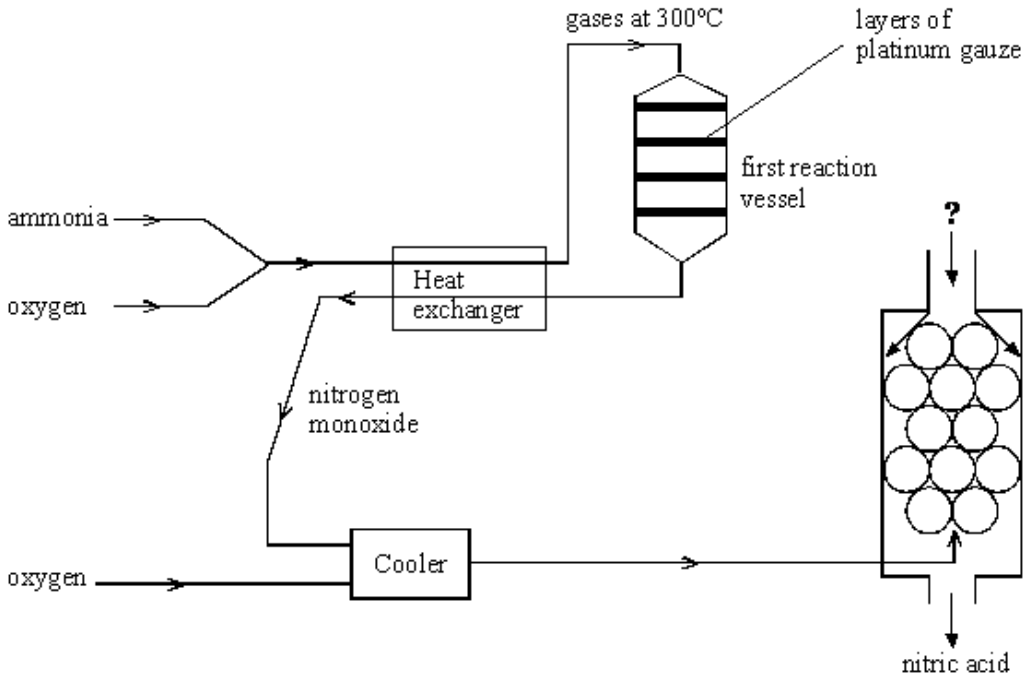
Q1. The chart shows the processes involved in the manufacture of nitric acid from ammonia.



(a) Complete the word equation for the reaction that takes place in the first reaction vessel.

ammonia + ... ⟶ nitrogen monoxide + water

(1)

(b) What is the use of the platinum gauze in the reaction vessel?

.....

(1)

(c) To convert nitrogen monoxide into nitric acid, **two** further reactants are needed.
What are they?

..... and .....

(1)

(d) Complete the word equation below, to show how to make the fertiliser, ammonium nitrate.

..... + ... ⟶ ammonium nitrate + water

(2)

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

.....

.....

.....

.....

(2)
(Total 7 marks)

##

Here is a symbol equation, with state symbols, for a chemical reaction between solutions of lead nitrate and potassium chloride.

$$\mathbf{Pb(NO_3)_{2\,(aq)} + 2\,KCl_{(aq)} \longrightarrow 2KNO_{3\,(aq)} + PbCl_{2\,(s)}}$$

The equation tells you the formulae of the two products of the reaction.

(a) What are the names of the **two** products?

1 .....

2 .....

(2)

(b) What else does the equation tell you about these products?

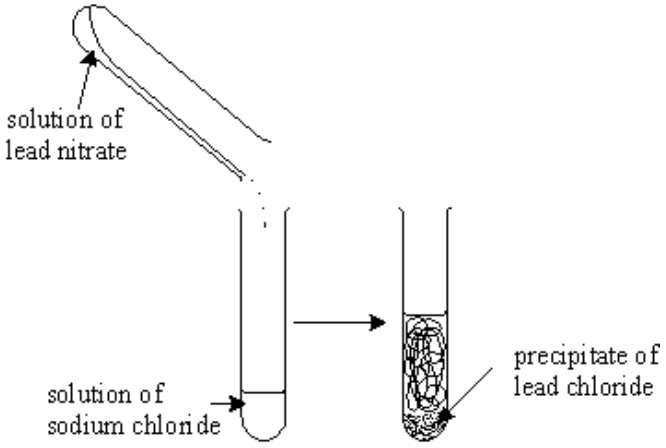
.....

.....

.....

(2)
(Total 4 marks)

Q3. When a solution of lead nitrate is added to a solution of sodium chloride, a white precipitate of lead chloride is produced.



(a) (i) Why is a precipitate formed?

.....

.....

(1)

(ii) Complete and balance the equation for this precipitation reaction.

$Pb^{+2}_{(aq)} + Cl^{-}_{(aq)} \rightarrow$

(3)

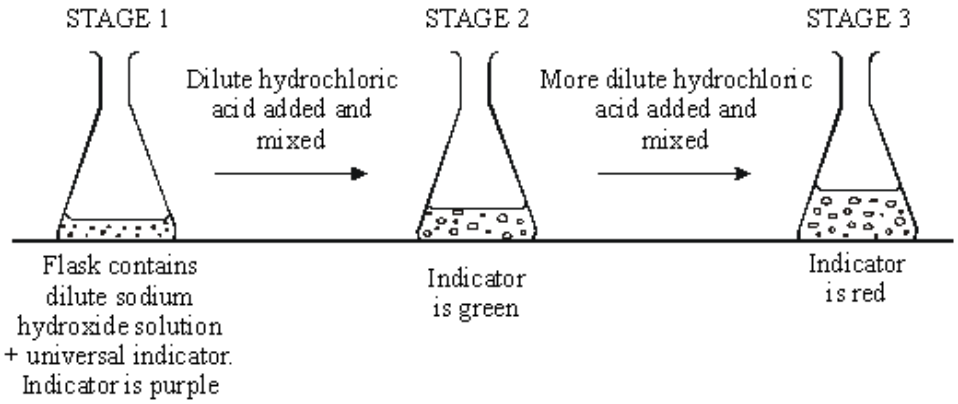
(b) Complete the table below by writing in the name and formula of the precipitate formed for each reaction. If there is no precipitate, write “no precipitate”.

SOLUTION 1	ADDED TO	SOLUTION 2	NAME OF PRECIPITATE FORMED	FORMULA
(i) copper sulphate	→	sodium hydroxide		
(ii) lead nitrate	→	magnesium sulphate		
(iii) sodium chloride	→	zinc nitrate		

(5)

(Total 9 marks)

Q4. The diagrams show what happens when an acid is added to an alkali.



(a) What is present in the solution at stages 2 and 3 apart from universal indicator and water?

(i) At stage 2 .....

(ii) At stage 3.....

(3)

(b) Write an ionic equation to show how water is formed in this reaction and state the sources of the ions.

.....

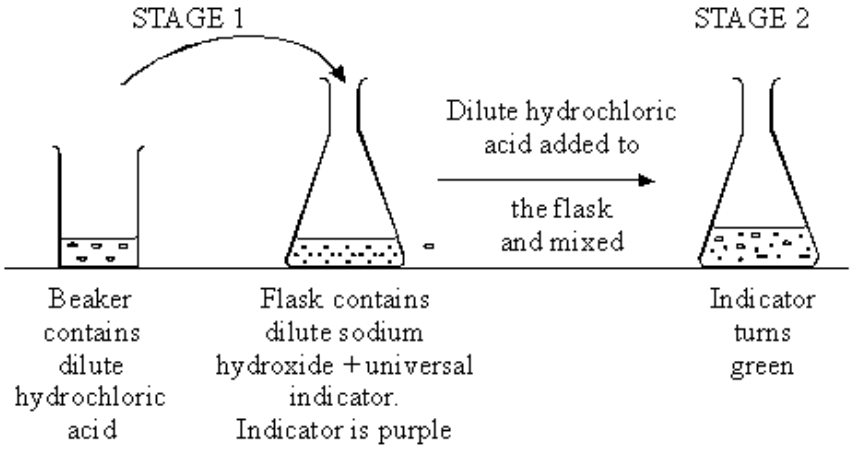
.....

