

Structure and Bonding

Question Paper

Level	GCSE
Subject	Chemistry
Exam Board	AQA
Unit	C2
Topic	Structure and Bonding
Difficulty Level	Silver Level
Booklet	Question Paper

Time Allowed: 273 minutes

Score: /273

Percentage: /100

Q1. This question is about atomic structure and elements.

(a) Complete the sentences.

(i) The atomic number of an atom is the number of

(1)

(ii) The mass number of an atom is the number of

.....

(1)

(b) Explain why an atom has no overall charge.

Use the relative electrical charges of sub-atomic particles in your explanation.

.....
.....
.....
.....

(2)

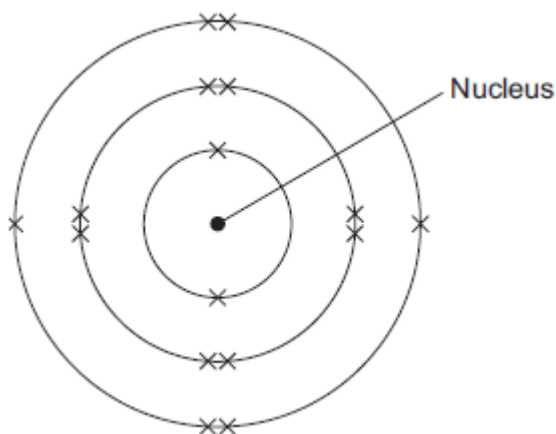
(c) Explain why fluorine and chlorine are in the same group of the periodic table.

Give the electronic structures of fluorine and chlorine in your explanation.

.....
.....
.....
.....

(2)

(d) The diagram shows the electronic structure of an atom of a non-metal.



What is the chemical symbol of this non-metal?

Tick (✓) **one** box.

Ar ☐

O ☐

S ☐

Si ☐

(1)

- (e) When elements react, their atoms join with other atoms to form compounds.

Complete the sentences.

- (i) Compounds formed when non-metals react with metals consist of particles called

(1)

- (ii) Compounds formed from only non-metals consist of particles called

(1)

(Total 9 marks)

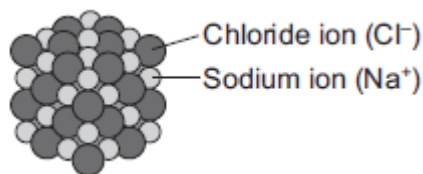
Q2. In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Explain why chlorine (Cl_2) is a gas at room temperature, but sodium chloride (NaCl) is a solid at room temperature.

Chlorine



Sodium chloride



Include a description of the bonding and structure of chlorine and sodium chloride in your answer.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Extra space

.....

.....

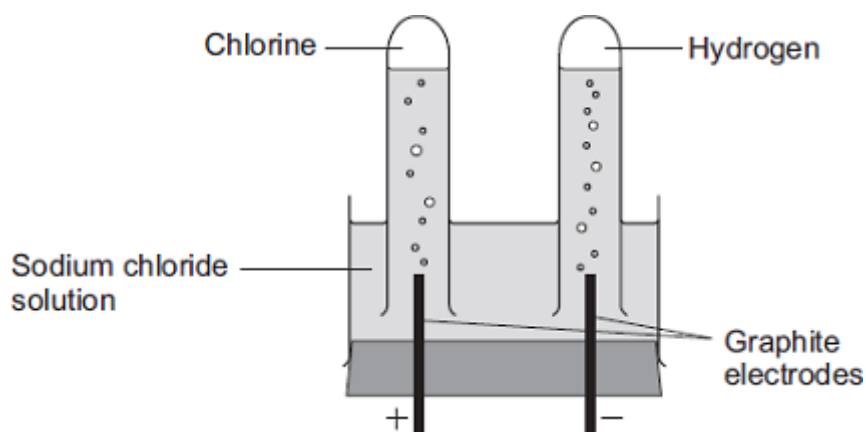
.....

.....

(Total 6 marks)

Q3. 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?

.....
.....

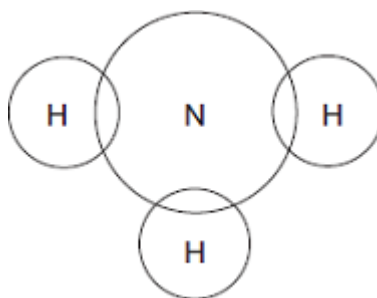
(1)

(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.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

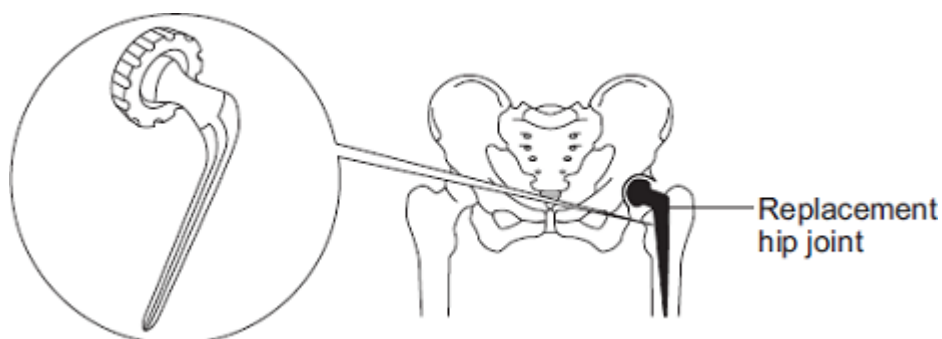
.....

.....

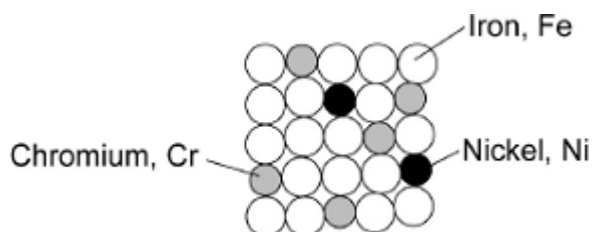
.....

(6)
(Total 12 marks)

Q4. The hip joint sometimes has to be replaced.
Early replacement hip 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

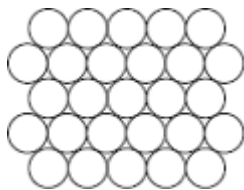
(a) Use the diagram to complete the percentages of metals in this stainless steel.

The first one has been done for you.

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

(2)

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



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

.....
.....

(1)

- (ii) Pure iron would **not** be suitable for a replacement hip joint.

Suggest why.

.....
.....

(1)

- (iii) The three metals in stainless steel have different sized atoms.
Stainless steel is harder than pure iron.

Explain why.

.....
.....
.....
.....

(2)

(Total 6 marks)

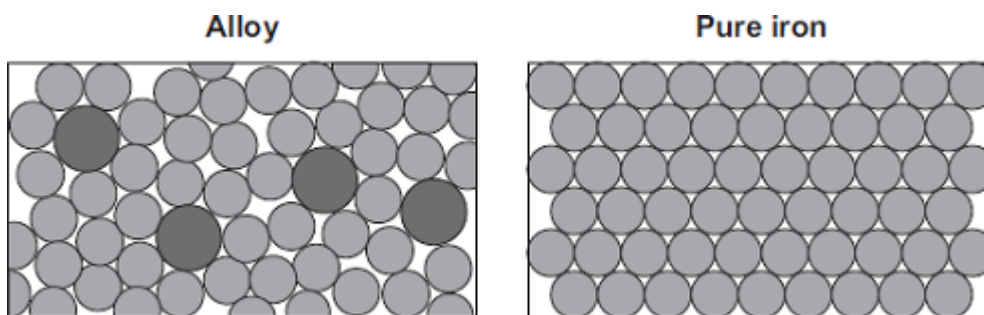
Q5.Oil rigs are used to drill for crude oil.



© Digital Vision/Photodisc

- (a) Drills are made from an alloy of iron.

The diagrams show the particles in the alloy and in pure iron.



Use the diagrams to explain why the alloy is harder than pure iron.

.....

.....

.....

.....

(2)

- (b) Drill heads contain diamonds.

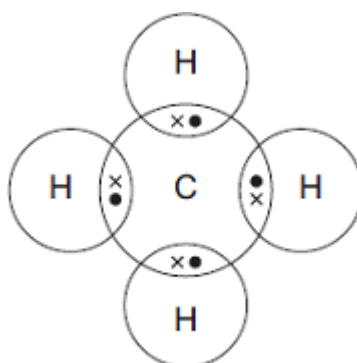
Tick (✓) **two** reasons why diamonds are hard.

Reason	Tick (✓)
Diamonds have a giant covalent structure.	
Diamonds have high melting points.	
Diamonds are unreactive.	

