



PART 1 – Equilibrium quantities

1)	CH ₄ (g) + H ₂ O(g) ⇌ CO(g) + 3 H ₂ (g)	<i>equation</i>	2)	CH ₄ (g) + H ₂ O(g) ⇌ CO(g) + 3 H ₂ (g)	
	3.0 2.0 0 0	<i>initial moles</i>		0.50 0.20 0 0	
	-0.6 -0.6 +0.6 +1.8	<i>changes in moles</i>		-0.10 -0.10 +0.10 +0.30	
	2.4 1.4 0.6 1.8	<i>equilibrium moles</i>		0.40 0.10 0.10 0.30	
3)	N ₂ (g) + 3 H ₂ (g) ⇌ 2 NH ₃ (g)	<i>equation</i>	4)	N ₂ (g) + 3 H ₂ (g) ⇌ 2 NH ₃ (g)	
	3.0 1.0 0	<i>initial moles</i>		0.50 0.50 0	
	-0.15 -0.45 +0.3	<i>changes in moles</i>		-0.05 -0.15 +0.10	
	2.85 0.55 0.3	<i>equilibrium moles</i>		0.45 0.35 0.10	
5)	2A(g) + B(g) ⇌ C(g) + 3D(g)	<i>equation</i>	6)	2A(g) + B(g) ⇌ C(g) + 3D(g)	
	0.40 0.40	<i>initial moles</i>		0.60 0.20	
	-0.20 -0.10 +0.10 +0.30	<i>changes in moles</i>		-0.14 -0.07 +0.07 +0.21	
	0.20 0.30 0.10 0.30	<i>equilibrium moles</i>		0.46 0.13 0.07 0.21	

PART 2 – Mole fractions and partial pressures

mole fraction of substance A = $\frac{\text{moles of substance A}}{\text{total moles of all substances}}$ (NB: sum of all the mole fractions = 1)

partial pressure of substance A = mole fraction of A x total pressure (NB: sum of partial pressures = total pressure)

<i>equation</i>	1)	CH ₄ (g) + H ₂ O(g) ⇌ CO(g) + 3 H ₂ (g)	total p47.8ressure = 255 kPa
<i>initial moles</i>		2.00 2.00 0 0	
<i>changes in moles</i>		-1.20 -1.20 +1.20 +3.60	
<i>equilibrium moles</i>		0.80 0.80 1.20 3.60	total moles = 6.40
<i>mole fraction</i>		0.125 0.125 0.1875 0.5625	sum of mole fractions = 1.00
<i>partial pressure</i>		31.9 kPa 31.9 kPa 47.8 kPa 143.4 kPa	sum of partial pressures = 255 KPa
<i>equation</i>	2)	N ₂ (g) + 3 H ₂ (g) ⇌ 2 NH ₃ (g)	total pressure = 45.0 MPa
<i>initial moles</i>		0.800 1.000 0	
<i>changes in moles</i>		-0.200 -0.600 +0.400	
<i>equilibrium moles</i>		0.600 0.400 0.400	total moles = 1.40
<i>mole fraction</i>		0.429 0.286 0.286	sum of mole fractions = 1.00
<i>partial pressure</i>		19.3 MPa 12.9 MPa 12.9 MPa	sum of partial pressures = 45 MPa

equation	3)	$2 \text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2 \text{SO}_3(\text{g})$		total pressure = 2.0 MPa
initial moles		5.00	4.00	0
changes in moles		-1.50	-0.75	+1.50
equilibrium moles		3.50	3.25	1.50
mole fraction		0.424	0.394	0.182
partial pressure		0.848 MPa	0.788 MPa	0.364 MPa
				total moles = 8.25
				sum of mole fractions = 1.00
				sum of partial pressures = 2.0 MPa

equation	4)	$\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2 \text{HI}(\text{g})$		total pressure = P
initial moles		1.50	1.00	0
changes in moles		-0.80	-0.80	+1.60
equilibrium moles		0.70	0.20	1.60
mole fraction		0.28	0.08	0.64
partial pressure		0.28P	0.08P	0.64P
				total moles = 2.50
				sum of mole fractions = 1.00
				sum of partial pressures = P

PART 3 – K_p expressions and units

	equilibrium	K _p	units (assume all pressures are in Pa)
1	$\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g})$	$K_p = \frac{(\text{pNH}_3)^2}{(\text{pN}_2) (\text{pH}_2)^3}$	Pa ⁻²
2	$\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$	$K_p = \frac{(\text{pPCl}_3) (\text{pCl}_2)}{(\text{pPCl}_5)}$	Pa
3	$\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2 \text{HI}(\text{g})$	$K_p = \frac{(\text{pHI})^2}{(\text{pH}_2) (\text{pI}_2)}$	No units
4	$2 \text{O}_3(\text{g}) \rightleftharpoons 3 \text{O}_2(\text{g})$	$K_p = \frac{(\text{pO}_2)^3}{(\text{pO}_3)^2}$	Pa
5	$\text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + 3 \text{H}_2(\text{g})$	$K_p = \frac{(\text{pCO}) (\text{pH}_2)^3}{(\text{pCH}_4) (\text{pH}_2\text{O})}$	Pa ²
6	$\text{CO}(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons \text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g})$	$K_p = \frac{(\text{pCH}_4) (\text{pH}_2\text{O})}{(\text{pCO}) (\text{pH}_2)^3}$	Pa ⁻²
7	$2 \text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2 \text{SO}_3(\text{g})$	$K_p = \frac{(\text{pSO}_3)^2}{(\text{pSO}_2)^2 (\text{pO}_2)}$	Pa ⁻¹
8	$\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2 \text{NO}_2(\text{g})$	$K_p = \frac{(\text{pNO}_2)^2}{(\text{pN}_2\text{O}_4)}$	Pa