.....

.....

(3)
(Total 6 marks)

Q5. The diagrams show what happens when an acid is added to an alkali.



(a) What is present in the flask at stage 2, besides universal indicator and water?

.....

(1)

(b) Write an ionic equation to show how water is formed in this reaction and state the sources of the ions.

.....

.....

.....

.....

(3)
(Total 4 marks)

Q6. (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)

Q7. Ammonium nitrate and ammonium sulphate are used as fertilisers.

(i) Which acid reacts with ammonia to form ammonium nitrate?

.....

(1)

(ii) Which acid reacts with ammonia to form ammonium sulphate?

.....

(1)

(iii) The reactions in (i) and (ii) are both exothermic. How can you tell that a reaction is exothermic?

.....

.....

(1)

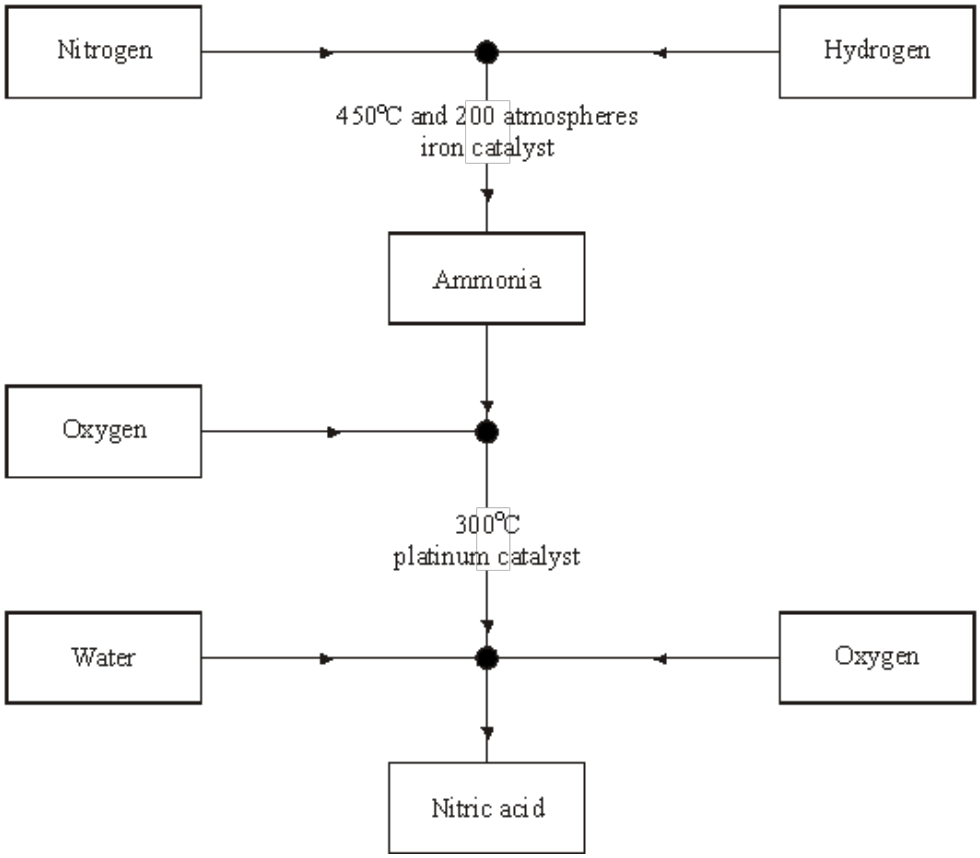
(iv) The reactions in (i) and (ii) are both examples of acid + base reactions. What is the name of the chemical change which takes place in every acid + base reaction?

.....

(1)

(Total 4 marks)

Q8. 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.

.....

.....

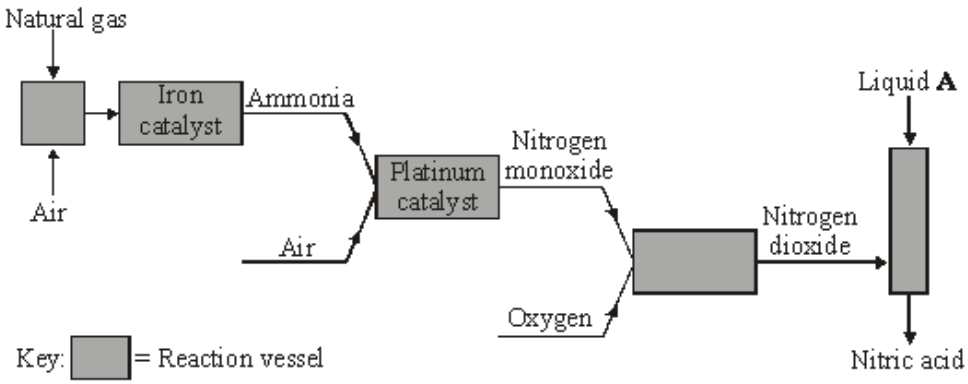
.....

.....

(2)

(Total 7 marks)

Q9. The flow diagram shows some stages in the manufacture of the fertiliser ammonium nitrate (NH_4NO_3).



(a) The elements needed to make ammonia (NH_3) are obtained from natural gas and air.
Which element is obtained from the air?

.....

(1)

(b) The word equation for the formation of nitrogen monoxide is:

ammonia + oxygen → nitrogen monoxide + water

The platinum catalyst needs to be heated only at the start of the reaction.
Suggest why.

.....

.....

.....

(1)

(c) Name the liquid **A** that reacts with nitrogen dioxide (NO_2) to produce nitric acid (HNO_3).

.....

(1)

(d) Describe how ammonium nitrate (NH_4NO_3) can be made from **two** of the products shown in the flow diagram.

.....

.....

.....

.....

(2)

(Total 5 marks)

Q10. (a) Magnesium burns in oxygen, forming magnesium oxide.

This equation represents the reaction.

$Mg\ (s) + O_2\ (g) \rightarrow MgO\ (s)$

(i) Balance the equation.

(1)

(ii) Give the meaning of the state symbols (s) and (g).

(s) .....

(g) .....

(2)

(b) Use the Formulae of Some Common Ions table on the Data Sheet to help you to answer this question.

Magnesium also reacts with chlorine to form magnesium chloride.

Give the formula of magnesium chloride .....

(1)

(Total 4 marks)

Q11. Use the Formulae of Some Common Ions table on the Data Sheet to help you to answer this question.

Acids react with alkalis to form salts and water.

Complete the table below by writing in the name and formula of the salt formed in each reaction.

The first one has been done for you.

Acid	Alkali	Salt	Formula of salt
Hydrochloric acid	Sodium hydroxide	Sodium chloride	NaCl
Nitric acid	Sodium hydroxide		
Sulphuric acid	Potassium hydroxide		

(Total 4 marks)

Q12. This item appeared in the Wolverhampton *Express and Star* on October 31st, 1997. Read the passage and answer the questions that follow.

Fumes scare at factory

Workers were forced to flee a factory after a chemical alert. The building was evacuated when a toxic gas filled the factory.
It happened when nitric acid spilled on to the floor and mixed with magnesium metal powder.