Diamonds have strong bonds between carbon atoms.

(2)

- (c) Methane gas is often found where crude oil is found.
The diagram shows how atoms bond in methane.
Only the outer electrons are shown.



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

Methane is

a compound.
an element.
a mixture.

(1)

- (ii) Draw a ring around the correct answer to complete each sentence.

The formula of methane
is

C_4H
 C_4H_4
 CH_4

(1)

- (iii) Name the type of bond between the carbon and hydrogen atoms in methane.

.....

..

(1)

- (d) Explain why methane is a gas at 20°C.

.....

.....

.....

.....

(2)


(Total 9 marks)

Q6. Read the information

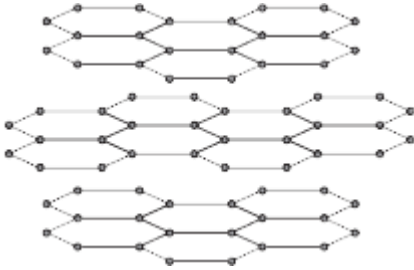
Graphene

Scientists have made a new substance called graphene.
The bonding and structure of graphene are similar to graphite.

Graphene is made of a single layer of the same atoms as graphite.



Graphene



Graphite

Use the information above and your knowledge of graphite to answer the questions.

- (a) This part of the question is about graphene.

Choose the correct answer to complete each sentence.

(i)

ionic

covalent

metallic

The bonds between the atoms in graphene are

(1)

(ii)

chromium

carbon

chlorine

Graphene is made of atoms.

(1)

(iii)

2

3

4

In graphene each atom bonds to other atoms.

(1)

(b) This part of the question is about graphite.

Graphite is used in pencils.

Explain why. Use the diagrams to help you.

.....

.....

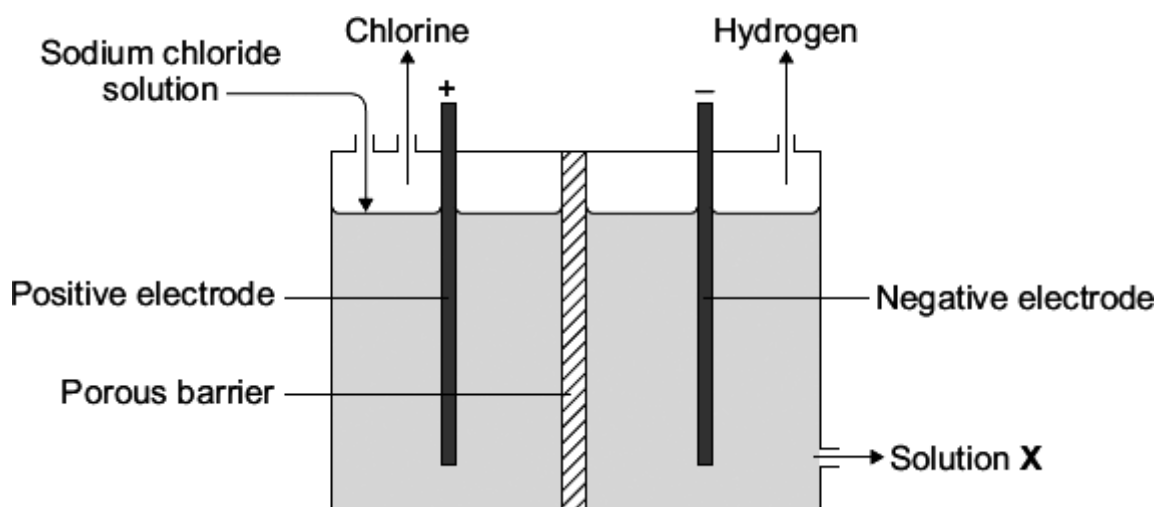
.....

.....

(2)

(Total 5 marks)

Q7. The electrolysis of sodium chloride solution is an industrial process.



- (a) Why do chloride ions move to the positive electrode?

.....

(1)

- (b) Sodium chloride solution contains two types of positive ions, sodium ions (Na^+) and hydrogen ions (H^+).

Tick (✓) the reason why hydrogen is produced at the negative electrode and **not** sodium.

Reason	Tick (✓)
Hydrogen is a gas.	
Hydrogen is less reactive than sodium.	
Hydrogen is a non-metal.	
Hydrogen ions travel faster than sodium ions.	

(1)

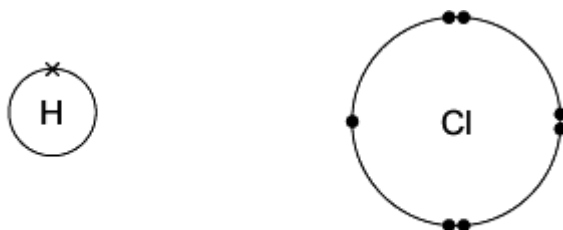
- (c) Solution X is alkaline.

Which ion makes solution X alkaline?

.....

(1)

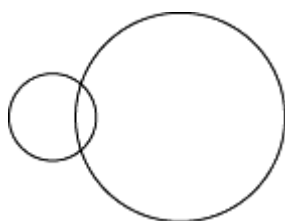
- (d) Electrolysis of sodium chloride solution produces hydrogen and chlorine. The hydrogen and chlorine can be used to make hydrogen chloride.
- (i) The diagrams show how the outer electrons are arranged in atoms of hydrogen and chlorine.



Hydrogen atom

Chlorine atom

Complete the diagram to show how the electrons are arranged in a molecule of hydrogen chloride (HCl).



(1)

- (ii) Name the type of bond between the hydrogen and the chlorine atoms in a molecule of hydrogen chloride.

.....

(1)

- (iii) Some hydrogen chloride was bubbled into water. This made a solution with a pH of 1.

Which ion gave the solution a pH of 1?

.....

(1)

(Total 6 marks)

Q8. Calamine lotion is used to treat itching. The main ingredients are two metal oxides.



- (a) One of the metal oxides has a relative formula mass (M_r) of 81.

The formula of this metal oxide is MO .
(M is **not** the correct symbol for the metal.)

The relative atomic mass (A_r) of oxygen is 16.

- (i) Calculate the relative atomic mass (A_r) of metal M .

.....
.....
.....

Relative atomic mass (A_r) =

(2)

- (ii) Use your answer to part (a)(i) and the periodic table on the Data Sheet to name metal M .

The name of metal M is

(1)

- (b) The other metal oxide is iron(III) oxide.

This contains iron(III) ions (Fe^{3+}) and oxide ions (O^{2-}).

- (i) Explain in terms of electrons how an iron atom (Fe) can change into an iron(III) ion (Fe^{3+}).

.....

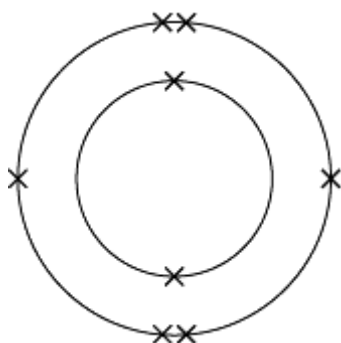
.....

.....

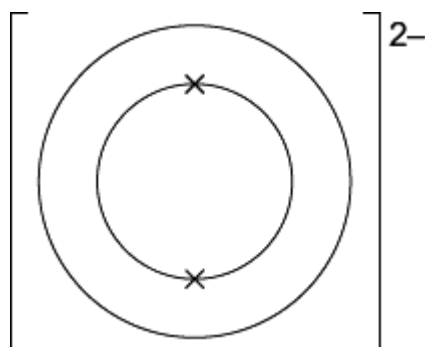
.....

(2)

- (ii) The diagram below represents the electronic structure of an oxygen atom (O).

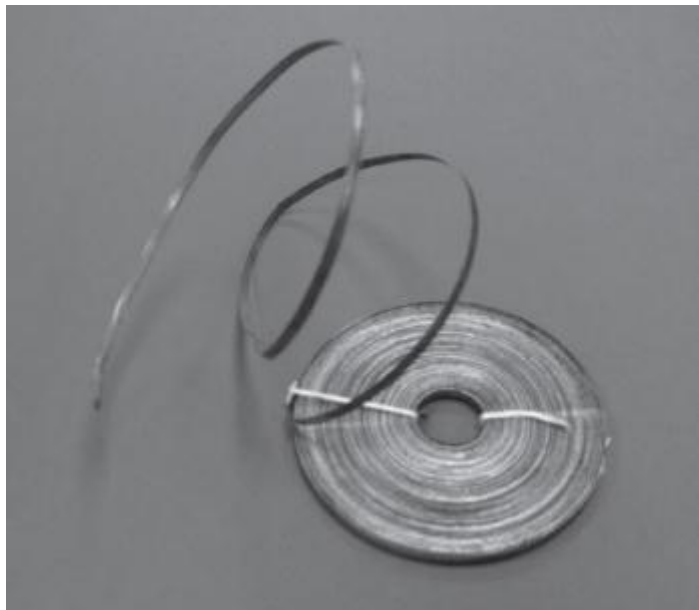


Complete the diagram below to show the electronic structure of an oxide ion (O^{2-}).



