



# DYNAMIC EQUILIBRIA

## Dynamic equilibrium in a closed system

What is a closed system? **No substances can get in or out**

What happens at dynamic equilibrium?

**both forward and reverse reactions take place simultaneously  
and at the same rate**

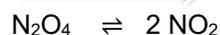
## Energy changes in reversible reactions

–92 kJ/mol (exothermic)



**+92 kJ/mol (endothermic)**

+58 kJ/mol (endothermic)



**–58 kJ/mol (exothermic)**

## Le Chatelier's principle

If the conditions of a reaction at equilibrium are changed, then the position of the equilibrium moves to oppose that change.

(see over the page)

## The effect of catalysts on an equilibrium

A catalyst increases the rate of both the forward and reverse reactions equally.

It does not change the position of the equilibrium, but it reaches equilibrium faster.

Change	Comments	Example
Temperature	<p>If temperature is increased:</p> <ul style="list-style-type: none"> <li>• <b>equilibrium position shifts to oppose the increase in temperature</b></li> <li>• <b>so shifts in the endothermic direction</b></li> </ul> <p>If temperature is decreased:</p> <ul style="list-style-type: none"> <li>• <b>equilibrium position shifts to oppose the decrease in temperature</b></li> <li>• <b>so shifts in the exothermic direction</b></li> </ul>	$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ <p>(reaction is exothermic)</p> <p>What happens to the yield of ammonia if the temperature is increased and why?</p> <ul style="list-style-type: none"> <li>• <b>equilibrium position shifts to oppose the increase in temperature</b></li> <li>• <b>so shifts in the endothermic direction</b></li> <li>• <b>so shifts LEFT giving LOWER yield of NH<sub>3</sub></b></li> </ul>
Pressure	<p>If pressure is increased:</p> <ul style="list-style-type: none"> <li>• <b>equilibrium position shifts to oppose the increase in pressure</b></li> <li>• <b>so shifts to the side with fewer gas molecules</b></li> </ul> <p>If pressure is decreased:</p> <ul style="list-style-type: none"> <li>• <b>equilibrium position shifts to oppose the decrease in pressure</b></li> <li>• <b>so shifts to the side with more gas molecules</b></li> </ul>	$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ <p>What happens to the yield of ammonia and why if the pressure is increased and why?</p> <ul style="list-style-type: none"> <li>• <b>equilibrium position shifts to oppose the increase in pressure</b></li> <li>• <b>so shifts to the side with fewer gas molecules</b></li> <li>• <b>so shifts RIGHT giving HIGHER yield of NH<sub>3</sub></b></li> </ul>
Concentration	<p>If concentration of a substance is increased:</p> <ul style="list-style-type: none"> <li>• <b>equilibrium position shifts to oppose the increase in concentration</b></li> <li>• <b>so shifts in the direction to use up the added substance</b></li> </ul> <p>If concentration of a substance is decreased:</p> <ul style="list-style-type: none"> <li>• <b>equilibrium position shifts to oppose the decrease in concentration</b></li> <li>• <b>so shifts in the direction to create more of the substance that was removed</b></li> </ul>	$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ <p>What happens to the yield of ammonia and why if more nitrogen is added and why?</p> <ul style="list-style-type: none"> <li>• <b>equilibrium position shifts to oppose the increase in concentration of N<sub>2</sub></b></li> <li>• <b>so shifts in the direction to use up the added N<sub>2</sub></b></li> <li>• <b>so shifts RIGHT giving HIGHER yield of NH<sub>3</sub></b></li> </ul>