AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.2.1 CHEMICAL BONDS: IONIC, COVALENT AND METALLIC (PACK 2)

SCORE	PERCENTAGE
/255	%

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Q1.

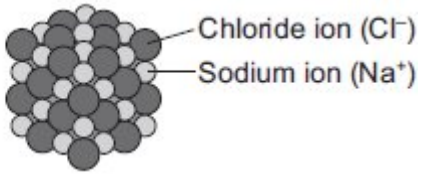
In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

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

Chlorine

Cl — Cl

Sodium chloride



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

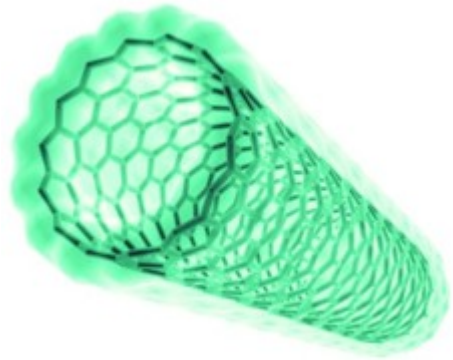
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(Total 6 marks)

Q2.

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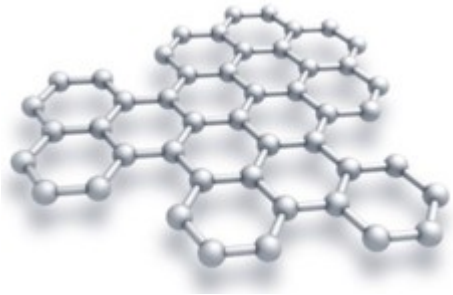
Carbon atoms are used to make nanotubes.



© Denis Nikolenko/Hemera/Thinkstock

Carbon atoms in a nanotube are bonded like a single layer of graphite.

The figure below shows the structure of a single layer of graphite.



© Evgeny Sergeev/iStock/Thinkstock

(a) Suggest why carbon nanotubes are used as lubricants.

_____

_____

_____

_____

(2)

(b) Explain why graphite can conduct electricity.

_____

_____

_____

_____

(2)

(Total 4 marks)

Q3.

Glass is made from silicon dioxide.

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(a) Silicon dioxide has a very high melting point.

Other substances are added to silicon dioxide to make glass. Glass melts at a lower temperature than silicon dioxide.

Suggest why.

_____

_____

(1)

(b) Sodium oxide is one of the substances added to silicon dioxide to make glass.

(i) Sodium oxide contains Na^+ ions and O^{2-} ions.

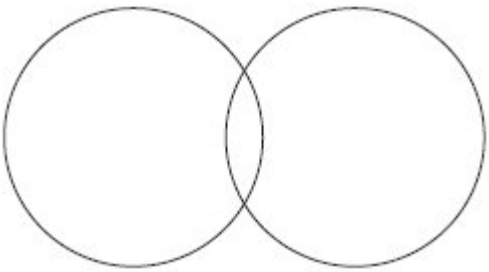
Give the formula of sodium oxide.

_____

(1)

(ii) Sodium oxide is made by heating sodium metal in oxygen gas.

Complete the diagram to show the outer electrons in an oxygen molecule (O_2).



(2)

(c) Glass can be coloured using tiny particles of gold. Gold is a metal.

Describe the structure of a metal.

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_____

_____

_____

_____

_____

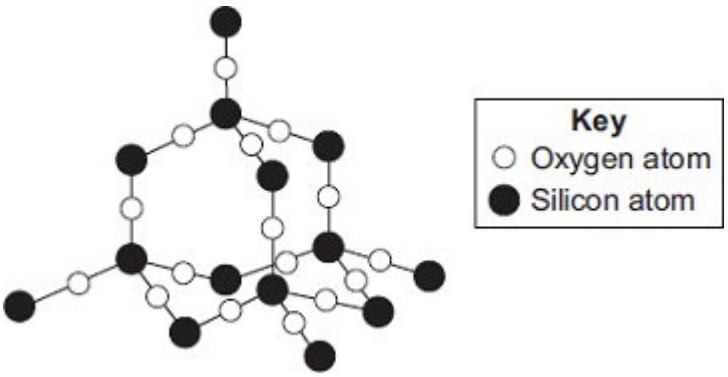
_____

(3)

(Total 7 marks)

Q4.

The diagram shows a small part of the structure of silicon dioxide.



(a) Use the diagram above to answer the question.

Draw a ring around the correct answer to complete each sentence.

In silicon dioxide, each silicon atom is bonded with

two
three
four

oxygen atoms.

The bonds in silicon dioxide are

ionic.
covalent.
metallic.

(2)

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(b)



© Oleksiy Mark/iStock

Silicon dioxide is used as the inside layer of furnaces.

Suggest why.

_____

_____

(1)

(c) Nanowires can be made from silicon dioxide.

Draw a ring around the correct answer to complete the sentence.

The word 'nano' means the wires are very

brittle.
thick.
thin.

(1)

(Total 4 marks)

Q5.

Kelp is a seaweed.

Kelp can be burned to give out energy.

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

Reactions which give out energy are

endothermic.

exothermic.

reversible.

(1)

(b) Which **two** of the following questions **cannot** be answered by scientific experiments alone?

Tick (✓) **two** boxes.

Question	Tick (✓)
How much carbon dioxide is produced when 100 g of kelp is burned?	
Does kelp give out more heat energy than coal when burned?	
Should people use kelp instead of oil as an energy source?	
Will kelp be more popular than coal in the next 10 years?	

(2)

(c) Potassium iodide can be produced from kelp.

(i) Potassium can be reacted with iodine to produce potassium iodide.

potassium + iodine → potassium iodide

The diagram shows how this happens.

Only the outer electrons are shown.

The dots (●) and crosses (×) are used to represent electrons

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Use the diagram to help you answer this question.

Describe, as fully as you can, what happens when potassium reacts with iodine to produce potassium iodide.

To get full marks you should use the words atom, electron and ion in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(ii) Potassium iodide reacts with lead nitrate.

$$2\ KI(aq) + Pb(NO_3)_2(aq) \rightarrow 2\ KNO_3(aq) + PbI_2(s)$$

Why is this reaction a precipitation?

_____

_____

(1)

(iii) How can the precipitate be removed from the reaction mixture?

_____

_____

(1)

(Total 9 marks)

Q6.

Thermosoftening polymers can be used to make plastic bottles and food packaging.

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(a) Why are thermosoftening polymers **not** suitable for storing very hot food?

_____

_____

(1)

(b) The reaction to produce the polymers uses a catalyst.

Why are catalysts used in chemical reactions?

_____

_____

(1)

(c) Compounds from food packaging must not get into food.

Gas chromatography can be used to separate compounds in food.

The output from the gas chromatography column can be linked to an instrument which can identify the compounds.

(i) Name the instrument used to identify the compounds.

_____

_____

(1)

(ii) Give **one** reason why instrumental methods of analysis are used to identify the compounds.

_____

_____

(1)

(d) Poly(ethene) is a thermosoftening polymer.

Poly(ethene) can be made with different properties. The properties depend on the conditions used when poly(ethene) is made.

Suggest **two** conditions which could be changed when poly(ethene) is made.

_____

_____

(2)

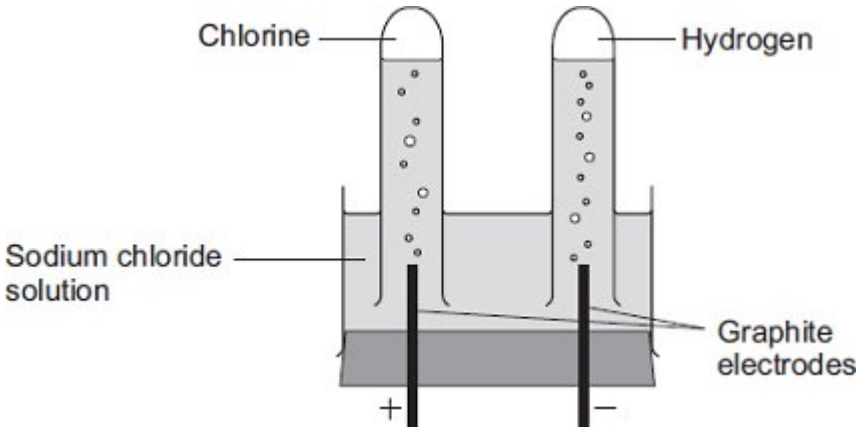
(Total 6 marks)

Q7.

The electrolysis of sodium chloride solution is an industrial process.

The diagram shows the apparatus used in a school experiment.

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(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?

_____

_____

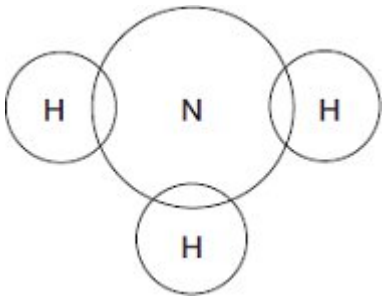
(1)

(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

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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)

Q8.

Kelp is a seaweed.

Kelp can be used in foods and as a renewable energy source.



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(a) Scientific experiments, on their own, **cannot** fully answer one of the following questions. Which one?

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Tick (✓) **one** box.

Questions	Tick (✓)
How much carbon dioxide is produced when 100 g of kelp is burned?	
Does kelp give out more heat energy than coal?	
Will kelp last longer than coal as an energy source?	
Which fuel, kelp or coal, produces the most ash when burned?	

(1)

(b) Scientists cannot answer the question 'should people use kelp instead of coal as an energy source?'

Give **two** reasons why.

_____

_____

_____

_____

(2)

(c) Sodium iodide can be produced from kelp.

(i) How many electrons are in the outer shell of an iodine atom?

(1)

(ii) Sodium iodide contains sodium ions (Na^+) and iodide ions (I^-).

Describe, as fully as you can, what happens when sodium atoms react with iodine atoms to produce sodium iodide.