(1)
(Total 6 marks)

- Q9. (a) Magnesium metal is shaped to make magnesium ribbon.



Explain why metals can be shaped.

.....

.....

.....

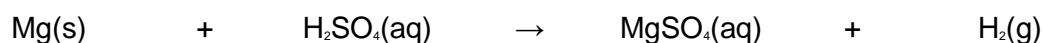
.....

.....

(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:



- (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.

.....

.....

.....

.....

.....

(2)

(iii) The magnesium sulfate is in solution.

How could you obtain solid magnesium sulfate from this solution?

.....

.....

(1)

(Total 6 marks)

Q10. Read the article and then answer the questions.

TOXIC SOCKS?

Silver nanoparticles are added to the fibres used to make some socks. Silver has the special property that it can kill bacteria. As a result there are no unpleasant smells when wearing these socks.



Some scientists are concerned about the use of silver nanoparticles in socks.

The silver can be released from the socks when they are washed. This silver may end up in rivers. Silver in rivers may kill fish.

Scientists found that some makes of socks release the silver more easily than others. Socks in which the silver nanoparticles are trapped in the fibres released very little silver when washed.

By tfkrawksmysocks [CC BY-SA 2.0], via Flickr

- (a) Suggest why silver stops unpleasant smells when wearing the socks.

.....
.....

(1)

- (b) How is the size of silver nanoparticles different from normal sized silver particles?

.....

(1)

- (c) The silver nanoparticles are more effective at preventing unpleasant smells than normal sized silver particles.

Suggest why.

.....
.....

(1)

- (d) The silver nanoparticles should be trapped in the sock fibres.

Use the information in the article to explain why.

.....

.....

.....

.....

(2)

(Total 5 marks)

Q11. Read the information in the box.

Flash powder is used to produce special effects at pop concerts.



Flash powder contains aluminium. The powder burns with a bright white flame and gives out lots of heat and light. It also produces white smoke.

The flash powder is placed on stage in a special container. At the bottom of the container there is a thin piece of wire. When the flash is needed, electricity is passed through the wire. The wire gets hot and starts the aluminium

burning.

By russelljsmith [CC BY 2.0], via Flickr

- (a) When aluminium burns the reaction is *exothermic*.

What is the meaning of *exothermic*?

.....
.....

(1)

- (b) The hot wire provides energy to start the aluminium burning.

What is the name given to the heat energy needed to start a chemical reaction?

..... energy

(1)

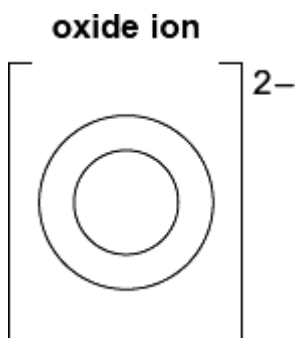
- (c) The white smoke produced is aluminium oxide.

Aluminium oxide contains aluminium ions (Al^{3+}) and oxide ions (O^{2-}).

- (i) Complete the diagram to show the electronic structure of an oxide ion.

The atomic number of oxygen = 8

Use crosses (x) to represent the electrons.



(1)

- (ii) The bonding in aluminium oxide is ionic.

What causes the aluminium ions and oxide ions to be held together strongly?

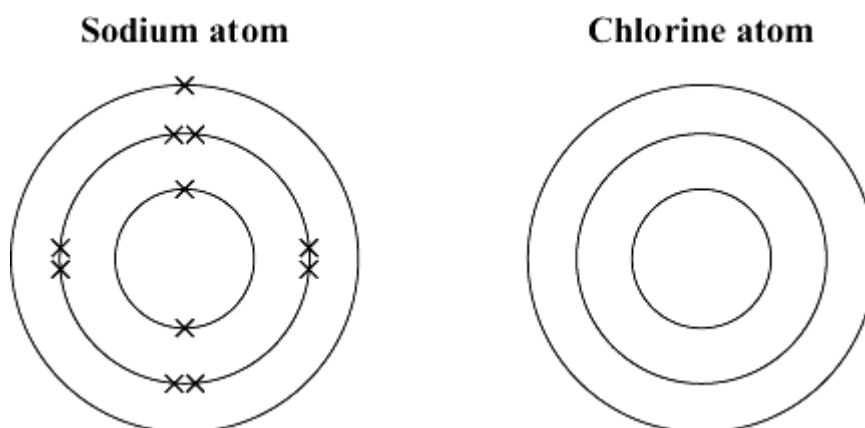
.....

(1)
 (Total 4 marks)

Q12. Sodium chloride is a raw material.

- (a) The electronic structure of a sodium atom is shown below.

Complete the diagram for the electronic structure of a chlorine atom. A chlorine atom has 17 electrons.



(1)

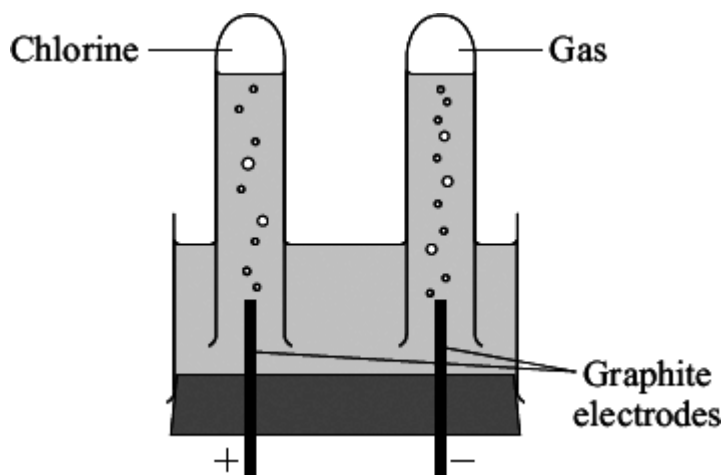
- (b) When sodium and chlorine react to form sodium chloride they form sodium ions (Na^+) and chloride ions (Cl^-).

How does a sodium atom change into a sodium ion?

.....

(2)

- (c) The diagram shows apparatus used in a school laboratory for the electrolysis of sodium chloride solution.



The solution contains sodium ions (Na^+), chloride ions (Cl^-), hydrogen ions (H^+) and hydroxide ions (OH^-).

- (i) Why do chloride ions move to the positive electrode?

.....

(1)

- (ii) Name the gas formed at the negative electrode.

.....

(1)

- (d) Chlorine and chlorine compounds are used to bleach wood pulp that is used to make paper.

The article below is from a newspaper.

Local people have been protesting outside a paper factory. They say:
'We want the company to stop using chlorine compounds. Chlorine compounds release poisons into the environment. The company should use safer compounds.'

The company replied:
'Chlorine has been used safely for many years to treat drinking water. Only tiny amounts of chlorine are released, which cause no harm. Using other compounds will be more expensive and may put us out of business.'

- (i) Why are some local people worried about the use of chlorine compounds?

.....

.....

(1)

- (ii) Why might other local people want the company to continue to use chlorine compounds?

.....

.....

(1)

- (iii) It is decided to have an inquiry.

Why should this be done by independent scientists?

.....

.....

(1)

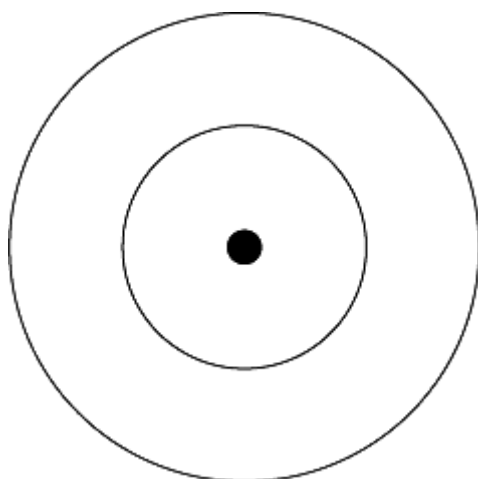
(Total 8 marks)

Q13. Pure carbon can exist in two forms, diamond and graphite.

- (a) Complete the diagram to show the electronic structure of a carbon atom.

