

Assignment 6:

1. Hebden p.60 #31acegj, 32, 35 abcd & p.62 #36, 40, 41, 44-46
2. Given the following equation and data:

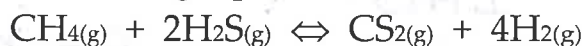


$$K_{\text{eq}} = 12.0 \text{ at } 200^{\circ}\text{C}$$

$$K_{\text{eq}} = 20.0 \text{ at } 300^{\circ}\text{C}$$

Is the forward reaction exothermic or endothermic? Support your answer with explanations.

3. Given the following equation and data:

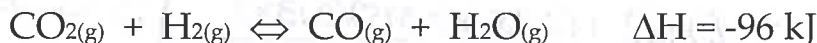


$$K_{\text{eq}} = 1.0 \times 10^{-2} \text{ at } 500^{\circ}\text{C}$$

$$K_{\text{eq}} = 2.4 \times 10^{-3} \text{ at } 800^{\circ}\text{C}$$

- a) Is the forward reaction endothermic or exothermic? Explain.
- b) What effect will increasing the $[\text{H}_2\text{S}]$ have on the value of K_{eq} ?

4. For the following reaction:



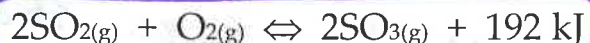
What effect will decreasing the temperature have on the value of K_{eq} ? Support your answer with explanations.

VII) Type 1 K_{eq} Problems

For Type 1 K_{eq} problems, the data provided in the question is exclusively equilibrium data.

Example:

1. For the following reaction:



Equilibrium concentrations were found to be as follows:

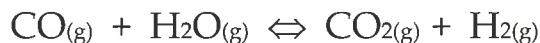
$$[\text{SO}_2] = 2.0\text{M}, [\text{O}_2] = 0.50\text{M}, [\text{SO}_3] = 1.6\text{M} \quad \leftarrow \text{@ equilibrium}$$

Calculate the value of K_{eq} .

$$K_{\text{eq}} = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2[\text{O}_2]} = \frac{(1.6)^2}{(2.0)^2(0.5)} = \underline{\underline{1.3}}$$

Example:

2. At equilibrium, a 2.00L vessel contained 0.750mol CO, 0.276mol H₂O, 0.600mol CO₂, and a $K_{eq} = 0.986$. Calculate the moles of H₂ at equilibrium.



$$[\text{CO}] = \frac{0.750 \text{ mol}}{2.00 \text{ L}} = 0.375 \text{ M}$$

$$[\text{CO}_2] = \frac{0.600 \text{ mol}}{2.00 \text{ L}} = 0.300 \text{ M}$$

$$[\text{H}_2\text{O}] = \frac{0.276 \text{ mol}}{2.00 \text{ L}} = 0.138 \text{ M}$$

$$[\text{H}_2] = ?$$

$$C = \frac{n}{V}$$

$$\therefore n = C \cdot V$$

$$\text{mol H}_2 = (0.170 \text{ M})(2.00 \text{ L})$$

$$K_{eq} = \frac{[\text{CO}_2][\text{H}_2]}{[\text{CO}][\text{H}_2\text{O}]}$$

$$0.986 = \frac{(0.300)[\text{H}_2]}{(0.375)(0.138)}$$

$$[\text{H}_2] = \frac{(0.986)(0.375)(0.138)}{0.300}$$

$$[\text{H}_2] = 0.170 \text{ M}$$

$$\therefore 0.340 \text{ mol H}_2$$

VIII) Type 2 K_{eq} Problems

Type 2 K_{eq} problems provide some initial data and some equilibrium data for certain substances, which you are to use to calculate the K_{eq} constant. Use an

'R' 'ICE' table for assistance.

Example:

1..A mixture of H₂ and I₂ was prepared by placing 0.100mol of H₂ and 0.100mol of I₂ into a 1.00L flask. At equilibrium, the I₂ concentration dropped to 0.020M. Calculate the K_{eq} .

Reaction

	H _{2(g)}	+ I _{2(g)}	\rightleftharpoons	2HI(g)
Initial	0.100 M	0.100 M		0
Change	-0.080 M	-0.080 M		+0.16 M
Equilibrium	0.020 M	0.020 M		0.16 M

no products at start of rxn.

