

Name:

Date:

C10 - Test 6
USING RESOURCES
Advanced

GCSE

CHEMISTRY

AQA - Triple Science

Mark

Grade

Materials

For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

Instructions

- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information

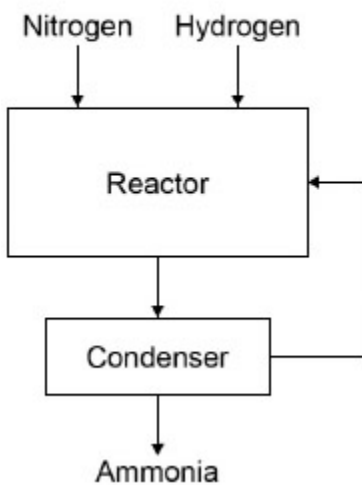
- The marks for the questions are shown in brackets

1.

Nitrogen and hydrogen react to produce ammonia in the Haber process.

Figure 1 shows the Haber process.

Figure 1



A gaseous mixture of ammonia, hydrogen and nitrogen leaves the reactor.

Table 1 shows the boiling points of the gases.

Table 1

Gas	Boiling point in °C
Ammonia	-33
Nitrogen	-196
Hydrogen	-253

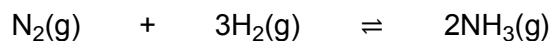
(a) Suggest how ammonia is separated from the other gases.

(2)

(b) What happens to the unreacted hydrogen and nitrogen?

(1)

The equation for the reaction is:



The forward reaction is exothermic.

(c) Calculate the volume of ammonia produced from the complete reaction of 825 dm³ of hydrogen.

Volume of ammonia = _____ dm³

(2)

(d) The Haber process uses a temperature of 450 °C and a pressure of 200 atmospheres.

Why are these conditions used?

Tick **two** boxes.

A higher pressure is maintained using less energy

A higher temperature would increase the equilibrium yield

A lower pressure would decrease the equilibrium yield

A lower temperature would make the reaction too slow

There are more product molecules than reactant molecules

(2)

Most of the ammonia produced is used to make fertilisers.

Table 2 shows information about compounds used as fertilisers.

Table 2

Compound	Formula	Cost in £ / tonne
A	NH_4NO_3	220
B	$(\text{NH}_4)_2\text{HPO}_4$	350
C	KCl	235

(e) Which element in compound A improves agricultural productivity?

(1)

(f) Which **two** compounds can be mixed to make a fertiliser containing three elements that improve agricultural productivity?

Give a reason why you have chosen these compounds.

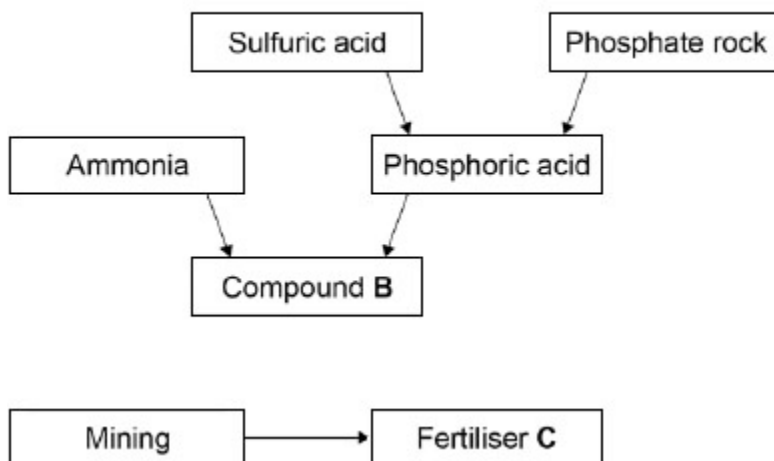
Compounds _____ and _____

Reason _____

(2)

(g) **Figure 2** shows a flow chart for the production of compounds B and C.

Figure 2



Suggest **two** possible reasons for the difference in cost between compounds **B** and **C**.

