From page 8

Q4.b) Plan an investigation to show how the concentration of the sodium thiosulfate solution affects the rate of the reaction with dilute hydrochloric acid. Your plan should give valid results.

Level 3: The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6
Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4
Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2
No relevant content	0

Indicative content

method

- measure (indicated) volume of sodium thiosulfate
- place sodium thiosulfate in (conical) flask
- measure (indicated) volume of hydrochloric acid
- place on cross **or** between light sensor
  or
  connect to a gas syringe
  or
  other suitable method for timing a change
- add hydrochloric acid to (conical) flask
- swirl
- start stopclock / stopwatch
- measure time for cross to become no longer visible
  or
  log light transmission over time
  or
  measure time for fixed volume of gas to be produced
- repeat and find mean
- repeat for different concentrations of sodium thiosulfate
  or change ratio of sodium thiosulfate volume : water volume

control variables

- concentration of hydrochloric acid
- volume of hydrochloric acid
- (total) volume of sodium thiosulfate solution

[6 marks]

AQA June 18 H Q5.2

This question is about reversible reactions and equilibrium. Hydrogen is used to produce ammonia in the Haber process. The hydrogen is made in two stages. Stage 1 is the reaction of methane and steam to produce carbon monoxide and hydrogen. The equation for the reaction is: $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$

HT

Q9.a) Explain why a low pressure is used in stage 1. Give your answer in terms of equilibrium.

- higher yield
- fewer moles/molecules on left

[2 marks]

AQA June 19 H Q10.2

Q9.b) Stage 2 uses the carbon monoxide produced in stage 1. The carbon monoxide is reacted with more steam to produce carbon dioxide and more hydrogen. The equation for the reaction in stage 2 is: $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$

What is the effect of increasing the pressure on the equilibrium yield of hydrogen in stage 2?

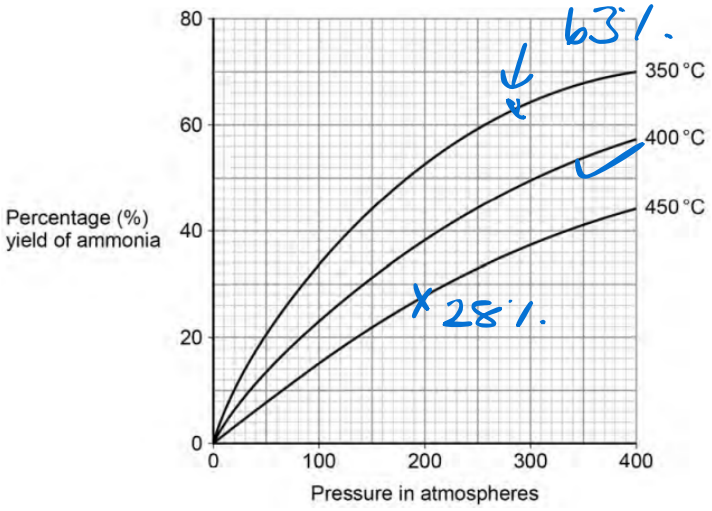
no effect

[1 mark]

AQA June 19 H Q10.3

The graph shows the percentage yield of ammonia produced at different temperatures and pressures in the Haber process. A temperature of 450 °C and a pressure of 200 atmospheres are used in the Haber process.

Q9.c) A student suggested that a temperature of 350 °C and a pressure of 285 atmospheres could be used instead of those used in the Haber process. Determine how many times greater the percentage yield of ammonia obtained would be.



$63/28 = 2.25$

[3 marks]

AQA June 19 H Q10.4

Q9.d) A pressure of 285 atmospheres is not used in the Haber process instead of 200 atmospheres. Give one reason why.

energy cost higher / equipment more expensive

[1 mark]

AQA June 19 H Q10.5

Q11. The equation for the production of ammonia in the Haber process is: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ The forward reaction is exothermic.

HT

The conditions used are:

- a temperature of 450 °C
- a pressure of 200 atmospheres
- the presence of an iron catalyst.

Explain why these conditions are chosen for economical production of ammonia in the Haber process. You should include references to the rate of reaction and the position of equilibrium.

Level 3: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6
Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4
Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2
No relevant content	0

rate

- higher temperature gives higher rate because of more frequent collisions
- higher temperature gives higher rate because more particles have the activation energy
- higher pressure gives higher rate because of more frequent collisions
- use of catalyst gives higher rate because the activation energy is lowered

equilibrium

- higher temperature shifts the position of equilibrium to the left because reaction is exothermic
- higher pressure shifts the position of equilibrium to the right because more molecules on left-hand side
- use of catalyst has no effect on the position of equilibrium

other factors

- higher temperature (than 450°C) uses more energy so increases costs
- higher pressure (than 200 atmospheres) uses more energy so increases costs
- higher pressure (than 200 atmospheres) requires stronger reaction vessels so increases costs
- use of a catalyst reduces energy costs

compromise

- the temperature chosen is a compromise between rate of reaction and position of equilibrium
- the temperature chosen is a compromise between rate and cost
- the pressure chosen is a compromise between yield / rate and cost

[6 marks]

AQA June 22 H Q7.6