(a) The equation which represents the reaction between magnesium and nitric acid is:

$$Mg_{(s)} + 4HNO_{3(aq)} \rightarrow Mg(NO_3)_{2(aq)} + 2H_2O_{(1)} + 2NO_{2(g)}$$

Give the formula of the toxic gas that was produced.

.....

(1)

(b) Explain, in terms of particles, how the toxic gas was able to fill the factory quickly.

.....

.....

.....

(2)

(c) The reaction of nitric acid with magnesium metal powder is more dangerous than if the acid had fallen on to the same mass of magnesium bars. Explain why.

.....

.....

.....

(1)

(d) (i) Water was sprayed on to the magnesium and nitric acid to slow down the reaction. Explain, in terms of particles, why the reaction would slow down.

.....

.....

.....

(2)

(ii) Explain why it is better to add alkali, rather than just add water to the spillage.

.....

.....

(1)

(Total 7 marks)

Q13. (i) Which acid from the list should the student add to sodium hydroxide solution to make sodium sulphate?

ethanoic acid **hydrochloric acid** **nitric acid** **sulphuric acid**

.....

(1)

(ii) When the acid was added to the alkali the beaker became warm.
Name the type of reaction that releases heat.

.....

(1)

(iii) Use the Data Sheet to help you to write the formula of sodium sulphate.

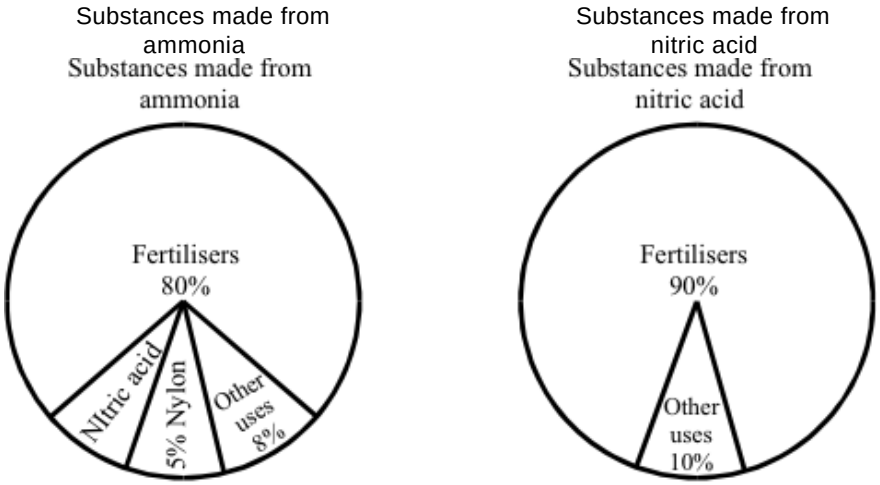
Formula: .....

(1)

(Total 3 marks)

Q14. 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.



(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)

Q15. Calcium tablets are taken to build and maintain strong bones and teeth.

(a) These tablets react with hydrochloric acid in the stomach.

$CaCO_3(\ \ ) + 2HCl(aq) \rightarrow CaCl_2(\ \ ) + H_2O(\ \ ) + CO_2(\ \ )$

(i) Add all these missing state symbols | aq | g | l | s | to the balanced chemical equation.

(2)

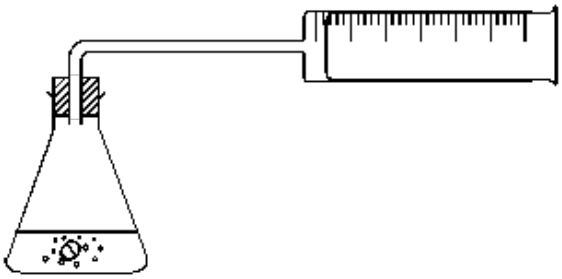
(ii) The calcium salt that is formed is absorbed during digestion. What is the name of the calcium salt?

.....

.....

(1)

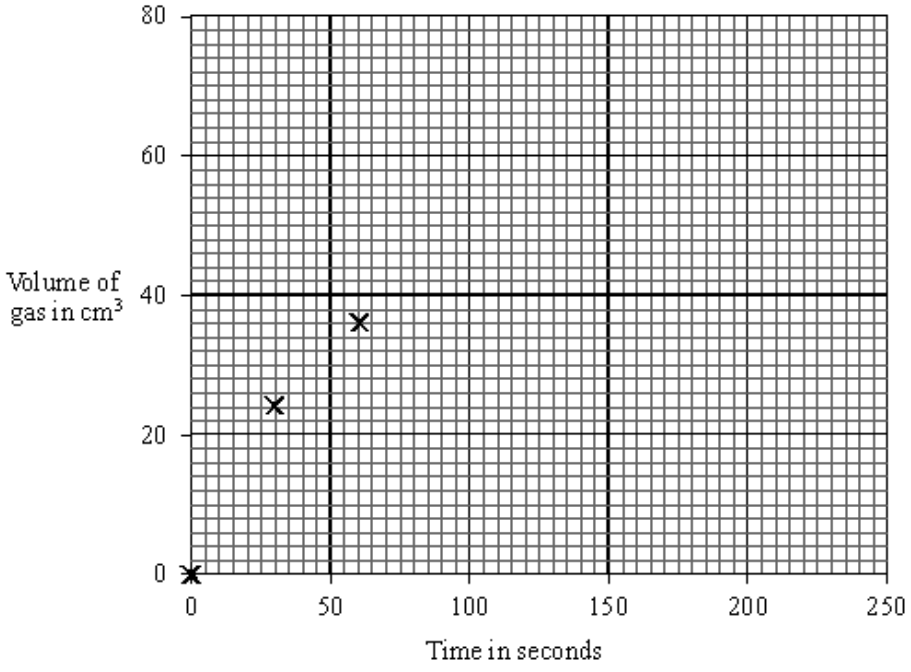
(b) The volume of carbon dioxide produced by one calcium tablet in the stomach can be found as shown.



The volume of carbon dioxide was recorded every 30 seconds until the reaction stopped.

Time in seconds	0	30	60	90	120	150	180	210	240
Volume of gas in cm^3	0	24	36	46	52	56	59	60	60

(i) Complete the graph of these results.



(3)

(ii) Describe **one** way in which this reaction can be made to go faster.

.....

.....

(1)

(iii) A calculation, using the mass of this tablet, showed that 80 cm^3 of carbon dioxide would be produced if the tablet was pure calcium carbonate. What do the results show about the purity of the tablet? Explain your answer by calculating the purity of this tablet.

.....

.....

.....

.....

.....

.....

(3)

(Total 10 marks)

Q16. Many everyday substances can be classified as acids, bases or salts. For example, car batteries contain sulphuric acid, oven cleaners contain sodium hydroxide and table salt contains sodium chloride.

(a) A solution of each of these substances was tested with universal indicator.

Solution	Colour of universal indicator
Sulphuric acid (H_2SO_4)	red
Sodium hydroxide (NaOH)	purple
Sodium chloride (NaCl)	green

(i) Explain how these universal indicator colours and the corresponding pH values could be used to identify each of these solutions.

.....

.....

.....

.....

.....

(3)

(ii) Name and give the formula of the ion which causes the solution to be acidic.

Name of ion .....

Formula of ion .....

(2)

(b) Sodium chloride can be made by reacting sodium hydroxide with hydrochloric acid in the presence of an indicator.

(i) What is the name of this type of reaction?

.....

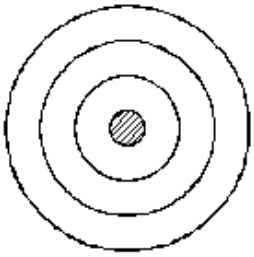
(1)

(ii) Write a balanced chemical equation for this reaction.

