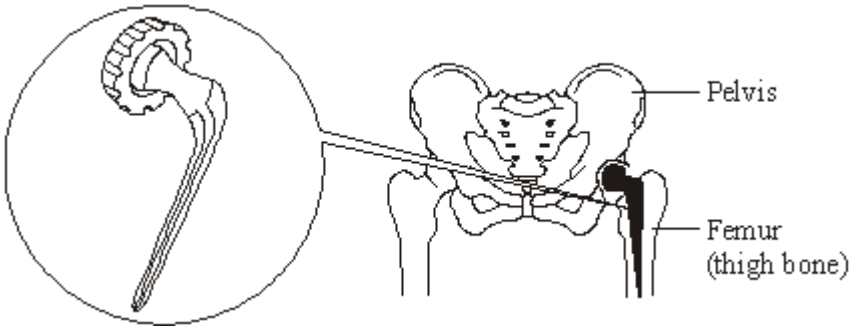
Using resources part 3

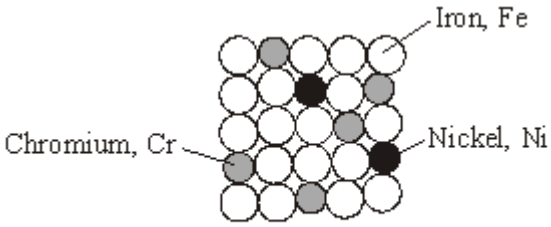
Q1.

The hip joint between the femur and pelvis sometimes has to be replaced.
Early hip replacement joints were made from stainless steel.



Stainless steel is an alloy of iron, chromium and nickel.

The diagram below represents the particles in stainless steel.



Particle diagram of stainless steel

(a) Use the particle diagram to complete the percentages of metals in this stainless steel.

The first one has been done for you.

Element	Percentage (%)
Iron, Fe	72
Chromium, Cr	
Nickel, Ni	

(2)

(b) Pure iron is a relatively soft, metallic element.

(i) Why is iron described as an *element*?

_____

_____

(1)

(ii) Suggest why pure iron would **not** be suitable for a hip replacement joint.

_____

_____

(1)

(iii) Use the particle diagram to help you to explain why stainless steel is harder than pure iron.

_____

_____

_____

_____

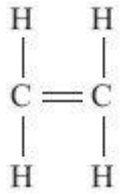
(2)

(Total 6 marks)

Q2.

Crude oil is used to make useful substances such as alkenes and plastics.

(a) The alkene shown is ethene.



(i) Tick (✓) the correct formula for ethene.

Formula	(✓)
CH_4	
C_2H_4	
C_2H_6	

(1)

(ii) Tick (✓) the name of the plastic formed when many ethene molecules join together.

Name of plastic	(✓)
Poly(ethene)	
Poly(ethanol)	
Poly(propene)	

(1)

(b) Read the article about plastics and then answer the questions.

THE PROBLEM WITH PLASTIC WASTE

The UK produces about 3 million tonnes of plastics from crude oil every year.

Most of the litter found on UK beaches is plastic waste.

80% of the plastics produced end up in landfill sites.

The UK recycles only 7% of plastic waste.

(i) Draw a ring around the correct answer in the box to complete the sentence.

Litter that is plastic waste needs to be removed from beaches

because it

decomposes
is flammable
is not biodegradable

.

(1)

(ii) Suggest a problem caused by 80% of the plastics going to landfill sites.

_____

_____

(1)

(iii) The UK government has set a target to recycle 30% of plastic waste.

How are resources saved by recycling more plastics?

_____

_____

(1)

(Total 5 marks)

Q3.

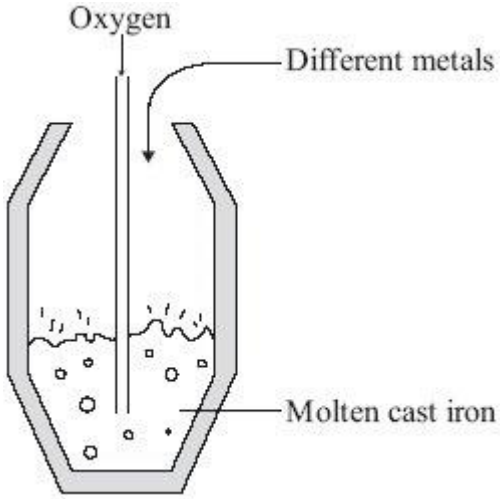
The demand for iron and steel is high.

(a) Iron that is extracted from its oxide by carbon reduction in a blast furnace is called cast iron. Cast iron contains about 4% carbon. This carbon makes cast iron very brittle.

Carbon steels can be made by the following processes.

- Blowing oxygen into molten cast iron to remove most of the carbon.
- Adding a calculated amount of carbon.

Sometimes different metals may also be added to the molten carbon steels.



(i) Suggest how blowing oxygen into molten cast iron removes most of the carbon.

_____

_____

_____

_____

(2)

(ii) Why are different metals sometimes added to molten carbon steels?

_____

_____

(1)

(b) The percentage of iron and steel recycled in the UK has been increasing.

Year	%iron and steel recycled
1998	25
2000	35
2002	42
2004	46
2006	57

The UK government has set targets for the percentage of iron and steel to be recycled.
In 2006 the target was exceeded.

Suggest **two** reasons why the UK government wants to encourage recycling of iron and steel.

1. _____

_____

2. _____

_____

(2)

(Total 5 marks)

Q4.

(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)

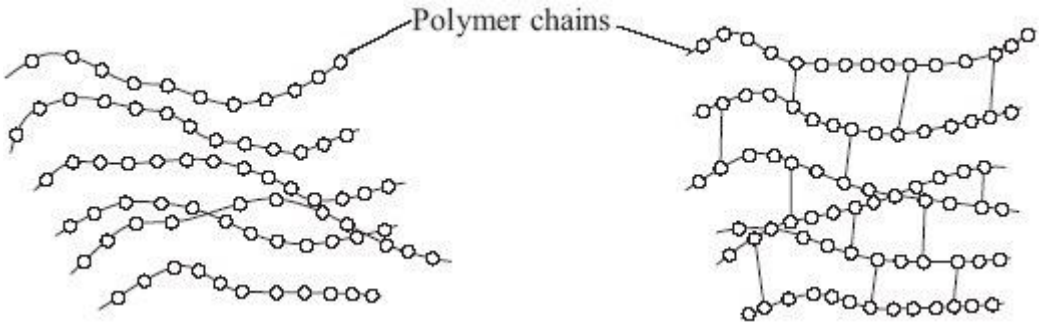
(ii) PEX is a shape memory polymer. What property does a shape memory polymer have?

_____

_____

(1)

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



Poly(ethene) **PEX**

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.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

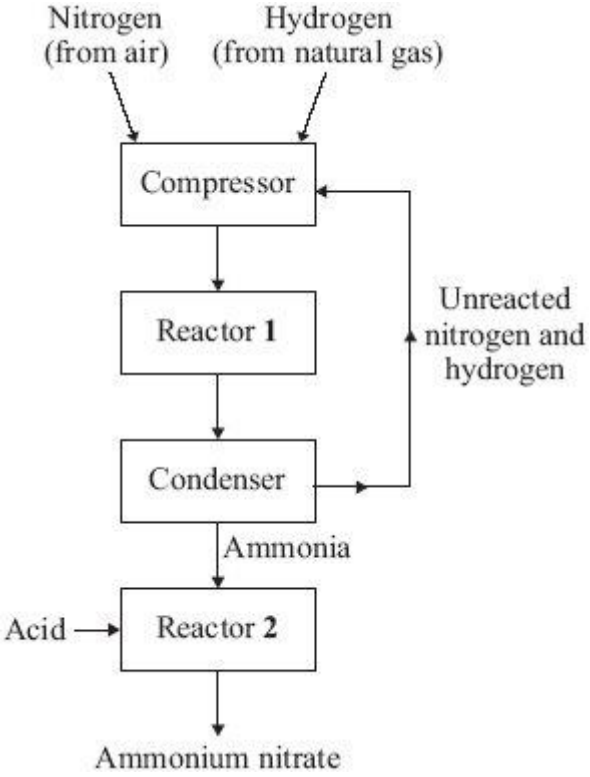
(4)

(Total 10 marks)

Q5.

Ammonium nitrate is an important chemical. The diagram shows the main stages in the manufacture of ammonium nitrate.

Study the diagram and then answer the questions.



Draw a ring around the correct answer in each box to complete the sentences.

(a) The compressor increases the [pressure / temperature / volume] to 200 atmospheres.

(1)

(b) In reactor **1** ammonia is made by reacting [air / natural gas / nitrogen] with [air. / hydrogen. / natural gas.]

(2)

(c) In the condenser the mixture is [cooled / heated / reduced] and the ammonia is separated as a liquid.

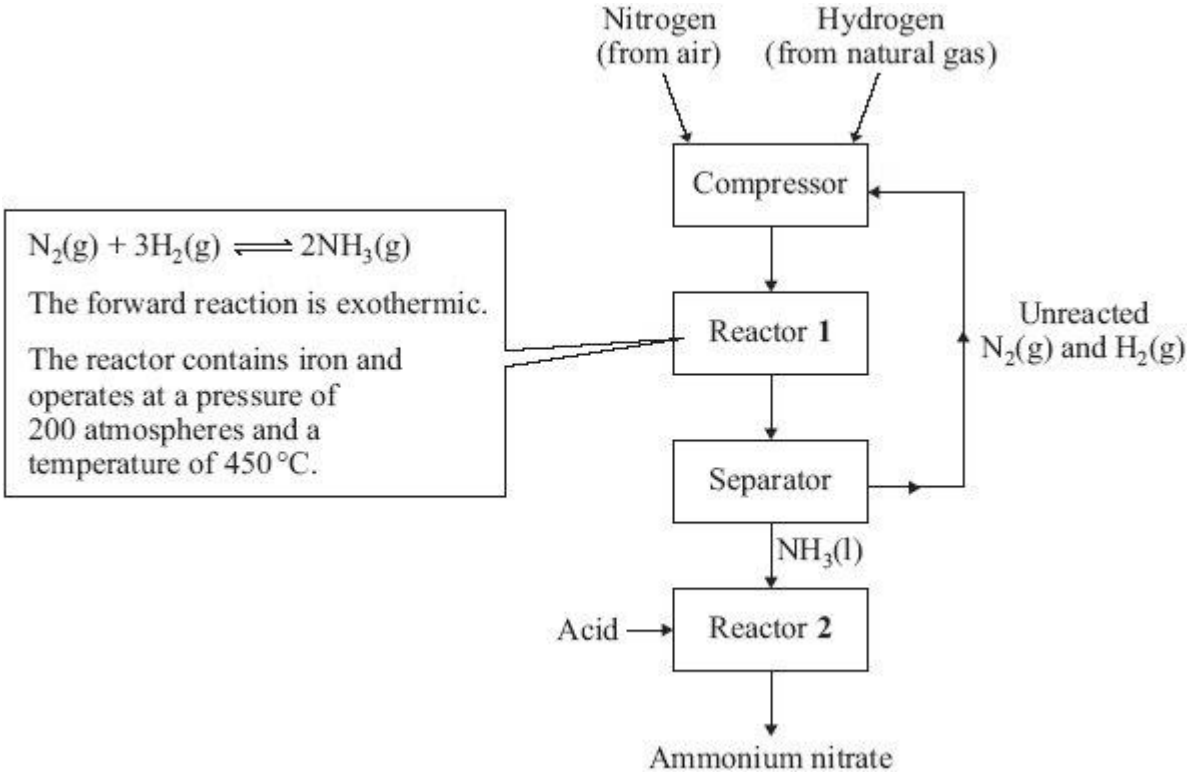
(1)

(Total 4 marks)

Q6.

Ammonium nitrate is an important chemical. The diagram shows the main stages in the manufacture of ammonium nitrate.

Study the diagram and then answer the question.



(a) What is the purpose of the iron in reactor **1**?

_____

_____

(1)

(b) Explain why the best yield of ammonia at equilibrium is obtained:

(i) at low temperature

_____

_____

(1)

(ii) at high pressure.

_____

_____

(1)

(c) The temperature used in reactor **1** is 450 °C.

Explain why a much lower temperature is **not** used.

_____

_____

(1)

(d) A mixture of ammonia, nitrogen and hydrogen leaves reactor **1**.

In the separator, what is done to the mixture to separate the ammonia from the

other gases?

_____

_____

(1)

(Total 5 marks)

Q7.

Chlorine and bromine are important Group 7 elements.

(a) Explain why chlorine is added to drinking water.

_____

_____

(1)

(b) Describe what you would **see** when bromine water is added to an unsaturated organic compound.

_____

_____

(1)

(c) Bromine can be extracted from seawater. The dissolved bromide ions are reacted with chlorine. Bromine and chloride ions are formed.

(i) Complete and balance the equation below, which represents the reaction between chlorine and bromide ions.

$Cl_2 + 2Br^- \rightarrow$ _____ + _____

(1)

(ii) Describe what you **see** when chlorine is added to a solution containing bromide ions.

_____

_____

(1)

(d) In terms of electronic structure:

(i) state why bromine and chlorine are both in Group 7

_____

_____

(1)

(ii) explain why bromine is less reactive than chlorine.

_____

_____

_____

_____

_____

_____

_____

(3)

(e) What is the result of adding acidified silver nitrate solution to a solution containing:

(i) chloride ions

_____

(1)

(ii) bromide ions?

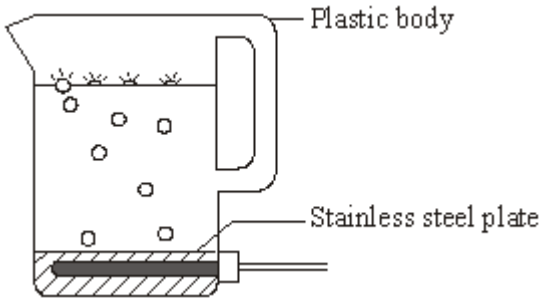
_____

(1)

(Total 10 marks)

Q8.

Plastics are used to make many everyday items, such as the body of the kettle.



(a) Complete the sentences by drawing a ring around the correct words.

(i) The plastic is made from many small molecules called

catalysts
monomers
polymers

(1)

(ii) Propene is produced by cracking some of the fractions that are

separated from

crude oil
limestone

metal ores

(1)

(b) After a few years the kettle no longer worked.

- Some parts of the kettle are made of plastic.
- Some parts of the kettle are made of stainless steel.
- The owner of the kettle disposed of it in a landfill site.

Consider these statements.

Suggest **three** reasons why the kettle should **not** be disposed of in a landfill site.