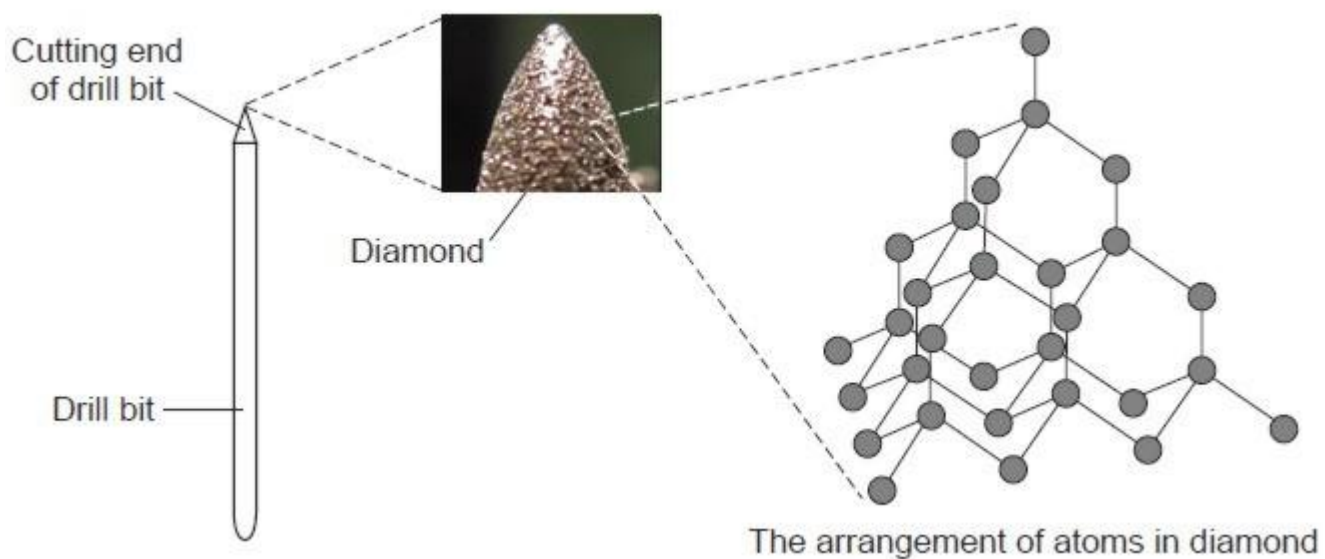
A carbon atom has 6 electrons.

Show the electrons as crosses (x).



(1)

- (b) A drill bit is used to cut holes through materials. The cutting end of this drill bit is covered with very small diamonds.



By Wanderlinse [CC By 2.0], via Flickr

- (i) What property of diamond makes it suitable for use on the cutting end of a drill bit?

.....

(1)

- (ii) Explain, as fully as you can, why diamond has this property. Use your knowledge of the structure and bonding of diamond and the information shown opposite to help you to answer this question.

.....

.....

.....

.....

.....

.....

.....

.....

(3)

- (c) Explain why graphite is a good conductor of electricity and why diamond does **not** conduct electricity.

.....

.....

.....

.....

.....

.....

.....

.....

(3)

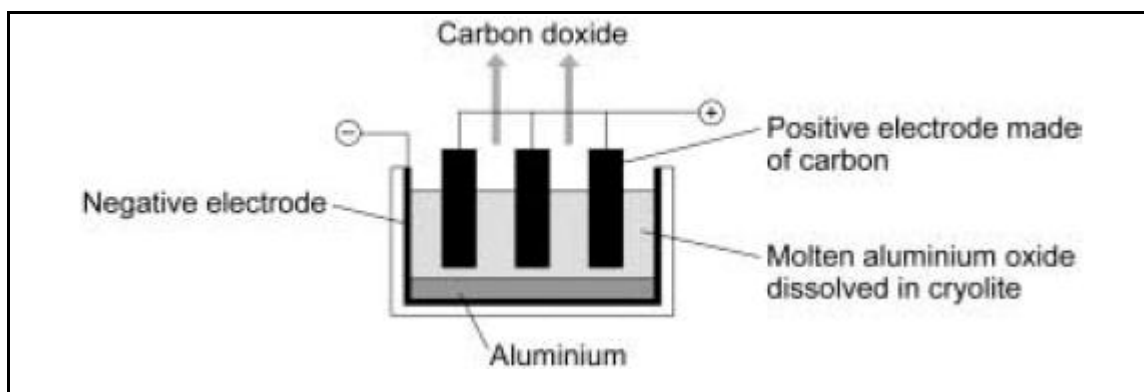
(Total 8 marks)

- Q14.** Read the information in the box and then answer the question.

Aluminium is made by the electrolysis of aluminium oxide.

Aluminium oxide is an ionic compound containing aluminium ions (Al_{3+}) and oxide ions (O_{2-}).

The diagram below shows the apparatus used to electrolyse aluminium oxide.



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

Use information in the box and your knowledge and understanding of this process to answer this question.

Explain, as fully as you can, how aluminium and carbon dioxide are formed in this process.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(6)

- (b) Aluminium is a metal.

Explain why aluminium conducts electricity.

.....

.....

.....

.....

(2)
(Total 8 marks)

Q15. Read the article and then answer the questions that follow.

Nanotennis!

Tennis balls contain air under pressure, which gives them their bounce. Normal tennis balls are changed at regular intervals during tennis matches because they slowly lose some of the air. This means that a large number of balls are needed for a tennis tournament, using up a lot of materials.



'Nanocoated' tennis balls have a 'nanosize' layer of butyl rubber. This layer slows down the escape of air so that the ball does not lose its pressure as quickly. The 'nanocoated' tennis balls last much longer and do not need to be replaced as often.

- (a) How does the 'nanosize' layer make the tennis balls last longer?

.....

.....

(1)

- (b) Put a tick (✓) next to the best description of a 'nanosize' layer.

Description	(✓)
A layer one atom thick.	
A layer a few hundred atoms thick.	
A layer millions of atoms thick.	

(1)

- (c) Suggest why using 'nanocoated' tennis balls would be good for the environment.

.....

.....

.....

.....

.....

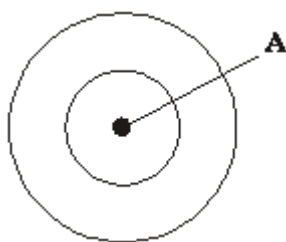
(2)

(Total 4 marks)

Q16. This question is about oxygen atoms. The periodic table on the Data Sheet may help you to answer this question.

- (a) (i) Oxygen atoms have 8 electrons.

Complete the diagram to represent the arrangement of electrons in an oxygen atom.
Use crosses (x) to represent the electrons.



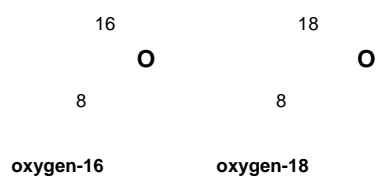
(1)

- (ii) Name the part of the oxygen atom that is labelled **A** on the diagram.

.....

(1)

- (b) Two isotopes of oxygen are oxygen-16 and oxygen-18.



Explain, in terms of particles, how the nucleus of an oxygen-18 atom is different from the nucleus of an oxygen-16 atom.

.....

.....

.....

.....

(2)

(Total 4 marks)

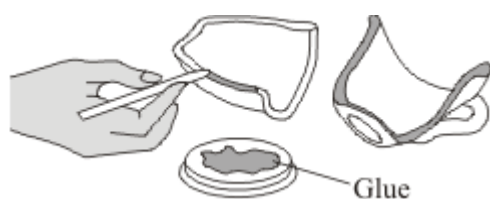
Q17. The following steps show how to use a type of glue.

Step 1 Measure out equal amounts of the liquids from tubes **A** and **B**.

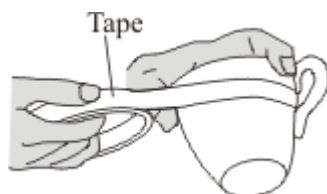


Step 2 Mix the liquids to make the glue.

Put a thin layer of the glue onto each of the surfaces to be joined.



Step 3 Assemble the pieces to be joined and then hold them together with tape.



Step 4 Leave the glue to set.

(a) When liquids **A** and **B** are mixed a chemical reaction takes place.

(i) This reaction is exothermic.

State how the temperature of the mixture will change as the glue is mixed.

.....

.....

(1)

- (ii) When the glue sets it forms a giant covalent structure.

Explain why substances with giant covalent structures have high melting points.

.....

.....

.....

.....

(2)

- (b) The time taken for the glue to set at different temperatures is given in the table below.

Temperature in °C	Time taken for the glue to set
20	3 days
60	6 hours
90	1 hour

Explain, in terms of particles, why increasing the temperature changes the rate of the reaction which causes the glue to set.

.....

.....

.....

.....

.....

(2)

(Total 5 marks)

Q18. Read the article and then answer the questions.

Nanotennis!

