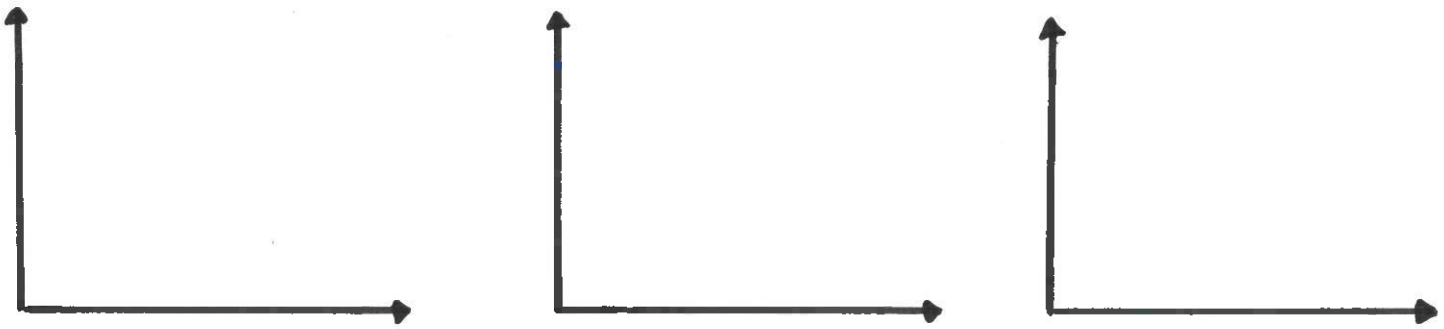
# Dynamic Equilibria

1 2 3 4 5

Dynamic Equilibrium

+ ⇌ +

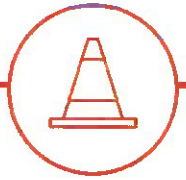


Equilibrium Reached when :

# Le chatelier's Principle



- Helps to predict



N.B. A catalyst has NO EFFECT on the position of the equilibrium.
However, a system will reach equilibrium more quickly.

## You need to...

•

•

•

# Le Chatelier's - Concentration [ ]

1 2 3 4 5

+ ⇌

Equilibrium Shifts Right if: a)

b)

Equilibrium Shifts Left if: a)

b)

e.g. If [ ] is increased -

If [ ] is decreased -

# Le Chatelier's - Pressure

1 2 3 4 5

+ ⇌

↑ Pressure favours the side with

↓ Pressure favours the side with

★

NB, Pressure changes can also affect rate.

# Le Chatelier's - Temperature

1 2 3 4 5

+ ⇌ ΔH =

+ ⇌

- 

↑ Temperature favours the

↓ Temperature favours the

★

NB, Temp changes can also affect rate!

# The Haber Process - A case Study

1 2 3 4 5

+ ⇌ $\Delta H$ =

| Ideal Conditions | Actual Conditions |
| --- | --- |
| | |
| | |
| | |
| | |
| | |
| | |