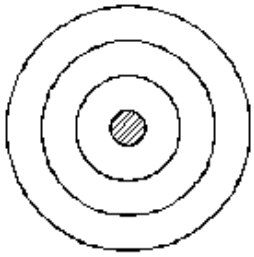
.....(aq) + ...(aq) → .....(aq) + ...(l)

(2)

(c) The atomic number for sodium is 11 and for chlorine is 17.



Sodium atom



Chlorine atom

(i) Complete the diagrams to show the electron arrangements for a sodium atom and a chlorine atom.

(2)

(ii) These atoms form different particles by one electron transferring from the sodium atom to the chlorine atom. What is the name given to the particles formed?

.....

(1)

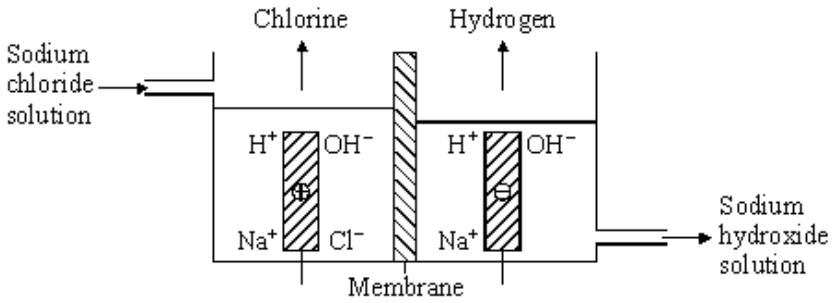
(iii) Why do these sodium and chloride particles bond?

.....

.....

(1)

(d) Sodium chloride solution is electrolysed to form three products, hydrogen, chlorine and sodium hydroxide.



Describe how each of these products are formed.

.....

.....

.....

.....

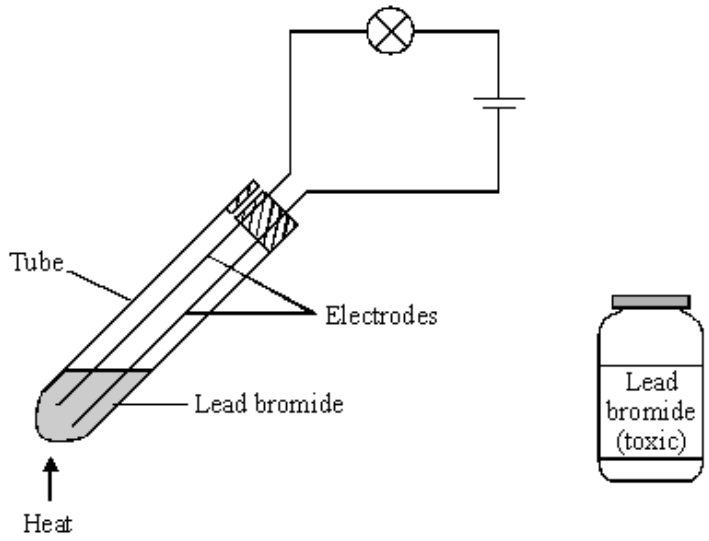
.....

.....

(3)

(Total 15 marks)

Q17. A student investigated the *electrolysis* of lead bromide.



Lead bromide was placed in the tube and the circuit was switched on. The light bulb did not light up.

The tube was heated and soon the bulb lit up. The observations are shown in the table.

Positive electrode	Negative electrode
red-brown gas	silver liquid

(a) What is meant by *electrolysis?*

.....

(2)

(b) Why did the lead bromide conduct electricity when the tube was heated?

.....

(1)

(c) Name the substances formed at the:

positive electrode; .....

negative electrode. .....

(2)

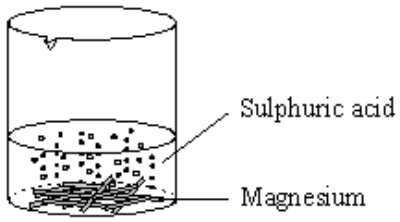
(d) Suggest **one** safety precaution that should be taken during this investigation.

.....

(1)

(Total 6 marks)

Q18. A student tried to make some magnesium sulphate. Excess magnesium was added to dilute sulphuric acid. During this reaction fizzing was observed due to the production of a gas.



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

..... + H_2SO_4 → ..... + ...

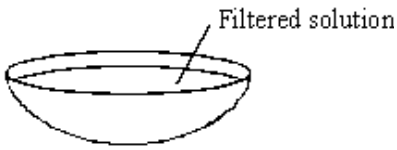
(3)

(ii) At the end of the reaction the solution remaining was filtered. Why was the solution filtered?

.....

(1)

(iii) The filtered solution was left in a warm place.



Explain why the filtered solution was left in a warm place.

.....

.....

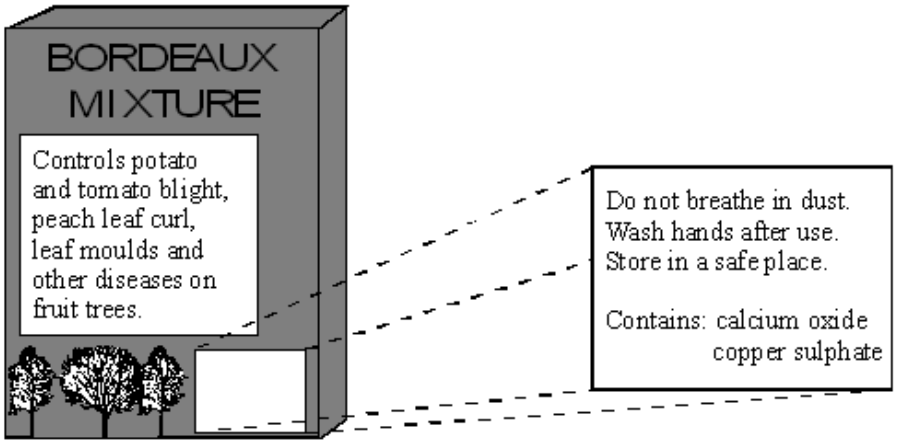
.....

(2)

(Total 6 marks)

Q19. Bordeaux Mixture controls some fungal infections on plants.

A student wanted to make some Bordeaux Mixture.



(a) The student knew that calcium oxide could be made by heating limestone. Limestone contains calcium carbonate, $CaCO_3$.

(i) Write the word equation for this reaction.

.....

(1)

(ii) What type of reaction is this?

.....

(1)

(b) The student knew that copper sulphate, $CuSO_4$, could be made by the following general reaction.

acid + base → salt + water

(i) What type of reaction is this?

.....

(1)

(ii) The base used is copper oxide. Name and give the chemical formula of the acid used.

Name .....

Chemical formula .....

(2)

(c) The student wrote about how the copper sulphate was made.

"Some of the acid was warmed. Copper oxide was added. The mixture was stirred. More copper oxide was added until no more would react. The mixture was then filtered."

(i) Why was the acid warmed?

.....

.....

(1)

(ii) Copper oxide was added until no more would react. Explain why.

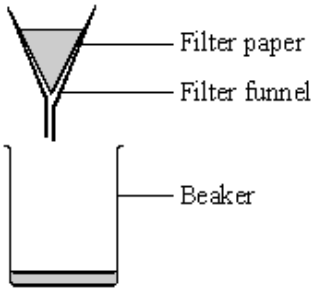
.....

.....

.....

(2)

(iii) The filtration apparatus is shown.



Describe and explain what happens as the mixture is filtered.

.....

.....

.....

.....

.....

.....

(2)

(Total 10 marks)

Q20. The information in the box is about the preparation of copper sulphate crystals.