Tennis balls contain air under pressure, which gives them their bounce. Normal tennis balls are changed at regular intervals during tennis matches because they slowly lose some of the air.



'Nanocoated' tennis balls have a 'nanosize' layer of butyl rubber. This layer slows down the escape of air so that the ball does not lose its pressure as quickly.

(a) What is the meaning of *nanosize*?

.....

.....

(1)

(b) Suggest why using 'nanocoated' tennis balls would be good for the environment.

.....

.....

.....
.....

(2)
(Total 3 marks)

Q19. Read this passage about metals.

Metals are crystalline materials. The metal crystals are normally about 20 000 nm (nanometres) in diameter. The atoms inside these crystals are arranged in layers.

A new nanoscience process produces nanocrystalline metals. Nanocrystalline metals are stronger and harder than normal metals.

It is hoped that nanocrystalline metals can be used in hip replacements.



The use of nanocrystalline metals should give people better hip replacements which last longer.

- (a) State why metals can be bent and hammered into different shapes.

.....
.....

(1)

- (b) How is the size of the crystals in nanocrystalline metals different from the size of the crystals in normal metals?

.....
.....

(1)

- (c) Hip joints are constantly moving when people walk.

Suggest and explain why the hip replacement made of nanocrystalline metal should last longer than one made of normal metals.

.....
.....
.....
.....

(2)

(Total 4 marks)

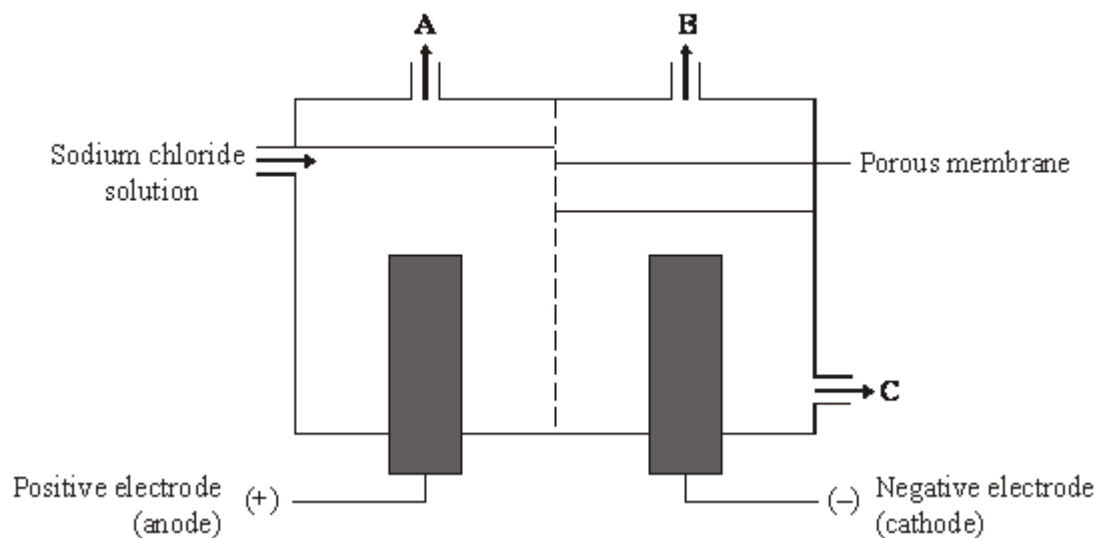
Q20. The *electrolysis* of sodium chloride solution produces useful substances.

- (a) Explain the meaning of *electrolysis*.

.....
.....
.....
.....

(2)

- (b) The diagram shows an apparatus used for the electrolysis of sodium chloride solution.



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

The electrolysis produces two gases, chlorine and Gas A.

Name Gas A

(1)

- (c) The electrodes used in this process can be made of graphite. Explain why graphite conducts electricity.

.....

.....

.....

.....

(2)

(Total 5 marks)

- Q21.** Toothpastes often contain fluoride ions to help protect teeth from attack by bacteria.



Some toothpastes contain tin(II) fluoride.

This compound has the formula SnF_2 .

- (a) Calculate the relative formula mass (M_r) of SnF_2 .

Relative atomic masses: F = 19; Sn = 119

.....

.....

.....

.....

Relative formula mass (M_r) =

(2)

- (b) Calculate the percentage by mass of fluorine in SnF_2 .

.....

.....

.....

.....

Percentage by mass of fluorine = %

(2)

- (c) A tube of toothpaste contains 1.2 g of SnF_2 .

Calculate the mass of fluorine in this tube of toothpaste.

.....

.....

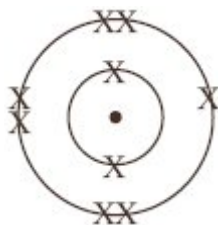
.....

.....

Mass of fluorine = g

(1)

(d) The diagram represents the electron arrangement of a fluorine atom.



Explain how a fluorine atom can change into a fluoride ion, F⁻.

.....

.....

.....

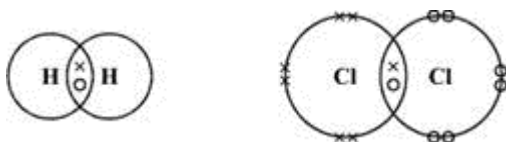
.....

(2)

(Total 7 marks)

Q22. Hydrogen chloride (HCl) can be made by the reaction of hydrogen (H₂) with chlorine (Cl₂).

(a) The diagrams represent molecules of hydrogen and chlorine.



Draw a similar diagram to represent a molecule of hydrogen chloride (HCl).
You need show only the outer energy level (shell) electrons.

(1)

- (b) The word equation for the reaction of hydrogen with chlorine is shown below.

hydrogen + chlorine → hydrogen chloride

Write a balanced symbol equation for this reaction.

.....
.....

(2)

- (c) Hydrogen chloride gas reacts with magnesium to form the ionic compound called magnesium chloride. Use the table of ions on the Data Sheet to help you to write the formula of magnesium chloride.

.....
.....

(1)

- (d) Why does magnesium chloride have a much higher melting point than hydrogen chloride?

.....
.....

.....
.....

.....

.....

(2)
 (Total 6 marks)

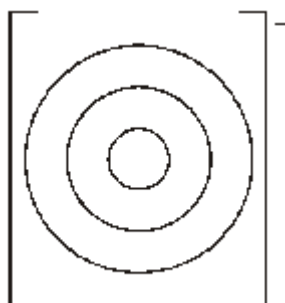
- Q23.** (a) A tin of red kidney beans contains calcium chloride as a firming agent.



Calcium chloride is an ionic compound which contains calcium ions (Ca^{2+}) and chloride ions (Cl^-).

- (i) The diagram on the left represents the electronic structure of a chlorine atom.

Complete a similar diagram on the right to represent a chloride ion.



(2)

- (ii) Explain how a calcium **atom** changes into a calcium **ion** which has a 2+ charge.

.....

.....

(2)

- (b) Cola drinks contain phosphoric acid, H_3PO_4 . The two equations show how phosphoric acid can be made from phosphorus.

Balance these two equations.



(1)

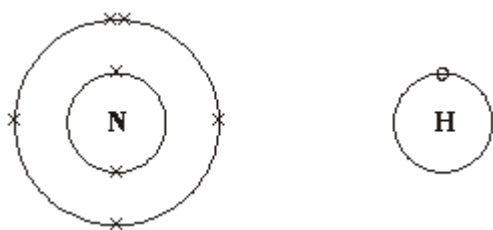


(1)

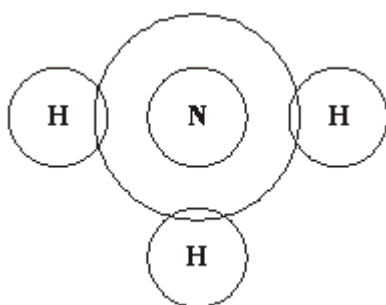
(Total 6 marks)

Q24. Ammonia (NH_3) is an important chemical which is used to make fertilisers. Ammonia is made from nitrogen and hydrogen,

- (a) The diagrams represent the electron arrangements in atoms of nitrogen and hydrogen.



Complete the diagram showing the arrangement of electrons in a molecule of ammonia.



(1)

- (b) Name the type of bonding which holds the nitrogen and hydrogen atoms together in an ammonia molecule.

.....

(1)

(Total 2 marks)

Q25. 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?

.....