You may use a diagram in your answer

_____

_____

_____

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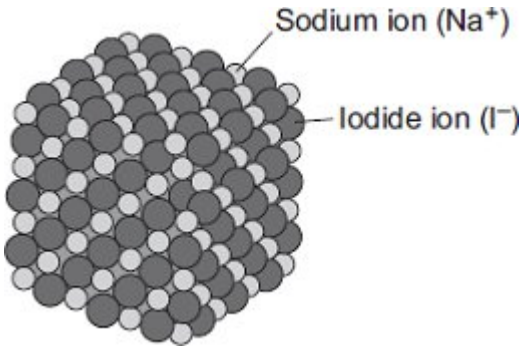
_____

_____

_____

(3)

(iii) The diagram shows the structure of sodium iodide.



Solid sodium iodide does not conduct electricity.

Why does sodium iodide solution conduct electricity?

_____

_____

(1)

(iv) When sodium iodide solution is electrolysed, iodine is formed at the positive electrode.

Complete and balance the half equation for the formation of iodine.

$$_____I^- \rightarrow I_2 + _____e^-$$

(1)

(v) What is formed at the negative electrode when sodium iodide solution is electrolysed?

Explain why.

_____

_____

_____

_____

(2)

(Total 11 marks)

Q9.

The picture shows a student filling in a multiple choice answer sheet using a pencil.

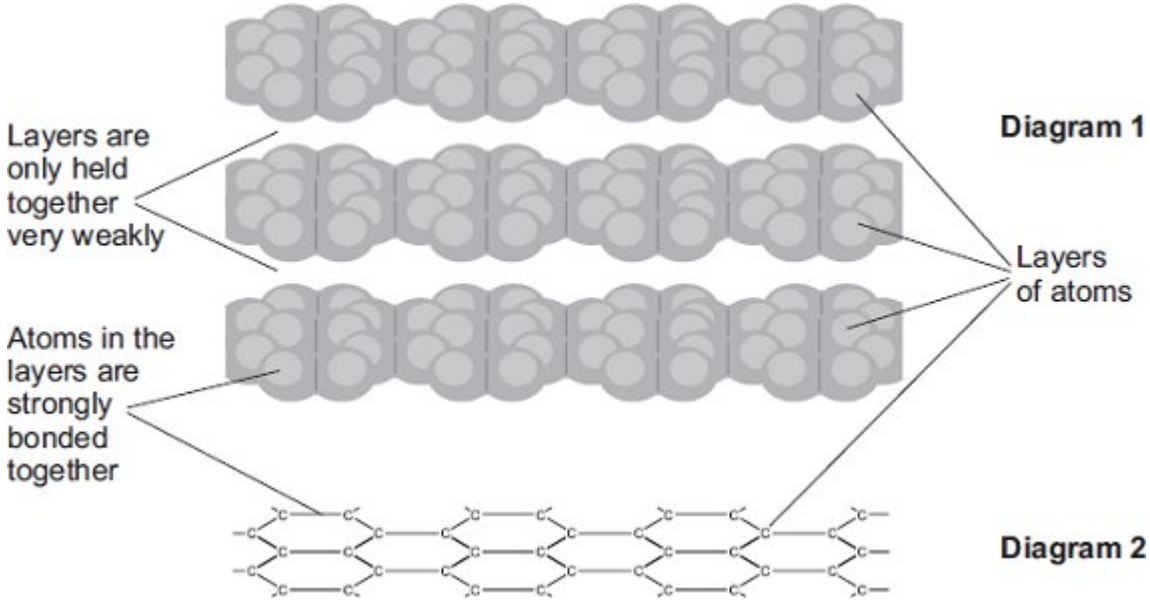
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The pencil contains graphite. Graphite rubs off the pencil onto the paper.

Diagrams **1** and **2** show how the atoms are arranged in graphite.



(a) Use the diagrams to help you explain why graphite can rub off the pencil onto the paper.

_____

_____

_____

_____

(2)

(b) Draw a ring around the type of bond which holds the atoms together in each layer.

covalent **ionic** **metallic**

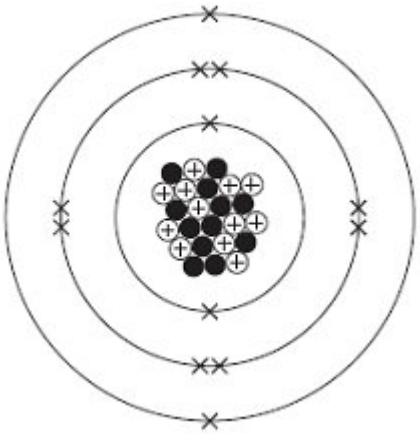
(1)

(Total 3 marks)

Q10.

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The diagram represents a magnesium atom.



(a) Use words from the box to answer these questions.

electron	**neutron**	**nucleus**	**proton**

(i) What is the name of the central part of the atom? _____

(1)

(ii) What is the name of the particle with no charge? _____

(1)

(iii) What is the name of the particle with a negative charge? _____

(1)

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

(i) Draw a ring around the atomic (proton) number of this magnesium atom.

12 **24** **36**

(1)

(ii) Draw a ring around the mass number of this magnesium atom.

12 **24** **36**

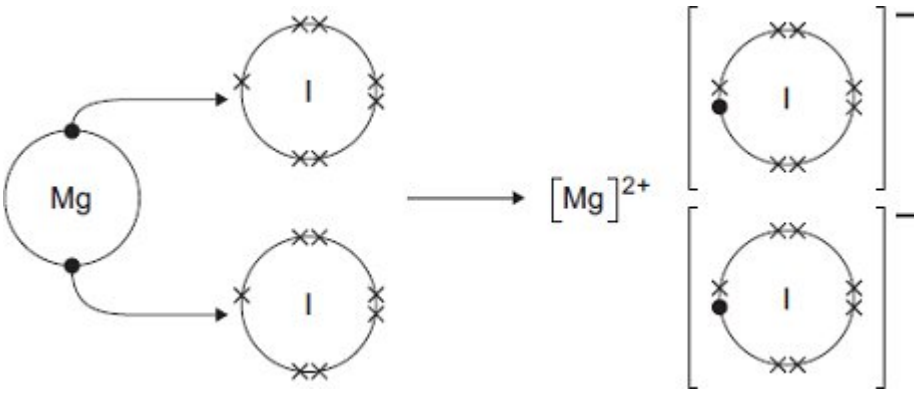
(1)

(c) The diagram shows how magnesium and iodine atoms form magnesium iodide.

Only the outer electrons are shown.

The dots (●) and crosses (×) are used to represent electrons.

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Use the diagram to help you to answer this question.

Describe, as fully as you can, what happens when magnesium reacts with iodine to make magnesium iodide.

To gain full marks you should use the words atom, electron and ion in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 9 marks)

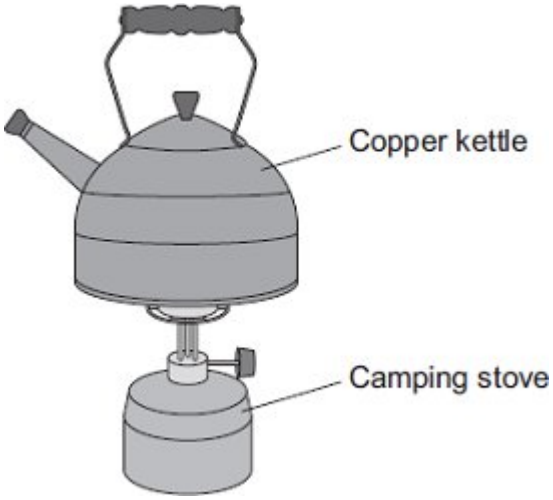
Q11.

The picture shows a copper kettle being heated on a camping stove.

Copper is a good material for making a kettle because:

- it has a high melting point
- it is a very good conductor of heat.

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(a) Explain why copper, like many other metals, has a high melting point.

Your answer should describe the structure and bonding of a metal.

_____

_____

_____

_____

_____

_____

_____

_____

_____

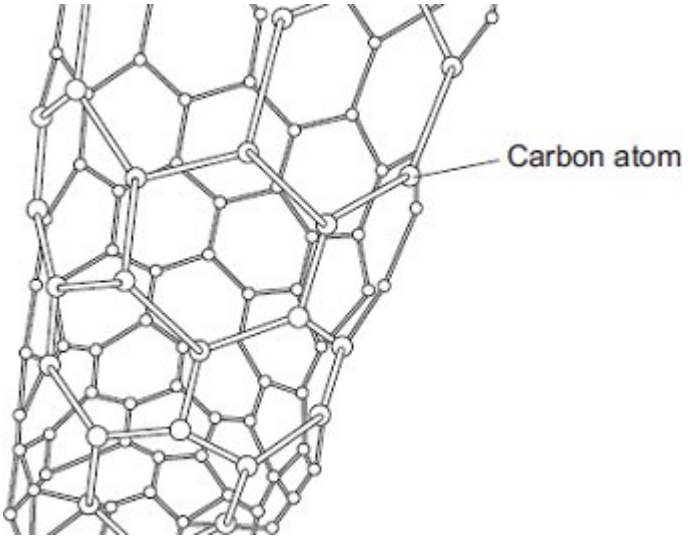
(4)

(b) Aeroplanes contain many miles of electrical wiring made from copper. This adds to the mass of the aeroplane.

It has been suggested that the electrical wiring made from copper could be replaced by carbon nanotubes which are less dense than copper.

The diagram shows the structure of a carbon nanotube.

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(i) What does the term ‘nano’ tell you about the carbon nanotubes?

_____

_____

(1)

(ii) Like graphite, each carbon atom in the carbon nanotube is joined to three other carbon atoms.

Explain why the carbon nanotube can conduct electricity.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q12.

This question is about some compounds made from iodine.

(a) Lead iodide can be made by mixing a solution containing lead ions with a solution containing iodide ions. Lead iodide is formed as a precipitate.

$$Pb^{2+}(aq) + 2I^{-}(aq) \longrightarrow PbI_2(s)$$

The table below gives information about the solubility of some compounds.

Soluble compounds	Insoluble compounds

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All sodium and potassium salts	
All nitrates	
Most chlorides, bromides and iodides	Silver and lead chlorides, bromides and iodides

Use the table to help you to name:

(i) A soluble compound which contains lead ions_____

(1)

(ii) A soluble compound which contains iodide ions

_____

(1)

(b) Magnesium iodide can be made by reacting magnesium with iodine.

$$Mg + I_2 \longrightarrow MgI_2$$

Magnesium iodide is an ionic compound. It contains magnesium ions (Mg^{2+}) and iodide ions (I^-).

