GCSE Chemistry B (Twenty First Century Science)

J258/02 Depth in chemistry (Foundation Tier)

Question Set 17

1 Ammonium sulfate is a fertiliser. It is usually sold to farmers as a solid in large sacks.

Different industrial processes can be used to make ammonium sulfate.

Process	Equation	How the process works	Other points
1	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$	Reactor kept at 60 °C. Uses concentrated sulfuric acid. A solution of ammonium sulfate is made.	Reaction is exothermic. Atom economy 100%.
2	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$	Sulfuric acid is sprayed into dry ammonia gas. Dry powdered ammonium sulfate is made.	Reaction is exothermic. Atom economy 100%.
3	$(NH_4)_2CO_3 + CaSO_4 \rightarrow (NH_4)_2SO_4 + CaCO_3$	Calcium carbonate forms as a precipitate in a solution of ammonium sulfate.	Atom economy 57%. Calcium carbonate is a waste product.

Use information from the table to answer these questions.

(a) In **process 1**, the reactor reaches 60 °C without being heated.

Explain why the reactor keeps hot **without** being heated. **[2]**

(b) Suggest **one** advantage of using **process 2** to make ammonium sulfate, rather than the other two processes. **[2]**

(c) Use the equations in the table to explain why the atom economies of the processes are different. **[2]**

(d) **(i)** The method used in **process 3** can also be done in the laboratory.

Which two techniques are needed to separate solid ammonium sulfate from the final reaction mixture?

Tick (✓) **two** boxes.

- Filtration ☐
- Distillation ☐
- Neutralisation ☐
- Evaporation ☐

[2]

(ii) Ammonium sulfate is made in the laboratory in a **batch** process.

The processes that make ammonium sulfate in industry are **continuous** processes.

Describe the **differences** between batch and continuous processes. **[2]**

Total Marks for Question Set 17: 10