GCSE Chemistry A (Gateway Science)
J248/04 Chemistry A C4-C6 and C7 (Higher Tier)

Question Set 24

1   Ammonium sulfate, $(NH_4)_2SO_4$, is a fertiliser.

Ammonium sulfate can be manufactured from ammonia and sulfuric acid.

(a)   The Haber Process is used to manufacture ammonia.

Explain the importance of the Haber Process in agriculture.   **[2]**

Ammonia is very important in fertilisers. The Haber Process is used to produce ammonia, which the plants require to grow to meet agricultural demand

(b)   The Contact Process is used to manufacture sulfuric acid.

- The Contact Process involves the reaction between sulfur dioxide and oxygen.
- The conditions used are 450°C and about 10 atmospheres pressure.

(i)   If the temperature is increased to 500°C the rate of reaction changes.

Describe and explain this change in rate of reaction.   **[2]**

The average speed of the particles will increase, increasing the frequency of collisions between reactant particles. This will increase the rate of reaction   per unit time

(ii)   If the pressure is reduced to 5 atmospheres the rate of reaction changes.
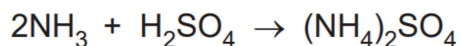
Describe and explain this change in rate of reaction.   **[2]**

This will decrease the rate of reaction, as there will be fewer reactant particles in the same volume, and so a decrease in the frequency of collisions per unit of time

(c) Ammonium sulfate is a salt.

It is made using the reaction between the alkali, ammonia, and sulfuric acid.

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

(i) Describe how a sample of solid ammonium sulfate could be prepared in a laboratory starting from a solution of ammonia and sulfuric acid.

Explain why this method is **not** suitable to be used industrially. **[4]**

- Run 3 titrations with indicator to find a titre. Then use this value to produce a solution of the salt, without an indicator.
- Heat this solution to remove most of the solvent, using a water bath.
- Leave this solution to evaporate and allow the salt to crystalise.
- This is not suitable for industry as the apparatus does not work with larger volumes.

(ii) Calculate the maximum mass of ammonium sulfate that can be made from 51 tonnes of ammonia.

$$n \text{ ammonia} = \frac{m}{mr} = \frac{51}{17} = 3 \text{ mol}$$

$$\Rightarrow n \text{ salt} = \frac{3}{2} \text{ mol}$$

$$m \text{ salt} = n \times mr = \frac{3}{2} \times 132 = 198$$

Answer = ...198............ tonnes **[2]**

Total Marks for Question Set 24: 12