{0.80}{20}$ $\frac{1.20}{20}$ $\frac{1.20}{20}$

$= 0.040$ 0.060 0.060

$K_c = \dfrac{[PCl_3][Cl_2]}{[PCl_5]}$

$= \dfrac{0.060 \times 0.060}{0.040}$

$= \underline{\underline{0.090 \text{ mol dm}^{-3}}}$ (2sf)

5 $A + 2B \rightleftharpoons 2C$

Start 5.0 5.0

Change -1.5 -3.0 +3.0

Eqm 3.5 2.0 3.0

[Eqm] $\frac{3.5}{12}$ $\frac{2.0}{12}$ $\frac{3.0}{12}$

$= 0.2917$ 0.1667 0.25

$K_c = \dfrac{[C]^2}{[A][B]^2}$

$= \dfrac{0.25^2}{0.2917 \times 0.1667^2}$

$= \underline{\underline{7.7 \text{ mol}^{-1}\text{dm}^3}}$ (2sf)

6

	ester	+	water	⇌	acid	+	alcohol
Start	$\frac{200.0}{88.0}$		$\frac{7.00}{18.0}$				
	= 2.27		= 0.389		–		–
change	−0.250		−0.250		+0.250		+0.250
Equ	2.02		0.139		0.250		0.250
[Equ]	$\frac{2.02}{V}$		$\frac{0.139}{V}$		$\frac{0.250}{V}$		$\frac{0.250}{V}$

$$K_c = \frac{[\text{acid}][\text{alcohol}]}{[\text{ester}][\text{water}]} = \frac{\left(\frac{0.250}{V}\right)\left(\frac{0.250}{V}\right)}{\left(\frac{2.02}{V}\right)\left(\frac{0.139}{V}\right)} = \underline{\underline{0.222}} \quad (3\text{sf})$$

7 a)

	H_2	+	I_2	⇌	$2HI$
[Equ]	4.80×10^{-4}		?		3.53×10^{-3}

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

$$= \frac{(3.53 \times 10^{-3})^2}{54.1 \times 4.80 \times 10^{-4}}$$

$$= \underline{\underline{4.80 \times 10^{-4}}} \text{ mol dm}^{-3} \quad (3\text{sf})$$

b) position: moves right

K_c: no change

c) position: moves right

K_c: increases

8

	N_2	+	O_2	$\rightleftharpoons$	$2NO$
Start	1		1		–
Eqn	$1-x$		$1-x$		$2x$
[Eqm]	$\frac{1-x}{V}$ ✓		$\frac{1-x}{V}$ ✓		$\frac{2x}{V}$ ✓

$$K_c = \frac{[NO]^2}{[N_2][O_2]}$$

$$0.0036 = \frac{\left(\frac{2x}{V}\right)^2}{\left(\frac{1-x}{V}\right)^2}$$

$$0.0036 = \frac{4x^2}{(1-x)^2}$$

Square root both sides : $0.060 = \frac{2x}{1-x}$

$$0.060(1-x) = 2x$$

$$0.060 - 0.060x = 2x$$

$$0.060 = 2.060x$$

$$x = 0.0291$$

$$2x = 0.0583$$

mass NO = $30.0 \times 0.0583 = 1.75$ g

9

$2HI \rightleftharpoons H_2 + I_2$

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

	$2HI$	H_2	I_2
Start	1.00	-	-
Change	-0.22		
Eqm	0.78	0.11	0.11
[Eqm]	$\frac{0.78}{V}$	$\frac{0.11}{V}$	$\frac{0.11}{V}$

$= \dfrac{\left(\frac{0.11}{V}\right)\left(\frac{0.11}{V}\right)}{\left(\frac{0.78}{V}\right)^2}$

$= \underline{\underline{0.0199}}$ (3sf)

10

$H_2O + CO \rightleftharpoons H_2 + CO_2$

	H_2O	CO	H_2	CO_2	
Start	1.00	1.00	-	-	
Change	$-x$	$-x$	$+x$	$+x$	
Eqm	$1.00-x$	$1.00-x$	x	x	total = 2.00
	$= 1/3$	$1/3$	$2/3$	$2/3$	$\therefore \frac{x}{2.00} = \frac{1}{3}$ $\therefore x = 2/3$
[Eqm]	$\frac{1/3}{V}$	$\frac{1/3}{V}$	$\frac{2/3}{V}$	$\frac{2/3}{V}$	

$K_c = \dfrac{[H_2][CO_2]}{[H_2O][CO]} = \dfrac{\left(\frac{2/3}{V}\right)\left(\frac{2/3}{V}\right)}{\left(\frac{1/3}{V}\right)\left(\frac{1/3}{V}\right)} = \underline{\underline{4.00}}$ (3sf)

11

	ester	+	water	⇌	acid	+	alcohol
start	1		5				
Eqn	$1-x$		$5-x$		x		x
[Eqn]	$\frac{1-x}{\sqrt{}}$		$\frac{5-x}{\sqrt{}}$		$\frac{x}{\sqrt{}}$		$\frac{x}{\sqrt{}}$

$$K_c = \frac{[\text{acid}][\text{alcohol}]}{[\text{ester}][\text{water}]}$$

$$10 = \frac{\frac{x}{\sqrt{}} \; \frac{x}{\sqrt{}}}{\left(\frac{1-x}{\sqrt{}}\right)\left(\frac{5-x}{\sqrt{}}\right)}$$

$$10 = \frac{x^2}{(1-x)(5-x)}$$

$$10(5-6x+x^2) = x^2$$

$$50 - 60x + 10x^2 = x^2$$

$$9x^2 - 60x + 50 = 0$$

$$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

$$x = \frac{60 \pm \sqrt{3600-1800}}{18}$$

$$x = \frac{60 \pm 42.43}{18}$$

$$x = 0.976 \quad (\text{or } 5.69)$$

$\therefore$ ester = 0.024 mol

water = 4.024 mol

acid = 0.976 mol

alcohol = 0.976 mol