Step 1 Add a small amount of black copper oxide to some hot dilute sulphuric acid, and stir.
Step 2 Keep adding copper oxide until it is in excess.
Step 3 Remove the excess copper oxide to leave blue copper sulphate solution.
Step 4 Evaporate the copper sulphate solution until it is saturated.
Step 5 Leave the saturated solution of copper sulphate to cool. Blue copper sulphate crystals form on cooling.
Step 6 Remove the crystals from the solution remaining.
Step 7 Dry the blue crystals on a piece of filter paper.

(i) Suggest a reason for using excess copper oxide in Step 2.

.....

.....

(1)

(ii) Suggest how the excess copper oxide can be removed from the solution in Step 3.

.....

.....

(1)

(iii) What is meant by the term *saturated solution*?

.....

.....

.....

(2)

(iv) Why do crystals form when a hot saturated solution cools?

.....

.....

(1)

(v) Suggest why the blue crystals are dried in Step 7 using filter paper instead of by heating.

.....

.....

(1)

(Total 6 marks)

Q21. The following passage is about the preparation of lead iodide, an insoluble salt.

> An excess of potassium iodide in solution was shaken with some lead nitrate solution in a test tube.
>
> The lead iodide precipitate was separated from the mixture and then washed several times with water.
>
> The lead iodide was dried and then placed in a bottle.

(a) Suggest a reason why excess potassium iodide was used.

.....

.....

(1)

(b) What word used in the passage shows that lead iodide is insoluble?

.....

(1)

(c) Suggest how lead iodide can be separated from the mixture.

.....

.....

(1)

(d) Why was the lead iodide washed with water?

.....

.....

(1)

(e) Suggest a method which could be used to dry this lead iodide.

.....

.....

(1)

(f) Lead compounds are toxic.

Suggest a suitable safety precaution that should be taken when using toxic substances in laboratories.

.....

(1)

(Total 6 marks)

Q22. Copper sulfate ($CuSO_4$) is a salt that has many uses.

An aqueous solution of copper sulfate can be made by reacting copper oxide (CuO) with an acid.

(a) (i) Name this acid. .....

(1)

(ii) Write a balanced symbol equation, including state symbols, for this reaction.

.....

(2)

(b) Copper oxide reacts much faster with acid at 40 °C than at 20 °C.

Explain why in terms of particles.

.....

.....

.....

.....

(2)

(Total 5 marks)

Q23. Waste water from some industrial processes contains harmful metal ions, such as chromium ions. Harmful metal ions must be removed from the water before the water is returned to a river.

(a) A method of removing chromium ions (Cr^{3+}) from water is represented by this equation.

Balance the equation.

$$Cr^{3+}(aq) + ...OH^-(aq) \rightarrow Cr(OH)_3(s)$$

(1)

(b) Suggest a suitable chemical that could be added to the water to provide the OH^- ions.

.....

(1)

(c) Explain how chromium ions are removed from the water.

.....

.....

(1)

(Total 3 marks)

Q24. *In this question you will get marks on using good English, organising information clearly and using specialist terms correctly.*

Copper sulfate crystals can be made from copper oxide powder and dilute sulfuric acid.

Describe a method to make copper sulfate crystals from copper oxide and dilute sulfuric acid.

For the method you should include:

- the names of the pieces of apparatus used
- a risk assessment.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total 6 marks)

Q25. (a) Read the article about the mineral strontianite.

Strontianite is a mineral that was discovered near the village of Strontian in Scotland. At first some scientists thought that strontianite was barium carbonate.

Strontianite

In 1790, Professor Adair Crawford and William Cruikshank were both lecturers in chemistry and doctors of medicine. They investigated the properties of strontianite. They found that strontianite had different properties from barium carbonate. They concluded that strontianite contained a new element.

After this, other scientists also showed that strontianite and barium carbonate had different properties. Strontianite is now known to be strontium carbonate.

(i) What evidence did Crawford and Cruikshank use to prove that strontianite was **not** barium carbonate?

.....

.....

(1)

(ii) Crawford and Cruikshank's conclusion was immediately accepted by other scientists. Suggest why.

.....

.....

(1)

(iii) How was the reliability of the work of Crawford and Cruikshank confirmed?

.....

.....

(1)

(b) One of Crawford and Cruikshank's experiments was repeated in a school laboratory.

Samples of strontianite and barium carbonate were reacted with hydrochloric acid to produce strontium chloride and barium chloride.

Solid strontium chloride and solid barium chloride were separately added to water. The change in temperature of the water was measured.

The results of the experiments are shown below.

	Experiment 1 Strontium chloride dissolved in water	**Experiment 2** Barium chloride dissolved in water
Temperature of water before adding the chloride in °C	19.5	19.6
Temperature of water after adding the chloride in °C	21.2	17.5

(i) State **one** variable that should be controlled to make it a fair test.

.....

.....

(1)

(ii) Which experiment, **1** or **2**, is endothermic?

Explain how you know.

Experiment ☐ because .....

.....

(1)

(iii) The results prove that strontium chloride and barium chloride must be different even if all of the variables had not been controlled when they were dissolved. Explain why.

.....

.....

(1)

(c) In 1808, Humphry Davy was the first person to extract strontium. He did this by the electrolysis of molten strontium chloride. Strontium formed at the negative electrode.

Suggest why strontium ions are attracted to the negative electrode.

.....

.....

(1)

(Total 7 marks)

Q26. Read the article.

In the late eighteenth century the French scientist Nicolas Leblanc invented a process to change sodium chloride into sodium carbonate.

The main steps in the original process were:

Step 1. Sodium chloride was reacted with sulfuric acid to make sodium sulfate. Hydrogen chloride was formed and escaped into the atmosphere.
The hydrogen chloride damaged plants over a wide area around the factory.

Step 2. The sodium sulfate was heated with limestone and coal. A solid mixture was formed which contained sodium carbonate, calcium sulfide and unreacted coal.
The calcium sulfide gave off a very unpleasant smell.

Step 3. The sodium carbonate was dissolved in water and separated from the insoluble calcium sulfide and unreacted coal.

Step 4. Crystals of sodium carbonate were obtained from the solution of sodium carbonate.

The process was later improved.

- The hydrogen chloride produced in **Step 1** was changed into chlorine which was used to make bleach.
- The calcium sulfide produced in **Step 2** was converted into sulfur. This sulfur was used to make sulfuric acid.

(a) The symbol equation for the reaction in **Step 1** is shown below.

$$2NaCl(s) + H_2SO_4(l) \rightarrow Na_2SO_4(s) + 2HCl(g)$$

What property of hydrogen chloride allowed it to escape into the atmosphere?

.....

(1)

(b) The insoluble solids, calcium sulfide and unreacted coal were separated from the sodium carbonate solution in **Step 3**.

Suggest how this was done.

.....

.....

(1)

(c) Sodium carbonate crystals were obtained from sodium carbonate solution in **Step 4**.

Suggest how this was done.

.....

.....

(1)

(d) It has been stated that: 'the Chemical Industry can turn problems into profit'.

State **two** problems with the original process and explain how they were turned into profit.

1 .....

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2 .....