Describe, in terms of electrons, what happens when magnesium reacts with iodine.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

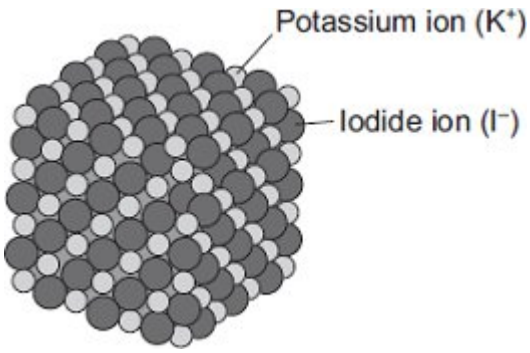
_____

_____

(4)

(c) The diagram shows the structure of potassium iodide.

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Explain why a high temperature is needed to melt potassium iodide.

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

Q13.

This question is about lithium and sodium.

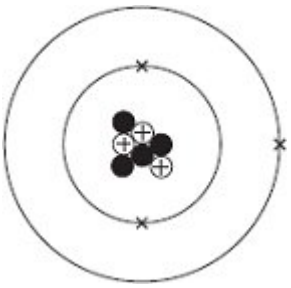
(a) Use the Chemistry Data Sheet to help you to answer this question.

In which group of the periodic table are lithium and sodium? Group ☐

(1)

(b) A lithium atom can be represented as $^{7}_{3}Li$

The diagram represents the lithium atom.



(i) Some particles in the nucleus have a positive charge.

What is the name of these particles?

_____

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(1)

(ii) Some particles in the nucleus have no charge.

What is the name of these particles?

_____

(1)

(iii) Use the correct answer from the box to complete the sentence.

3	4	7

The mass number of this atom of lithium is ☐

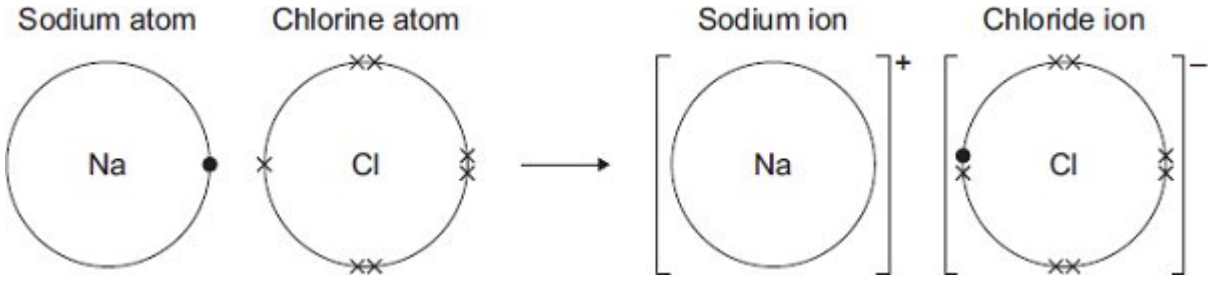
(1)

(c) Sodium reacts with chlorine to produce sodium chloride.

sodium + chlorine ⟶ sodium chloride

The diagram shows how the reaction happens.

Only the outer electrons are shown.



Draw a ring around the correct answer to complete each sentence.

(i) A sodium atom changes into a sodium ion by

gaining
losing
sharing

an electron.

(1)

(ii) A sodium ion has

a negative
no
a positive

charge.

(1)

(iii) The ions in sodium chloride are held together by

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strong | covalent / electrostatic / magnetic | forces.

(1)

(d) Sodium chloride is an ionic compound.

Tick (✓) **two** properties of ionic compounds.

Property	Tick (✓)
Do **not** dissolve in water	
High melting points	
Low boiling points	
Strong bonds	

(2)

(e) (i) The formula of sodium chloride is NaCl

Calculate the relative formula mass of sodium chloride.

Relative atomic masses: Na = 23; Cl = 35.5

_____

_____

Relative formula mass = _____

(1)

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

The relative formula mass of a substance, in grams,

is one | ion / isotope / mole | of the substance.

(1)

(f) Nanoparticles of sodium chloride (salt) are used to flavour crisps.

What are nanoparticles?

_____

_____

(1)

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(Total 12 marks)

Q14.

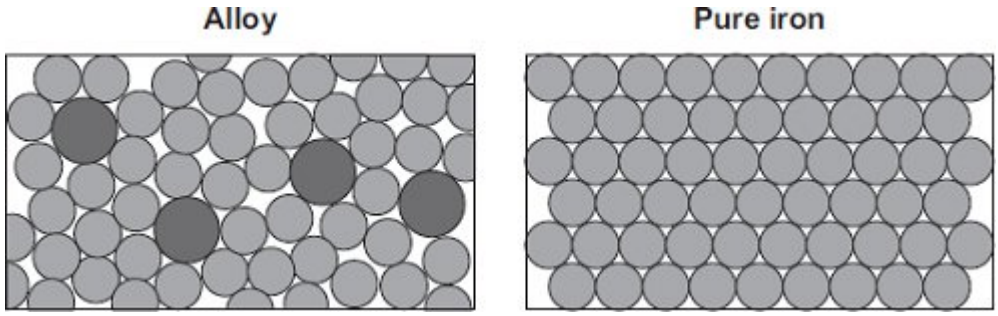
Oil rigs are used to drill for crude oil.



© 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.

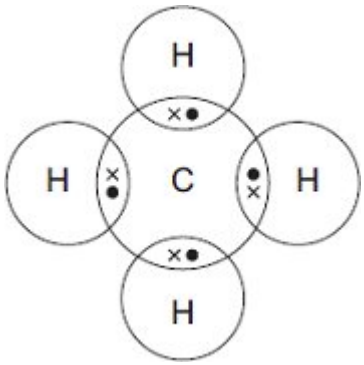
Reason	Tick (✓)
Diamonds have a giant covalent structure.	
Diamonds have high melting points.	
Diamonds are unreactive.	

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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_4
- C_4H
- 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)

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Q15.

Humphrey Davy was a professor of chemistry.

In 1807 Humphrey Davy did an electrolysis experiment to produce potassium.

(a) (i) Humphrey Davy was the first person to produce potassium.

Draw a ring around the correct answer to complete each sentence.

Humphrey Davy's experiment to produce this new element was quickly

accepted by other scientists because he

had a lot of money.
had a lot of staff to help.
was well qualified.

(1)

(ii) Other scientists were able to repeat Davy's experiment.

Draw a ring around the correct answer to complete each sentence.

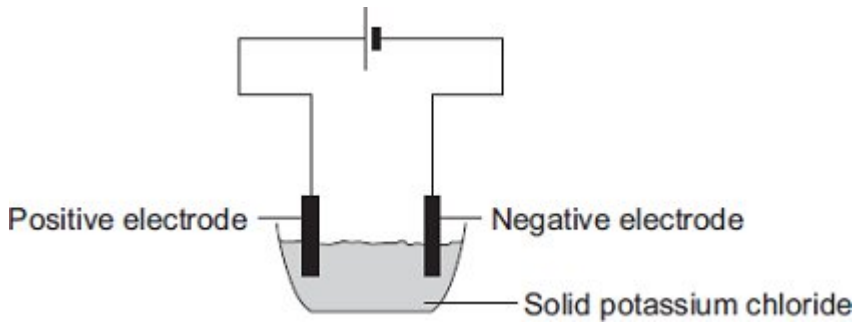
Being able to repeat Davy's experiment is important because

other scientists can

check the results of the experiment.
see if the experiment is safe.
take the credit for the discovery.

(1)

(b) A student tried to electrolyse potassium chloride.



Potassium chloride contains potassium ions (K^+) and chloride ions (Cl^-).

(i) The student found that solid potassium chloride does not conduct electricity.

Use the correct answer from the box to complete the sentence.

are too big	**cannot move**	**have no charge**

Solid potassium chloride does not conduct electricity because

the ions _____ .

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(1)

(ii) What could the student do to the potassium chloride to make it conduct electricity?

_____

(1)

(iii) During electrolysis why do potassium ions move to the negative electrode?

_____

(1)

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

When the potassium ions reach the negative electrode

they turn into potassium

atoms.
electrodes.
molecules.

(1)

(Total 6 marks)

Q16.

Ammonia is produced from nitrogen and hydrogen.

The equation for this reaction is:

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

(a) (i) A company wants to make 6.8 tonnes of ammonia.

Calculate the mass of nitrogen needed.

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

_____

_____

_____

_____

_____

Mass of nitrogen = _____ tonnes

(3)

(ii) The company expected to make 6.8 tonnes of ammonia.

The yield of ammonia was only 4.2 tonnes.

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Calculate the percentage yield of ammonia.

_____

_____

Percentage yield of ammonia = _____ %

(2)

(iii) Use the equation above to explain why the percentage yield of ammonia was less than expected.

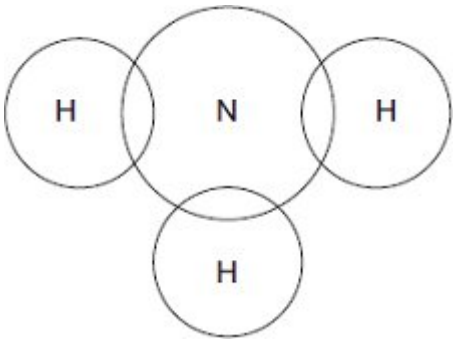
_____

_____

(1)

(b) Complete the diagram to show the arrangement of the outer shell electrons of the nitrogen and hydrogen atoms in ammonia.

Use dots (●) and crosses (x) to represent the electrons.



(2)

(c) Ammonia dissolves in water to produce an alkaline solution.

(i) Which ion makes ammonia solution alkaline?

_____

(1)

(ii) Name the type of reaction between aqueous ammonia solution and an acid.

_____

(1)

(iii) Name the acid needed to produce ammonium nitrate.

_____

(1)

(iv) The reaction of ammonia with sulfuric acid produces ammonium sulfate.

Use the formulae of the ions on the Chemistry Data Sheet.

Write the formula of ammonium sulfate.

