OCR B GCSE Chemistry

Topic 6: Making useful chemicals

What factors affect the yield of chemical reactions?

Notes

1. Recall that some reactions may be reversed by altering the reaction conditions including: reversible reactions are shown by the symbol (see below in the Haber Process equation), reversible reactions (in closed systems) do not reach 100% yield

- 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

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

- When a reversible reaction occurs in a closed system, equilibrium is reached when the reactions occur at exactly the same rate in each direction.
    - Therefore, does not reach 100% yield

2. Recall that dynamic equilibrium occurs when the rates of forward and reverse reactions are equal

- this means the concentration of reactants and products remains constant
- though the concentration of the reactants can be different from that of the products

3. (HT only) predict the effect of changing reaction conditions (concentration, temperature and pressure) on equilibrium position and suggest appropriate conditions to produce a particular product, including: catalysts increase rate but do not affect yield, the disadvantages of using very high temperatures or pressures

- 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.

The 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 so more product is produced until equilibrium is reached again
- if concentration of products is increased: position of equilibrium shifts towards reactants so more reactant is produced until equilibrium is reached again

The effect of temperature changes on equilibrium:

- 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	Increases yield of reaction
A decrease in temperature...	Increases yield of reaction	Decreases yield of reaction

The effect of pressure changes on equilibrium:

- 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 pressure is increased: equilibrium shifts to side of equation with fewer moles of gas (e.g. $N_2 + 3H_2 \rightleftharpoons 2NH_3$, left side has 4 moles of gas (1+3) and right has 2 moles of gas. If you increase the pressure equilibrium moves right as there are fewer moles of gas on the right hand side, making more product)
- if pressure is decreased: equilibrium will shift to side of equation with more moles of gas (e.g. for previous example equilibrium would move left, making more reactant)

If a reaction produces a...	**...larger volume of gas (more moles)**	**...smaller volume of gas (fewer moles)**
An increase in pressure...	Decreases yield of reaction	Increases yield of reaction
A decrease in pressure...	Increases yield of reaction	Decreases yield of reaction

- Catalysts affect rate, but not yield
    - Increase the rate of reaction of both the forward and reverse reactions, this means that equilibrium is reached quicker, but this does not have an effect overall on the yield of the reaction
- Disadvantages of using very high temperatures or pressures
    - Expensive
    - Dangerous
    - If a high temperature/pressure does not favour the forward reaction in a reversible reaction, this means that it will cause a lower yield to be produced (shift to the left)