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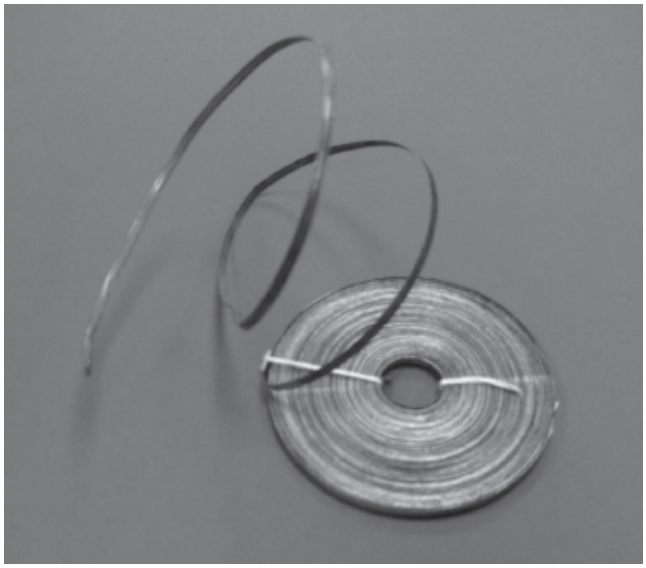
(4)
(Total 7 marks)

Q27. (a) Magnesium metal is shaped to make magnesium ribbon.



Explain why metals can be shaped.

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(2)

(b) Magnesium sulfate is a salt of magnesium.

It can be prepared by the reaction of magnesium metal with an acid. The equation for the reaction of magnesium with this acid is:

$$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$$

(i) Name the acid used to make magnesium sulfate.

..... acid

(1)

(ii) Use the equation to help you to describe what you would **observe** when magnesium reacts with the acid.

.....

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(2)

(iii) The magnesium sulfate is in solution.

How could you obtain solid magnesium sulfate from this solution?

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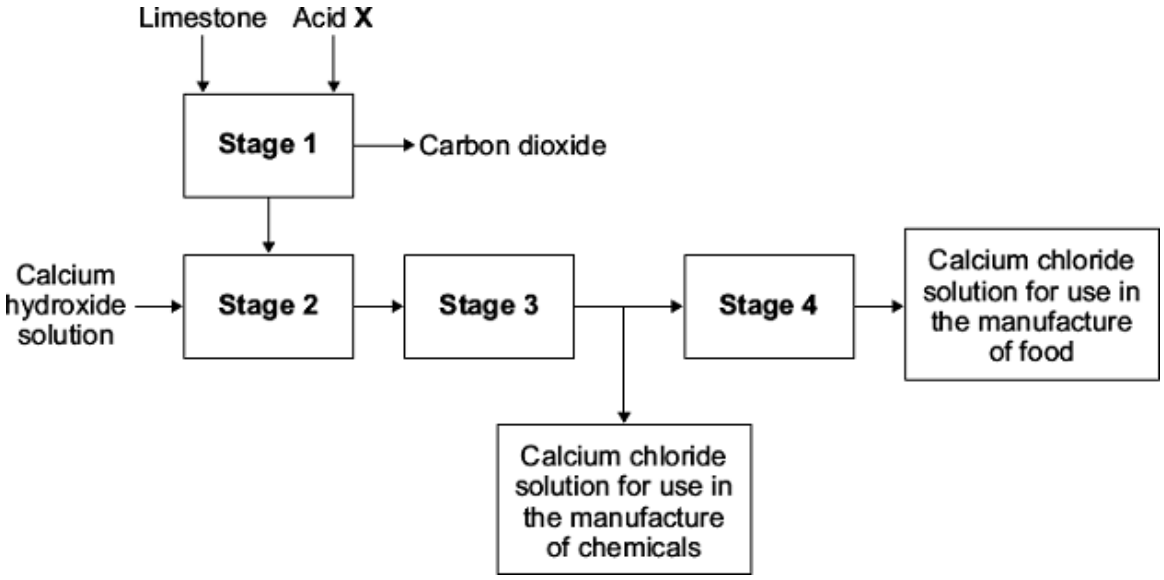
(1)

(Total 6 marks)

Q28. (a) Calcium chloride is made from limestone. The limestone used contains mainly calcium carbonate and a small amount of magnesium carbonate.



(i) In **stage 1** calcium carbonate reacts with acid **X** to form calcium chloride.

Name acid **X**.

.....

(1)

(ii) **Stage 1** produces a concentrated solution of calcium chloride.
The solution also contains magnesium chloride.

Calcium hydroxide solution is added to remove the magnesium chloride:

$$MgCl_2(aq) + Ca(OH)_2(aq) \rightarrow Mg(OH)_2(s) + CaCl_2(aq)$$

This is an example of a *precipitation* reaction.

What is the meaning of the term *precipitation* reaction?

.....

.....

(1)

(iii) The magnesium hydroxide can be separated from the calcium chloride solution.

State how.

.....

.....

(1)

(iv) Suggest why **stage 4** is needed.

.....

.....

(1)

(v) Name a method that can be used to change calcium chloride solution into solid calcium chloride.

.....

(1)

(b) Calcium chloride can also be made by reacting calcium with chlorine.

Calcium chloride is an ionic compound. It contains calcium ions (Ca^{2+}).

(i) Complete the equation for the formation of calcium ions.

$$Ca \rightarrow Ca^{2+} + ...$$

(1)

(ii) Why can the formation of calcium ions from calcium atoms be described as oxidation?

.....

.....

(1)

(Total 7 marks)

Q29. (a) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The salt called potassium chloride is made when potassium hydroxide solution reacts with hydrochloric acid.

potassium hydroxide solution + hydrochloric acid → potassium chloride solution + water

Describe a method for making **crystals** of potassium chloride from potassium hydroxide solution and hydrochloric acid.

In this method you should:

- describe how you will add the correct amount of the hydrochloric acid to neutralise the potassium hydroxide solution
- describe how you will get crystals of potassium chloride.

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(6)

(b) Ammonium nitrate is another salt.
Ammonium nitrate is made when ammonia solution is neutralised with an acid.

Name the acid to complete the word equation.

ammonia + ... acid → ammonium nitrate

(1)

(c) Read the information.

Ammonium nitrate – good or bad?

Some farmers put a lot of ammonium nitrate on their farmland.

Many people are worried about this use of ammonium nitrate.

Rain water can wash the ammonium nitrate off the farmland and into rivers and lakes. The ammonium nitrate may get into drinking water supplies and could be harmful to health.

(i) Why do some farmers put ammonium nitrate on their farmland?

.....

.....

(1)

(ii) Which **one** of the questions in the table cannot be answered by science alone?

Tick (✓) **one** question.

Question	Tick (✓)
How much ammonium nitrate is in drinking water?	
Should farmers stop using ammonium nitrate on their farmland?	
Is ammonium nitrate soluble in rain water?	

Give **two** reasons why this question **cannot** be answered by science alone.

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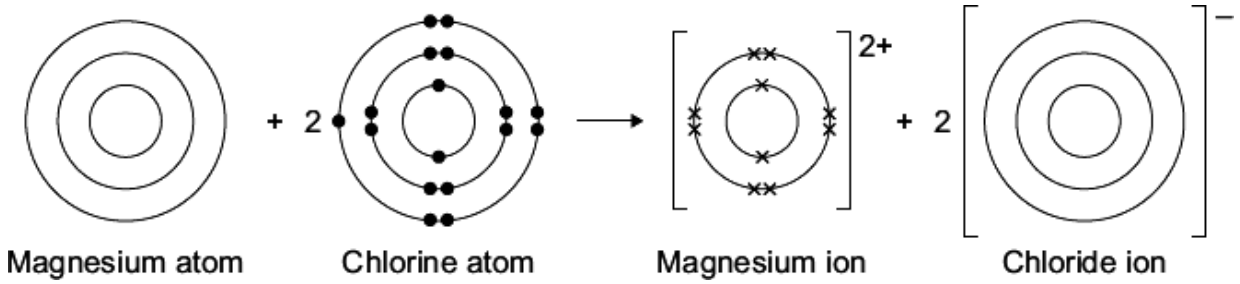
(3)

(Total 11 marks)

Q30. Magnesium reacts with chlorine to make the ionic compound called magnesium chloride.