1. _____

_____

2. _____

_____

3. _____

_____

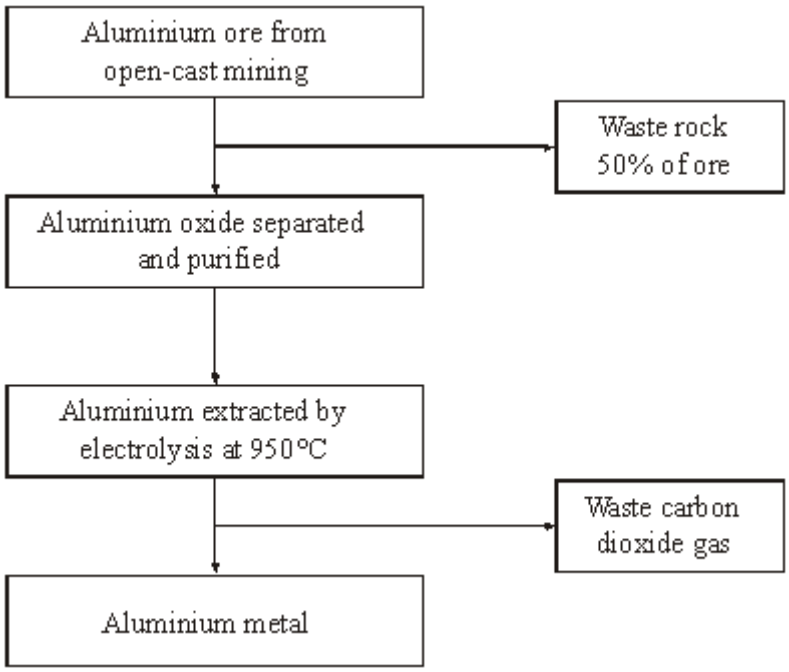
(3)

(Total 5 marks)

Q9.

Aluminium has many uses because of its low density, good electrical conductivity, flexibility and resistance to corrosion.

The main steps in the extraction of aluminium are shown in the flow chart.



(a) Use the information in the flow chart to suggest the benefits of recycling aluminium.

_____

(3)

(b) Pure aluminium is rarely used for the construction of large objects. Small amounts of other metals are usually mixed with aluminium.

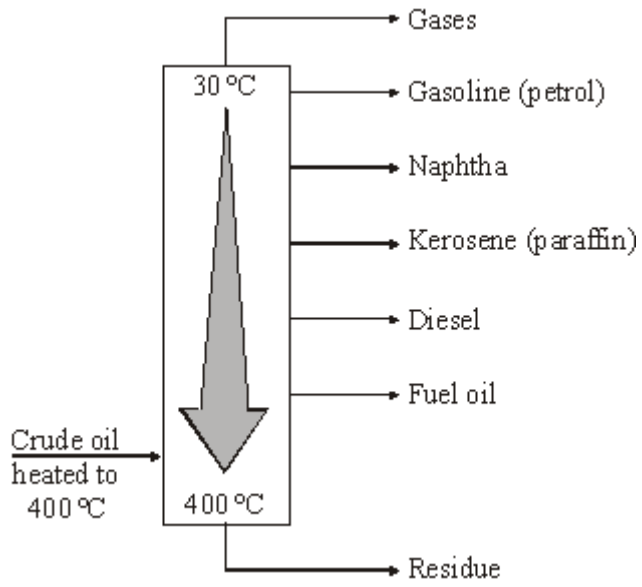
Explain why.

(2)

(Total 5 marks)

Q10.

Crude oil is the source of many useful materials. Crude oil is separated into fractions by fractional distillation.



(a) Describe how the naphtha fraction separates from the other fractions.

(2)

(b) The naphtha fraction is often used to make other useful materials.

This involves the cracking of hydrocarbons in the naphtha fraction.

For example:

decane → hexane + ethene

$C_{10}H_{22}$ → C_6H_{14} + C_2H_4

(i) Balance the symbol equation given above.

(1)

(ii) Describe how cracking is carried out.

_____

_____

_____

(2)

(iii) Why does ethene have different chemical properties from decane and hexane?

_____

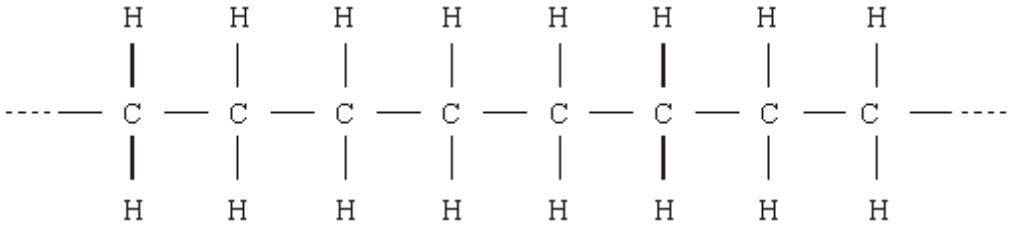
_____

_____

_____

(2)

(c) Ethene is used as the starting material for many polymers. The most common polymer is poly(ethene). One hydrocarbon molecule in poly(ethene) will contain thousands of carbon atoms.



Complete the diagram to show the bonds in ethene.

H H

C C

H H

(1)

(d) Read the following information.

Landfill, Incineration, Recycling and Re-use of Poly(ethene)

People could be encouraged to re-use their poly(ethene) bags and containers.

Recycling poly(ethene) saves raw materials and energy needed to make new plastic. When polymers are recycled the plastics must be collected, transported, sorted into different types by hand and washed. This requires the use of fossil fuels and is expensive.

Poly(ethene) can be burnt in an incinerator with other household waste. The heat released could be used to make steam to drive an electric generator. Surplus heat could be used to heat greenhouses used for growing vegetables. Incineration at too low a temperature can produce harmful substances. The residue (ash) has to go to landfill.

Landfill is probably the easiest way to dispose of polymers and it is cheap. Polymers are often mixed in with other household rubbish. Household waste does not get sorted into different materials because it is disposed of in the same hole in the ground. When the hole is eventually full, the waste is covered by a layer of soil to stop it smelling. The waste gets compressed under its own weight. Most polymers, such as poly(ethene), are not biodegradable so will remain in the ground forever.

You are asked to decide which option for the disposal of poly(ethene) will be put forward in your area. You decide that recycling is the best option.

Suggest **one** economic argument and **one** environmental argument that will be made against recycling.

For each argument made, how will you persuade those making the argument to accept your option?
(You must use only one sentence for each argument made against your decision and only one sentence for your response to it.)

_____

_____

_____

_____

_____

_____

_____

_____

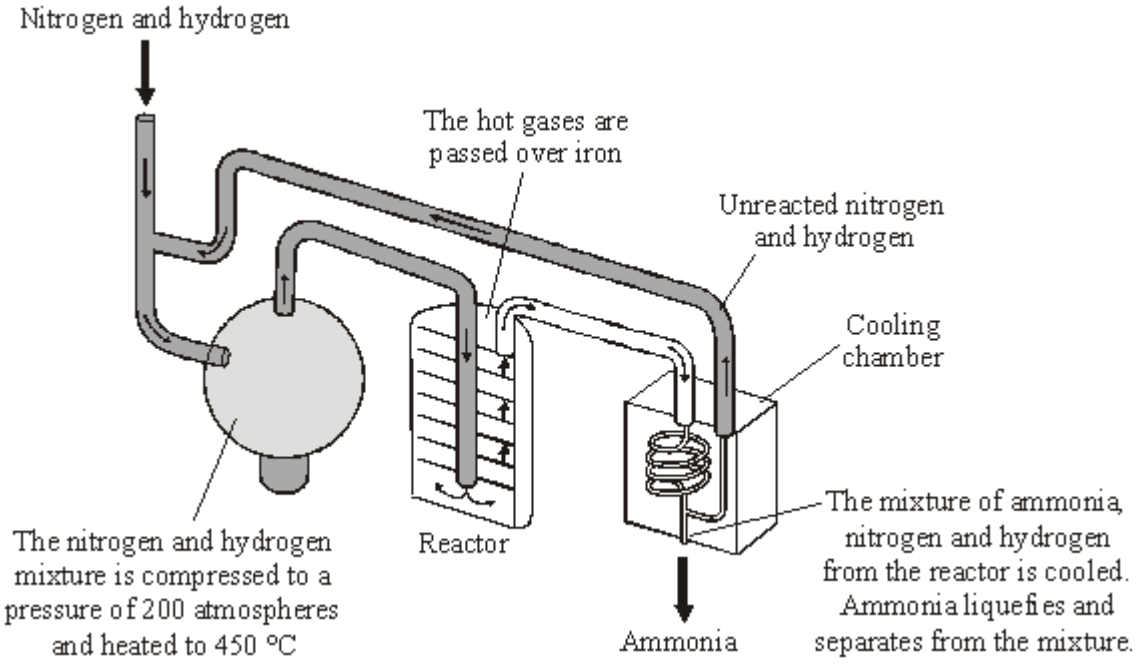
_____

(4)

(Total 12 marks)

Q11.

The Haber process is named after the German chemist, Fritz Haber.
The diagram shows the main stages in the Haber process.



Reproduced with the permission of Nelson Thornes Ltd from PATRICK FULLICK et al, ISBN 0-7487-9644- 4. First published in 2006

(a) Use the diagram to help you to answer these questions.

(i) Complete the word equation for the reaction that takes place in the reactor.

nitrogen + _____ ⇌ _____

(1)

(ii) What does the symbol ⇌ mean?

_____

(1)

(iii) What is the purpose of the iron in the reactor?

_____

(1)

(iv) Ammonia is separated from unreacted nitrogen and hydrogen.

Draw a ring around the physical property that allows this separation to take place.

_____

(1)

(v) What is done with the unreacted nitrogen and hydrogen?

_____

(1)

(b) Some of the products that can be made from ammonia are:

- fertilisers
- dyes
- explosives
- medicines
- plastics

(i) The Haber process was invented a few years before the start of the First World War. It is thought that the First World War would have finished earlier if the Germans had **not** invented the Haber process.

Suggest why.

_____

_____

(1)

(ii) The Haber process has helped to increase food production.

Explain why.

_____

_____

(1)

(c) Factories that make ammonia are very large and operate night and day.

(i) Ammonia factories are often near towns.

Suggest why.

_____

(1)

(ii) Suggest and explain **one** reason why local people might not want an ammonia factory near their town.

_____

_____

_____

_____

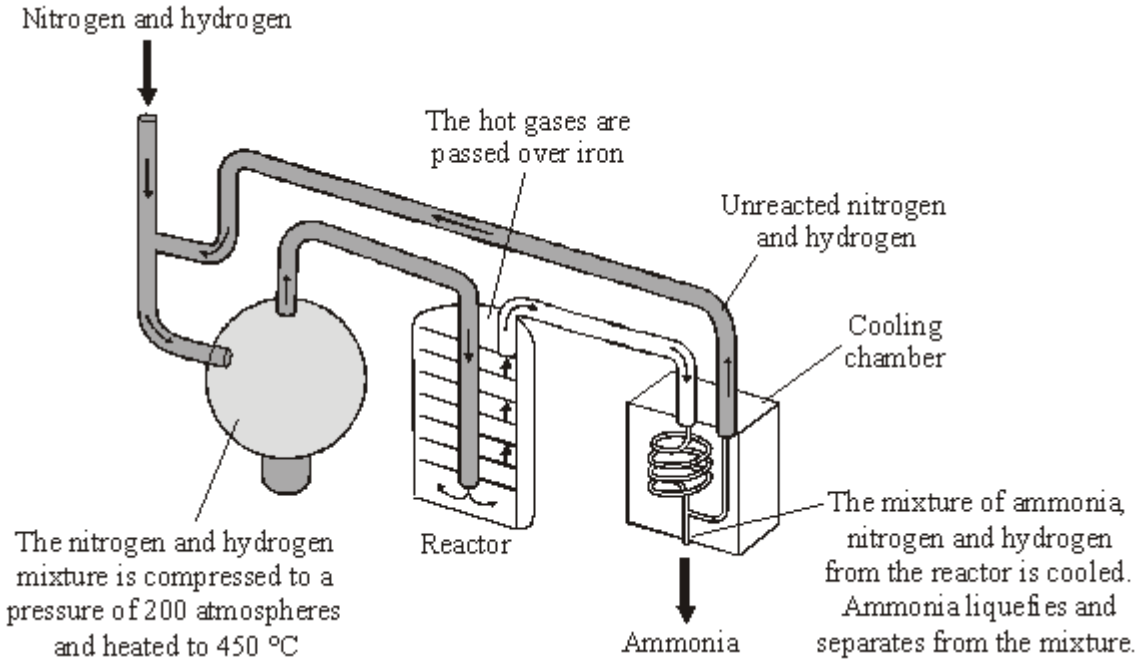
(2)

(Total 10 marks)

Q12.

The Haber process is named after the German chemist, Fritz Haber.

The diagram shows the main stages in the Haber process.



An exothermic reaction takes place when nitrogen reacts with hydrogen to make ammonia.

The reaction can be represented by this equation.

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g)$$

(a) Calculate the maximum mass of ammonia that could be made from 1000 g of nitrogen.

Relative atomic masses: H = 1; N = 14

Mass _____g

(3)

(b) At a temperature of 450 °C and 200 atmospheres the actual mass of ammonia produced when 1000 g of nitrogen is passed through the reactor is 304 g.

Calculate the percentage yield of ammonia produced in the reactor.

(If you did not answer part (a), then assume that the maximum mass of ammonia that can be made from 1000 g of nitrogen is 1100 g. This is **not** the correct answer to part (a).)

_____

_____

_____

Percentage yield of ammonia = _____ %

(2)

(c) State **and** explain:

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

_____

_____

_____

_____

(2)

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

_____

_____

_____

_____

(2)

(d) Factories that make ammonia are often near to large towns.

Discuss the economic, safety and environmental factors to be considered when there is an ammonia factory near a town.

_____

_____

_____

_____

_____

_____

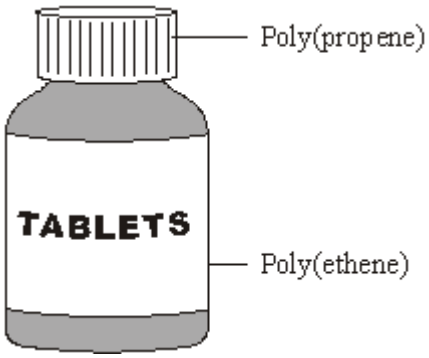
_____

(3)

(Total 12 marks)

Q13.

Tablet containers are often made from two different polymers.



(a) Ethene, C_2H_4, and propene, C_3H_6, can be made from crude oil.

(i) Complete the following sentence.