# $K_c$ - The Equilibrium Constant

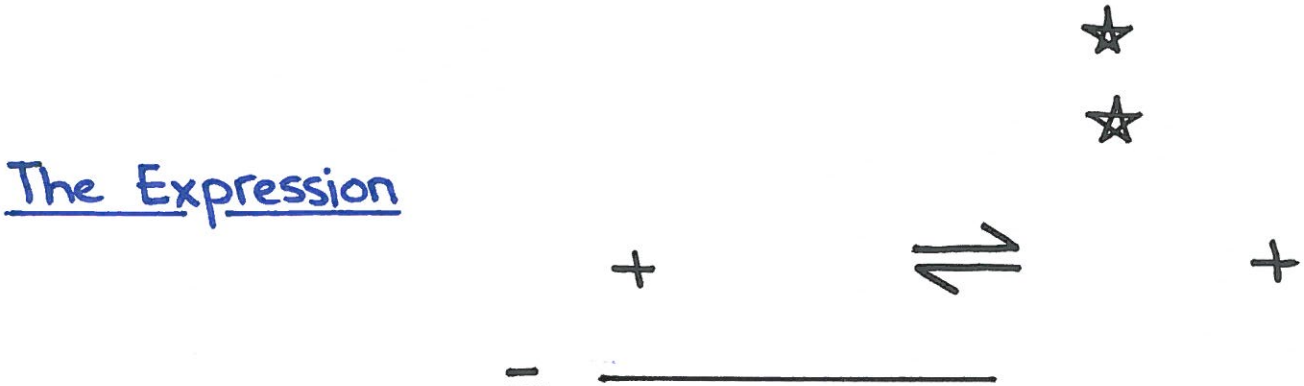
1 2 3 4 5

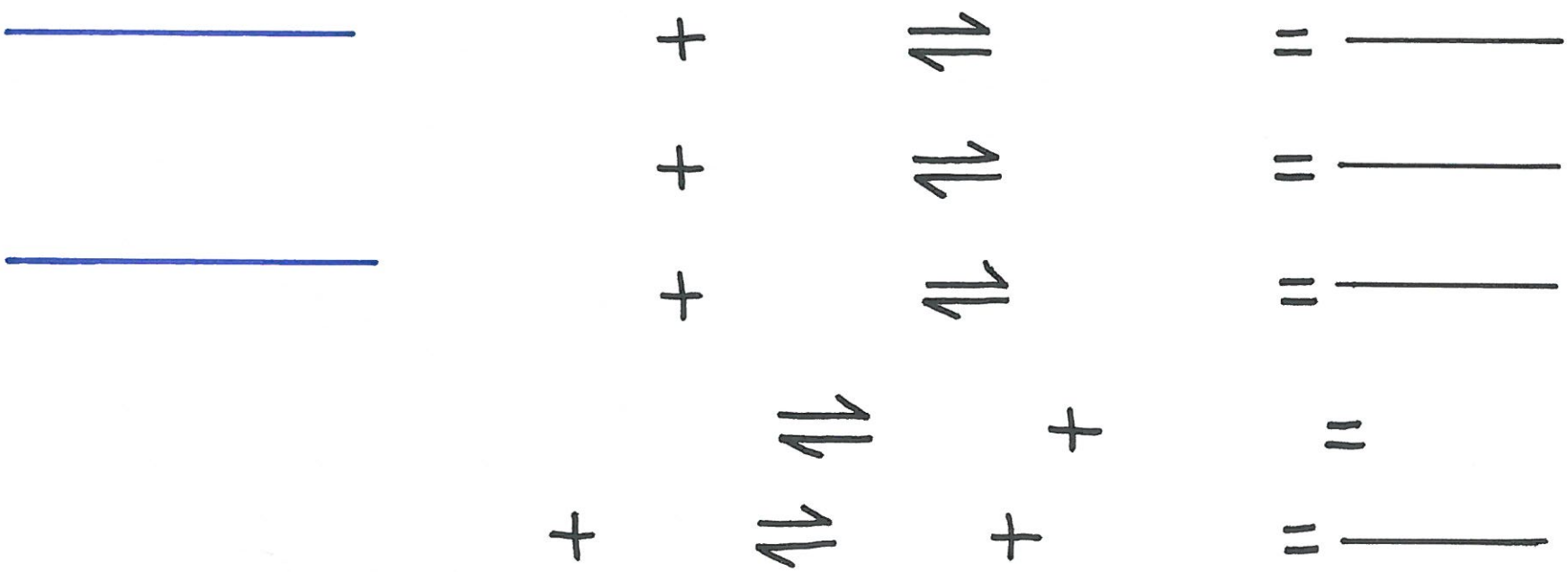
TT

Homogenous

Heterogenous

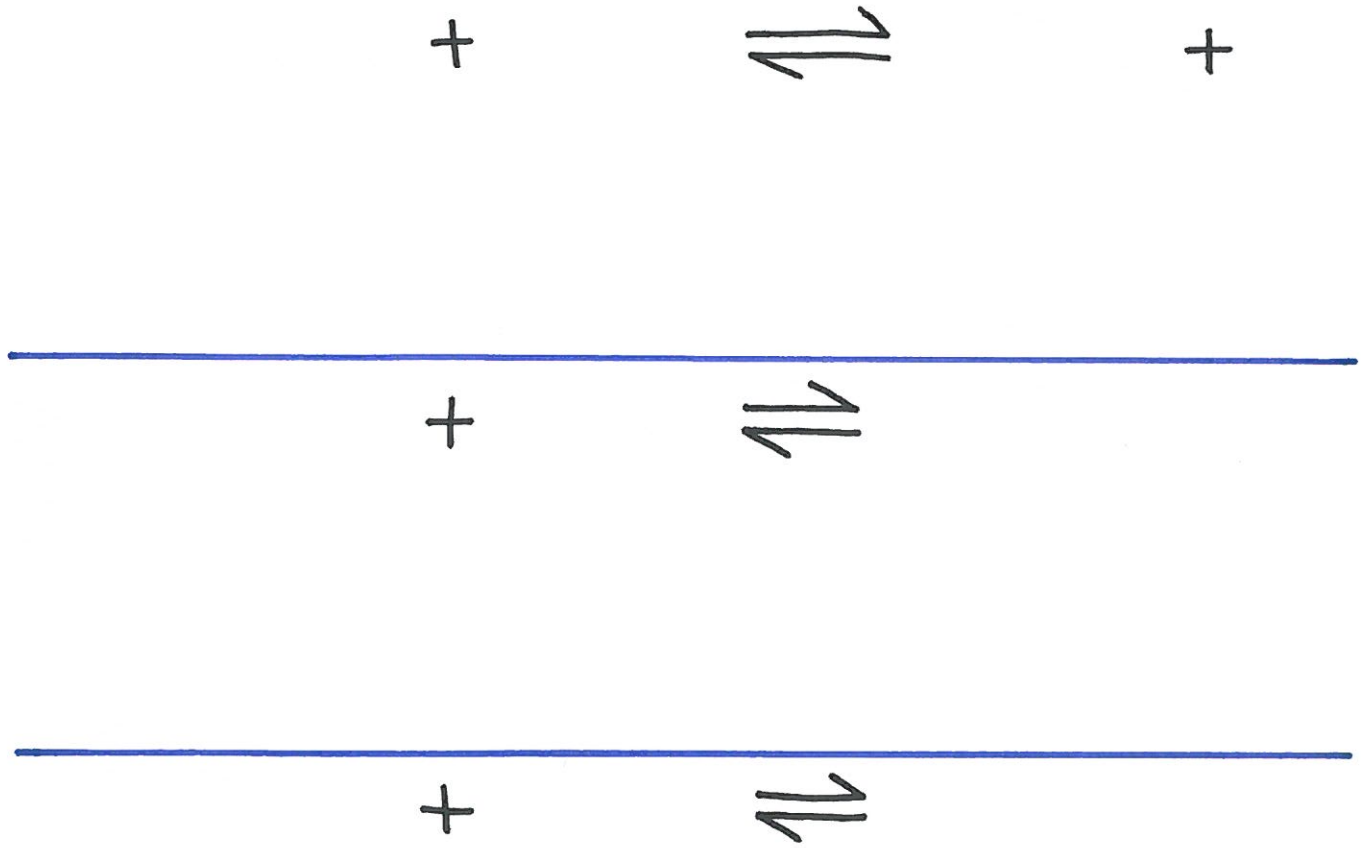
## The Expression





# Deducing Amounts at Equilibrium

1 2 3 4 5



# $K_c$ Calculations - Numbers & Units



$$\quad + \quad \rightleftharpoons$$

$$K_c = \frac{\quad}{\quad} = \frac{\quad}{\quad} =$$

$$\text{UNITS} = \frac{\quad}{\quad} = \frac{\quad}{\quad} =$$

$$\rightleftharpoons \quad +$$

$$K_c = \frac{\quad}{\quad} = \frac{\quad}{\quad} =$$

If $K_c = 1$

If $K_c < 1$

If $K_c > 1$

# Factors Affecting $K_c$



e.g. + ⇌

$$K_c = \frac{\qquad}{\qquad} =$$

## Predicting Change in $K_c$

### Increasing Temperature

- 
- 
- 
- 

### Decreasing Temperature

- 
- 
- 
- 

# EXAMPLE $K_c$ CALCULATIONS - HOMOGENOUS

1. Methanol can be manufactured using the following process.

$$CO_{(g)} + 2H_{2(g)} \quad CH_3OH_{(g)} \quad \Delta H = -94 \text{ kJmol}^{-1}$$

0.242 moles of CO were mixed with 0.360 moles of $H_2$ in sealed container with a volume of 400cm$^3$ at a temperature of 550K and left to reach equilibrium.

a) It was found that 0.100 moles of $CH_3OH$ was present at equilibrium.

Calculate $K_c$, including its units.

Kc = ..... Units .....

What would happen to value of $K_c$, if the temperature was decreased?

## EXAMPLE $K_c$ CALCULATIONS - HOMOGENOUS

2. A dynamic equilibrium is set up when Nitrogen reacts with Hydrogen to form Ammonia.

$$N_{2(g)} + 3H_{2(g)} \quad 2NH_{3(g)}$$

A 2.0dm$^3$ vessel was found to contain 0.05 moles of Nitrogen and 0.08 moles of Ammonia once equilibrium was reached at 300K. The value of $K_c$ for this equilibrium at this temperature is 9.6.

a) Calculate the number of moles of Hydrogen present at equilibrium.

b) Deduce the units for $K_c$ for this equilibrium