(a) Complete the diagram by adding the electronic structures of the magnesium atom and the chloride ion.



(2)

(b) Magnesium metal can be extracted from sea water.
Sea water contains magnesium chloride, $MgCl_2$

(i) Calcium hydroxide, $Ca(OH)_2$, is added to the sea water.
Magnesium hydroxide, $Mg(OH)_2$, is produced.

$$MgCl_2(aq) + Ca(OH)_2(aq) \rightarrow Mg(OH)_2(s) + CaCl_2(aq)$$

Name a method that could be used to separate magnesium hydroxide from the solution.

.....

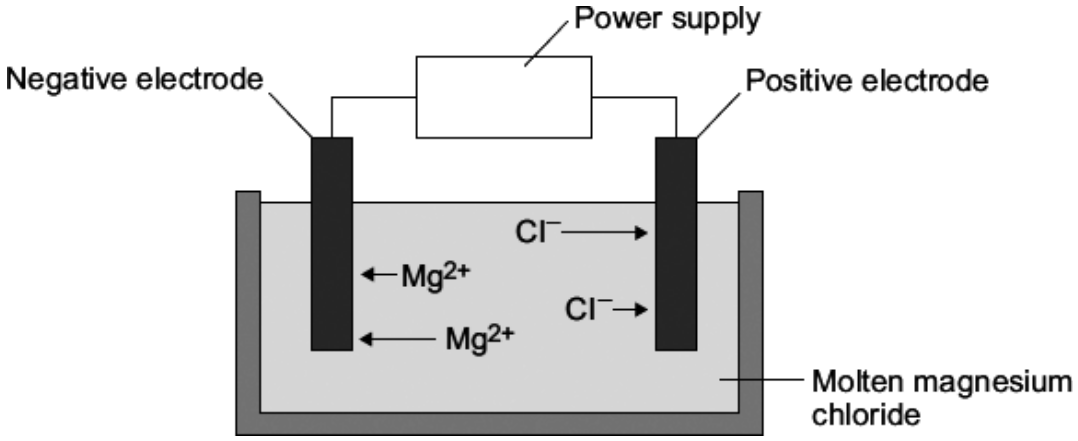
(1)

(ii) An acid is then added to the magnesium hydroxide to make magnesium chloride.

Name this acid. .....

(1)

(c) Electrolysis is used to extract magnesium metal from magnesium chloride.



(i) Why must the magnesium chloride be molten?

.....

.....

(1)

(ii) The equation shows the reaction that takes place at the positive electrode.

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

Why is this reaction an oxidation reaction?

.....

(1)

(iii) Complete the equation for the reaction at the negative electrode.

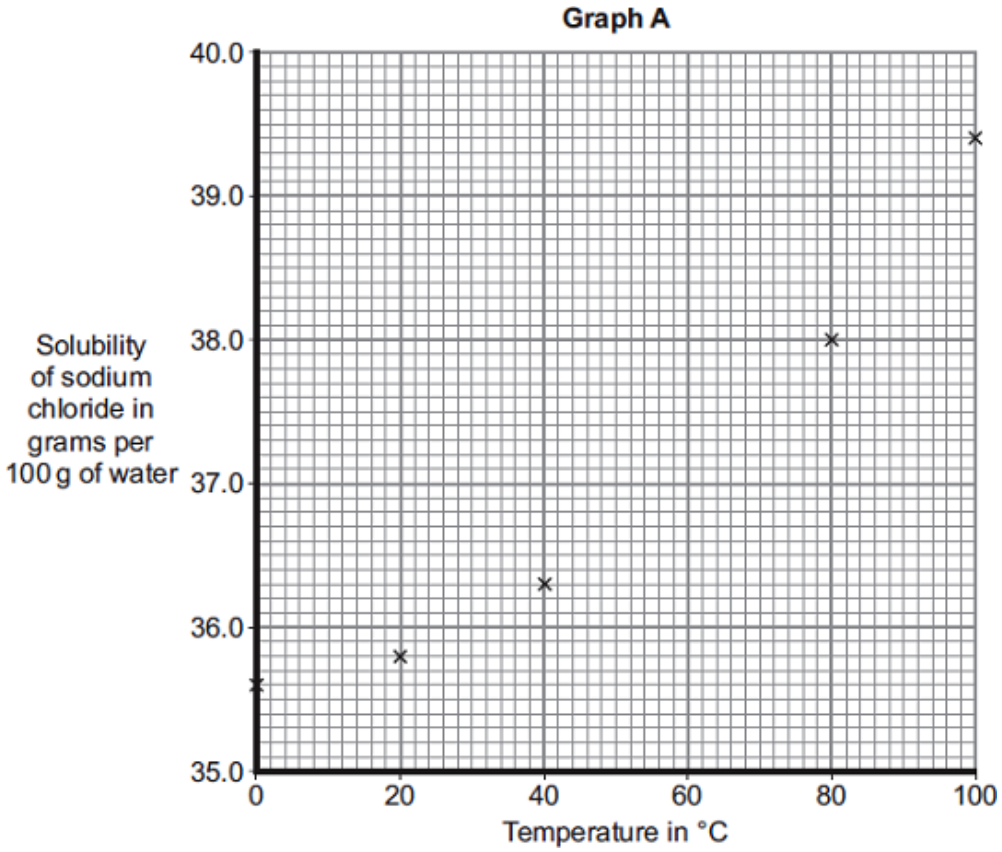
$$Mg^{2+} \rightarrow Mg$$

(1)
(Total 7 marks)

Q31. The table gives the solubility of sodium chloride in water at different temperatures.

Temperature in °C	0	20	40	80	100
Solubility in g per 100 g of water	35.6	35.8	36.3	38.0	39.4

(a) A student plotted Graph **A** using the data in the table.



(i) Draw a smooth curve through all the points on graph **A**.

(1)

(ii) Use this graph to find the mass of sodium chloride that dissolves in 100 g of water at 60 °C.

Mass = ... g

(1)

(iii) A saturated solution of sodium chloride in 100 g of water is made at 80 °C. It is then cooled to 20 °C.

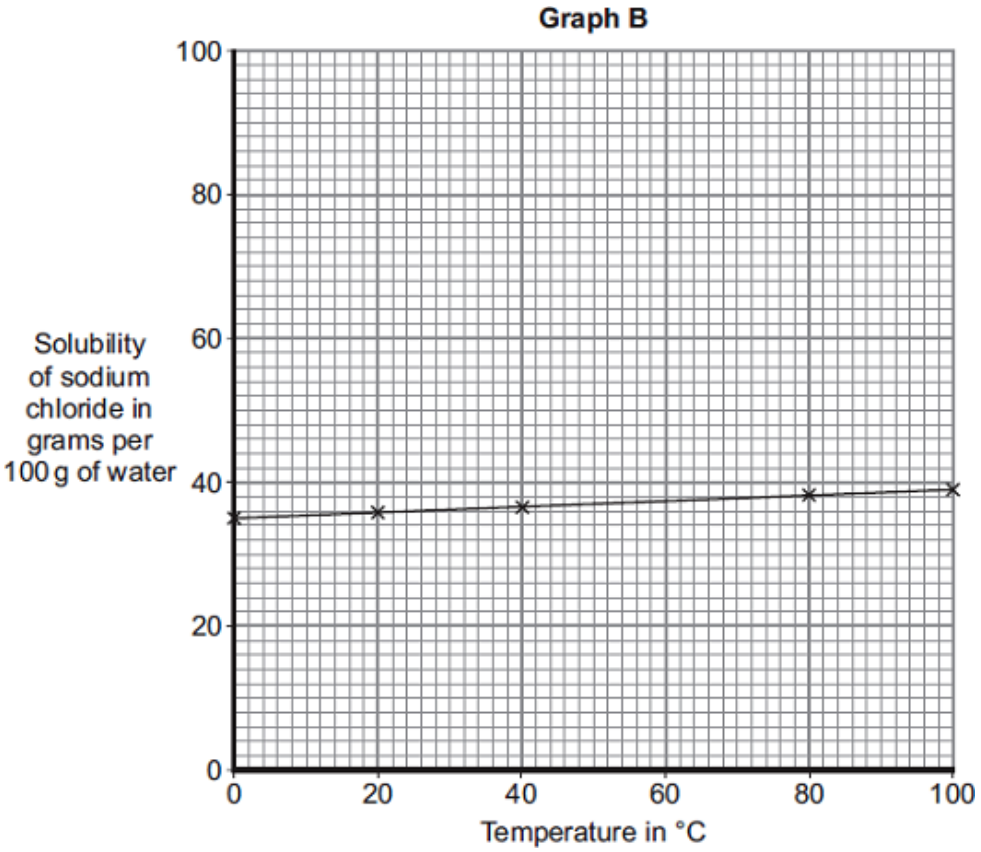
What mass of sodium chloride crystallises from the solution?