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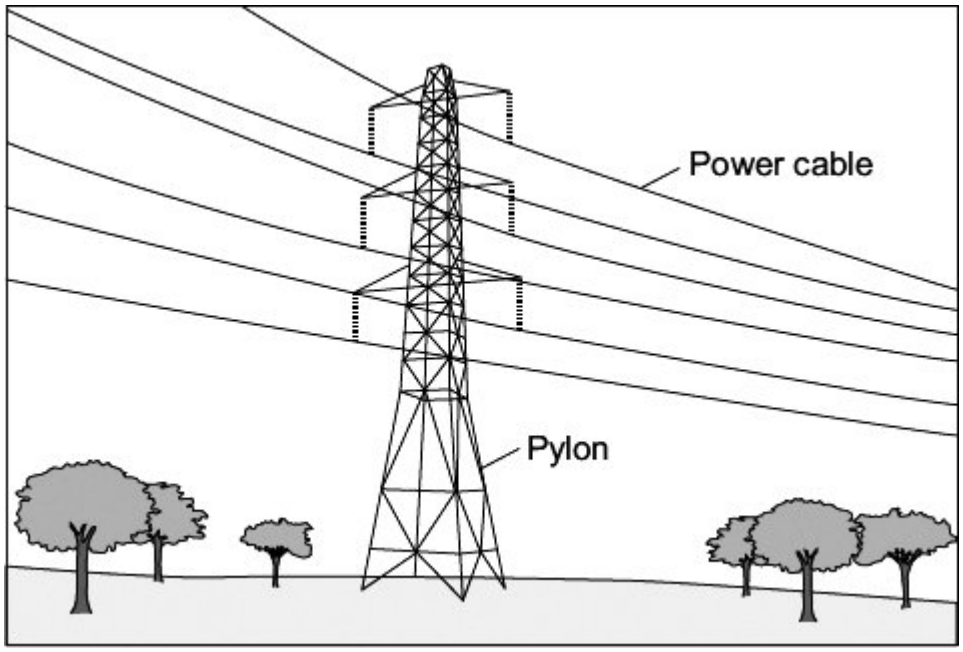
_____

(1)

(Total 12 marks)

Q17.

Metals are used in the manufacture of pylons and overhead power cables.



(a) Suggest **one** reason why iron (steel) is used to make pylons.

_____

_____

(1)

(b) The table shows some of the properties of two metals.

Metal	Density in g per cm^3	Melting point in °C	Percentage(%) relative electrical conductivity	Percentage(%) abundance in Earth's crust
copper	8.92	1083	100	0.007
aluminium	2.70	660	60	8.1

Use the information in the table to suggest why aluminium and **not** copper is used to conduct electricity in overhead power cables.

_____

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_____

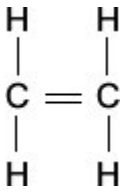
_____

_____

(2)

(c) A polymer can be used to cover and insulate power cables.

The polymer is made from the alkene:



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

(i) The chemical formula of this alkene is

CH
CH_4
C_2H_4

(1)

(ii) The two lines between the carbon atoms are called a

double bond.
nucleus.
single bond.

(1)

(iii) The name of the polymer formed when many of these alkene molecules join together is

poly(ethene).
poly(ethenol).
poly(propene).

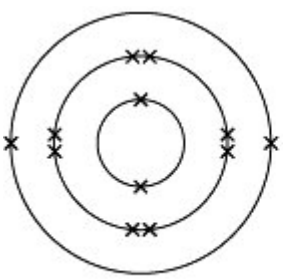
(1)

(Total 6 marks)

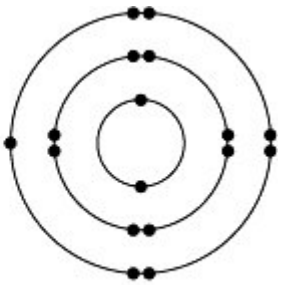
Q18.

The diagrams represent the electronic structure of a magnesium atom and a chlorine atom.

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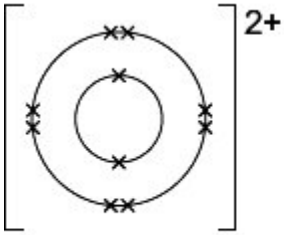
Magnesium atom



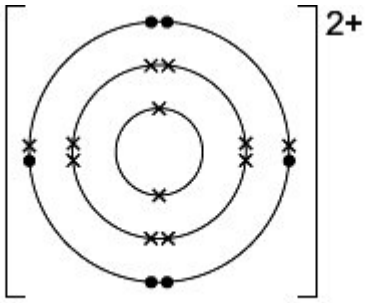
Chlorine atom

Magnesium reacts with chlorine to make the ionic compound called magnesium chloride.
This contains magnesium ions, Mg^{2+}, and chloride ions, Cl^-

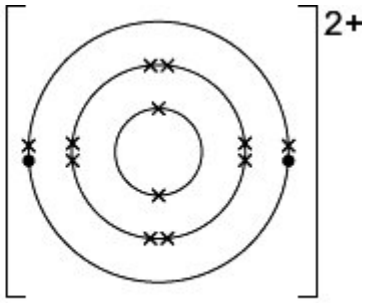
(a) (i) Which structure, **A**, **B** or **C**, represents a magnesium ion?



Structure **A**



Structure **B**

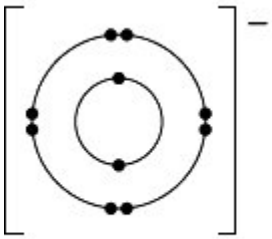


Structure **C**

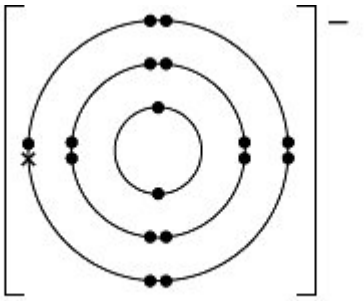
The magnesium ion is Structure ☐

(1)

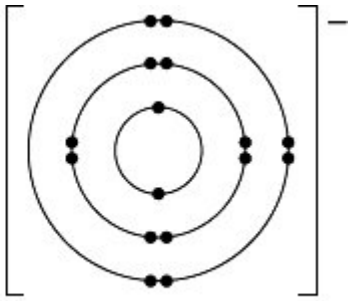
(ii) Which structure, **D**, **E** or **F**, represents a chloride ion?



Structure **D**



Structure **E**



Structure **F**

The chloride ion is Structure ☐

(1)

(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 as a solid.

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This is the equation for the reaction:

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

Draw a ring around the correct answer to complete each sentence.

Magnesium hydroxide forms as a solid because it is

soluble
insoluble
dissolved

in water.

This type of reaction is called

precipitation.
neutralisation.
thermal decomposition.

(2)

(ii) How is the solid magnesium hydroxide separated from the solution?

_____

(1)

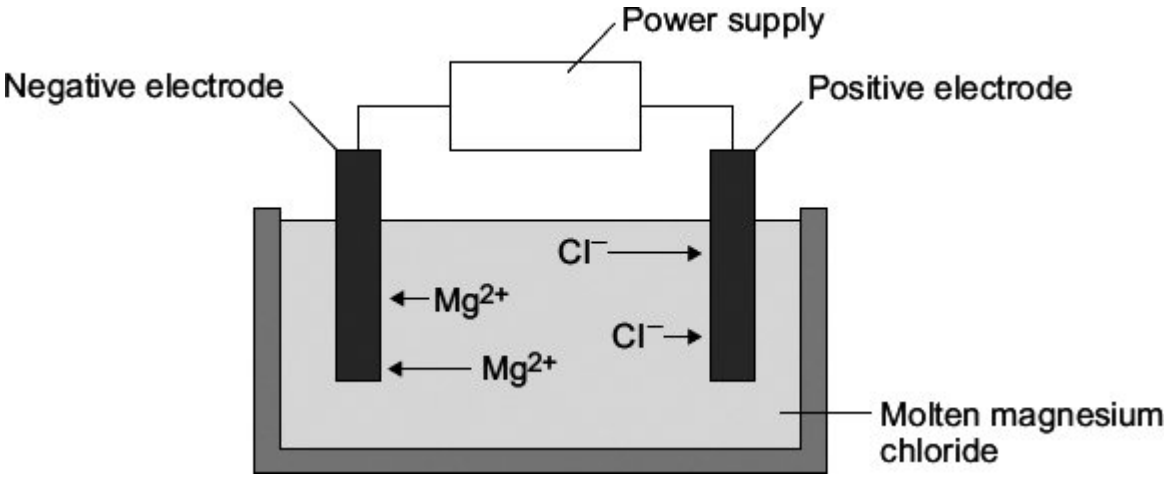
(iii) An acid is then added to the solid magnesium hydroxide to make magnesium chloride.

Draw a ring around the name of this acid.

nitric acid **hydrochloric acid** **sulfuric acid**

(1)

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



(i) What must be done to solid magnesium chloride to allow it to conduct electricity?

_____

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(1)

(ii) Why do the magnesium ions move to the negative electrode?

_____

_____

(1)

(iii) Name the product formed at the positive electrode.