1. _____

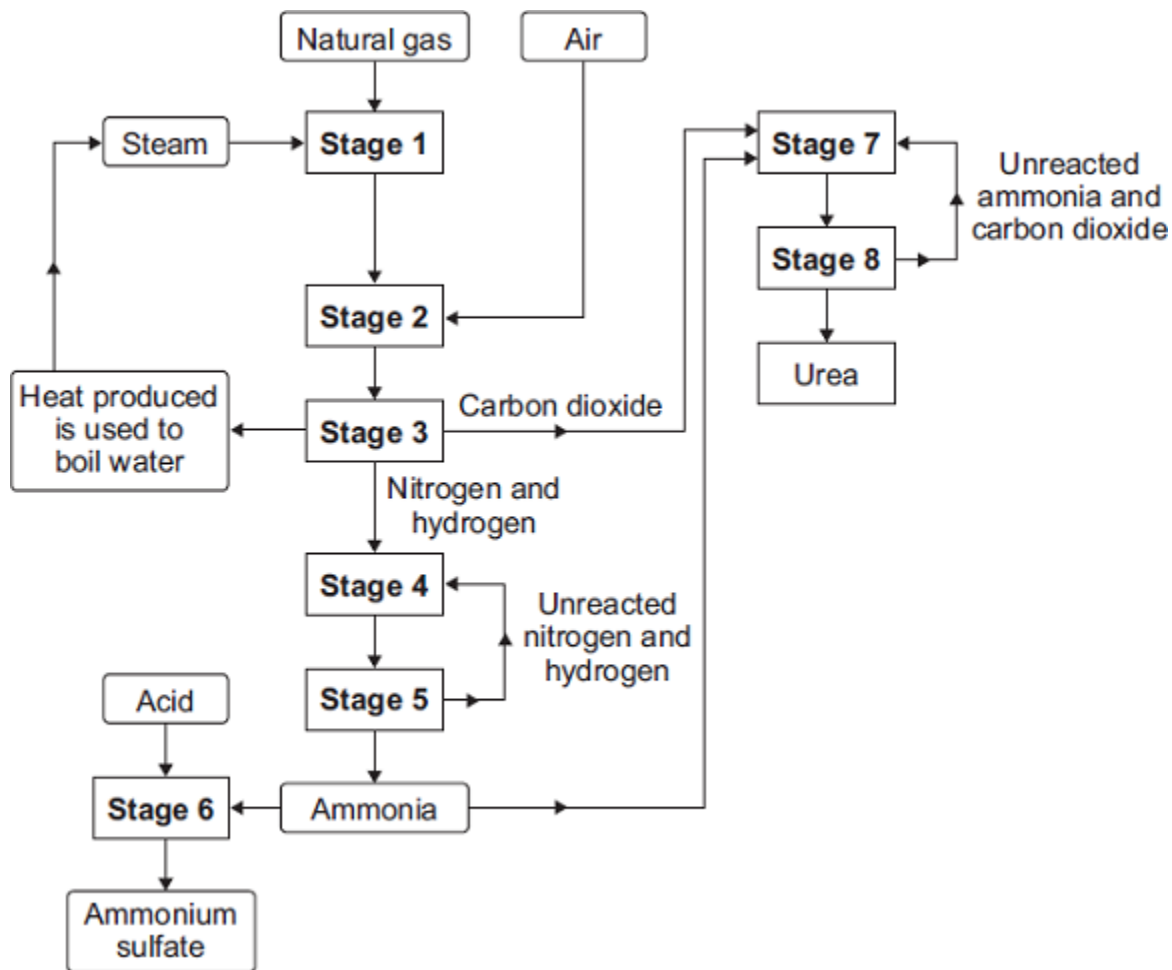
2. _____

(2)
(Total 12 marks)

2.

Ammonium sulfate and urea are made from ammonia. These compounds are used by farmers.

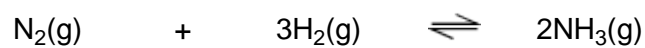
The flow diagram shows the stages to make ammonium sulfate and urea.



(a) Give **two** examples from the flow diagram of the efficient use of energy and raw materials.

(2)

(b) The equation for the reaction in Stage 4 is shown below.



The forward reaction is exothermic.

State **and** explain:

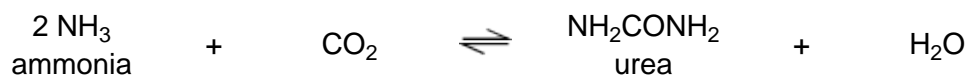
(i) how a **decrease** in temperature would affect the yield of ammonia at equilibrium

(2)

(ii) how an **increase** in pressure would affect the yield of ammonia at equilibrium.

(2)

(c) The equation for the reaction in Stage 7 is shown below.



The table gives the relative formula masses (M_r) of the reactants and the products for this reaction.

Formula of reactant or product	Relative formula masses (M_r)
NH ₃	17
CO ₂	44
NH ₂ CONH ₂	60
H ₂ O	18

Percentage atom economy can be calculated using:

$$\text{Percentage atom economy} = \frac{M_r \text{ of useful product}}{\text{total } M_r \text{ of all reactants added together}} \times 100\%$$

Calculate the percentage atom economy for the reaction in Stage 7.

Percentage atom economy = _____ %

(2)

(Total 8 marks)

3.

(a) PEX is a material that is used as an alternative to copper for hot water pipes. PEX is made from poly(ethene).

