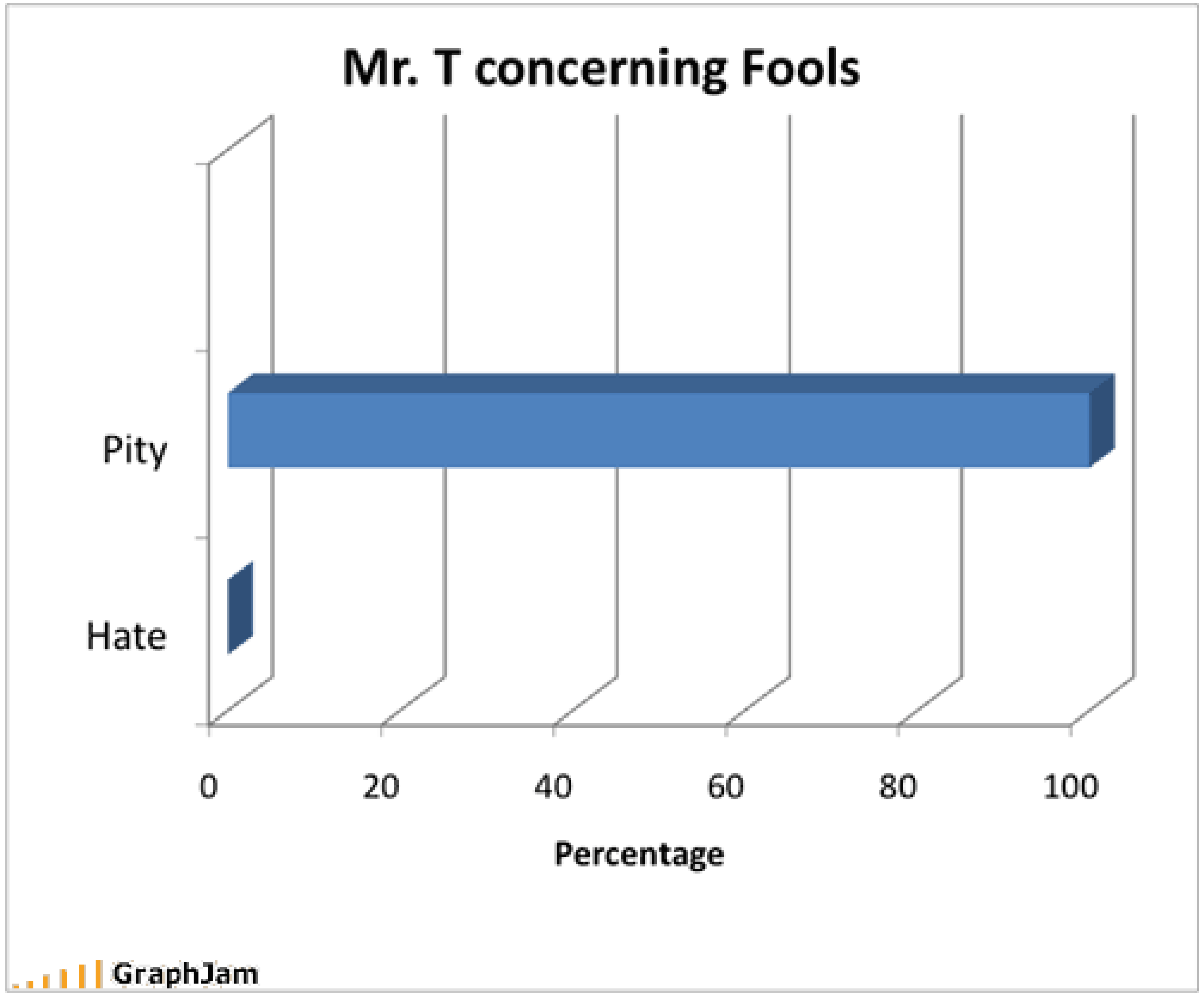
Equilibrium Graphs



Outcome:

Interpret concentration versus time graphs.