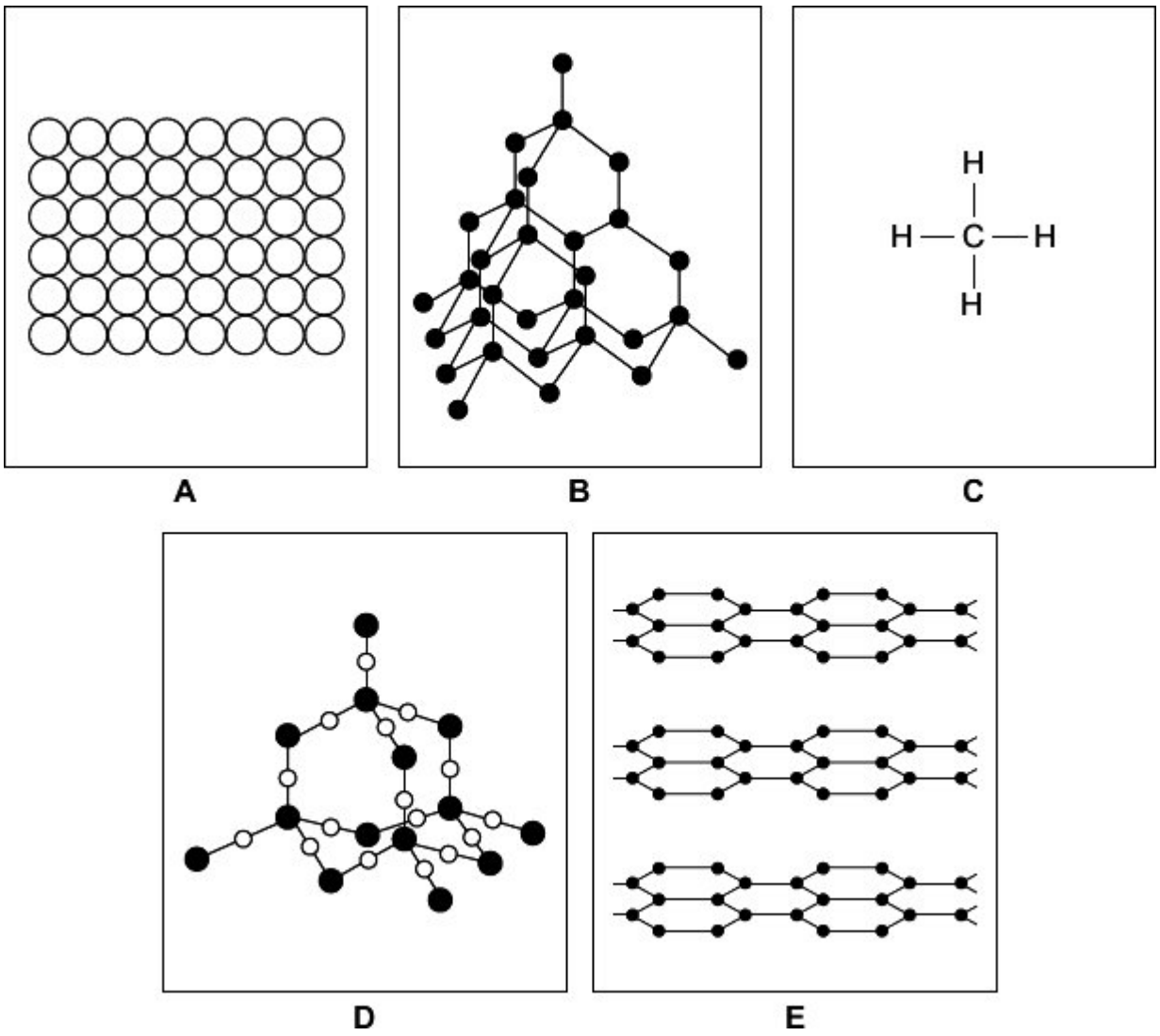
_____

(1)

(Total 9 marks)

Q19.

The diagrams represent the structures of five substances, **A**, **B**, **C**, **D** and **E**.



(a) Give **one** substance, **A**, **B**, **C**, **D** or **E**, that:

(i) has a very low boiling point

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(1)

(ii) is a compound ☐

(1)

(iii) is a metal. ☐

(1)

(b) Draw a ring around the type of bonding holding the atoms together in substance **C**.

covalent **ionic** **metallic**

(1)

(c) Explain why substance **E** is soft and slippery.

_____

_____

_____

_____

(2)

(Total 6 marks)

Q20.

(a) The symbol equation for the decomposition of hydrogen peroxide is:

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

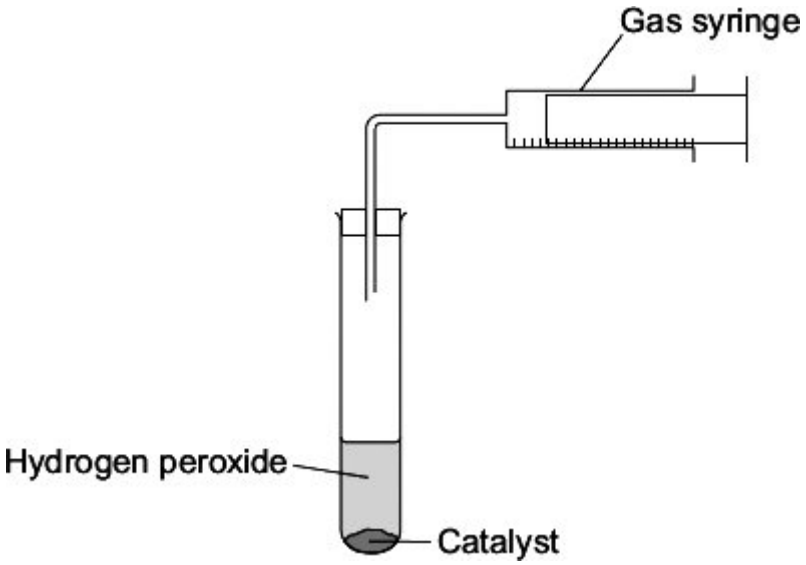
Complete the word equation for the decomposition of hydrogen peroxide.

Hydrogen peroxide → _____ + _____

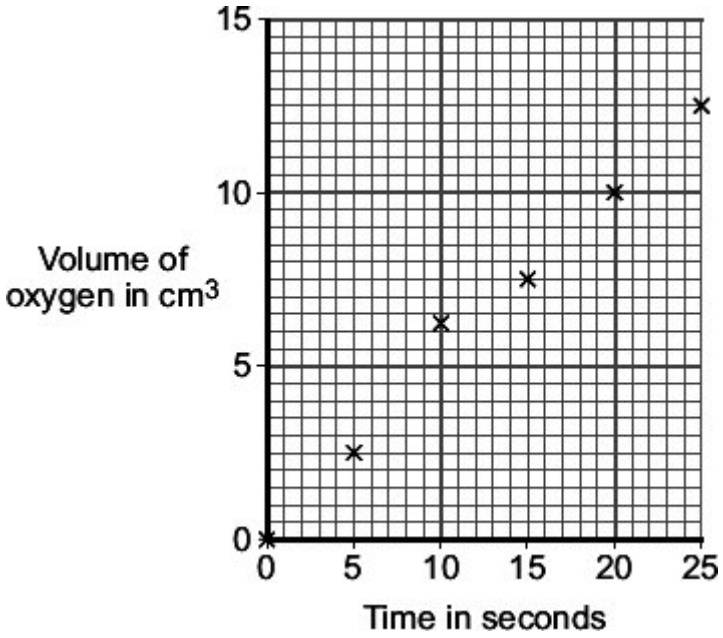
(1)

(b) A student did an experiment to see how quickly hydrogen peroxide decomposes. The student used the apparatus shown below to measure the volume of oxygen.

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(i) Draw a straight line of best fit to complete the graph.



(1)

(ii) Draw a circle around the anomalous point on the graph.

(1)

(iii) What is the volume of oxygen given off after 15 seconds?

_____ cm^3

(1)

(iv) How did the volume of oxygen change between 0 and 25 seconds?

_____

(1)

(c) The student wanted to make the reaction faster.

Draw a ring around the correct answer to complete each sentence.

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(i) To make the reaction faster, the temperature should be

higher.
lower.
the same.

(1)

(ii) To make the reaction faster, the hydrogen peroxide should be

more dilute.
more concentrated.
the same.

(1)

(d) The diagram represents the bonding in oxygen.

O=O

Draw a ring around the correct answer to complete each sentence.

(i) When two oxygen atoms bond, the atoms

share
transfer
delocalise

electrons.

(1)

(ii) The oxygen atoms are joined by

ionic
metallic
covalent

bonds.

(1)

(iii) Oxygen is made of

simple molecules.
a giant lattice.
macromolecules.

(1)

(e) When hydrogen peroxide decomposes water is produced.
Which **two** statements in the table explain why water is a liquid at room temperature?

Tick (✓) the **two** statements.

Statement	Tick (✓)

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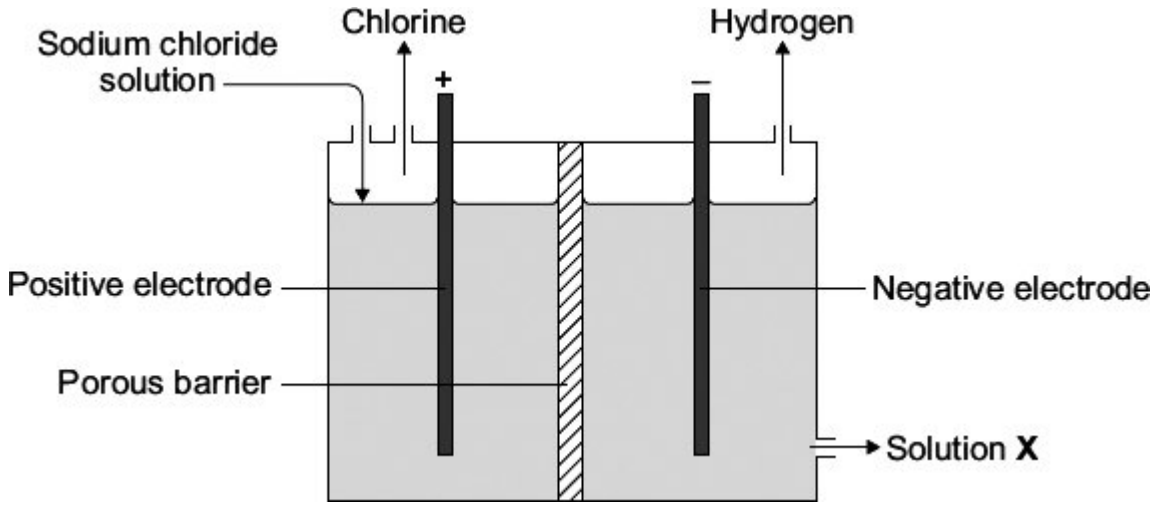
Water has a boiling point of 100 °C.	
Water is made of ions.	
Water has a melting point lower than room temperature.	
Water has a giant covalent structure.	

(2)

(Total 12 marks)

Q21.

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.	

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(1)

(c) Solution **X** is alkaline.

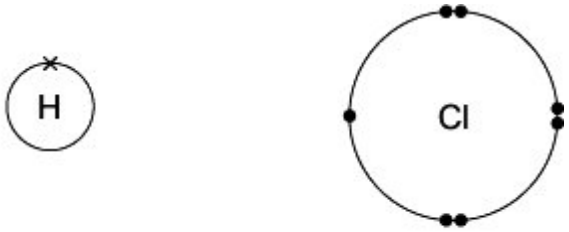
Which ion makes solution **X** alkaline?

