AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.2.2 HOW BONDING AND STRUCTURE ARE RELATED TO THE PROPERTIES OF SUBSTANCES (PACK 5)

SCORE	PERCENTAGE
/353	%

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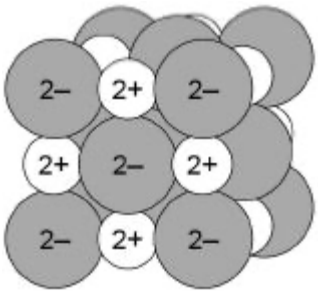
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Q1.

This question is about structure and bonding.

(a) **Figure 1** shows part of the structure of calcium oxide (CaO).

Figure 1



What type of bonding is present in calcium oxide?

Tick **one** box.

Covalent ☐

Ionic ☐

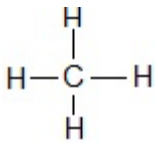
Macromolecular ☐

Metallic ☐

(1)

(b) **Figure 2** shows a particle of methane (CH_4).

Figure 2



What type of particle is present in **Figure 2**?

Tick **one** box.

An ion ☐

A lattice ☐

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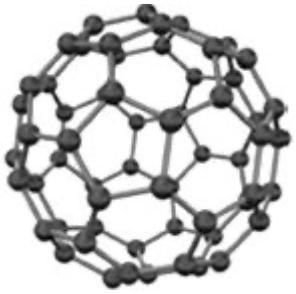
A molecule ☐

A polymer ☐

(1)

(c) **Figure 3** shows the structure of C_{60}

Figure 3



Complete the sentence.

Choose the answer from the box.

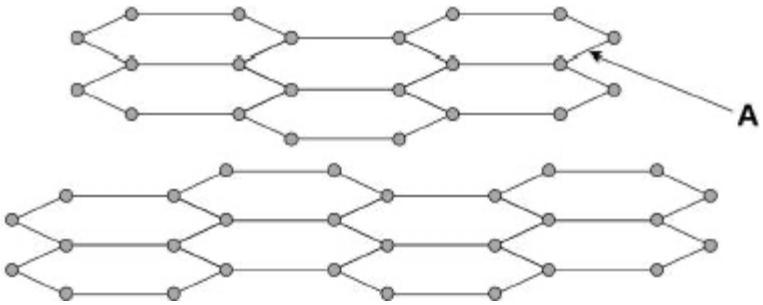
diatomic	**giant ionic**	**a fullerene**	**giant metallic**

The structure of C_{60} is _____ .

(1)

Figure 4 shows the structure of graphite.

Figure 4



(d) What type of bond is labelled **A** in **Figure 4**?

Tick **one** box.

covalent ☐

double ☐

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ionic ☐

metallic ☐

(1)

(e) In graphite, each carbon atom forms bonds with other carbon atoms as shown in **Figure 4**

How many electrons does **one** carbon atom use to form **one** bond?

Tick **one** box.

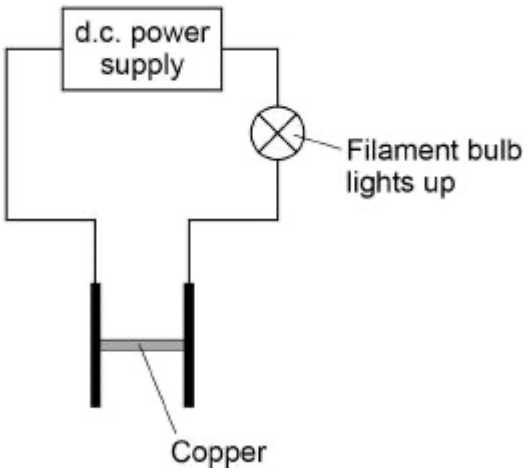
1 ☐ **2** ☐ **3** ☐ **4** ☐

(1)

An electric current is passed through copper.

Figure 5 shows the apparatus used.

Figure 5



(f) Complete the sentence.

Choose the answer from the box.

gas	**liquid**	**solid**	**solution**

Figure 5 shows that copper conducts electricity as a _____ .

(1)

(g) Complete the sentence.