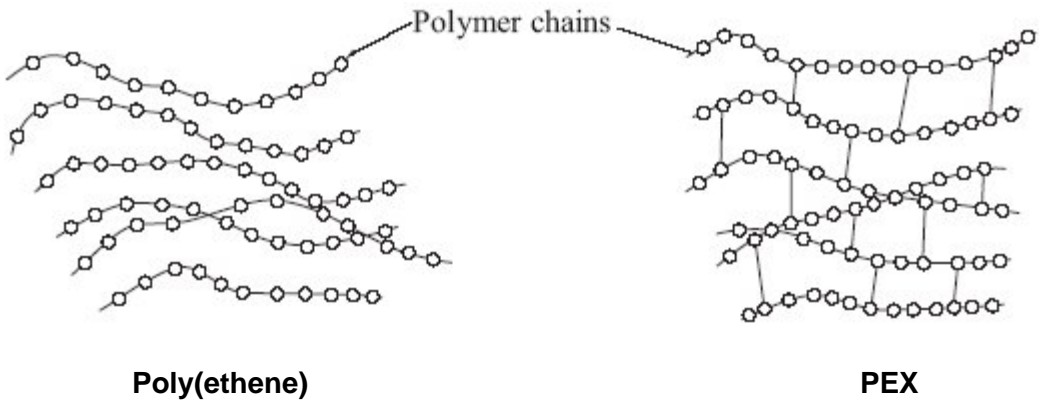
(i) Describe how ethene forms poly(ethene).

(2)

(ii) PEX is a shape memory polymer. What property does a shape memory polymer have?

(1)

(iii) The simplified structures of poly(ethene) and PEX are shown.



Poly(ethene) is a thermoplastic that softens easily when heated.

Suggest and explain how the structure of PEX changes this property.

(3)

- (b) Copper was considered to be the most suitable material to use for hot water pipes.
PEX is now used as an alternative material for hot water pipes.

Copper is extracted from its ore by a series of processes.

- 1 The low-grade ore is powdered and concentrated.
- 2 Smelting is carried out in an oxygen flash furnace. This furnace is heated to 1100 °C using a hydrocarbon fuel. The copper ore is blown into the furnace with air, producing impure, molten copper.
- 3 Oxygen is blown into the impure, molten copper to remove any sulfur. The copper is cast into rectangular slabs.
- 4 The final purification of copper is done by electrolysis.

PEX is made from crude oil by a series of processes.

- 1 Fractional distillation
- 2 Cracking
- 3 Polymerisation
- 4 Conversion of poly(ethene) into PEX

Suggest the possible environmental advantages of using PEX instead of copper for hot water pipes.

(4)

(Total 10 marks)

4. Early atmospheres on Earth contained ammonia (NH_3).

- (a) (i) Complete the sentence.

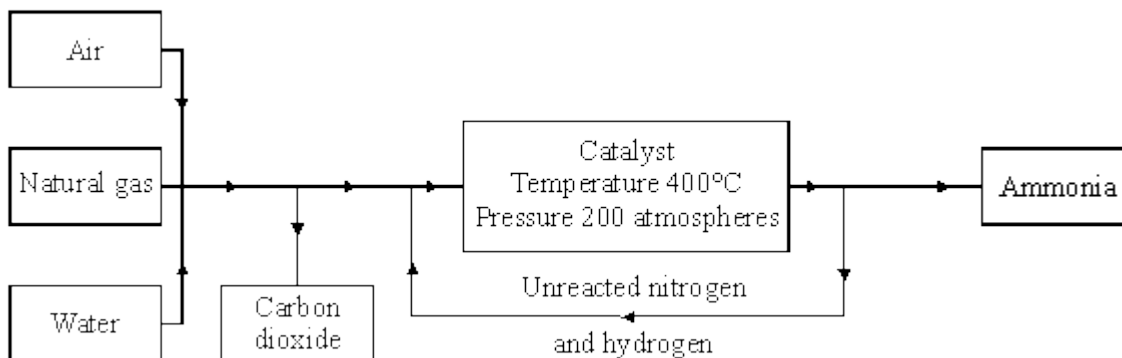
Our atmosphere today is made up of about _____ % nitrogen.

(1)

- (ii) Today we convert nitrogen back to ammonia mainly for the production of fertilisers. What do plants convert the nitrogen in these fertilisers into?

(1)

- (b) The conversion of nitrogen to ammonia is shown.



- (i) When making ammonia, what is **one** source of hydrogen?

(1)

- (ii) Apart from ammonia, name **one** other product formed during this conversion.

(1)

- (c) The main reaction is the formation of ammonia from nitrogen and hydrogen.

- (i) Complete and balance the equation for this reaction.



(2)

- (ii) Name the metal catalyst used in this reaction.

(1)

- (iii) This reaction does not work successfully at room temperature (20 °C) and needs a much higher temperature of 400 °C. Explain why.