_____

(1)

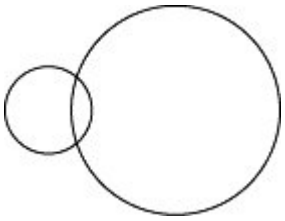
(d) Electrolysis of sodium chloride solution produces hydrogen and chlorine.
The hydrogen and chlorine can be used to make hydrogen chloride.

(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?

_____

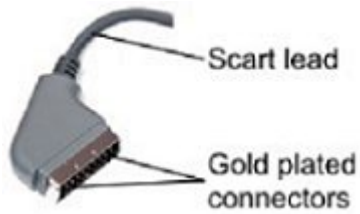
(1)

(Total 6 marks)

Q22.

High quality connectors are used to connect a satellite box to a television.
The connectors should conduct electricity very well and should not corrode.

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By Alphathon (Own work) [CC-BY-SA-3.0 or GFDL], via Wikimedia Commons

The connectors on this scart lead are coated with gold.

(a) Gold is a typical metal.

(i) Describe the structure and bonding of gold.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(ii) Why is gold a good conductor of electricity?

_____

_____

(1)

(b) The surface of some metals, such as iron, corrode when exposed to the air.

Suggest why this reduces the electrical conductivity of the metal.

_____

_____

_____

_____

(2)

(Total 6 marks)

Q23.

The picture shows a wooden bowl.
The pieces of wood used for this bowl were dyed different colours.

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By Bertramz (Own work) [CC-BY-SA-3.0], via Wikimedia Commons

The artist who made the bowl explained why he dissolved the coloured dyes in methanol.

I use different coloured dyes dissolved in methanol. I use methanol because with dyes dissolved in water the wood needs to be soaked for a longer time. The bowl dries more quickly if I use methanol instead of water.

(a) The artist uses methanol instead of water.

Give **two** reasons why.

1. _____

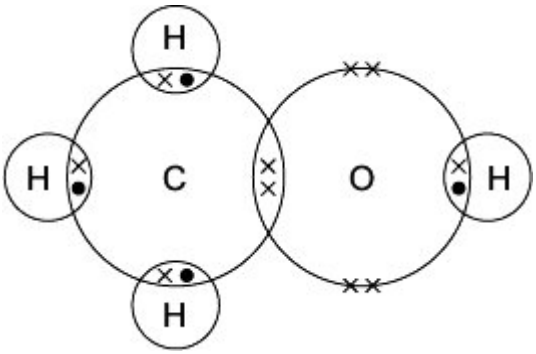
_____

2. _____

_____

(2)

(b) The diagram shows how the atoms are bonded in methanol.



Draw a ring around:

(i) the formula of methanol

CH_4O **CH^4O** **CHO_4**

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(1)

(ii) the type of bonding in methanol.

covalent **ionic** **metallic**

(1)

(c) Methanol has a low boiling point.

Tick (✓) the reason why.

Reason why	Tick (✓)
It has a giant covalent structure.	
It is made of small molecules.	
It has a giant metallic structure.	

(1)

(Total 5 marks)

Q24.

Welding blankets are placed under metals being welded. They protect the area under the welding from hot sparks or molten metal.



Some welding blankets are made from silicon dioxide.

(a) The table lists some properties of materials.

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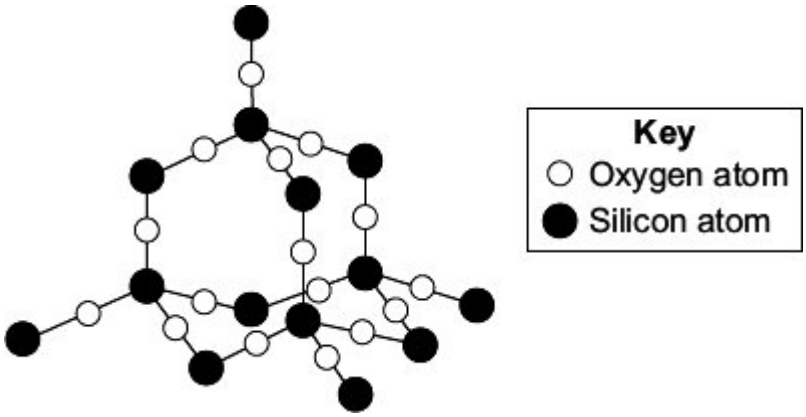
Two of these are properties of materials used to make welding blankets.

Tick (✓) the **two** correct properties.

Property	Tick (✓)
High melting point	
Reacts with sparks	
Not flammable	
Low boiling point	

(2)

(b) Silicon dioxide has a giant structure. The diagram shows a small part of this structure.



Draw a ring around the correct answer to complete each sentence.

(i) Silicon dioxide has a high melting point because

a few
some
all

of the atoms are joined to other atoms.

(1)

(ii) Each oxygen atom is joined to

two
three
four

silicon atoms.

(1)

covalent.

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(iii) The bonds between the atoms are

ionic.
metallic.

(1)

(iv) These bonds are

easily broken.
very strong.
weak.

(1)
(Total 6 marks)

Q25.

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.

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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+}).

_____

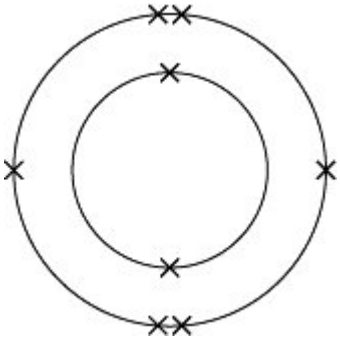
_____

_____

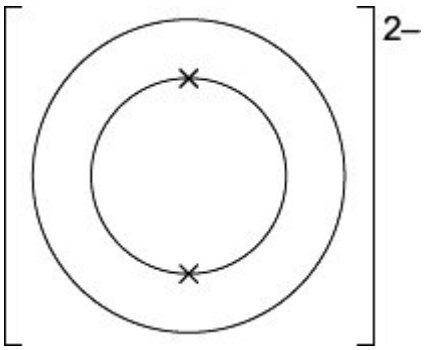
_____

(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)

Q26.

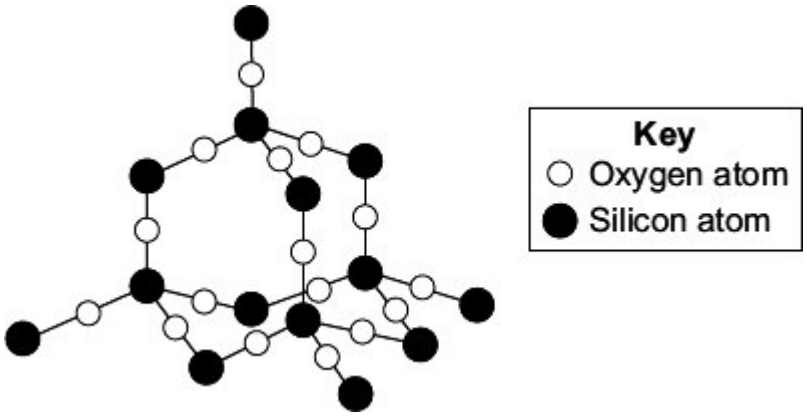
Welding blankets are placed under metals being welded. They protect the area under the welding.

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Some welding blankets are made from silicon dioxide which does not melt when hit by sparks or molten metal.

The diagram shows a small part of the structure of silicon dioxide.



Describe the structure and bonding in silicon dioxide **and** explain why it is a suitable material for making welding blankets.

_____

_____

_____

_____

_____

_____

_____

_____

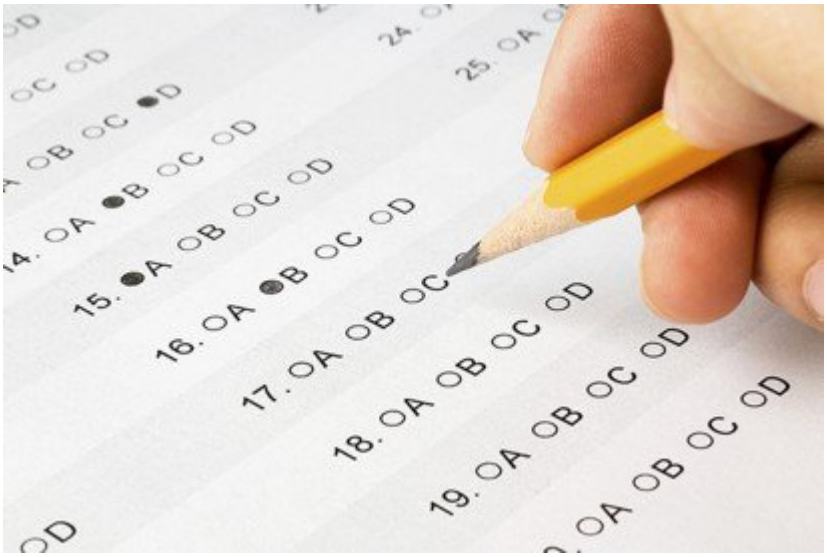
(3)

(Total 3 marks)

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Q27.