Equilibrium Graphs…

We can use Le Chatelier's Principle to interpret graphs of concentration vs. time. The graphs we will be studying in this lesson illustrate the changes for the NO_2-N_2O_4 equilibrium system:

$2\ NO_2(g) \leftrightarrow N_2O_4(g)$	$\Delta H = -58.0$ kJ/mol N_2O_4

In all scenarios, we will assume the system was at equilibrium, then a stress was applied.

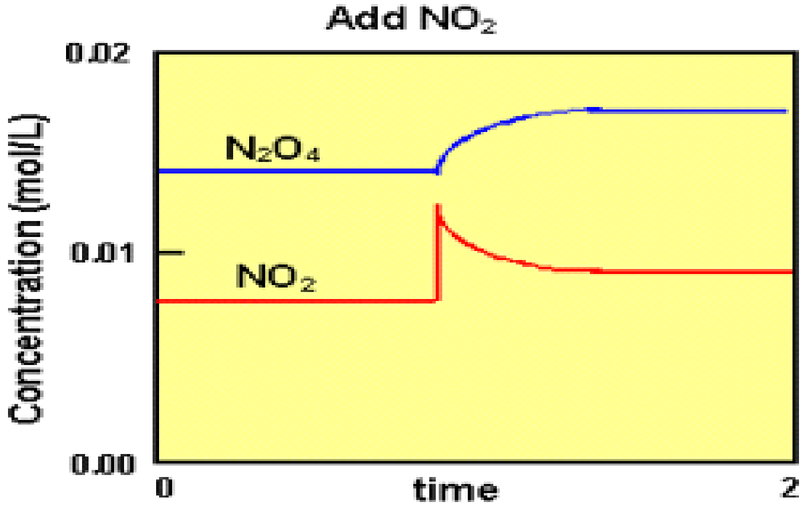
Concentration vs. Time Graphs:

Recall, **CONCENTRATIONS** are **CONSTANT** at equilibrium.

Changing Reactant Concentrations:

- **ADD** more **NO_2**, we get:

$$2NO_{2(g)} \leftrightarrow N_2O_{4(g)}$$



According to the graph,

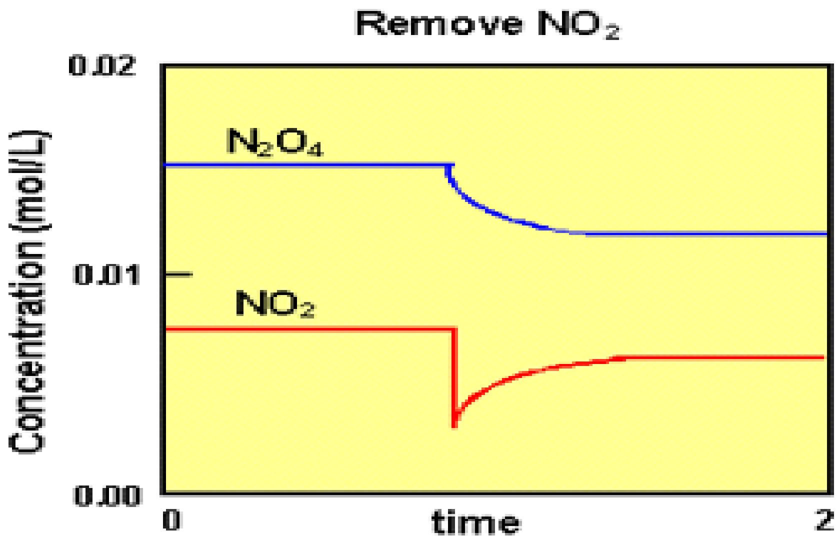
- **INITIALLY** the system is at **EQUILIBRIUM**.
- When **NO_2** is added, **[NO_2]** **INCREASES**, then **DECREASES** as it is **USED** up.
- **[N_2O_4]** will **INCREASE** as more **PRODUCTS** are made

Concentration vs. Time Graphs:

Changing Reactant Concentrations:

- If we **REMOVE** some **NO_2**, we get:

$2NO_{2(g)} \leftrightarrow N_2O_{4(g)}$



According to the graph,

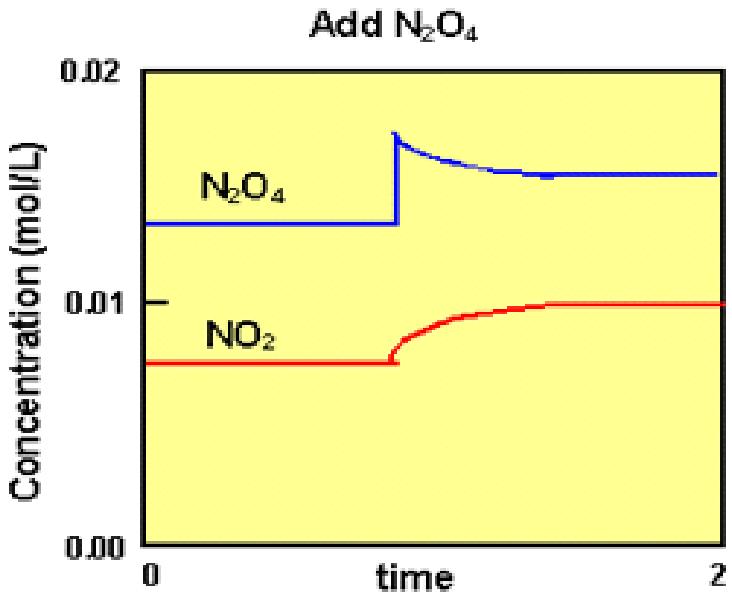
- **INITIALLY** the system is at **EQUILIBRIUM**.
- When **NO_2** is removed, **$[NO_2]$ DECREASES**, then **INCREASES** as it is **MADE**.
- **$[N_2O_4]$** will **DECREASE** as more **REACTANTS** are **MADE**.

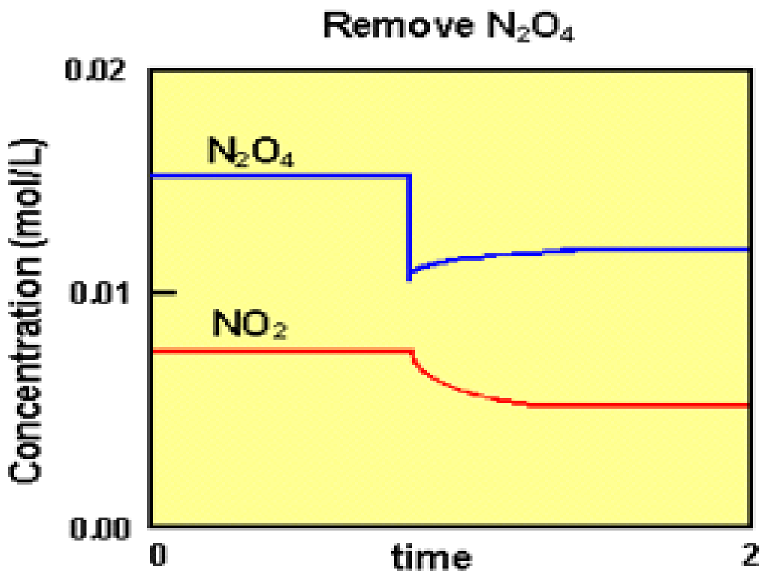
Concentration vs. Time Graphs:

Changing Product Concentrations:

- Same as above, but **OPPOSITE**.