Choose the answer from the box.

atoms	**electrons**	**ions**	**molecules**

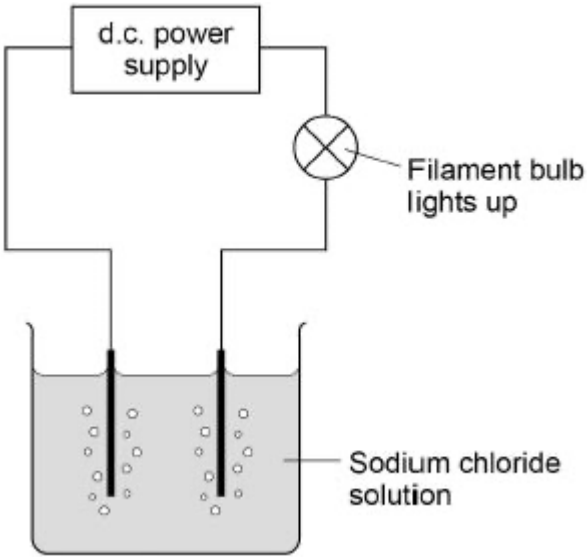
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Copper conducts electricity because of the movement of delocalised _____ .

(1)

(h) **Figure 6** shows the apparatus used to investigate the effect of electricity on sodium chloride solution.

Figure 6



Complete the sentence.

Choose the answer from the box.

dissolved	**gaseous**	**molten**

Figure 6 shows that sodium chloride conducts electricity when _____ .

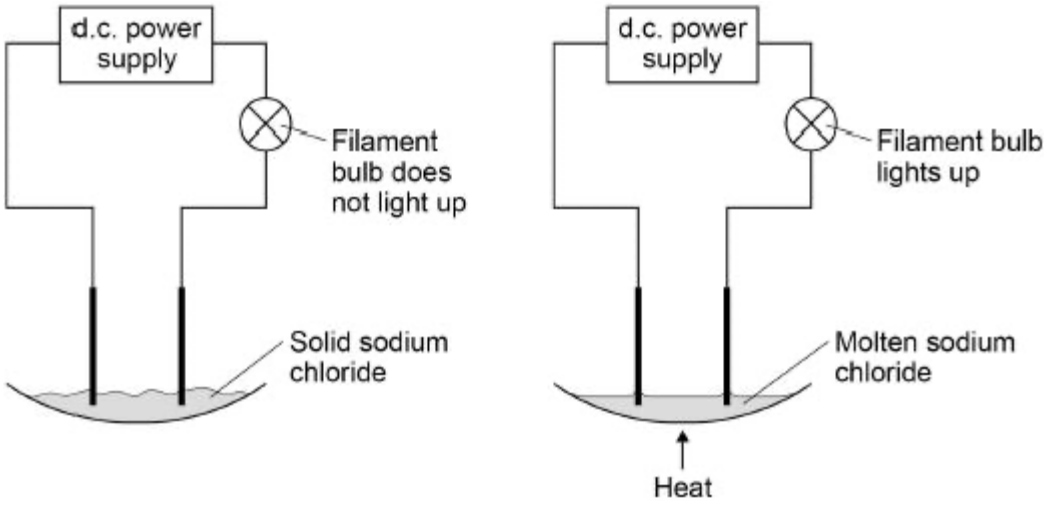
(1)

(i) Sodium chloride is made up of ions.

Figure 7 shows the apparatus used to investigate the effect of electricity on solid sodium chloride and molten sodium chloride.

Figure 7

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The table below shows the results.

	Solid sodium chloride	**Molten sodium chloride**
Observation	The filament bulb does not light up	The filament bulb lights up
Deduction	Does not conduct electricity	Does conduct electricity

Draw **one** line from each statement to the correct reason.

Statement	**Reason**
	The ions are fixed.
Solid sodium chloride does not conduct electricity.	The ions are mobile.
Molten sodium chloride conducts electricity.	The ions are neutral.
	The ions are vibrating.

(2)

(Total 10 marks)

Q2.

This question is about the halogens.

(a) Which group in the periodic table is known as the halogens?

Tick **one** box.

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Group 1 ☐

Group 2 ☐

Group 7 ☐

Group 0 ☐

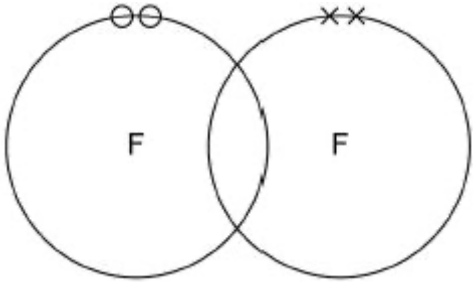
(1)

(b) A fluorine atom has 7 electrons in the outer shell.

The diagram below shows part of a dot and cross diagram to represent a molecule of fluorine (F_2).

Complete the dot and cross diagram.

You should show only the electrons in the outer shells.



(2)

(c) Chlorine reacts with potassium bromide solution.