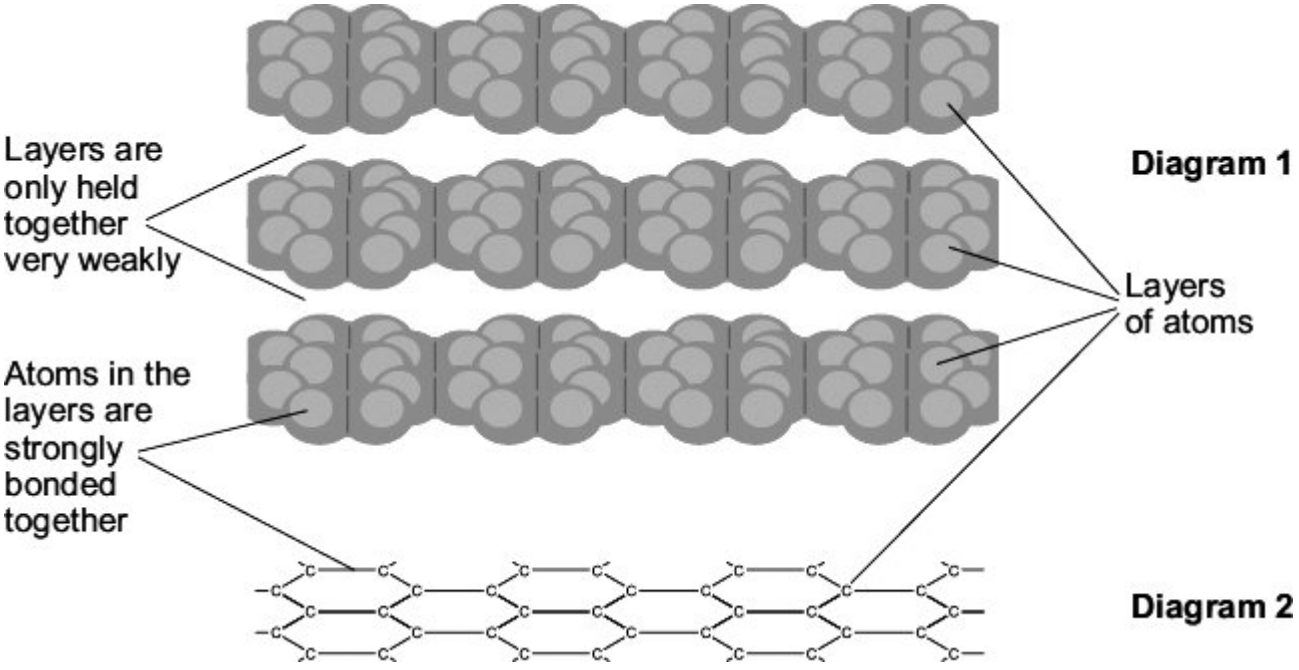
The picture shows a student using a pencil to complete a multiple choice answer sheet.



By albertogp123 [CC BY 2.0] , via Flickr

The pencil contains graphite. Graphite rubs off the pencil onto the paper.

Diagrams 1 and **2** show how the atoms are arranged in graphite.



(a) Use **Diagram 2** and your Data Sheet to help you to name the element from which graphite is made.

_____

(1)

(b) Use **Diagram 1** to help you explain why graphite can rub off the pencil onto the paper.

_____

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_____

_____

_____

(2)

(c) Draw a ring around the type of bond which holds the atoms together in each layer.

covalent **ionic** **metallic**

(1)
(Total 4 marks)

Q28.

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.

Give **one** piece of information from the box which shows that the reaction is exothermic.

_____

(1)

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

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Draw a ring around the name given to the energy needed to start a chemical reaction.

activation energy **potential energy** **solar energy**

(1)

(c) When aluminium burns it reacts with oxygen to make aluminium oxide.

Complete the word equation for this reaction.

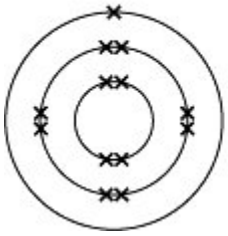
aluminium + _____ → _____

(1)

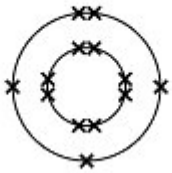
(d) An aluminium atom has 13 electrons.

Which diagram, **A**, **B** or **C**, represents the electronic structure of an aluminium atom?

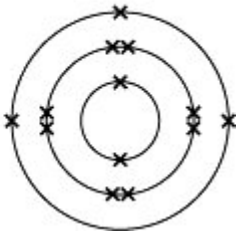
A



B



C



The electronic structure of an aluminium atom is diagram ☐

(1)

(e) The white smoke produced is aluminium oxide.

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

Draw a ring around the correct word in each box to complete each sentence.

(i) Electrons have [a negative / no / a positive] charge.

(1)

(ii) When an aluminium atom (Al) turns into an aluminium ion (Al^{3+})

it [gains / loses] three electrons.

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shares

(1)

(iii) When an oxygen atom (O) turns into an oxide ion (O^{2-})

it

gains
loses
shares

one
two
three

electrons.

(2)
(Total 8 marks)

Q29.

Lead compounds have been used for thousands of years as colours in paint.



Johannes Vermeer [Public domain], via Wikimedia Commons

(a) A sample of a red oxide used in paint was found to contain 6.21 g of lead and 0.64 g of oxygen.

Calculate the empirical (simplest) formula of this compound.

You **must** show all your working to gain full marks.

Relative atomic masses: O = 16; Pb = 207.

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_____

_____

_____

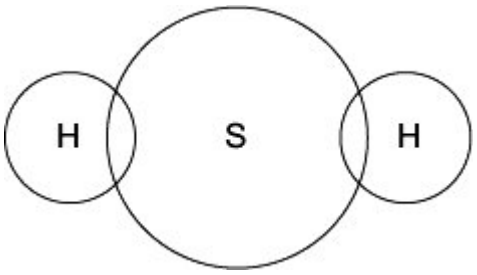
(4)

(b) A problem with lead compounds is that they slowly react with hydrogen sulfide in the air. This produces lead sulfide which is black.

(i) Hydrogen sulfide has the formula H_2S. The bonding in a molecule of hydrogen sulfide can be represented as:

H–S–H

Complete the diagram below to show the arrangement of the outer electrons of the hydrogen and sulfur atoms in hydrogen sulfide.
Use dots (●) and crosses (x) to represent the electrons.
You need only show the outer shell electrons.
(Atomic numbers: H = 1; S = 16.)



(1)

(ii) Hydrogen sulfide has a low boiling point.

Explain why.

_____

_____

_____

_____

(2)

(iii) Lead white is also used in paint. The white colour slowly darkens when lead sulfide is produced.

The painting can be restored with hydrogen peroxide. This converts the black lead sulfide into white lead sulfate.

Balance the equation for the reaction between lead sulfide and hydrogen peroxide (H_2O_2).

$$PbS(s) + _____H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$$

(1)

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(Total 8 marks)

Q30.

Hydrogen fluoride is used to make hydrofluoric acid.

(a) A company makes hydrogen fluoride by reacting solid calcium fluoride with sulfuric acid. The reaction takes place in a rotating kiln.

calcium fluoride + sulfuric acid → calcium sulfate + hydrogen fluoride

The company want this reaction to take place quickly.

(i) Rotating the kiln makes the reaction take place faster.

Suggest why.

_____

_____

(1)

(ii) Draw a ring around the correct word in each box.

To make the reaction take place **faster**:

the temperature should be [higher / lower] so that the particles have [less / more] energy

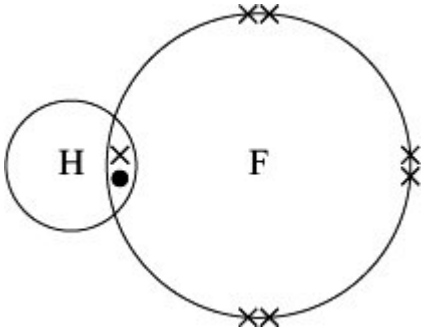
the solid calcium fluoride should be [powder / lumps] to give a [small / big] surface area

the sulfuric acid solution should be [dilute / concentrated] to give [less / more] collisions between the particles each second.

(3)

(b) The diagram represents a molecule of hydrogen fluoride.

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The hydrogen and fluorine atoms are joined by a covalent bond.

Use the correct word from the box to complete the sentence.

electrons	**neutrons**	**protons**

In a covalent bond the atoms share _____ .

(1)

(c) Hydrogen fluoride is dissolved in water to make an acidic solution of hydrofluoric acid.

Draw a ring around the symbol of the ion that makes the solution acidic.

H^+ **OH^-** **F^-**

(1)

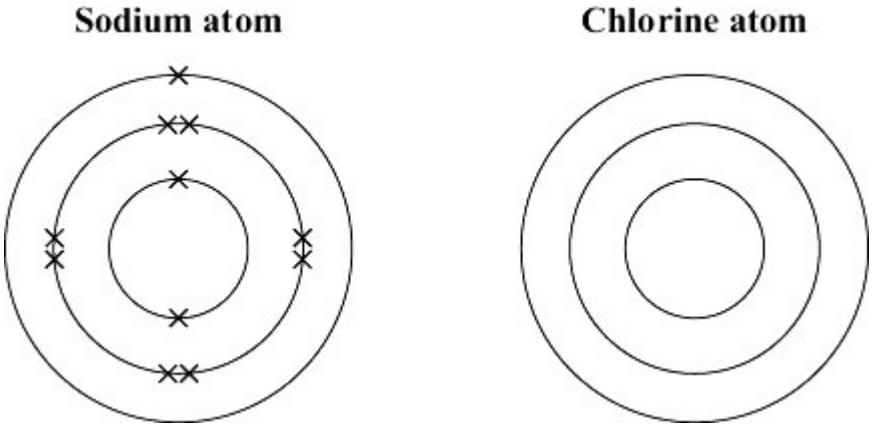
(Total 6 marks)

Q31.

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 ions (Na^+) and chloride ions (Cl^-).

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How does a sodium atom change into a sodium ion?

_____

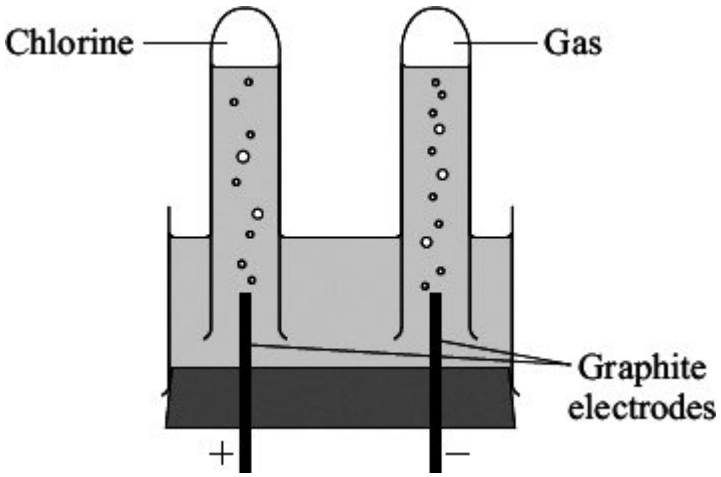
_____

_____

_____

(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.'