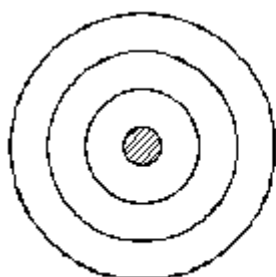
(1)

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

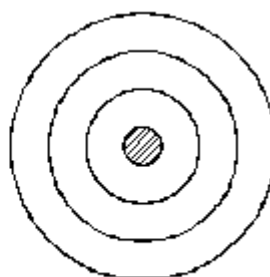
.....(aq) +(aq) →(aq) +(l)

(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)

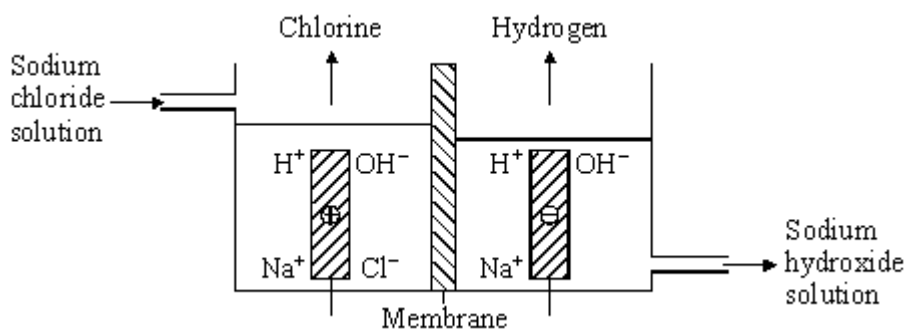
- (iii) Why do these sodium and chloride particles bond?

.....

.....

(1)

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



Describe how each of these products are formed.

.....

.....

.....

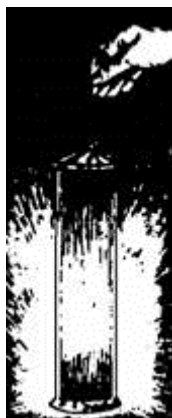
.....

.....

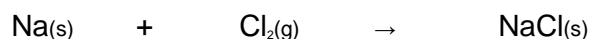
.....
(3)
(Total 15 marks)

Q26. This question is about sodium chloride (common salt) which is an important chemical.

Sodium chloride can be made by burning sodium in chlorine gas.

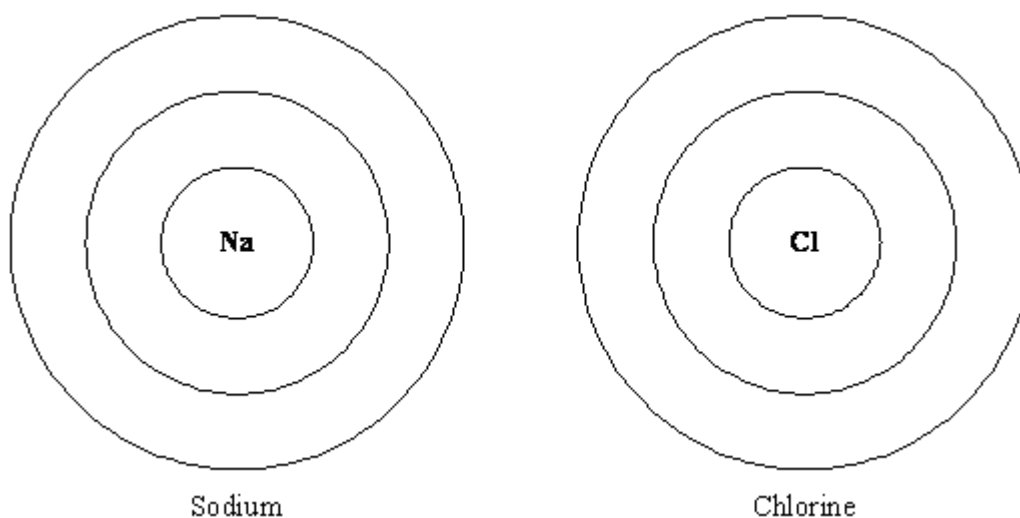


(a) Balance the symbol equation for the reaction of sodium with chlorine.



(1)

(b) (i) Complete the diagrams below to show the electronic structures of a sodium and a chlorine atom. (Atomic number of sodium = 11 and chlorine = 17.)



(3)

- (ii) When sodium reacts with chlorine the sodium atoms are changed into sodium ions (Na^+) and the chlorine atoms are changed into chlorine ions (Cl^-).

Explain how:

1. a sodium atom changes into a sodium ion;

.....
.....

(2)

2. a chlorine atom changes into a chloride ion.

.....
.....

(2)

- (c) The element potassium is in the same group of the Periodic Table as sodium. Potassium reacts with chlorine to make potassium chloride which is sometimes used instead of common salt in cooking.

- (i) Predict the formula of potassium chloride.

.....

(1)

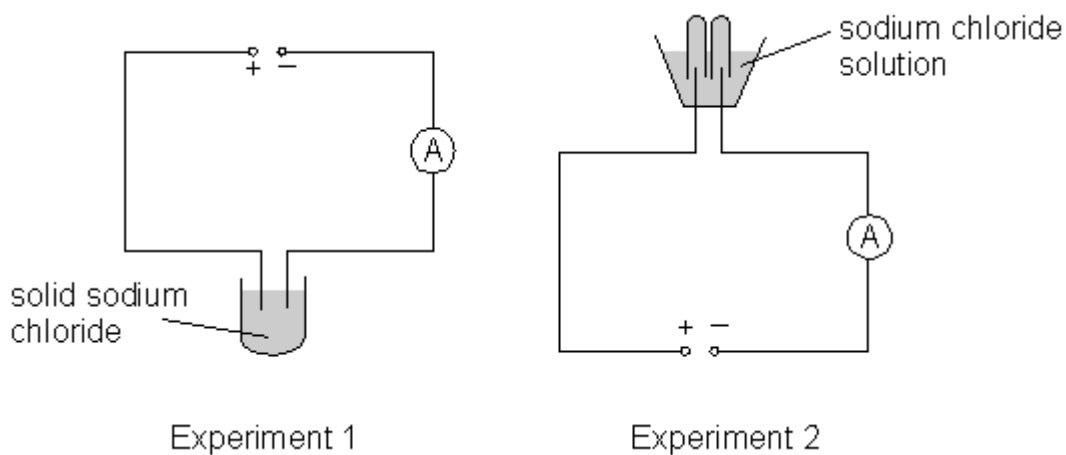
By reference to the electronic structures of potassium and sodium explain:

- (ii) Why the reaction of potassium with chlorine is similar to the reaction of sodium with chlorine.

.....

(1)

- (d) The electrolysis of sodium chloride solution is an important industrial process. The diagrams below show two experiments set up during an investigation of the electrolysis of sodium chloride.



- (i) What would be the reading on the ammeter in experiment 1?

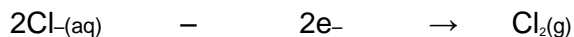
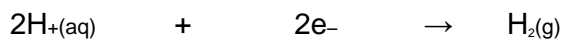
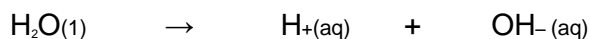
..... A

- (ii) Explain your answer.

.....

(3)

- (e) The equations below show the reactions which take place in experiment 2.



- (i) Which substance provides hydrogen ions?

.....

(1)

- (ii) Name the product formed at:

(A) the positive electrode;

.....

(B) the negative electrode.

.....

(1)

(Total 15 marks)

Q27. Calcium and magnesium are elements. They are found in the Earth's crust as compounds, often carbonates and sulphates. Magnesium is also found as its chloride.

- (a) Calcium and magnesium are in the same Group in the Periodic Table. State which Group this is.

.....

(1)

- (b) Use the Data Sheet to help you to answer this question.

- (i) Write the chemical formula of magnesium chloride.

.....

(1)

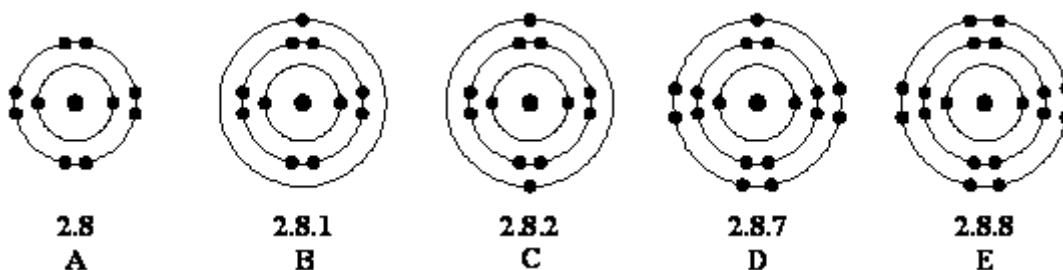
- (ii) Name the type of bonding in magnesium chloride.

.....

(1)
(Total 3 marks)

Q28. Use the Data Sheet to help you answer this question.

When sodium reacts with water it forms sodium ions.
The diagrams below represent the electron arrangements of some atoms and ions.