.....

Mass = ... g

(2)

(b) Another student plotted Graph **B** using the same data.



The table shows the conclusion that each student made.

	How solubility changes as temperature increases
1st student (Graph A)	Very large increase
2nd student (Graph B)	Very small increase

Why did the two students make different conclusions even though they had used the same data to plot their graphs?

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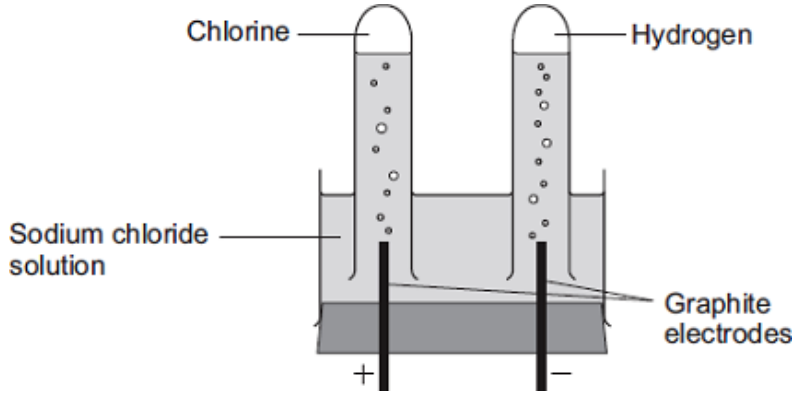
(1)
(Total 5 marks)

Q32. The electrolysis of sodium chloride solution is an industrial process.

The diagram shows the apparatus used in a school experiment.



(a) One of the products of the electrolysis of sodium chloride solution is hydrogen.

(i) Why do hydrogen ions move to the negative electrode?

.....

.....

(1)

(ii) How does a hydrogen ion change into a hydrogen atom?

.....

.....

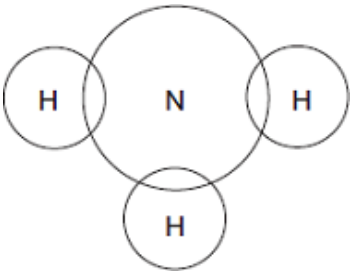
(1)

(b) Hydrogen is used to make ammonia (NH_3).

Complete the diagram to show the bonding in ammonia.

Use dots (●) and crosses (x) to show electrons.

Show only outer shell electrons.



(2)

(c) The table shows the ions in sodium chloride solution.

Positive ions	Negative ions
hydrogen	chloride
sodium	hydroxide

In industry, some of the waste from the electrolysis of sodium chloride solution is alkaline and has to be neutralised.

(i) Which ion makes the waste alkaline?

.....

(1)

(ii) This waste must be neutralised.

Write the ionic equation for the neutralisation reaction.

.....

(1)

(d) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The electrolysis of sodium chloride solution also produces chlorine and sodium hydroxide.

In industry, the electrolysis of sodium chloride solution can be done in several types of electrolysis cell.

Some information about two different types of electrolysis cell is given below.

	Mercury cell	Membrane cell
Cost of construction	Expensive	Relatively cheap
Additional substances used	Mercury, which is recycled. Mercury is toxic so any traces of mercury must be removed from the waste	Membrane, which is made of a polymer. The membrane must be replaced every 3 years.
Amount of electricity used for each tonne of chlorine produced in kWh	3400	2950
Quality of chlorine produced	Pure	Needs to be liquefied and distilled to make it pure.
Quality of sodium hydroxide solution produced	50% concentration. Steam is used to concentrate the sodium hydroxide solution produced.	30% concentration. Steam is used to concentrate the sodium hydroxide solution produced.

Use the information and your knowledge and understanding to compare the environmental and economic advantages and disadvantages of these **two** types of electrolysis cell.

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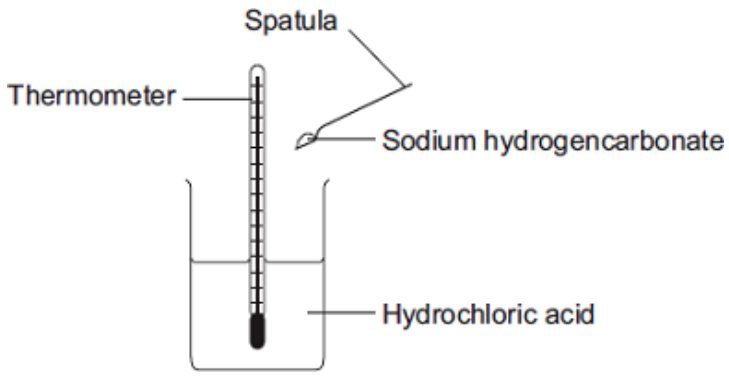
(6)
(Total 12 marks)

Q33. (a) Some students did an experiment to find the temperature change when hydrochloric acid reacts with sodium hydrogencarbonate.



The results are in the table.

Number of spatula measures of sodium hydrogencarbonate	Start temperature in °C	Final temperature in °C	Change in temperature in °C
2	20	16	4
4	20	14	6
6	19	11	8
8	20	10	10
10	19	9	10
12	20	10	10

(i) Describe, as fully as you can, the trends shown in the students' results.

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(3)

(ii) State the type of energy transfer for this reaction.

.....

.....

(1)

(b) Sodium hydrogencarbonate is used as baking powder for making cakes.

When the cake mixture is baked the sodium hydrogencarbonate decomposes.

The equation for the reaction is:

$$2\,NaHCO_3(s) \xrightarrow{\text{Heat}} Na_2CO_3(s) + H_2O(g) + CO_2(g)$$

(i) The cake mixture rises when baked.

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Use the equation to suggest why.

.....

.....

(1)

(ii) The same reaction can be reversed to produce sodium hydrogencarbonate from sodium carbonate.

$$Na_2CO_3 + H_2O + CO_2 \longrightarrow 2NaHCO_3$$

Do the reactants need to be heated?

Give a reason for your answer.

.....

.....

(1)

(c) (i) Calculate the relative formula mass of sodium hydrogencarbonate ($NaHCO_3$).

Relative atomic masses (A_r): H=1; C=12; O=16; Na=23

.....

.....

.....

Relative formula mass (M_r) = ...

(2)

(ii) Calculate the percentage by mass of carbon in sodium hydrogencarbonate.

.....

.....

Percentage of carbon = ... %

(1)

(Total 9 marks)