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(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?

_____

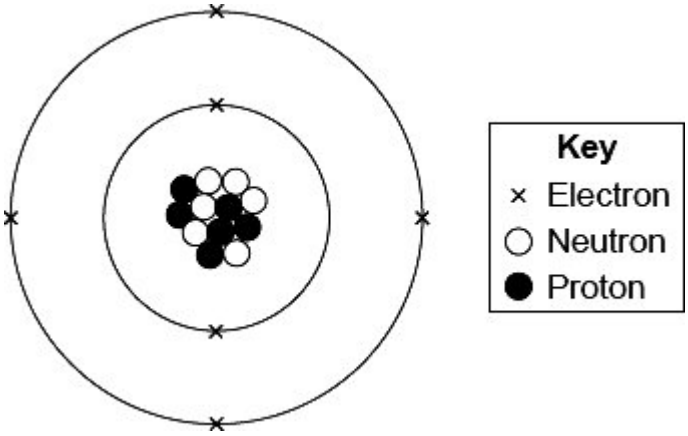
_____

(1)

(Total 8 marks)

Q32.

The diagram represents a carbon atom.



(a) Use words from the box to answer the questions.

electron	**neutron**	**nucleus**	**proton**

(i) What is the name of the central part of the atom?

_____

(1)

(ii) What is the name of the particle with no charge?

_____

(1)

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(iii) What is the name of the particle with a negative charge?

_____

(1)

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

(i) Draw a ring around the atomic (proton) number of this carbon atom.

6 **12** **18**

(1)

(ii) Draw a ring around the mass number of this carbon atom.

6 **12** **18**

(1)

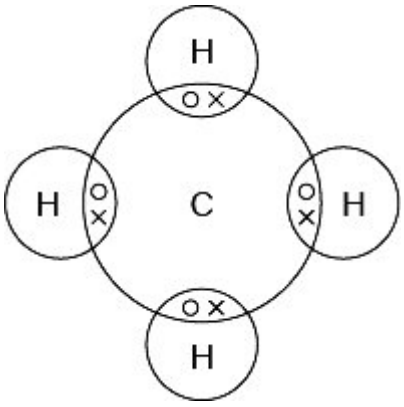
(c) A different carbon atom has 6 protons and 8 neutrons.

Draw a ring around the symbol that represents this atom.

$^{8}_{6}C$ $^{14}_{6}C$ $^{14}_{8}C$

(1)

(d) The diagram shows the bonding in a methane molecule.



(i) Draw a ring around the chemical formula of a methane molecule.

CH_4 **CH^4** **C_4H**

(1)

(ii) Draw a ring around the word that describes methane.

compound **element** **mixture**

(1)

(iii) Draw a ring around the type of bonding in a methane molecule.

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covalent **ionic** **metallic**

(1)

(Total 9 marks)

Q33.

This question is about lead iodide and magnesium iodide.

(a) Lead iodide can be made by mixing a solution containing lead ions with a solution containing iodide ions.

Lead iodide is formed as a solid.

lead ions in solution	+	iodide ions in solution	→	lead iodide solid

(i) Draw a ring around the name given to this type of reaction.

electrolysis **neutralisation** **precipitation**

(1)

(ii) Tick (✓) the method used to separate solid lead iodide from the solution.

Method	Tick (✓)
distillation	
evaporation	
filtration	

(1)

(iii) The table below gives information about the solubility of some compounds.

Soluble compounds	Insoluble compounds
all sodium and potassium salts	
all nitrates	
most chlorides, bromides and iodides	silver and lead chlorides, bromides and iodides

Use the table to help you to:

draw a ring around a soluble compound which contains lead ions

lead bromide **lead chloride** **lead nitrate**

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draw a ring around a soluble compound which contains iodide ions.

lead iodide **silver iodide** **sodium iodide**

(2)

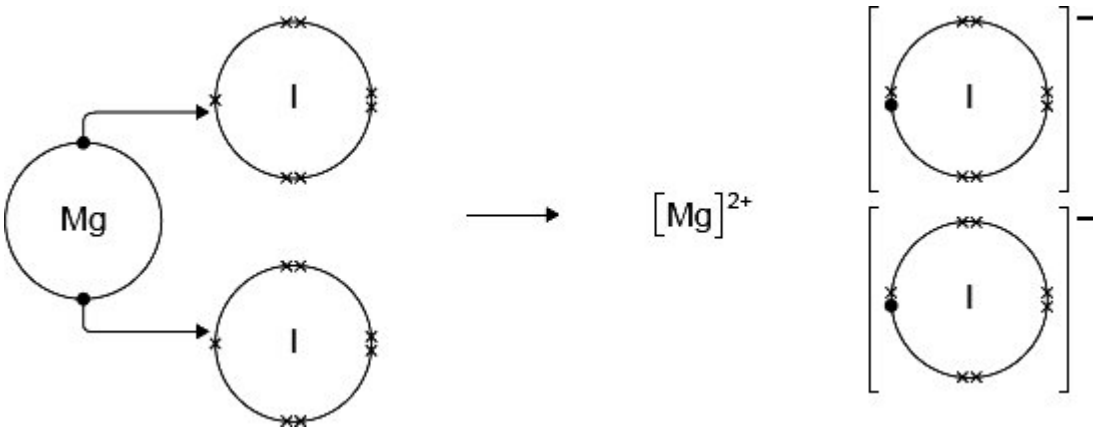
(b) Magnesium iodide can be made by reacting magnesium with iodine.

magnesium + iodine – magnesium iodide

The diagram shows how this takes place.

Only the outer electrons are shown.

The dots (●) and crosses(×) are used to represent electrons.



Use the diagram to help you to answer this question.

Describe, as fully as you can, what happens when magnesium reacts with iodine to make magnesium iodide.

To gain full marks you should use the words atom, electron and ion in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 8 marks)

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Q34.

This question is about some compounds of iodine.

(a) Lead iodide can be made by mixing a solution containing lead ions with a solution containing iodide ions.

Lead iodide is formed as a precipitate.

$$Pb^{2+}(aq) + 2I^{-}(aq) \rightarrow PbI_2(s)$$

(i) The table below gives information about the solubility of some compounds.

Soluble compounds	Insoluble compounds
all sodium and potassium salts	
all nitrates	
most chlorides, bromides and iodides	silver and lead chlorides, bromides and iodides

Use the table to help you name:

a soluble compound which contains lead ions _____

a soluble compound which contains iodide ions _____

(2)

(ii) Suggest a method of separating the lead iodide from the solution.

_____

(1)

(b) Magnesium iodide can be made by reacting magnesium with iodine.

$$Mg + I_2 \rightarrow MgI_2$$

Magnesium iodide is an ionic compound. It contains magnesium ions (Mg^{2+}) and iodide ions (I^{-}).

Describe, in terms of electrons, what happens when magnesium reacts with iodine.

_____

_____

_____

_____

_____

_____

_____

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_____

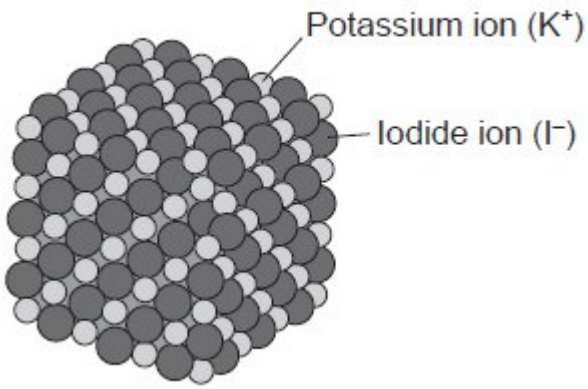
_____

_____

_____

(4)

(c) The diagram shows the structure of potassium iodide.



Explain why a high temperature is needed to melt potassium iodide.

_____

_____

_____

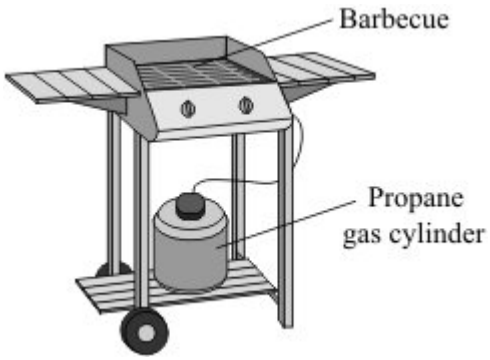
_____

(2)

(Total 9 marks)

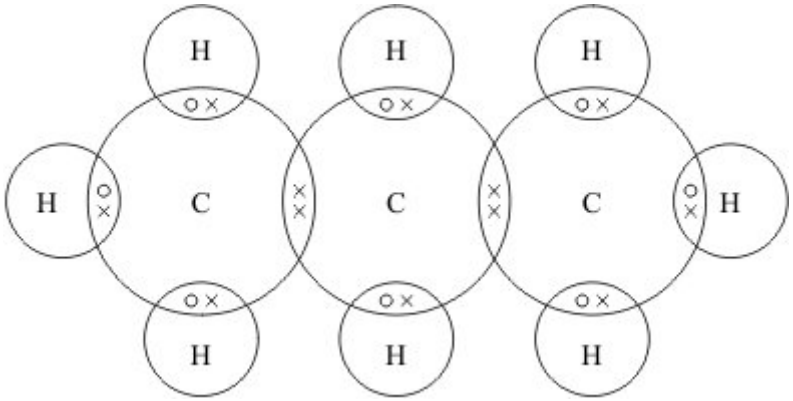
Q35.

This barbecue burns propane gas.



The diagram represents a propane molecule.

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(a) What is the formula of propane?

_____

(1)

(b) (i) Draw a ring around the name of the particle represented by the symbols ○ and × in the diagram.

electron **neutron** **proton**

(1)

(ii) Draw a ring around the type of bonding that holds the atoms together in a propane molecule.

covalent **ionic** **metallic**

(1)

(c) Under high pressure in the cylinder propane is a liquid.
Liquid propane evaporates easily to form a gas when the tap on the cylinder is opened.

Draw a ring around the correct answer in each box to explain why propane evaporates easily.

Propane has a [high / low] boiling point because it consists of [large / small] molecules.

(1)

(Total 4 marks)

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