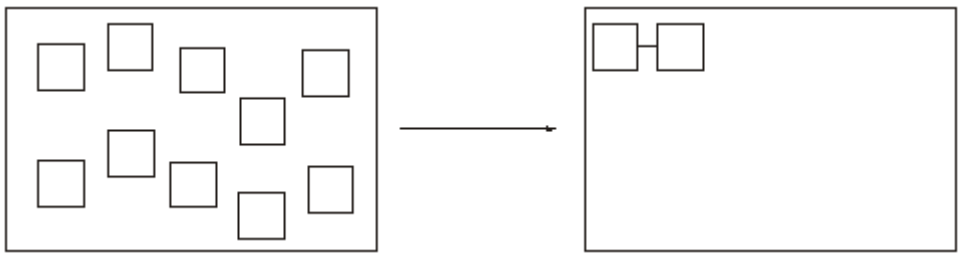
Ethene and propene are called hydrocarbons because they are made up of carbon and _____ atoms only.

(1)

(ii) Ethene molecules are used to form poly(ethene) molecules.

Complete the diagram to show the poly(ethene) molecule.

Ethene molecules **Poly(ethene) molecule**



(2)

(b) The tablet containers could be disposed of in a landfill site or could be recycled.

(i) Suggest **two** reasons why disposing of the tablet containers in a landfill site could cause problems.

1. _____

_____

2. _____

_____

(2)

(ii) Suggest **one** reason why recycling the tablet containers would be difficult.

_____

_____

(1)

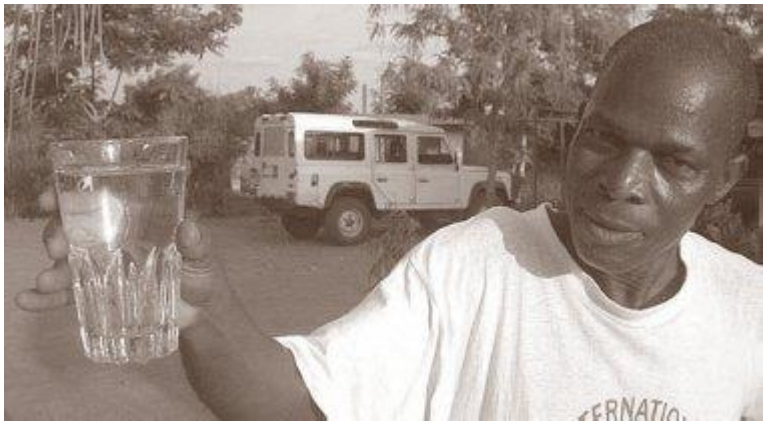
(Total 6 marks)

Q14.

Good quality water is needed for a healthy life.

In the United Kingdom, obtaining safe water for drinking is as simple as turning on a tap. The water is made safe to drink by water companies.

However, in many parts of Africa and Asia, water used for drinking is contaminated and untreated. It is estimated that 2.2 million people die each year as a result of drinking contaminated water.



DADA DANESHANANDA, Man with filtered water from the Mafi-Zongo water project. www.amurt.net/africa/ghana/2005

(a) Sea water is **not** used as drinking water.

Suggest why.

_____

_____

(1)

(b) Explain why water for drinking is filtered and then treated with chlorine.

_____

_____

_____

_____

(2)

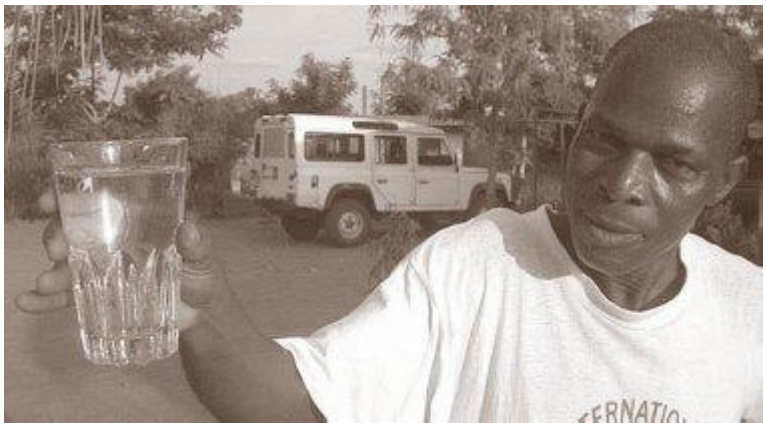
(Total 3 marks)

Q15.

Good quality water is needed for a healthy life.

In the United Kingdom, obtaining safe water for drinking is as simple as turning on a tap. The water is made safe to drink by water companies.

However, in many parts of Africa and Asia, water used for drinking is contaminated and untreated. It is estimated that 2.2 million people die each year as a result of drinking contaminated water.



DADA DANESHANANDA, Man with filtered water from the Mafi-Zongo water project. www.amurt.net/africa/ghana/2005

Efforts are being made to solve this problem and more water is being treated.

Describe how water in the United Kingdom is treated.

Explain how this makes it safe to drink.

_____

_____

_____

_____

_____

_____

_____

_____

(Total 3 marks)

Q16.

Polymers are used to make many materials that people need.

(a) Plastic bags are used to carry, protect and store food. Plastic bags are made from polymers.

Plastic bag made from a polymer

(i) Ethene is the small molecule (the monomer) used to make the polymer for this plastic bag.

Name the polymer that is made from ethene.

_____

(1)

(ii) Use the correct word from the box to complete the sentence about ethene.

condensing	**corroding**	**cracking**

Ethene is made by breaking down large hydrocarbon molecules into smaller hydrocarbon molecules by a process called _____

(1)

(iii) The hydrocarbon ethene has the formula C_2H_4

Complete the sentence about ethene.

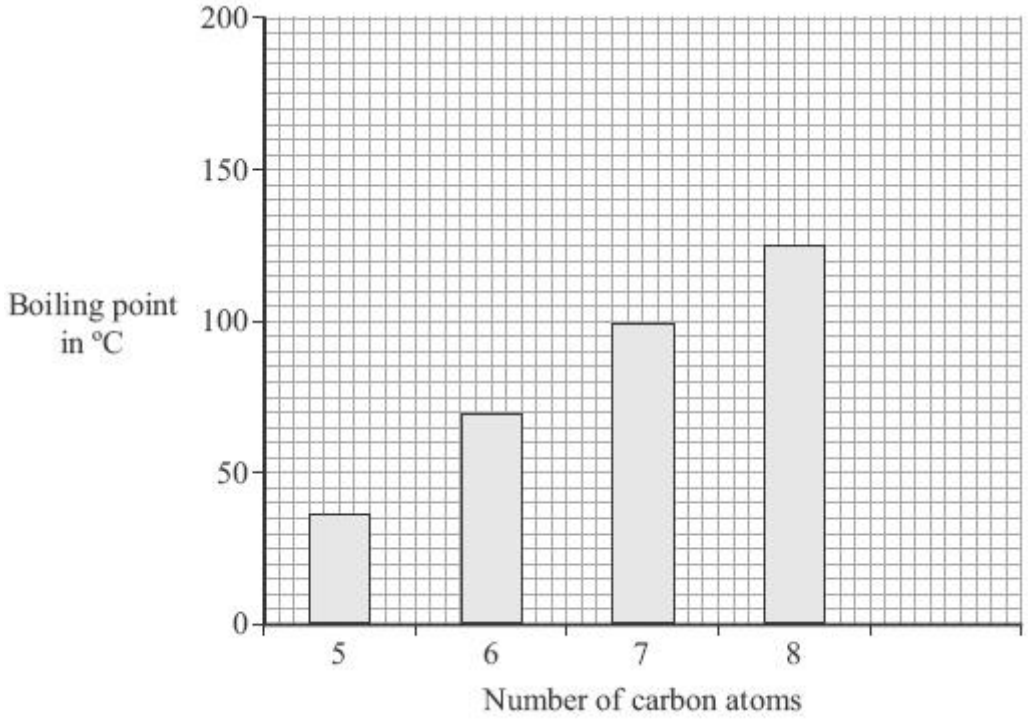
Ethene is a hydrocarbon made up of carbon and _____ atoms.

(1)

(b) The hydrocarbons used to make ethene come from crude oil. The properties of hydrocarbons are linked to the number of carbon atoms in their molecules.

Number of carbon atoms	5	6	7	8	9
Boiling point in °C	36	69	99	125	151

(i) Use the data in the table to complete the bar chart.



(2)

(ii) What happens to the boiling point of a hydrocarbon as the number of carbon atoms increases?

_____

(1)

(iii) All the hydrocarbons in the table are found in petrol. Petrol is one of the fractions separated from crude oil.

Describe how the fractions are separated from crude oil.

_____

_____

_____

_____

_____

(2)

(c) Most plastic bags that are made of hydrocarbons are not biodegradable.

Used plastic bags can be:

- dumped into large holes, which is called landfill
- burned to give out heat energy, which would produce large amounts of gases.

Would burning used plastic bags be better for the environment than dumping them in landfill?

Explain your answer.

_____

_____

_____

_____

(2)

(Total 10 marks)

Q17.

Many everyday items are made from iron.

(a) Haematite is an *ore* of iron. Haematite contains iron oxide, Fe_2O_3.

(i) What is the meaning of the term *ore*?

_____

_____

(1)

(ii) Iron can be produced by reacting iron oxide with carbon in a blast furnace.

What type of reaction produces the iron?

_____

_____

(1)

(iii) The word equation for this reaction is:

iron oxide + carbon → iron + carbon dioxide

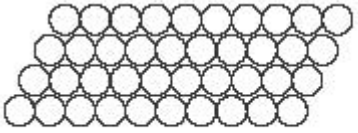
Complete and balance the symbol equation for this reaction.

___Fe_2O_3 + ___C → _____ + _____

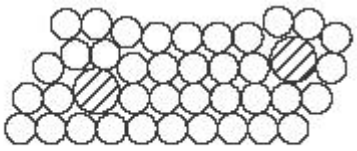
(2)

(b) Pure iron is relatively soft and not very strong.

The iron from the blast furnace is very hard and brittle. It contains about 4% carbon and is used as cast iron.



Pure iron



Cast iron

Explain the differences in the properties of pure iron and cast iron by referring to the diagrams.

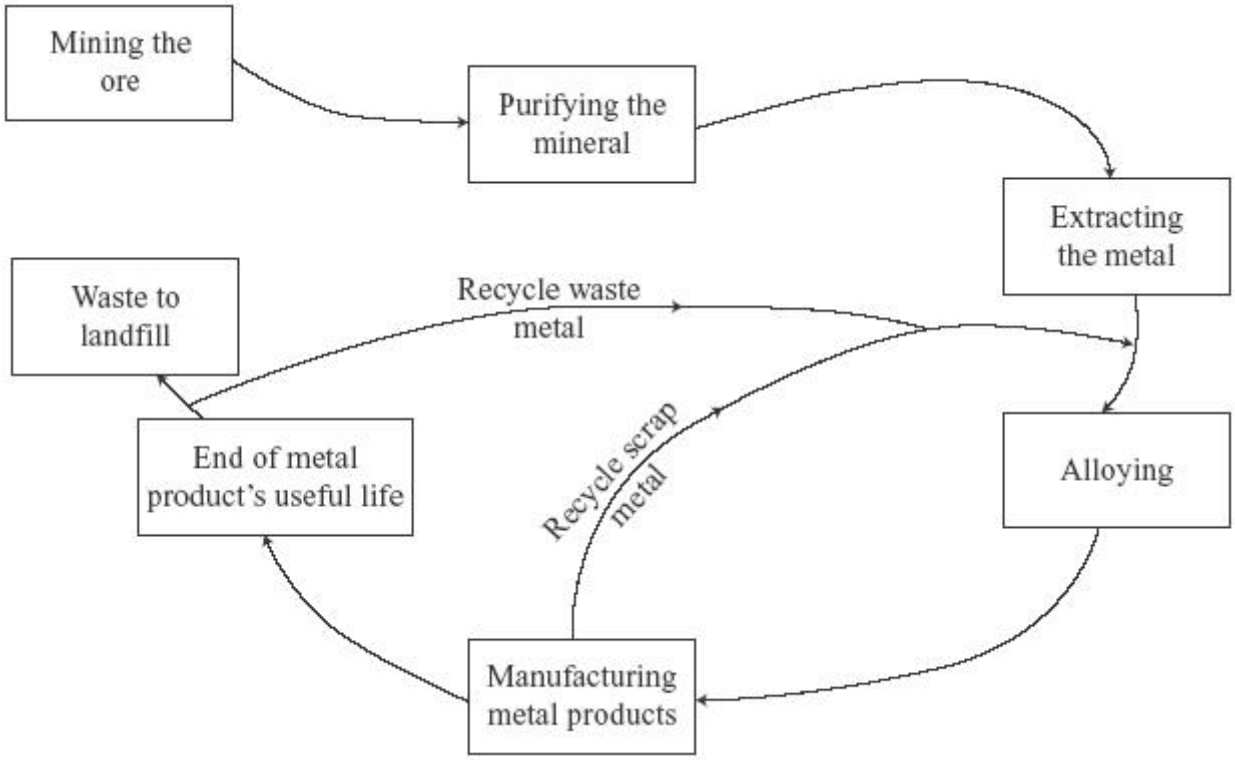
_____

_____

_____

(3)

(c) The diagram shows the way in which iron is extracted, used and recycled.



Explain why the recycling of iron is necessary for sustainable development.

(3)

(Total 10 marks)

Q18.

Copper is a widely used metal. The main ore of copper contains copper sulfide. Copper can be extracted from copper sulfide in a three stage process.

$$Cu_2S + \_\_\_\_O_2 \rightarrow \_\_\_\_\_CuO + SO_2$$

(1)

(ii) Explain why there would be an environmental problem if the gas from this reaction were allowed to escape into the atmosphere.

_____

_____

_____

_____

(2)

(b) In the second stage copper oxide, CuO, is reduced using carbon.

Describe and explain what happens during this reaction.

_____

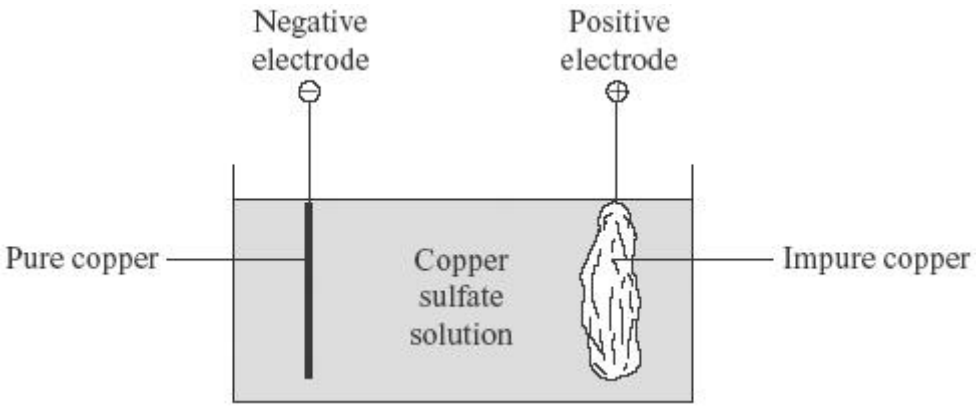
_____

_____

_____

(2)

(c) During the third stage the copper can be purified as shown in the diagram.



