Edexcel GCSE Chemistry

Topic 4: Extracting metals and equilibria

Reversible reactions and equilibria

Notes

4.13 Recall that chemical reactions are reversible, the use of the symbol ⇌ in equations and that the direction of some reversible reactions can be altered by changing the reaction conditions

- In some chemical reactions, the products of the reaction can react to produce the original reactants
    - These are called reversible reactions
    - The direction of the reaction can be changed by changing the conditions aka if the forwards reaction takes place in hot conditions, lowering the temperature can allow the reverse reaction to take place

E.g. The Haber Process: nitrogen + hydrogen ⇌ ammonia

- the ⇌ symbol is used to show that a reaction is reversible

4.14 Explain what is meant by dynamic equilibrium

- equilibrium:
    - rate of forward reaction = rate of backward reaction
    - concentration of reacting substances stay the same
- dynamic equilibrium:
    - once the forward and backward reaction reach equilibrium, they keep going

4.15 Describe the formation of ammonia as a reversible reaction between nitrogen (extracted from the air) and hydrogen (obtained from natural gas) and that it can reach a dynamic equilibrium

- Used to manufacture ammonia, which is used to produce nitrogen-based fertilisers
- The raw materials for the Haber process are nitrogen and hydrogen.
- Nitrogen is obtained from the air and hydrogen may be obtained from natural gas or other sources.
- The purified gases are passed over a catalyst of iron at a high temperature (about 450 °C) and a high pressure (about 200 atmospheres).
- Some of the hydrogen and nitrogen reacts to form ammonia.
- The reaction is reversible so ammonia breaks down again into nitrogen and hydrogen.

nitrogen + hydrogen ⇌ ammonia

4.16 Recall the conditions for the Haber process as: temperature 450 degrees C, pressure 200 atmospheres and iron catalyst

4.17 (HT only) Predict how the position of a dynamic equilibrium is affected by changes in: temperature, pressure and concentration

- The relative amounts of all the reacting substances at equilibrium depend on the conditions of the reaction.
- If a system is at equilibrium and a change is made to any of the conditions, then the system responds to counteract the change.
    - Effects of changing conditions on a system at equilibrium can be predicted using Le Chatelier's Principle.

- Effect of changing concentration:
    - If the concentration of one of the reactants or products is changed, the system is no longer at equilibrium and the concentrations of all the substances will change until equilibrium is reached again.
    - If concentration of reactants is increased: position of equilibrium shifts towards products (right) so more product is produced until equilibrium is reached again
    - if concentration of products is increased: position of equilibrium shifts towards reactants (left) so more reactant is produced until equilibrium is reached again

- Effect of changing pressure:
    - In gaseous reactions, an increase in pressure will favour the reaction that produces the least number of molecules as shown by the symbol equation for that reaction.

If a reaction produces a...	**...larger volume of gas (more moles on product side)**	**...smaller volume of gas (fewer moles on product side)**
An increase in pressure...	Decreases yield of reaction- equilibrium shifts left	Increases yield of reaction- equilibrium shifts right
A decrease in pressure...	Increases yield of reaction- equilibrium shifts right	Decreases yield of reaction- equilibrium shifts left

- Effect of changing temperature:
    - If temperature is increased: equilibrium moves in the direction of the endothermic reaction (e.g. if forwards reaction is endothermic and temperature is increased, equilibrium shifts right to produce more product)
    - If temperature is decreased: equilibrium moves in the direction of the exothermic reaction

- For the forwards being exo/endothermic and yield meaning the amount of product from the forwards reaction:

	Exothermic	Endothermic
An increase in temperature...	Decreases yield of reaction- equilibrium moves left	Increases yield of reaction- equilibrium moves right
A decrease in temperature...	Increases yield of reaction- equilibrium moves right	Decreases yield of reaction- equilibrium moves left