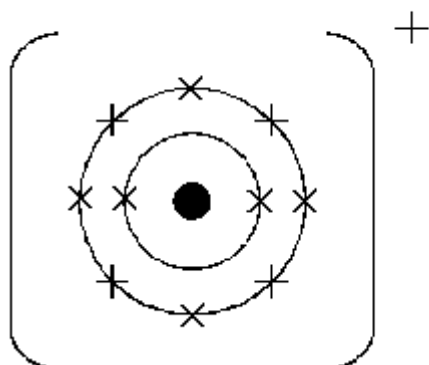
Which of the diagrams, **A** to **E**, represents the electron arrangement of each of the following?

- (i) A sodium atom, Na
- (ii) A sodium ion, Na⁺

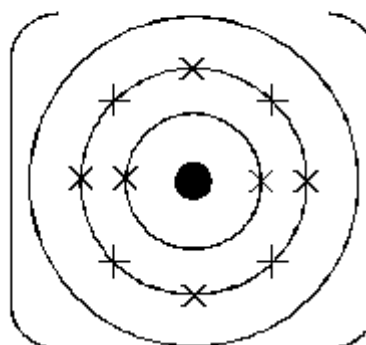
(Total 2 marks)

Q29. Sodium chloride is an ionic compound.

This is a diagram of a sodium ion.



Complete this diagram of a chloride ion.



(Total 2 marks)

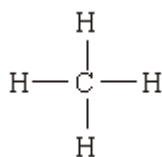
- Q30.** (a) A piece of lithium is placed on the surface of some water in a beaker. Hydrogen is given off. Lithium hydroxide is also formed.

Write a word equation for this reaction.

.....

(2)

- (b) The diagram shows the structure of a molecule of methane.



Write down everything that this diagram tells you about a methane molecule.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....

.....

.....

.....

.....

(4)
 (Total 6 marks)

Q31. Electrons, neutrons and protons are sub-atomic particles.

(a) Complete the **six** spaces in the following table.

Name of sub-atomic particle	Relative mass	Relative charge
.....	1
.....	0
.....	$\frac{1}{1840}$

(3)

(b) An aluminium atom has 13 electrons. How are these arranged in shells around the nucleus?

.....

(1)

(c) Chromium atoms have 24 protons and 28 neutrons.

(i) How many electrons does each neutral chromium atom have?

.....

(1)

(ii) What is the mass number of chromium?

.....

(1)

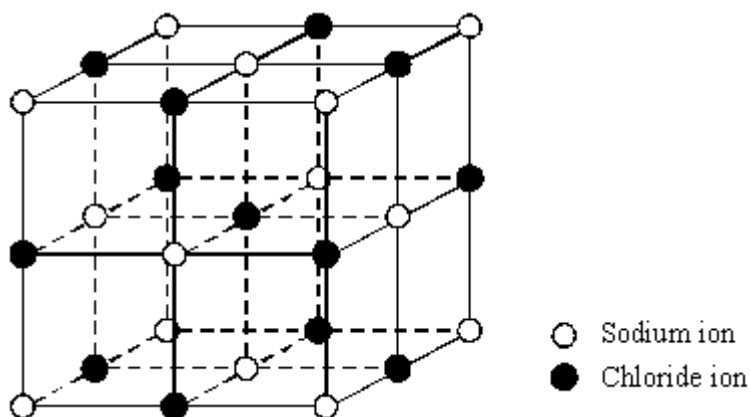
- (d) What change occurs to an atom which undergoes the process of *reduction* in a chemical reaction?

.....

.....

(1)

- (e) The diagram shows part of the ionic lattice of a sodium chloride crystal.



Explain why the ions in this lattice stay in place.

.....

.....

.....

.....

.....

.....

(3)

(Total 10 marks)

- Q32.** (a) Atoms are made of sub-atomic particles. Complete the **six** spaces in the table.

Name of sub-atomic particle	Relative mass	Relative charge
.....	$\frac{1}{1840}$
Neutron
.....	1

(3)

- (b) Complete the spaces in the sentences.

- (i) The atomic number of an atom is the number of in its nucleus and is equal to the number of if the atom is not charged.

(1)

- (ii) The mass number of an atom is the total number of and in its nucleus.

(1)

- (c) The table gives information about the atoms of three elements.

Name of element	Chemical symbol	Number of electrons in:		
		1st shell	2nd shell	3rd shell
Fluorine	F	2	7	0
Neon	Ne	2	8	0
Sodium	Na	2	8	1

Two of these elements can react together to form a chemical compound.

- (i) What is the name and the formula of this compound?

Name Formula

(2)

- (ii) What type of bonding holds this compound together?

.....

(1)

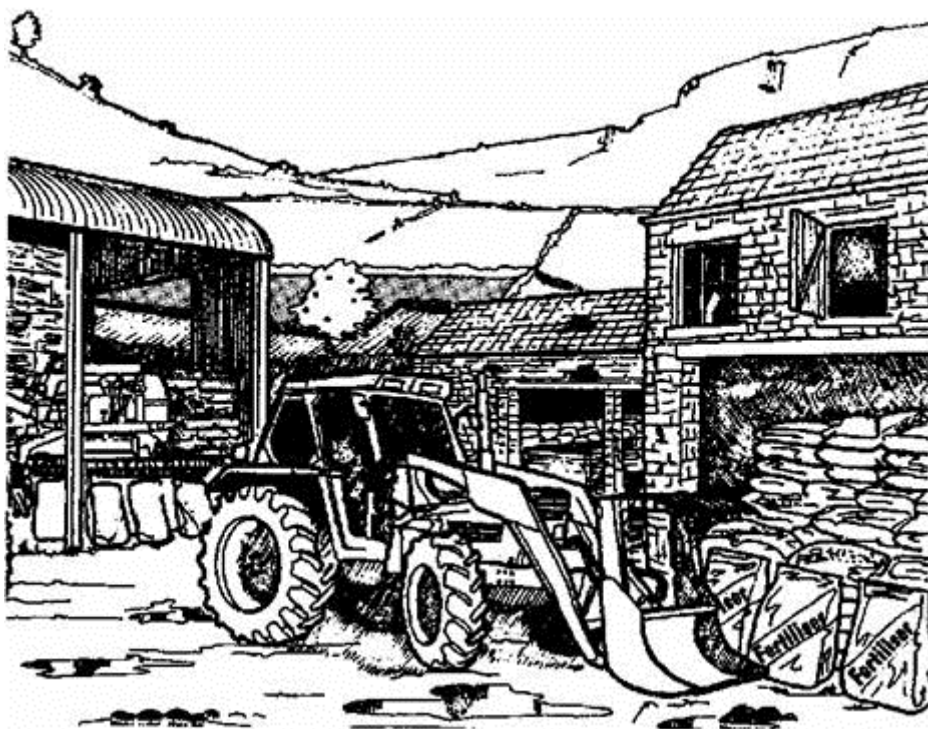
- (iii) Explain, in terms of electron transfer, how the bonding occurs in this compound.

.....
.....
.....
.....
.....
.....

(2)

(Total 10 marks)

Q33. 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?

Q34. Part of the Periodic Table showing the symbols for the first twenty elements is given below.

		H						He				
Li	Be						B	C	N	O	F	Ne
Na	Mg						Al	Si	P	S	Cl	Ar
K	Ca	Transition metals										

- (a) Draw diagrams showing the arrangement of electrons (electronic structures) in:
- (i) an aluminium atom;

- (ii) a chlorine atom.

(2)

- (b) (i) Use electronic structures to help you show why the formula of sodium oxide is



(3)

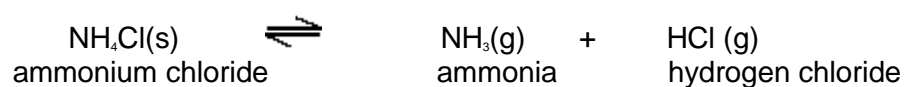
- (ii) State why the formation of sodium ions is classified as an oxidation.

.....
.....

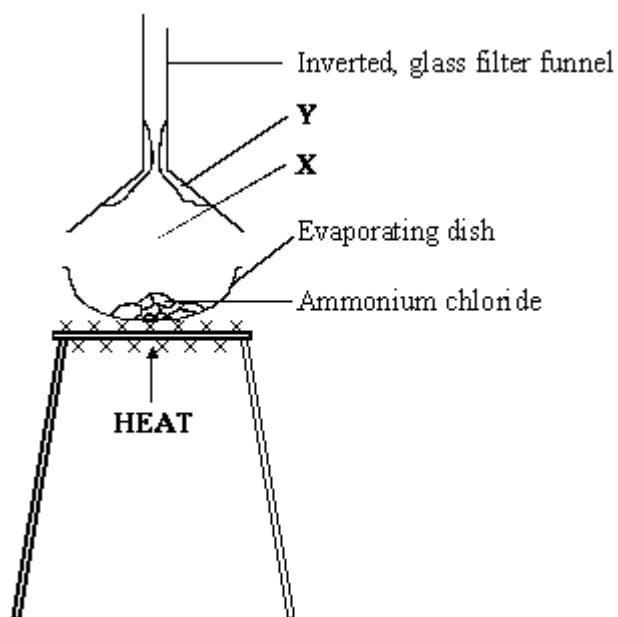
(1)

(Total 6 marks)

- Q35.** (a) The equation for the reaction that takes place when ammonium chloride is heated is:



The diagram shows how a teacher demonstrated this reaction. The demonstration was carried out in a fume cupboard.