(i) What is the name of the type of process used for this purification?

_____

(1)

(ii) Give **one** use of purified copper.

_____

(1)

(d) Copper-rich ores are running out.

New ways of extracting copper from low grade ores are being researched.

Recycling of copper may be better than extracting copper from its ores.

Explain why.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

Q19.

Nitric acid can be neutralised by alkalis to make salts.

(i) The salt called potassium nitrate can be made from nitric acid.

Complete the word equation for this neutralisation reaction.
Choose the correct substances from the box.

hydrogen	**oxygen**	**potassium chloride**
potassium hydroxide		**water**

nitric acid + _____ →potassium nitrate + _____

(2)

(ii) Ammonium nitrate is another salt made from nitric acid.

Which **one** of the following is the main use of ammonium nitrate? Draw a ring around your answer.

dye **fertiliser** **plastic** **fuel**

(1)

(iii) Complete this sentence by choosing the correct ion from the box.

H^+	NH_4^+	NO_3^-	O^{2-}	OH^-

The ion that makes solutions acidic is _____ .

(1)

(Total 4 marks)

Q20.

Neutralisation reactions can be used to make salts.

(a) Write an ionic equation for a neutralisation reaction, including state symbols.

_____

(2)

(b) Ammonium nitrate is a salt used as a fertiliser.

(i) Ammonium nitrate is made by mixing two solutions. Name these solutions.

_____ and _____

(1)

(ii) Hazard information about ammonium nitrate states:

- it is not itself a fire hazard (does not burn);
- it must not be allowed to come into contact with combustible materials such as fuels because it can cause these to catch fire.

Suggest why ammonium nitrate helps other substances to burn.

_____

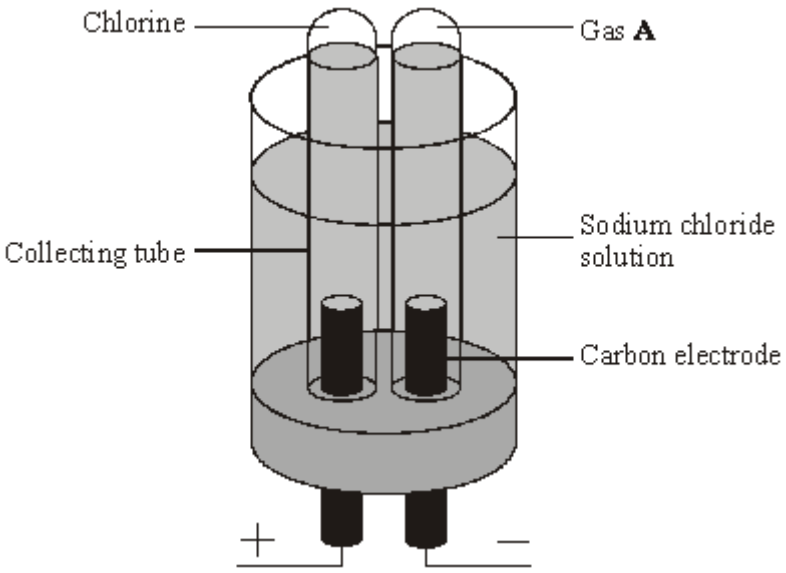
_____

(1)

(Total 4 marks)

Q21.

The electrolysis of sodium chloride solution is an important industrial process. The apparatus shown below can be used to show this electrolysis in the laboratory.



(a) Name gas **A**.

_____

(1)

(b) Chlorine is produced at the positive electrode. Describe and give the result of a chemical test to prove that the gas is chlorine.

_____

_____

_____

_____

(2)

(c) Chloride ions move to the positive electrode. Explain why.

_____

_____

(1)

(d) A small quantity of chlorine is added to drinking water. Explain why.

_____

_____

(1)

(e) The solution around the negative electrode becomes alkaline. Name the ion which makes the solution alkaline.

_____

_____

(1)

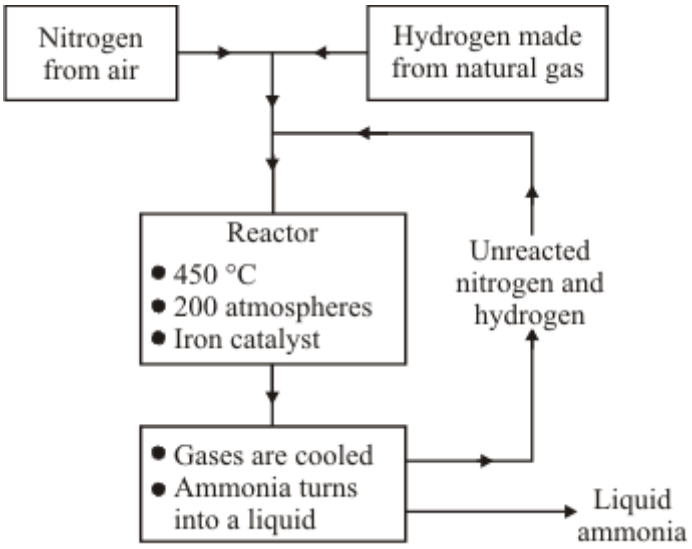
(Total 6 marks)

Q22.

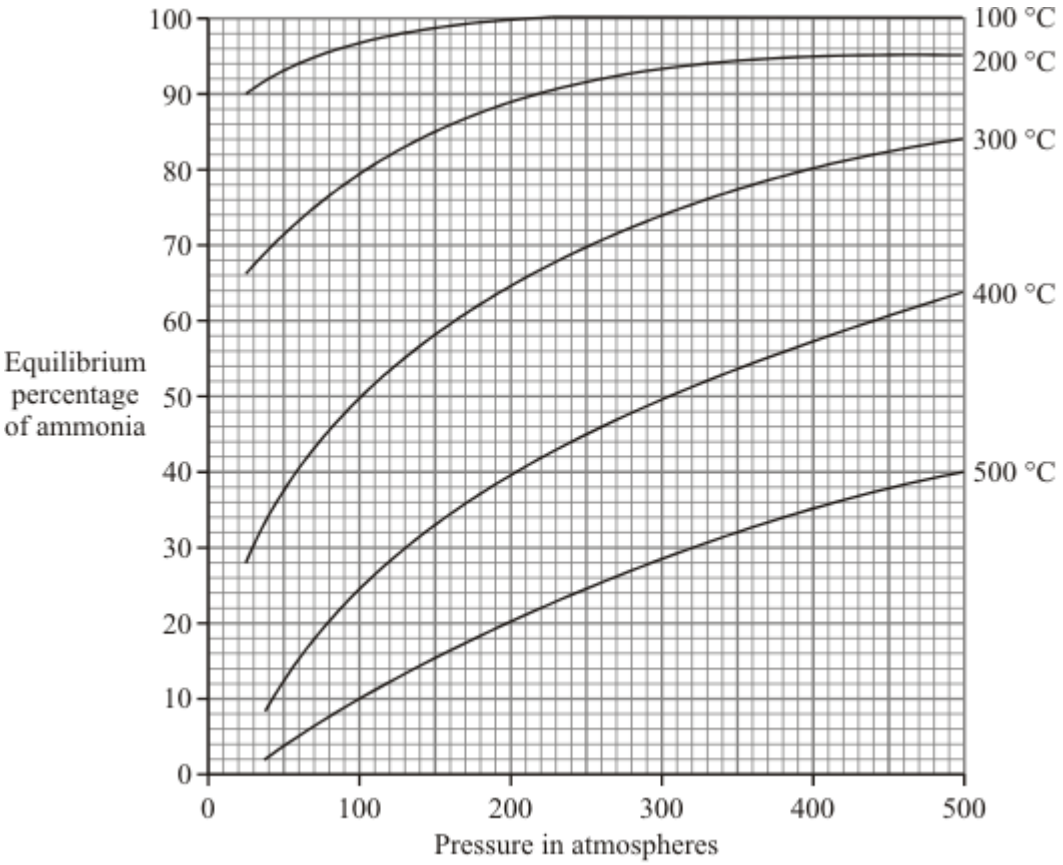
Ammonia is made from nitrogen and hydrogen in the Haber process.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ (+ heat)

Flow Chart for the Haber Process



Effect of temperature and pressure on the amount of ammonia at equilibrium



(a) Use the information given above and your knowledge of the Haber process and reversible reactions to help you to answer this question.

State which conditions of temperature and pressure would give the highest percentage of
ammonia at equilibrium. Explain why.

_____

_____

_____

_____

(4)

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

Explain why these conditions are chosen.

(3)

(Total 7 marks)

Q23.

As the world population increases there is a greater demand for fertilisers.

(a) Explain what fertilisers are used for.

(2)

(b) The amount of nitrogen in a fertiliser is important.

(i) How many nitrogen atoms are there in the formula, NH_4NO_3?

_____

(1)

(ii) Work out the relative formula mass of ammonium nitrate, NH_4NO_3.

Relative atomic masses: H 1; N 14; O 16.

_____

_____

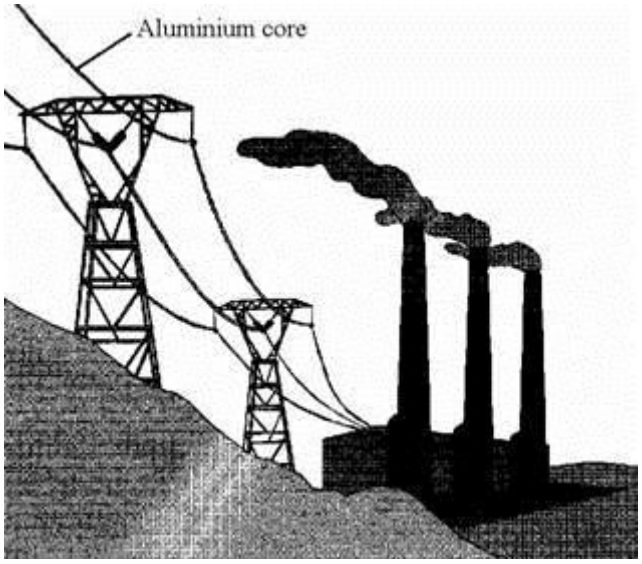
Relative formula mass of ammonium nitrate = _____

(1)

(Total 4 marks)

Q24.

(a) Aluminium is more expensive than iron. Why is aluminium and not iron used for the central core in power cables?



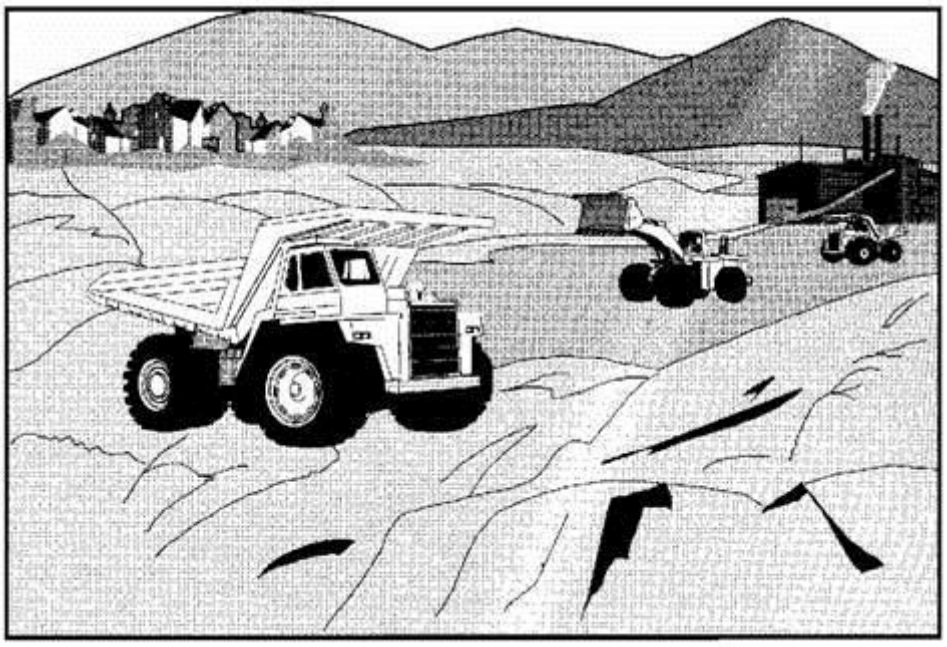
_____

_____

_____

(2)

(b) Many industrial processes involve the removal of minerals by quarrying.



All quarrying has some effect on the environment and on people's lives. Make comments about the social, economic, health, safety and environmental effects of quarrying.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(Total 7 marks)

Q25.

Early atmospheres on Earth contained ammonia (NH_3).

(a) (i) Complete the sentence.

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

(1)

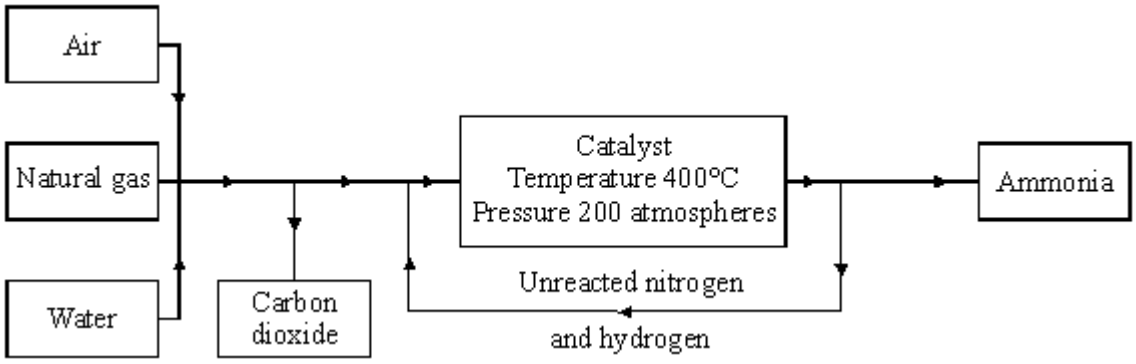
(ii) Today we convert nitrogen back to ammonia mainly for the production of fertilisers. What do plants convert the nitrogen in these fertilisers into?

_____

_____

(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.

