PART 1 – Equilibrium quantities

1)

	$CH_4(g)$	+	$H_2O(g)$	⇌	$CO(g)$	+	$3\ H_2(g)$
initial moles	3.0		2.0		0		0
changes in moles							
equilibrium moles					0.6		

2)

	$CH_4(g)$	+	$H_2O(g)$	⇌	$CO(g)$	+	$3\ H_2(g)$
initial moles	0.50		0.20		0		0
changes in moles							
equilibrium moles							0.30

3)

	$N_2(g)$	+	$3\ H_2(g)$	⇌	$2\ NH_3(g)$
initial moles	3.0		1.0		0
changes in moles					
equilibrium moles					0.3

4)

	$N_2(g)$	+	$3\ H_2(g)$	⇌	$2\ NH_3(g)$
initial moles	0.50		0.50		0
changes in moles					
equilibrium moles			0.35		

5)

	$2A(g)$	+	$B(g)$	⇌	$C(g)$	+	$3D(g)$
initial moles	0.40		0.40				
changes in moles							
equilibrium moles							0.30

6)

	$2A(g)$	+	$B(g)$	⇌	$C(g)$	+	$3D(g)$
initial moles	0.60		0.20				
changes in moles							
equilibrium moles					0.07		

PART 2 – K_p expressions and units

	equilibrium	K_p	units (assume all pressures are in Pa)
1	$N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$		
2	$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$		
3	$H_2(g) + I_2(g) \rightleftharpoons 2\ HI(g)$		
4	$2\ O_3(g) \rightleftharpoons 3\ O_2(g)$		
5	$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3\ H_2(g)$		
6	$CO(g) + 3\ H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$		
7	$2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g)$		
8	$N_2O_4(g) \rightleftharpoons 2\ NO_2(g)$		

PART 3 – Mole fractions and partial pressures

Mole fraction

If you have 10 moles of a mixture of gases, of which 3 moles is O_2, then the mole fraction of O_2 in the mixture is $\frac{3}{10}$ or 0.3 (or even 30%, but it is not usually expressed as a %)

$$\textbf{mole fraction of gas A in a mixture of gases} = \frac{moles\ of\ gas\ A}{total\ moles\ of\ gas\ in\ the\ mixture}$$

Note that the sum of all the mole fractions in a mixture should add up to 1

Partial pressure

Imagine a mixture of gases with a total pressure of 100 kPa.

If the mole fraction of gas A in that mixture is $\frac{3}{10}$, then that gas makes up 30 kPa (i.e $\frac{3}{10}$) of the total pressure. The contribution that each gas makes to the total pressure is called the partial pressure of that gas; therefore the partial pressure of gas A is 30 kPa.

partial pressure of gas A in a mixture of gases = mole fraction of gas A x total pressure

Note that the sum of all the partial pressures is the total pressure.

1)		$CH_4(g)$ +	$H_2O(g)$ ⇌	$CO(g)$ +	$3\ H_2(g)$	total pressure = 255 kPa
	initial moles	2.00	2.00	0	0	
	changes in moles					
	equilibrium moles				3.60	total moles =
	mole fraction					sum of mole fractions =
	partial pressure					sum of partial pressures =

2)		$N_2(g)$ +	$3\ H_2(g)$ ⇌	$2\ NH_3(g)$	total pressure = 45.0 MPa
	initial moles	0.800	1.000	0	
	changes in moles				
	equilibrium moles			0.400	total moles =
	mole fraction				sum of mole fractions =
	partial pressure				sum of partial pressures =

3)		$2\ SO_2(g)$ +	$O_2(g)$ ⇌	$2\ SO_3(g)$	total pressure = 2.0 MPa
	initial moles	5.00	4.00	0	
	changes in moles				
	equilibrium moles			1.50	total moles =
	mole fraction				sum of mole fractions =
	partial pressure				sum of partial pressures =

4)		$H_2(g)$ +	$I_2(g)$ ⇌	$2\ HI(g)$	total pressure = P
	initial moles	1.50	1.00	0	
	changes in moles				
	equilibrium moles			1.60	total moles =
	mole fraction				sum of mole fractions =
	partial pressure				sum of partial pressures =

PART 4 – K_p problems

Example: Gases A, B and C are in equilibrium. $2\ A(g) + B(g) \rightleftharpoons 2\ C(g)$

a) At equilibrium, there are 2.0 moles of A, 2.5 moles of B and 1.5 moles of C. The total pressure is 500 kPa. Calculate the value of K_p

b) If the total pressure of this equilibrium was increased, explain what would happen to the yield of C and the value of K_p

c) The forward reaction is exothermic. If the temperature of this equilibrium was increased, explain what would happen to the yield of C and the value of K_p