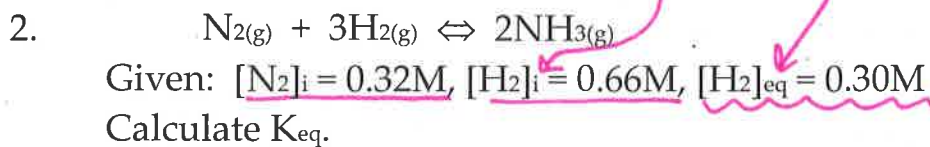
$C = \frac{n}{V}$ \therefore in a 1L flask mol = molarity.

Δ is 0.080 M
 $\therefore 2(0.080 \text{ M}) = 0.16 \text{ M}$
 (+) b/c products are being formed

$$\therefore K_{eq} = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]} = \frac{(0.16)^2}{(0.02)(0.02)} = 64$$

↑
[conc.] @ equilibrium

Example:



- ① Fill in "knows"
- ② solve for "change" + apply.
- ③ solve for K_{eq} .



I 0.32M 0.66M 0M ← products are always zero @ start

C -0.12M -0.36M $+0.24\text{M}$ } $3\text{H}_2 : 2\text{NH}_3 \therefore (-0.12\text{M}) \times 2 = 0.24\text{M}$

E 0.20M 0.30M 0.24M

don't forget + exp.

$$K_{\text{eq}} = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} = \frac{(0.24\text{M})^2}{(0.20\text{M})(0.30\text{M})^3}$$

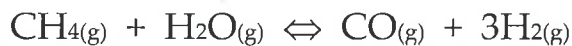
$K_{\text{eq}} = 11$

$\frac{-0.36}{3} = \Delta[\text{N}_2] = -0.12\text{M}$
 because $3\text{H}_2 : 1\text{N}_2$

Assignment 7

Type 1 Problems

1. For the following reaction at equilibrium:

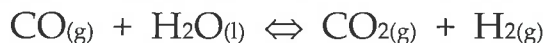


$[\text{CH}_4] = 0.600\text{M}$ $[\text{H}_2\text{O}] = 0.060\text{M}$

$[\text{CO}] = 0.200\text{M}$ $[\text{H}_2] = 0.700\text{M}$

Calculate the K_{eq} for this reaction. Are the reactants or products favoured?

2. For the following reaction:



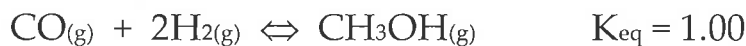
At equilibrium in a 1.0L container, 0.020mol of CO, 0.010mol H₂O, 0.030 mol CO₂, and 0.010mol of H₂ are present.

a) Calculate the K_{eq}

b) State whether reactants or products are favoured

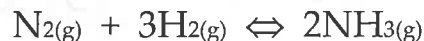
c) If H₂ is removed from the system and equilibrium is re-established, how does the value of K_{eq} change?

3. For the following reaction:



At equilibrium in a 2.0L container, 0.420mol CO and 0.100mol H₂ are present. Calculate the number of moles of CH₃OH present.

4. For the following reaction and data:



	[N ₂] (M)	[H ₂] (M)	[NH ₃] (M)
Trial 1	0.200	0.400	0.500
Trial 2	?	0.300	0.600

Find [N₂] in Trial 2.

Type 2 Exercises (ICE diagrams)

5. A mixture consisting of 1.00mol CO_(g) and 1.00mol H₂O_(g) is placed in a 10.00L container. At equilibrium, 0.665mol CO_{2(g)} and 0.665mol H_{2(g)} are present.



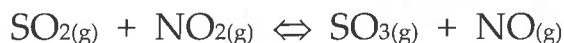
Calculate the K_{eq} for this reaction.

6. When 1.00M HBr is placed into a flask, the following equilibrium is achieved:



At equilibrium, 0.140M H₂ is present. Calculate the K_{eq}.

7. A 5.00L vessel was initially filled with 6.00mol SO₂, 2.50mol NO₂, and 1.00mol SO₃.



At equilibrium, the vessel was found to contain 3.00mol SO₃.

What is the K_{eq} for the reaction?

8. 0.50mol of NOCl was introduced into a 1.0L flask and allowed to come to equilibrium:



At equilibrium, there was 0.10mol of Cl₂. What is the K_{eq}?