_____(g) + _____(g) → _____NH_3(g)

(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)

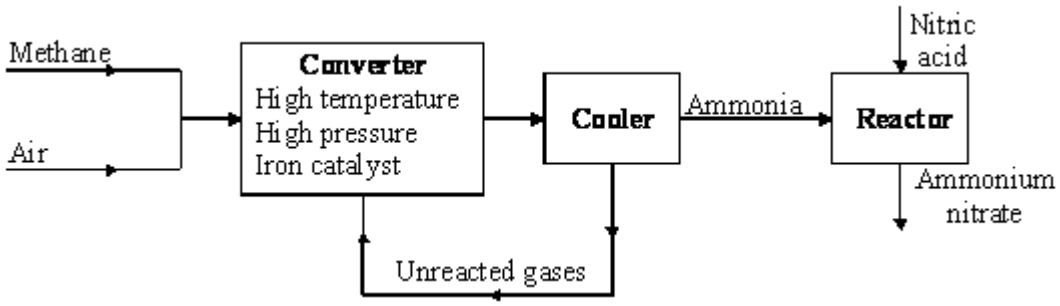
(d) Draw a diagram to show the arrangement of the electrons in a molecule of ammonia. The electron arrangement of each atom is hydrogen 1 and nitrogen 2.5.

(2)

(Total 11 marks)

Q26.

The flow diagram shows some stages in the manufacture of ammonium nitrate, NH_4NO_3.



(a) Which elements are obtained from the raw materials to make ammonia in the converter?

_____

_____

(2)

(b) Suggest the purpose of the iron catalyst.

_____

_____

(1)

(c) Farmers add ammonium nitrate to the soil. Explain why.

_____

_____

_____

_____

(2)

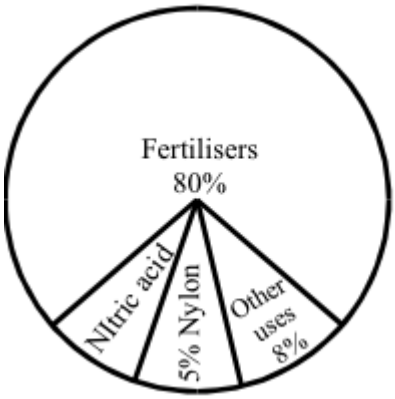
(Total 5 marks)

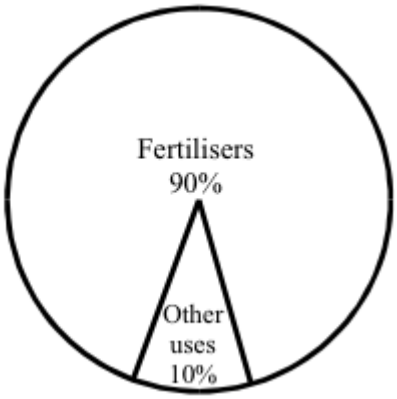
Q27.

Ammonia and nitric acid are both important chemicals. Nitric acid is made from ammonia.

The charts below show substances made from ammonia and nitric acid.

Substances made from ammonia	Substances made from nitric acid





(a) Use the charts to help you answer these questions.

(i) What is the main use of both ammonia and nitric acid?

_____

(1)

(ii) Work out the percentage of ammonia used to make nitric acid.

Percentage = _____ %

(1)

(iii) 100 million tonnes of ammonia are made in the world each year.

How much of this ammonia is used to make nylon?

_____ million tonnes

(1)

(b) The word equations below show how nitric acid is made.

1. nitrogen + hydrogen → ammonia

2. ammonia + oxygen → nitrogen monoxide + water

3. nitrogen monoxide + oxygen → nitrogen dioxide

4. nitrogen dioxide + water → nitric acid

Use the word equations to help you answer these questions.

(i) From which **two** elements is ammonia made?

_____ and _____

(1)

(ii) Name **two** of the raw materials needed to make nitric acid.

_____ and _____

(2)

(c) A large amount of nitric acid is reacted with ammonia to make a fertiliser.

nitric acid + ammonia → fertiliser

(i) The reaction is a neutralisation reaction.

What type of chemical must ammonia be?

_____

(1)

(ii) Complete the chemical name for the fertiliser made from ammonia and nitric acid.

ammonium _____

(1)

(iii) The reaction of nitric acid with ammonia is exothermic.

Name the piece of equipment you could put into the solution to prove that the reaction is exothermic.

_____

(1)

(Total 9 marks)

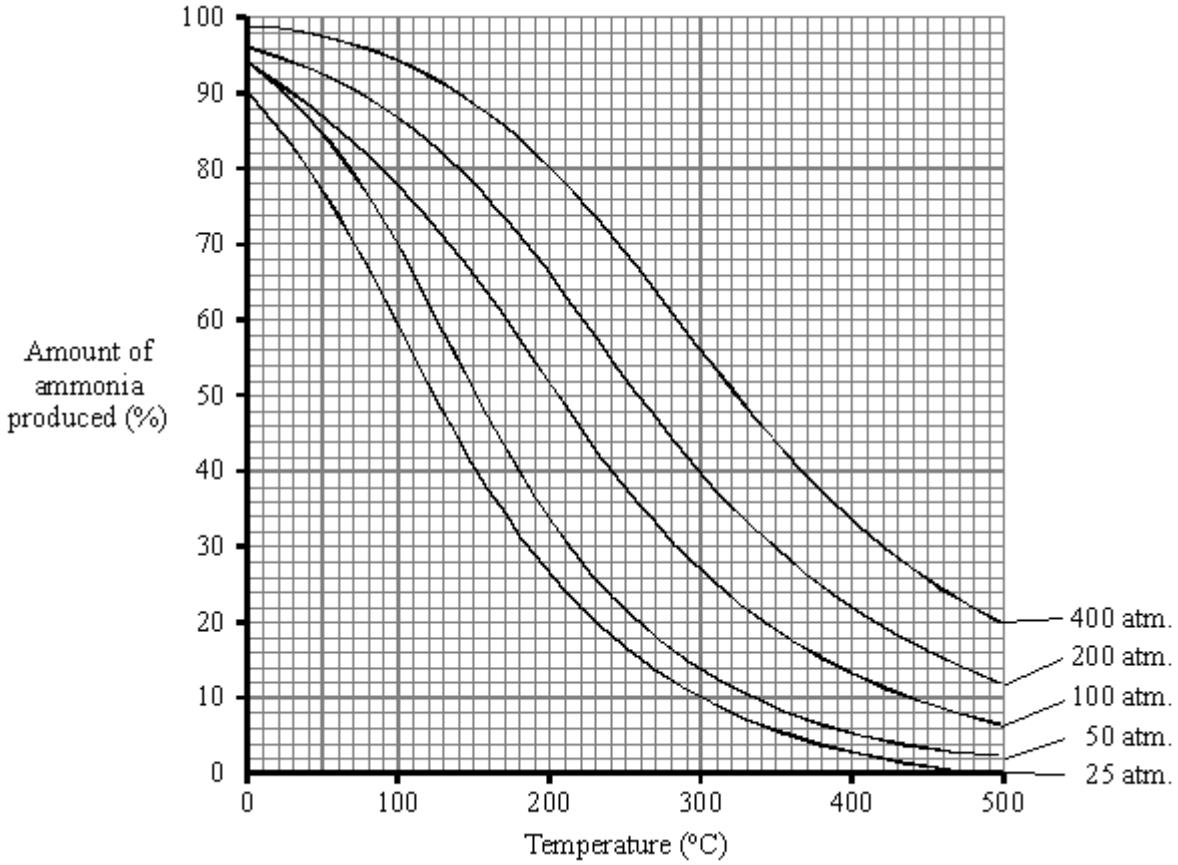
Q28.

The Haber process is used to make ammonia (NH_3) which is an important substance.

The equation below shows the reaction in which ammonia is formed.

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} + \text{Heat}$$

The graph below shows how temperature and pressure affect how much ammonia is produced in the reaction.



In the industrial process a mixture of nitrogen and hydrogen is passed over iron at a temperature of about 450 °C and 200 atmospheres pressure.

(a) Use the graph to find the percentage of ammonia present when the temperature and pressure are 450 °C and 200 atmospheres.

_____ %

(2)

(b) Explain why the nitrogen and hydrogen mixture is passed over iron.

_____

_____

(2)

(c) Explain, as fully as you can, using the graph and your knowledge of the Haber process why 450 °C and 200 atmospheres were chosen as conditions for this process.

_____

_____

_____

_____

_____

(8)

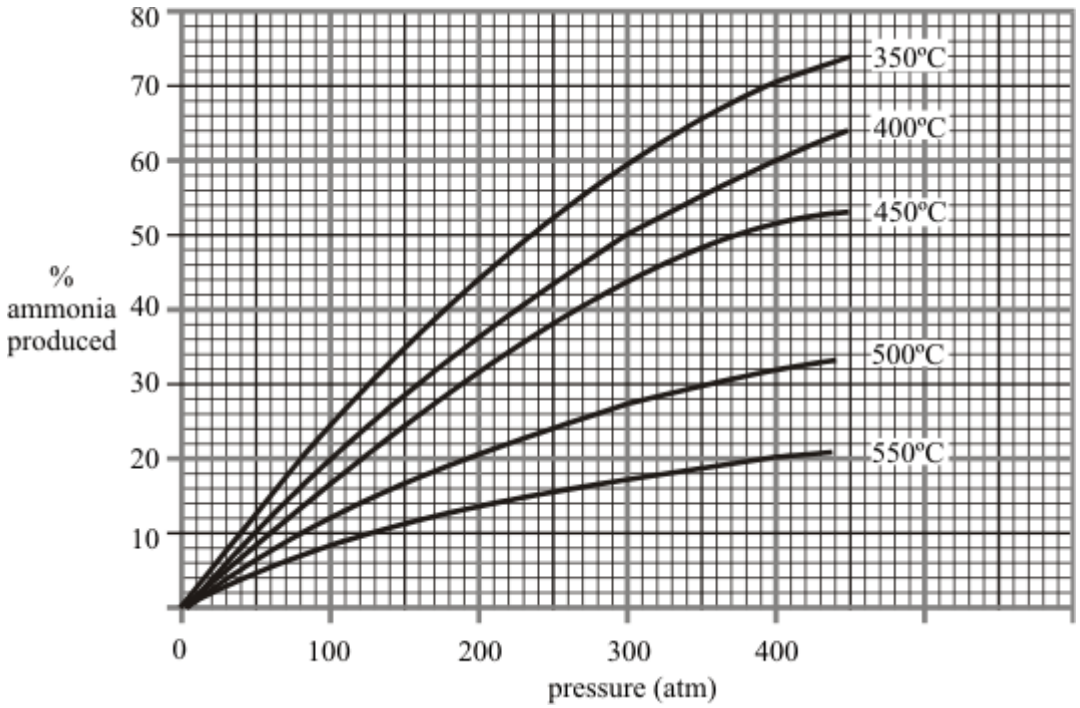
(Total 12 marks)

Q29.

Ammonia is produced by the Haber process. In the process nitrogen and hydrogen are mixed. The pressure is increased to about 200 atmospheres. The gases are passed over an iron catalyst at about 450°C. The equation for the reaction is:

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

The reaction between nitrogen and hydrogen is reversible. This affects the amount of ammonia that it is possible to obtain from the process. The graph below shows how the pressure and temperature affect the percentage of ammonia that can be produced.

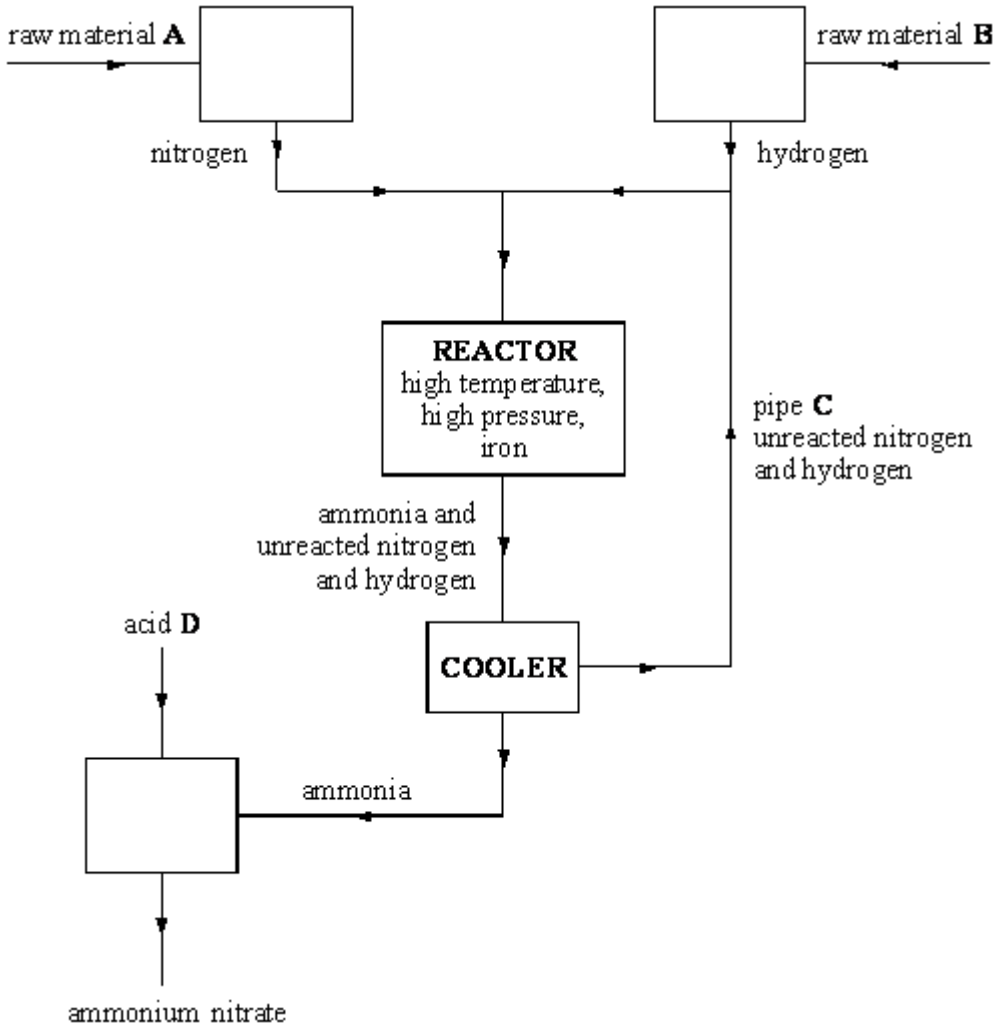


Use this information, together with your knowledge of the process, to explain why many industrial ammonia plants operate at 200 atmospheres and 450°C.

(Total 5 marks)

Q30.

The flow chart below shows the main stages in the production of ammonium nitrate.



(i) Name the **two** raw materials shown in the flow chart as **A** and **B** by choosing words from the list.

air **coke** **limestone** **natural gas**

Raw material **A** _____

Raw material **B** _____

(2)

(ii) Complete the word equation for the reaction which makes ammonia.

_____ + _____ → ammonia

(1)

(iii) What is the purpose of the iron in the reactor?