- (i) Apart from the gases normally in the atmosphere, which two gases would be at **X**?

..... and

(1)

- (ii) Name the white solid that has formed at **Y**.

.....

(1)

- (iii) Why was the demonstration carried out in a fume cupboard?

.....

.....

(1)

- (iv) Complete the **four** spaces in the passage.

The chemical formula of ammonia is NH_3 . This shows that there is one atom of and three atoms of in each

..... of ammonia. These atoms are joined by bonds that are formed by sharing pairs of electrons. This type of bond is called a bond.

(4)

(b) Electrons, neutrons and protons are sub-atomic particles.

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

Name of sub-atomic particle	Relative mass	Relative charge
.....	1	+1
.....	1	0
.....	$\frac{1}{1840}$	-1

(2)

(ii) Which **two** sub-atomic particles are in the nucleus of an atom?

..... and

(1)

(Total 10 marks)

Q36. Part of a reactivity series is:

	sodium
	calcium
	magnesium
	aluminium
increasing	zinc
reactivity	iron
	hydrogen
	copper

- (a) Carbon is used in blast furnaces to obtain iron and zinc from their oxides, but electrolysis has to be used to obtain aluminium from its oxide.

Draw an arrow on the reactivity series above to show where carbon fits into the series.

(1)

- (b) Predict the method of extraction used to obtain calcium from its ore and explain your answer.

.....

.....

.....

(2)

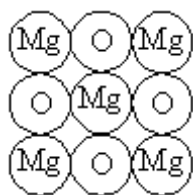
- (c) The formula for zinc oxide is ZnO. Write a balanced equation for the extraction of zinc in the blast furnace.

.....

(2)

(Total 5 marks)

Q37. Magnesium oxide is a compound, made up of magnesium ions and oxide ions.



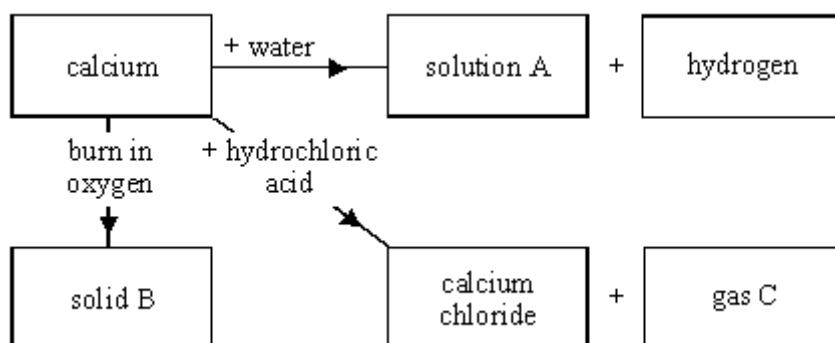
(a) What is the charge on each magnesium ion? (1)

(b) Explain how the magnesium ions get this charge.

.....

(2)
 (Total 3 marks)

Q38. (a) The chart shows the reactions of the metal calcium with water, oxygen and dilute hydrochloric acid.

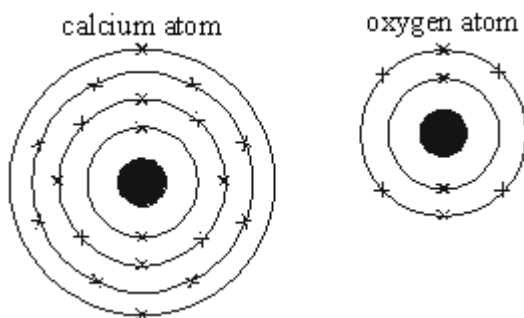


Name (i) solution A

(ii) solid B

- (iii) gas C (3)

- (b) The diagrams below show the electronic structure of an atom of calcium and an atom of oxygen.



Describe fully what happens to its electrons when:

- (i) a calcium atom forms a calcium ion. State the charge on the calcium ion formed.

.....

(3)

- (ii) an oxygen atom forms an oxygen ion. State the charge on the oxygen ion formed.

.....

(3)

- (c) Calcium oxide is an ionic compound. Why do ionic compounds have high melting points?

.....

.....

(2)
 (Total 11 marks)

##

Atoms of calcium, phosphorus and fluorine are represented below, each with its mass number and proton number.

40	31	19	← mass numbers
Ca	P	F	
20	15	9	← proton numbers

(a) Use this information to complete the table.

	CALCIUM	PHOSPHOROUS	FLUORINE
Number of protons in the nucleus	20		9
Number of neutrons in the nucleus	20	16	
Number of electrons		15	9

(3)

(b) Calcium and fluorine atoms can combine to form the compound calcium fluoride, CaF_2 .

The fluoride ion is represented by F^- .

(i) Explain how the fluorine atom forms a fluoride ion.

.....

(2)

- (ii) How is the calcium ion represented?

.....

(2)

- (c) Phosphorus and fluorine form a covalent compound, phosphorus trifluoride.

Complete the sentences below which are about this compound.

Phosphorus trifluoride is made up of phosphorus and fluorine

These are joined together by sharing pairs of to form
phosphorus trifluoride

(3)

- (d) (i) Sodium chloride, an ionic compound, has a high melting point whereas
paraffin wax, a molecular compound, melts easily.

Explain why.

.....
.....
.....
.....

(2)

- (ii) Molten ionic compounds conduct electricity but molecular compounds are
non-conductors, even when liquid.

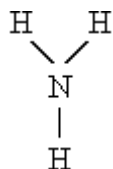
Explain why.

.....
.....
.....

(2)

(Total 14 marks)

Q40. The diagram shows one molecule of the compound ammonia.



Write down everything that the diagram tells you about each molecule of ammonia.

.....

.....

.....

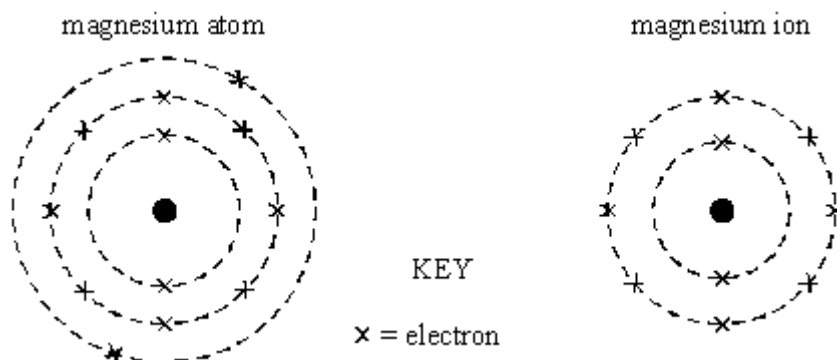
.....

.....

.....

(Total 4 marks)

Q41. (a) The diagrams below show the electronic structure of a magnesium atom and a magnesium ion.



What is the charge on the magnesium ion?

(2)

- (b) Calcium bromide has the formula CaBr_2 .

What does this tell you about the ions in this compound?

.....

.....

(2)

(Total 4 marks)

- Q42.** (a) Write down the symbols for

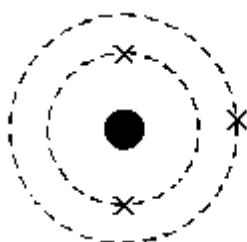
lithium

fluorine

(2)

- (b) The electronic structure of a lithium atom can be shown like this:

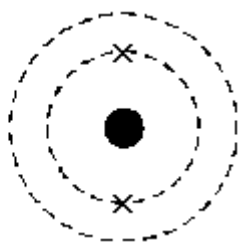
2,1 or



where **x** is an electron.

In a similar way, complete this diagram to show the electronic structure of a fluorine atom.

2,7 or



(1)

- (c) A lithium atom can lose one electron to form a lithium ion which can be written **(2)+**.
A fluorine atom can gain one electron to form a fluoride ion.

Choose from the list the correct way to write the fluoride ion.

(2,6)+ (2,7)+ (2,7)- (2,8)+ (2,8)-

Answer

(2)
(Total 5 marks)