$2NO_{2(g)}$ ←→ $N_2O_{4(g)}$



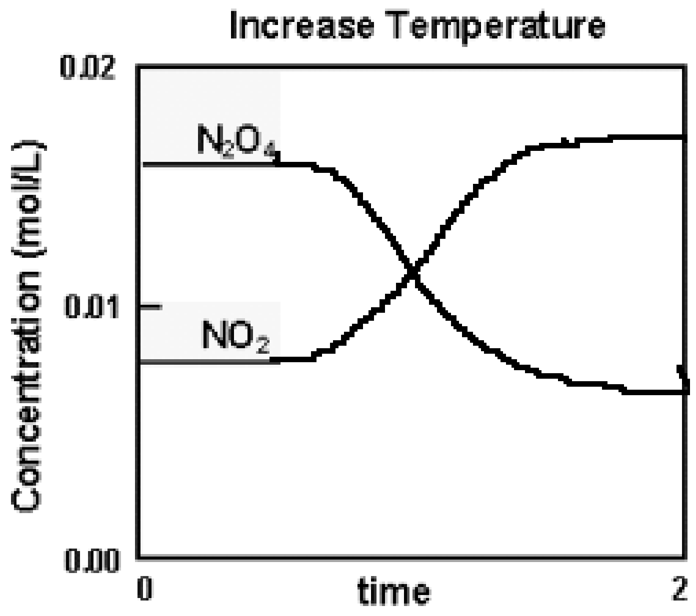


Concentration vs. Time Graphs:

Changing Temperature…

- Increase the temperature, we get:

$$2NO_{2(g)} \leftarrow\rightarrow N_2O_{4(g)} + 58kJ$$



According to the graph,

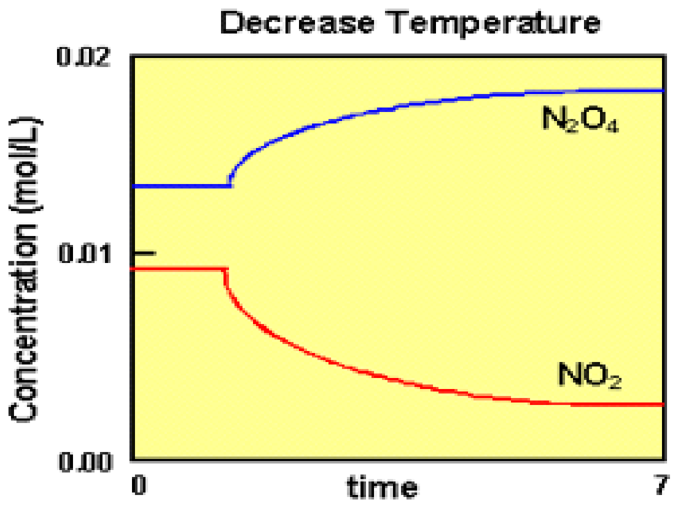
- **INITIALLY** the system is at **EQUILIBRIUM**.
- Reaction is **EXOTHERMIC**, **REVERSE** reaction **INCREASES**, so **[NO_2]** **INCREASES**, and **[N_2O_4]** **DECREASES**.

Concentration vs. Time Graphs:

Changing Temperature…

- If we **DECREASE** the temperature, the **OPPOSITE** will happen

$2NO_{2(g)} \leftarrow\rightarrow N_2O_{4(g)}$ + 58kJ



According to the graph,

- **INITIALLY** the system is at **EQUILIBRIUM**.
- Reaction is **EXOTHERMIC**, **REVERSE** rate **DECREASES**, so **$[NO_2]$ DECREASES**, and **$[N_2O_4]$ INCREASES**.

Since the **RATIO** of concentrations is changed, our **K_{eq} VALUE** will **CHANGE**. This is why **TEMPERATURE** is the **ONLY FACTOR** affecting **K_{eq}**.

Concentration vs. Time Graphs:

Adding a Catalyst:

- Recall that a catalyst **SPEEDS** up a reaction by **LOWERING** the **ACTIVATION** **ENERGY**.
- Since the **ACTIVATION** **ENERGY** is **LOWERED** for **BOTH** the **FORWARD** and **REVERSE** process, **BOTH** **REACTIONS** will go **FASTER**.
- The system will simply reach equilibrium much **FASTER** (**NO** **CHANGE** to equilibrium **CONCENTRATIONS**)
  - Therefore the concentration vs. time graph would just be **SHORTER**.
- If the system was **ALREADY** at **EQUILIBRIUM** when the catalyst was added, there would still be **NO** **CHANGE**, because **BOTH** **FORWARD** and **REVERSE** **PROCESSES** are **INCREASED**.