_____

_____

(1)

(iv) What is the purpose of pipe **C**?

_____

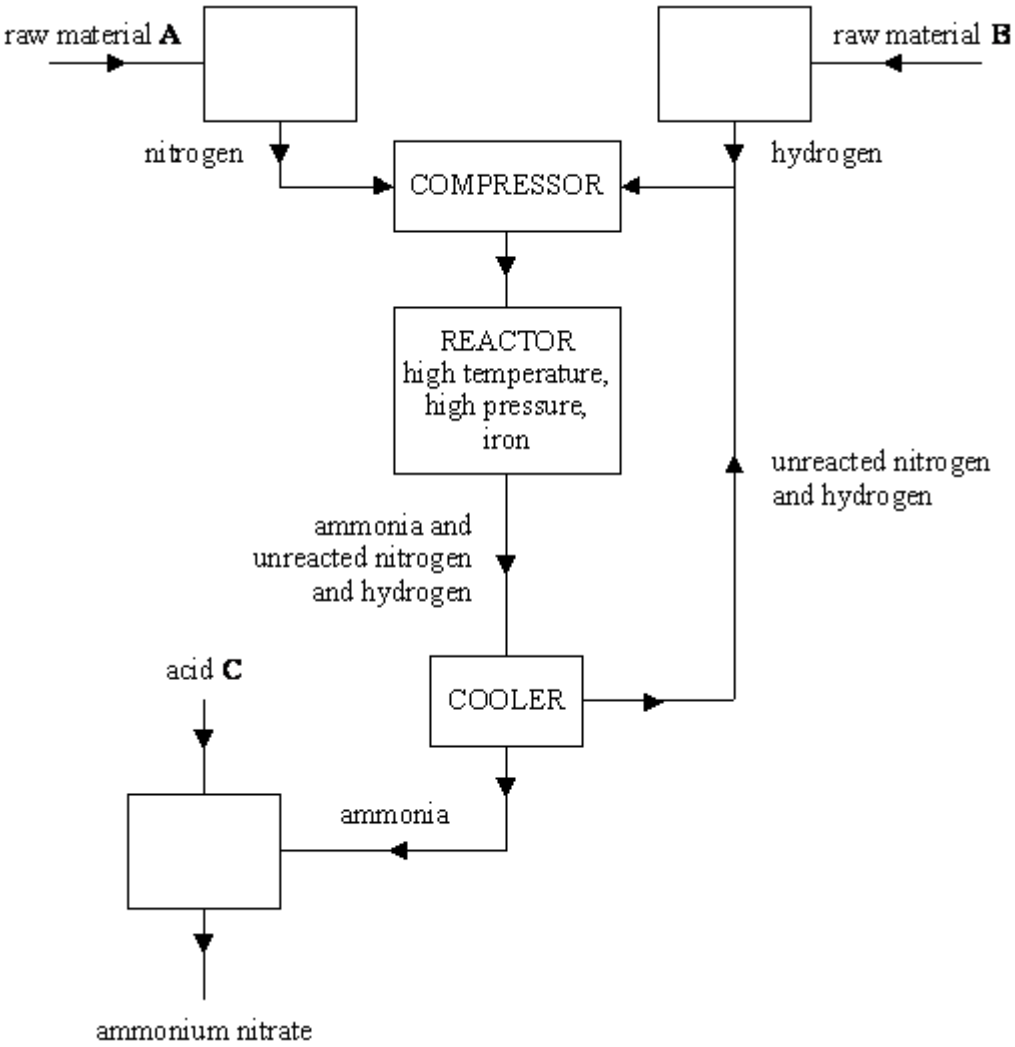
_____

(1)

(Total 5 marks)

Q31.

The flow chart below shows the main stages in the production of ammonium nitrate.



(a) (i) Name the two raw materials shown in the flow chart as **A** and **B**.

Raw material **A** _____

Raw material **B** _____

(2)

(ii) What is the purpose of the iron in the reactor?

_____

_____

(1)

(b) (i) Balance the equation which represents the reaction which produces ammonia in the Haber process.

N_2 + _____ H_2 $\rightleftharpoons$ _____ NH_3 and heat

(1)

(ii) The table shows how temperature and pressure affect the amount of ammonia

produced in this reaction.

TEMPERATURE (°C)	PRESSURE (ATM)	PERCENTAGE OF NITROGEN AND HYDROGEN CONVERTED TO AMMONIA (%)
250	200	75
250	1000	96
1000	1	0.01
1000	1000	1

Explain, as fully as you can, why a temperature of about 450°C and a pressure of about 200 atmospheres are normally used in the industrial process.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 10 marks)

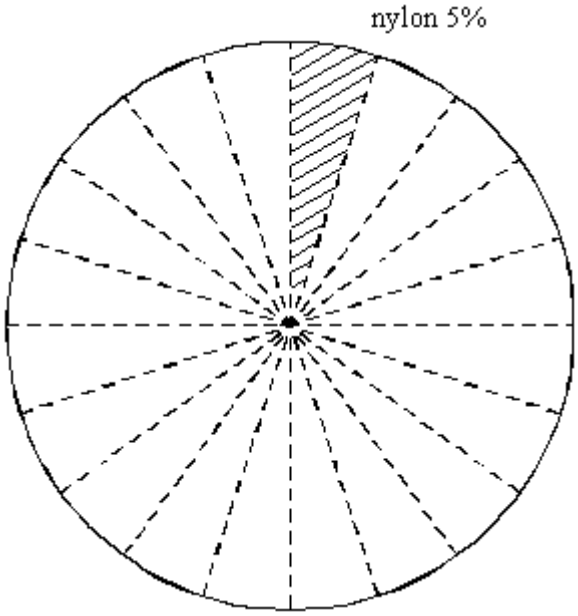
Q32.

Ammonia is a very important chemical.

(a) The table shows the percentage of ammonia used to make different substances.

SUBSTANCES MADE FROM AMMONIA	PERCENTAGE (%) OF AMMONIA USED
fertilisers	75
nitric acid	10
nylon	5
others	10

Shade on the pie chart the percentage of ammonia used to make nitric acid.



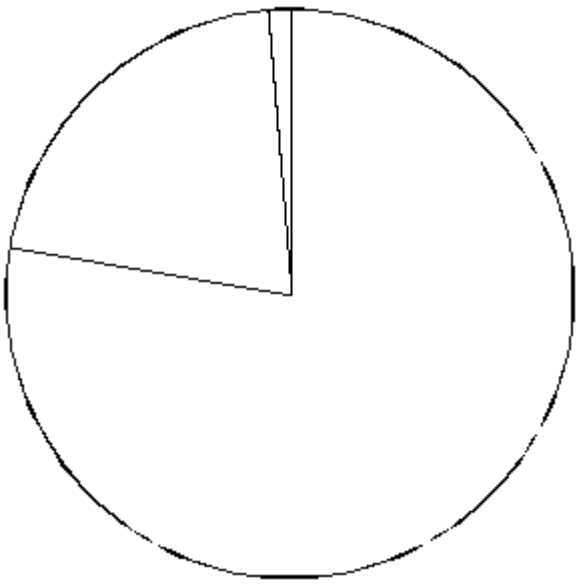
(1)

(b) Ammonia gas is made by the reaction between nitrogen gas and hydrogen gas.
Write a word equation to represent this reaction.

_____ + _____ ⇌ _____

(1)

(c) Nitrogen is one of the raw materials used to make ammonia.
Nitrogen is obtained from air.
This pie chart shows the proportion of nitrogen, oxygen and other gases in air.
Label the area which represents the proportion of nitrogen in air.



(1)

(d) An artificial fertiliser contains compounds with the formulae:

NH_4NO_3 and **KCl**

(i) Use the Data Sheet to help you answer this question.
Name the elements in the compound NH_4NO_3.

1. _____

2. _____

3. _____

(2)

(ii) Use the Data Sheet to help you answer this question.
Name the compound KCl.

_____

(1)

(e) (i) Ammonium nitrate is one type of artificial fertiliser.
Calculate the relative formula mass of ammonium nitrate NH_4NO_3.
(Relative atomic masses: H = 1, N = 14, O = 16.)

_____

_____

(1)

(ii) Use your answer to part (f)(i) to help you calculate the percentage by mass of nitrogen present in ammonium nitrate NH_4NO_3.

_____

_____

_____

(2)

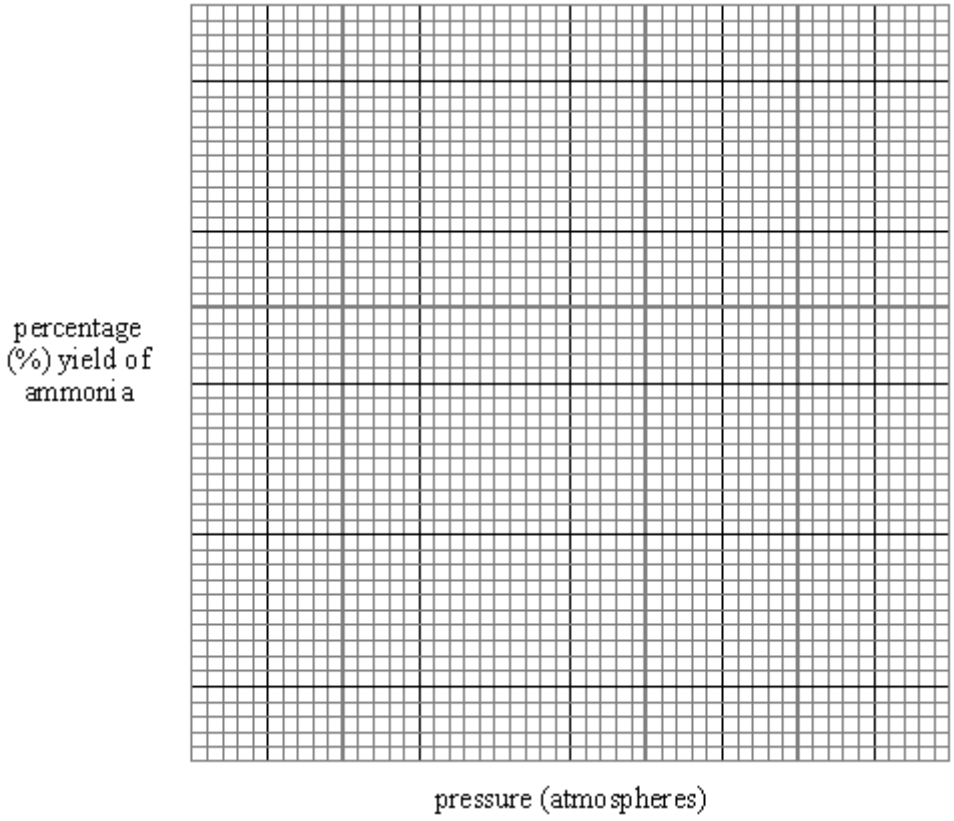
(Total 9 marks)

Q33.

The Haber process is used to make ammonia NH_3.
The table shows the percentage yield of ammonia at different temperatures and pressures.

PRESSURE (ATMOSPHERES)	PERCENTAGE (%) YIELD OF AMMONIA AT 350°C	PERCENTAGE (%) YIELD OF AMMONIA AT 500°C
50	25	5
100	37	9
200	52	15
300	63	20
400	70	23
500	74	25

(a) (i) Use the data in the table to draw two graphs on the grid below. Draw one graph for a temperature of 350°C and the second graph for a temperature of 500°C.
Label each graph with its temperature.



(4)

(ii) Use your graphs to find the conditions needed to give a yield of 30% ammonia.

_____ °C and _____ atmospheres

(1)

(iii) On the grid sketch the graph you would expect for a temperature of 450°C.

(1)

(b) (i) This equation represents the reaction in which ammonia is formed.

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} +$ heat

What does the symbol $\rightleftharpoons$ in this equation tell you about the reaction?

_____

(1)

(ii) Use your graphs and your knowledge of the Haber process to explain why a temperature of 450°C and a pressure of 200 atmospheres are used in industry.

_____

_____

_____

_____

_____

_____

(5)

(c) (i) Ammonium nitrate is one type of artificial fertiliser.
Calculate the relative formula mass of ammonium nitrate NH_4NO_3.
(Relative atomic masses: H = 1, N = 14, O = 16.)

_____

_____

(1)

(ii) Use your answer to part (c)(i) to help you calculate the percentage by mass of nitrogen present in ammonium nitrate NH_4NO_3.

_____

_____

(2)

(Total 15 marks)

Q34.

Nitrates, such as ammonium nitrate, are added to soil to help plant growth.

(a) When rain falls nitrates dissolve and can end up in drinking water.
Nitrates in drinking water can stop respiration in babies. This only happens if there is a lot of nitrate in the drinking water.

Plants use nitrates for growth. Humans need plants. Should large amounts of nitrates be added to soil?
Give **two** reasons for your answer.

Answer _____

Reason 1 _____

_____

Reason 2 _____

_____

(2)

(b) The amount of nitrogen in a nitrate compound is important.

(i) How many nitrogen atoms are there in the formula of ammonium nitrate, NH_4NO_3

_____

(1)

(ii) Calculate the percentage of nitrogen in ammonium nitrate, NH_4NO_3.

(Relative atomic masses: H = 1; N = 14; O = 16)

_____

_____

_____

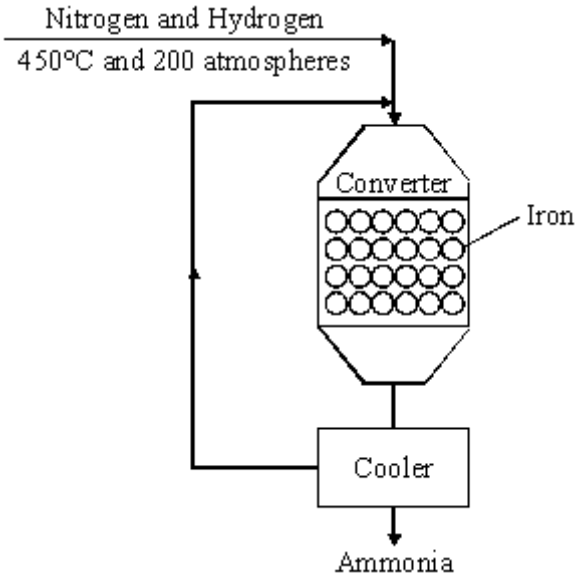
Percentage of nitrogen in ammonium nitrate = _____ %

(3)

(Total 6 marks)

Q35.

The diagram shows the final stages in the manufacture of ammonia.



(a) Why is iron used in the converter?

_____

_____

(1)

(b) Write the word equation for the reaction in the converter.

_____ + _____ ⇌ _____

(1)

(c) The yield of ammonia is only about 15%.

(i) Why can the yield **not** be 100%?