(2)

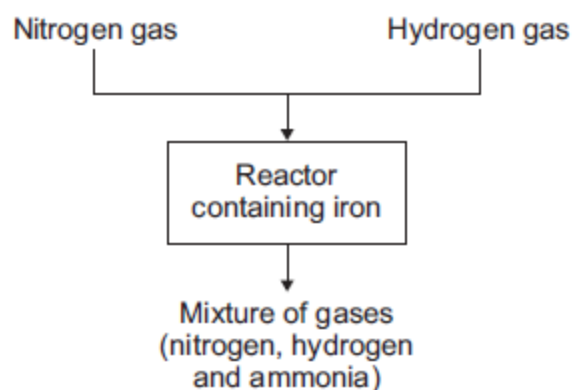
- (d) Draw a diagram to show the arrangement of the electrons in a molecule of ammonia. The electron arrangement of each atom is hydrogen 1 and nitrogen 2.5.

(2)
(Total 11 marks)

5.

The graph in **Figure 1** shows a flow diagram for the Haber process.

Figure 1



- (a) (i) Hydrogen gas is obtained from methane.
Name **one** source of methane.

(1)

- (ii) Air is the source used to produce nitrogen for the Haber process.
Suggest why air must **not** get into the reactor.

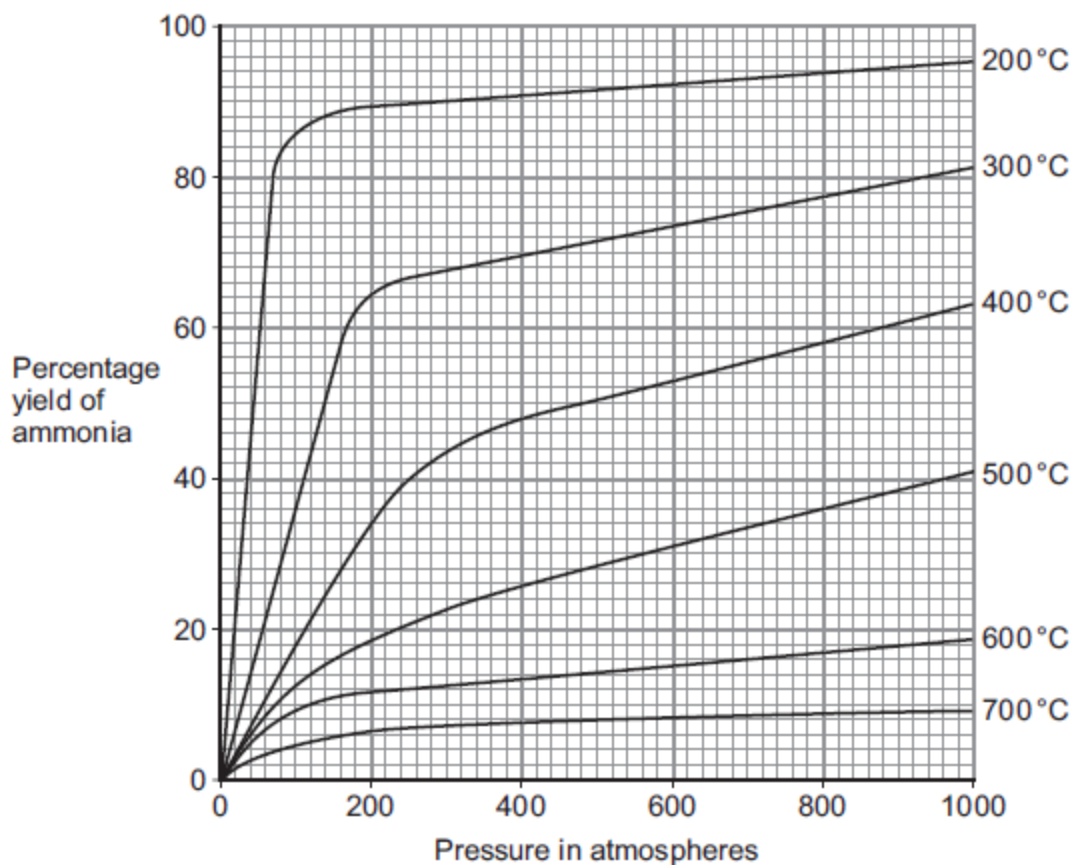
(2)

(iii) Describe what happens to the mixture of gases from the reactor.

(3)

(b) The graph in **Figure 2** shows the percentage yield of ammonia using different conditions.

Figure 2



(i) Use **Figure 2** to suggest the conditions that produce the greatest yield of ammonia.

(1)

- (ii) Use **Figure 2** to suggest and explain why the conditions used to produce ammonia in the Haber process are a temperature of 450 °C and a pressure of 200 atmospheres.

(5)
(Total 12 marks)