_____

_____

(1)

(ii) Describe what happens to the mixture of gases after it leaves the converter.

_____

_____

_____

(2)

(Total 5 marks)

Q36.

In the Haber process, nitrogen and hydrogen react to make ammonia.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

nitrogen + hydrogen $\rightleftharpoons$ ammonia

Pressure in atmospheres	**% ammonia present at equilibrium**				
	Temperature in ºC				
	100	**200**	**300**	**400**	**500**
10	88.2	50.7	14.7	3.9	1.2
25	91.7	63.6	27.4	8.7	2.9
50	94.5	74.0	39.5	15.3	5.6
100	96.7	81.7	52.5	25.2	10.6
200	98.4	89.0	66.7	38.8	18.3
400	99.4	94.6	79.7	55.4	31.9
1000	99.9	98.3	92.6	79.8	57.5

The actual conditions used in the Haber process are usually 450 °C and 200 atmospheres.

(a) What effect does increasing the pressure have on the percentage of ammonia made? Use the balanced symbol equation to explain why.

_____

_____

_____

_____

(2)

(b) A lower temperature of 100 °C gives high percentages of ammonia at most pressures. Why is this temperature **not** used in the Haber process?

(1)

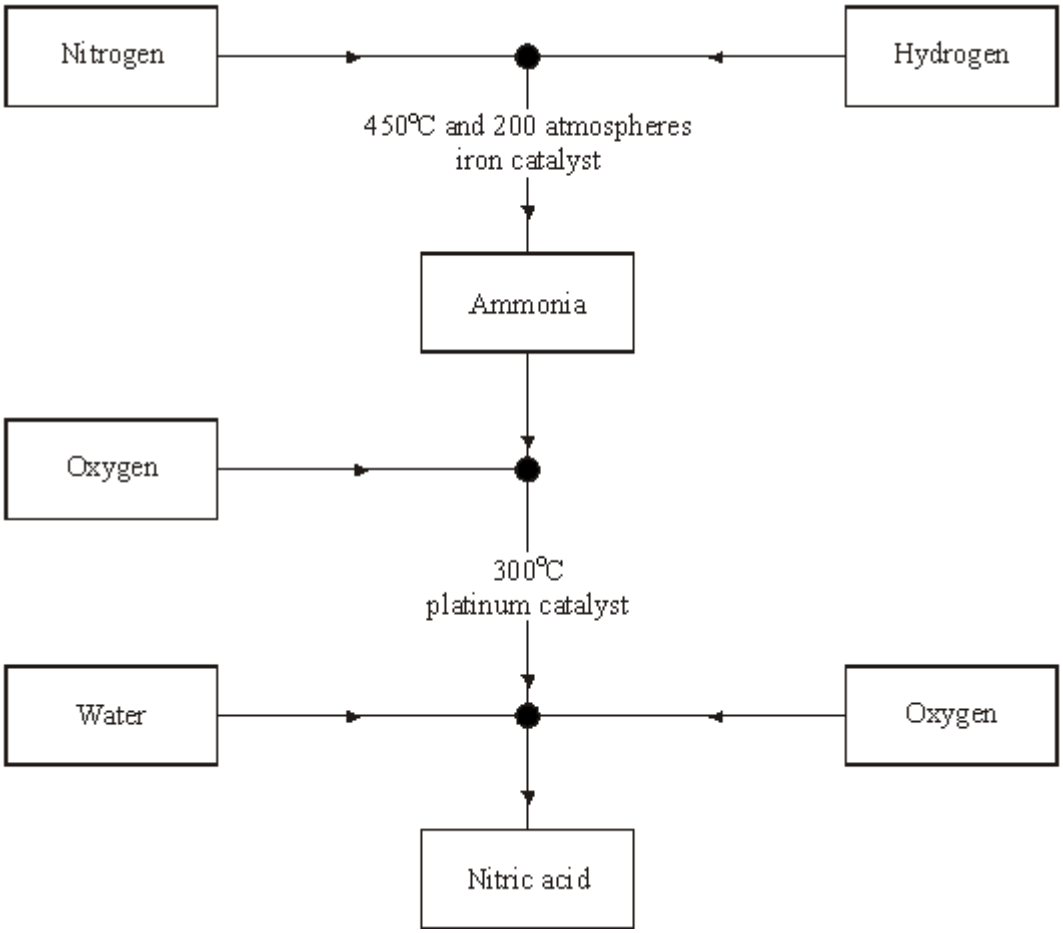
(c) Describe and explain the effect of an increase in the temperature on the reaction between nitrogen and hydrogen in the Haber process.

(3)

(Total 6 marks)

Q37.

The flow diagram shows how to make ammonia and nitric acid from the nitrogen in the air.



(a) A fertiliser is made by neutralising ammonia with nitric acid. What is the name of this fertiliser?

_____

(1)

(b) In the flow diagram, why are two different catalysts used?

_____

_____

(1)

(c) What happens to catalysts at the end of a reaction?

_____

_____

(1)

(d) Explain why catalysts are used in many industrial chemical reactions.

_____

_____

_____

(2)

(e) Explain, in terms of collisions between molecules, why a high pressure is used in

the reaction between nitrogen and hydrogen.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q38.

(a) In industry ammonia is produced from nitrogen and hydrogen. The equation for the reaction is:

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

(i) What does the symbol (g) represent?

_____

(1)

(ii) What does the symbol $\rightleftharpoons$ represent?

_____

(1)

(iii) Nitrogen is used for the industrial production of ammonia. From what raw material does this nitrogen come?

_____

(1)

(iv) Hydrogen is used for the industrial production of ammonia. It is obtained from the reaction between methane and steam. The equation for this reaction is:

$CH_4 + H_2O \rightarrow 3H_2 + CO$

Explain how you can tell that this equation is balanced.

_____

_____

_____

_____

(2)

(b) Ammonia is used to make ammonium salts which can be used as fertilisers.

(i) Complete the names in the following sentence.

One example is ammonium _____ which is made by reacting

ammonia with _____ acid.

(2)

(ii) All ammonium salts are soluble in water. Why is this a useful property of a fertiliser?

_____

_____

(1)

(c) Ammonia is a covalent, chemical compound.

(i) Complete the following sentence to describe a chemical compound.

In a chemical compound, two or more _____

_____

_____

(1)

(ii) What is a covalent bond?

_____

_____

(1)

(Total 10 marks)

Q39.

(a) Ammonia is manufactured from nitrogen and hydrogen. The equation for the reaction between them is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(i) What is the source of the nitrogen?

_____

(1)

(ii) Why does increasing the pressure increase the chance of molecules of hydrogen reacting with molecules of nitrogen?

_____

_____

(1)

(iii) The percentage yield of ammonia is the percentage, by mass, of the nitrogen and hydrogen which has been converted to ammonia. Calculate the mass, in tonnes, of ammonia which can be produced from 90 tonnes of hydrogen when the percentage yield is 50%. The relative atomic masses are: H 1; N 14.

Show clearly how you get to your answer.

_____

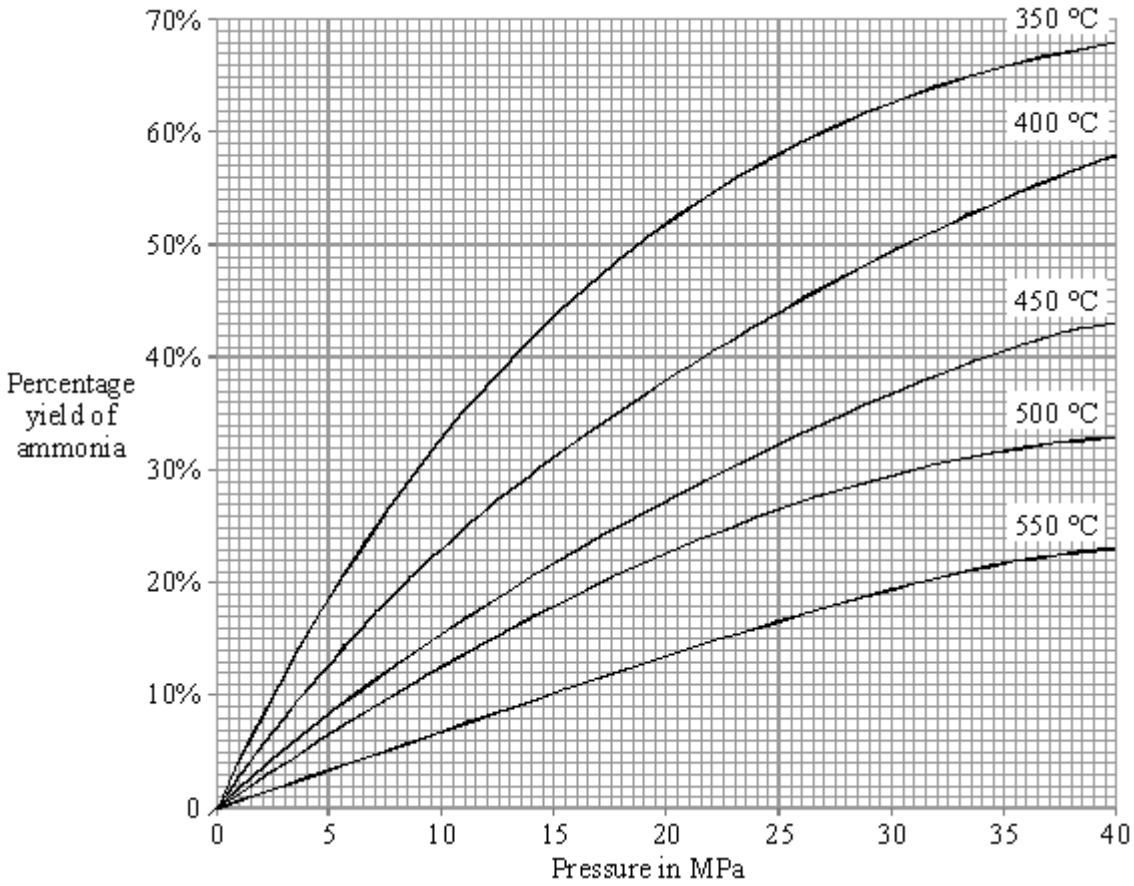
_____

_____

Mass = _____ tonnes

(2)

(b) The percentage yield of ammonia depends on the temperature and pressure inside the reaction vessel. The set of graphs show this.



(i) MPa is the symbol for which unit?

_____

(1)

(ii) What is the percentage yield of ammonia produced at a temperature of 450 °C and a pressure of 20 MPa?

_____

(1)

(iii) Suggest what changes the chemical engineers should make to both the temperature and the pressure to **increase** the percentage yield of ammonia.

Temperature _____

Pressure _____

(1)

(iv) How can the rate of ammonia production be increased without changing the temperature or pressure or the mass of hydrogen and nitrogen?

_____

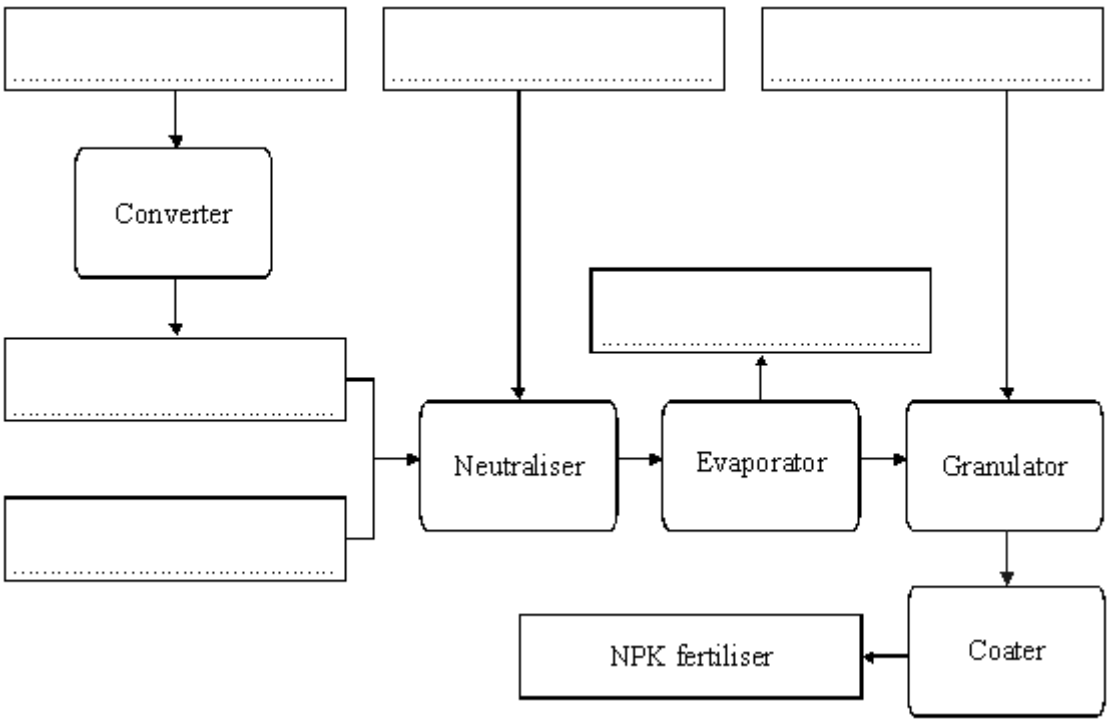
_____

(1)

(c) About four-fifths of ammonia production is used to produce fertilisers. One of them is known as NPK. It is made in the following way.

- Some ammonia is converted to nitric acid which is then mixed with phosphoric acid.
- The mixture is neutralised with more ammonia and the solution is partly evaporated.
- Potassium chloride is added to form granules.
- The granules are coated to make the fertiliser free-flowing.

Complete the flow-chart for the production of NPK by writing in the names of the correct chemicals in the **six** boxes.



(2)

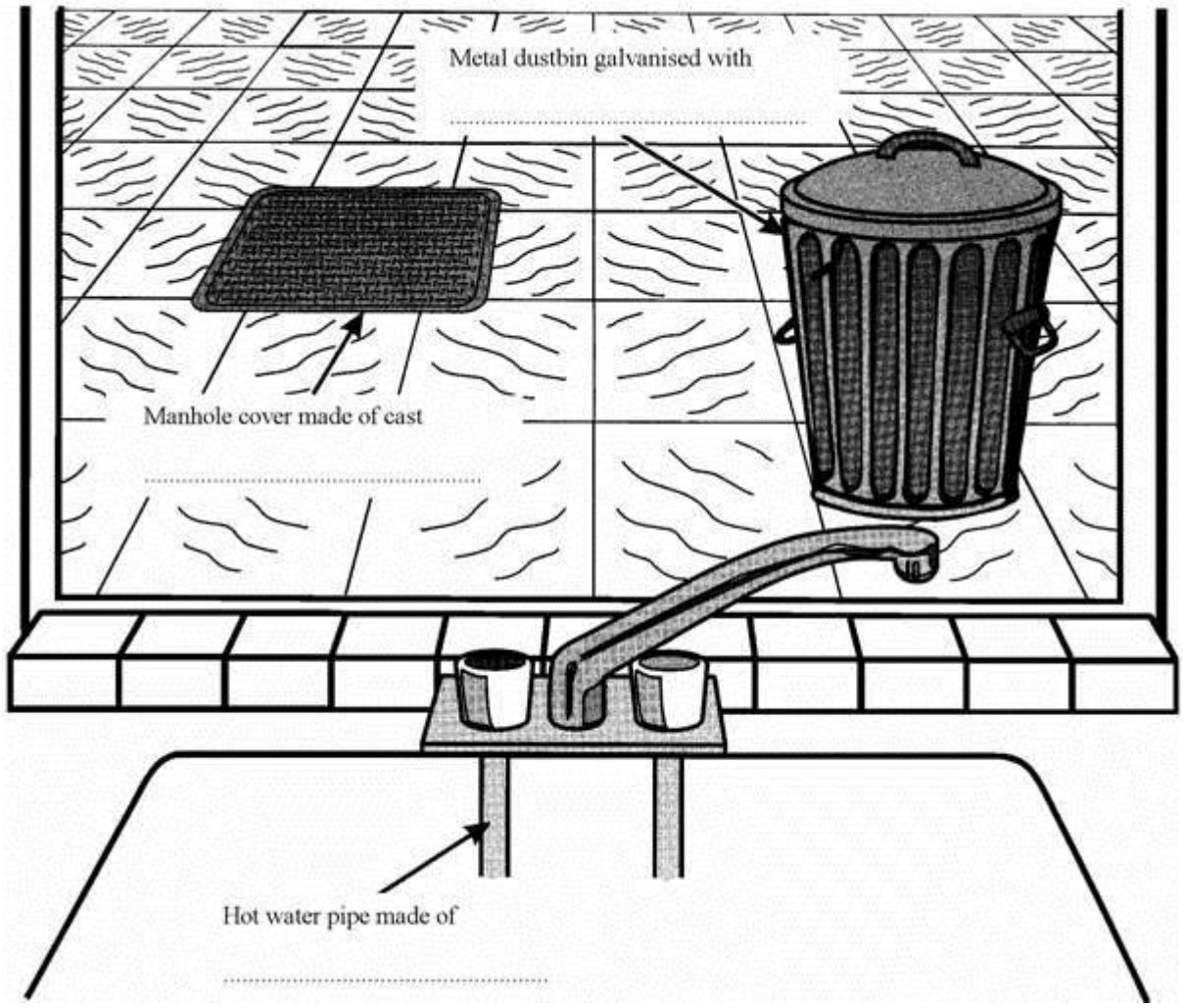
(Total 10 marks)

Q40.

The word box contains the names of some metals.

aluminium	copper	iron	manganese	zinc

(i) The drawing shows the view from a window. Choose from the names of metals in the box to complete the **three** spaces.



(3)

(ii) What is the name of the metal in the word box which has the chemical symbol Fe?

_____

(1)

(iii) What is the name of **one** metal in the word box which often has coloured compounds?

_____

(1)

(Total 5 marks)

Q41.

(a) Ammonium sulphate is made by the reaction:

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

(i) Complete the **three** answers in the table.

Question	Answer
How many hydrogens are there in the formula of ammonium	

sulphate?	_____
What is the name of the substance with the formula NH_3?	_____
What is the name of the substance with the formula H_2SO_4?	_____

(3)

(ii) What is the main use for ammonium sulphate?

_____

(1)

(iii) A similar reaction is used to make ammonium nitrate. What is the name of the acid which must be used?

_____

(1)

(b) NH_3 is made by the reversible reaction:

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

(i) Explain what the term *reversible reaction* means.

_____

_____

_____

(2)

(ii) What is the name of the raw material which is the source of nitrogen (N_2)?

_____

(1)

(iii) Nitrogen is an element. Explain what the term *element* means.

_____

_____

_____

(2)

(Total 10 marks)

Q42.

(a) Iron powder is used in the manufacture of ammonia. Why is it used?

_____

_____

(1)

(b) Ammonia is manufactured from nitrogen and hydrogen. The equation for the reaction between them is:

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

(i) Which **two** raw materials are used to make the hydrogen?

_____ and _____

(1)

(ii) Why does increasing the pressure increase the chance of molecules of nitrogen reacting with molecules of hydrogen?

_____

_____

(1)

(iii) Calculate the mass, in tonnes, of ammonia which could be produced from 560 tonnes of nitrogen.

The relative atomic masses are: H 1; N 14.

Show clearly how you get to your answer.

_____

_____

_____

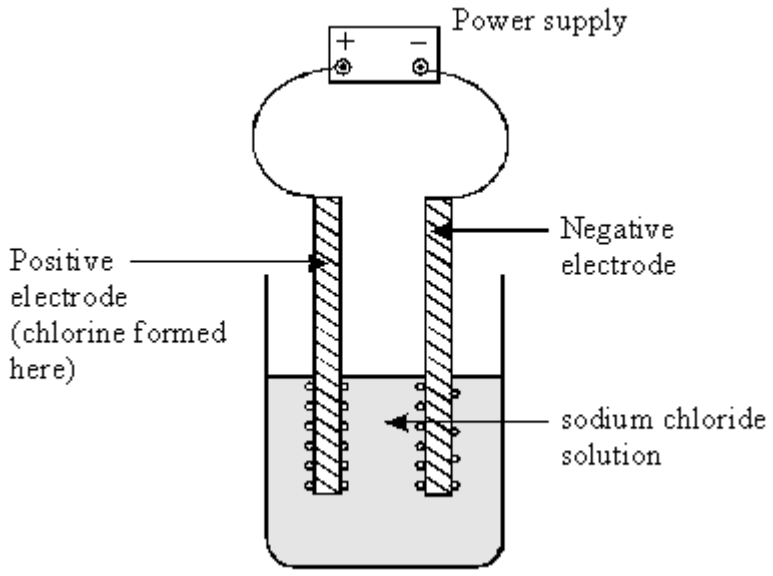
Mass of ammonia = _____ tonnes

(3)

(Total 6 marks)

Q43.

The diagram below shows the electrolysis of sodium chloride solution, in the laboratory.



(a) Which gas forms at the negative electrode? _____

(1)

(b) Explain why chlorine gas forms at the positive electrode.

_____

_____

_____

(2)

(c) State **one** use of chlorine gas.

_____

(1)

(Total 4 marks)

Q44.

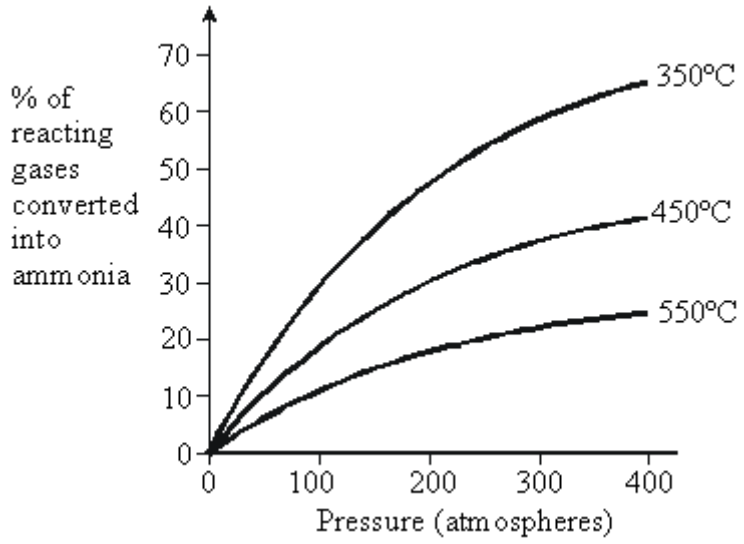
Ammonia is manufactured in the Haber Process, from nitrogen and hydrogen.

(a) Balance this symbol equation for the process.

$$N_2 + \quad H_2 \rightleftharpoons \quad NH_3$$

(2)

(b) The graph below shows the percentage of reacting gases converted into ammonia, at different temperatures and pressures.



(i) What does the graph suggest about the temperature and pressure needed to convert the maximum percentage of reacting gases into ammonia?

_____

_____

_____

(2)

(ii) Suggest reasons why the manufacture of ammonia in the Haber Process is

usually carried out at about 400°C and 200 atmospheres pressure.

_____

_____

_____

(2)

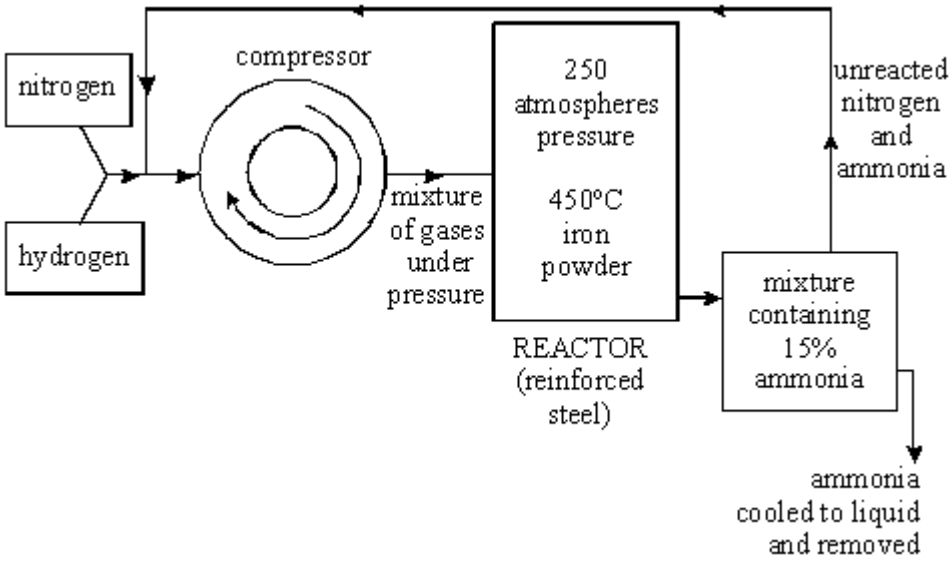
(Total 6 marks)

Q45.

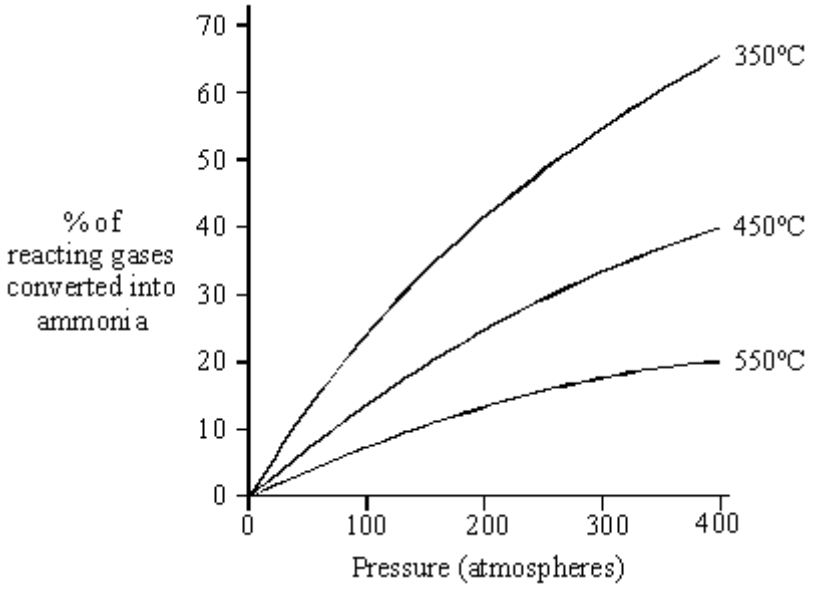
Ammonia is manufactured from nitrogen and hydrogen. The reaction is shown in the equation below.

$$N_2 \text{ (nitrogen)} + 3H_2 \text{ (hydrogen)} \underset{\text{endothermic}}{\overset{\text{exothermic}}{\rightleftharpoons}} 2NH_3 \text{ (ammonia)}$$

The diagram shows some details of the manufacturing process.



The graph shows the percentage of reacting gases converted into ammonia at different temperatures and pressures.



At room temperature and pressure, the reaction is very slow and only a small percentage of the reacting gases is converted to ammonia.

Use the information on the diagram and graph to:

(a) describe the conditions used in the manufacture of ammonia **to increase the rate of reaction**.

(4)

(b) describe and explain the conditions used in the manufacture of ammonia **to increase the yield.**

_____

_____

_____

_____

_____

(7)

(Total 11 marks)

Q46.

Ammonia is manufactured by the Haber Process, where nitrogen and hydrogen react together as follows:

$N_2 + 3H_2 \Leftrightarrow 2NH_3$

The reaction is reversible. A balance is eventually reached when ammonia is being formed at the same rate at which it is decomposing.

This point is called 'equilibrium'.

	PERCENTAGE OF AMMONIA AT EQUILIBRIUM		
PRESSURE (ATM)	100° C	300° C	500° C
25	91.7	27.4	2.9
100	96.7	52.5	10.6
400	99.4	79,7	31.9

(a) (i) What is meant by a 'reversible reaction'?

_____

_____

(1)

(ii) Which substances are present in the mixture at equilibrium?

_____

(1)

(b) (i) Under what conditions shown in the table is the maximum yield of ammonia obtained?

_____

_____

(2)

(ii) The Haber Process is usually carried out at a higher temperature than that which would produce the maximum yield. Suggest why.

_____

_____

_____

_____

(2)

(c) Ammonia can be converted into nitric acid in three stages:

Stage 1 Ammonia reacts with oxygen from the air to form nitrogen monoxide and water

$4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$

Stage 2 On cooling, nitrogen monoxide reacts with oxygen from the air to form nitrogen dioxide.

Stage 3 Nitrogen dioxide reacts with water to form nitric acid and nitrogen monoxide.

(i) Describe the conditions under which the reaction in Stage 1 takes place.

_____

_____

_____

_____

(3)

(ii) Balance the equation for the reaction at Stage 2.

$NO + O_2 \longrightarrow NO_2$

(1)

(iii) Balance the equation for the reaction at Stage 3.

$NO_2 + H_2O \longrightarrow HNO_3 + NO$

(1)

(d) The chemical plant for manufacturing ammonia is often on the same site as plants manufacturing nitric acid and fertilisers.

(i) What advantages will this have for the manufacturing company?

_____

_____

_____

_____

(2)

(ii) Briefly describe **two** important ways in which it is possible to reduce the environmental impact of such plants on the surrounding area.

1. _____

_____

2. _____

_____

(2)

(Total 15 marks)