Complete the word equation.

chlorine + potassium bromide → _____ + _____

(2)

(d) What type of reaction happens when chlorine reacts with potassium bromide solution?

Tick **one** box.

decomposition ☐

displacement ☐

neutralisation ☐

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precipitation ☐

(1)

(e) Complete the sentence.

Choose the answer from the box.

an atom	**an electron**	**a neutron**	**a proton**

Chlorine is more reactive than bromine.

This is because chlorine gains _____ more easily.

(1)

(f) How does the size of a chlorine atom compare with the size of a bromine atom?

Complete the sentence.

Choose the answer from the box.

bigger than	**the same size as**	**smaller than**

A chlorine atom is _____ a bromine atom.

(1)

(g) Give a reason for your answer to part **(f)**

Reason _____

_____

(1)

(h) Fluorine reacts with chlorine to produce ClF_3

Balance the chemical equation for the reaction.

$$Cl_2 + _____F_2 \longrightarrow 2\ ClF_3$$

(1)

(i) Explain why fluorine is a gas at room temperature.

Use the following words in your answer:

energy **forces** **molecules** **weak**

_____

_____

_____

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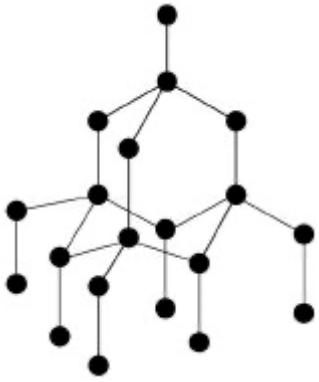
(3)
(Total 13 marks)

Q3.

This question is about structure and bonding.

(a) **Figure 1** shows part of the structure and bonding in diamond.

Figure 1



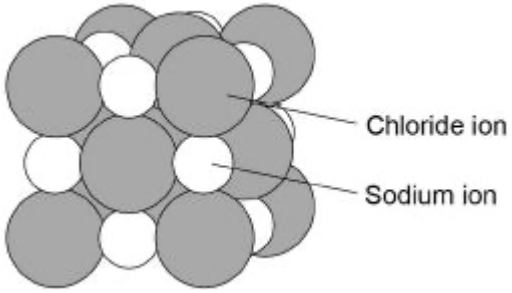
Explain why diamond has a high melting point.

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(3)

(b) **Figure 2** shows part of the structure and bonding in sodium chloride (NaCl).

Figure 2



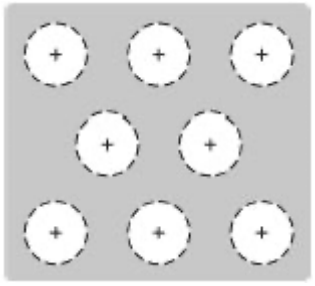
Explain the conditions needed for sodium chloride to conduct electricity.

(3)

(c) **Figure 3** shows the structure of sodium.

Figure 3

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Describe how sodium conducts thermal energy.

(3)
(Total 9 marks)

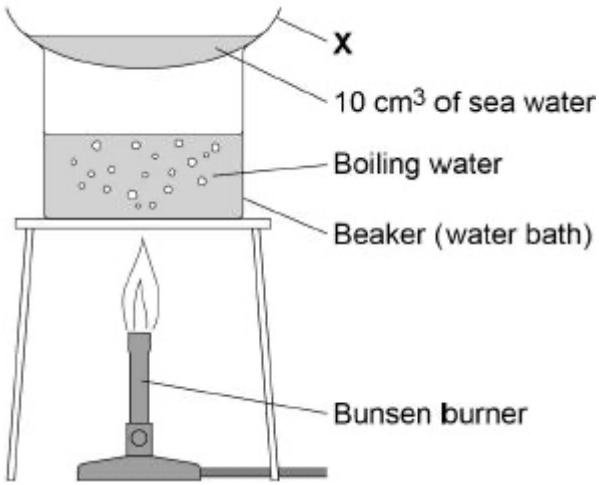
Q4.

A student tested a sea water sample for dissolved solids.

Figure 1 shows the apparatus.

Figure 1

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(a) What is apparatus **X** on **Figure 1**?

Tick **one** box.

Boiling tube ☐

Condenser ☐

Funnel ☐

Watch glass ☐

(1)

(b) The student did the test four times.

The student calculated the mass of solid on apparatus **X** after heating.

The table below shows the student's results.

	Test 1	**Test 2**	**Test 3**	**Test 4**
Mass of solid in grams	0.12	0.29	0.14	0.15

Calculate the mean mass of solid.

Do not include the anomalous result in your calculation.

Give your answer to 2 significant figures.

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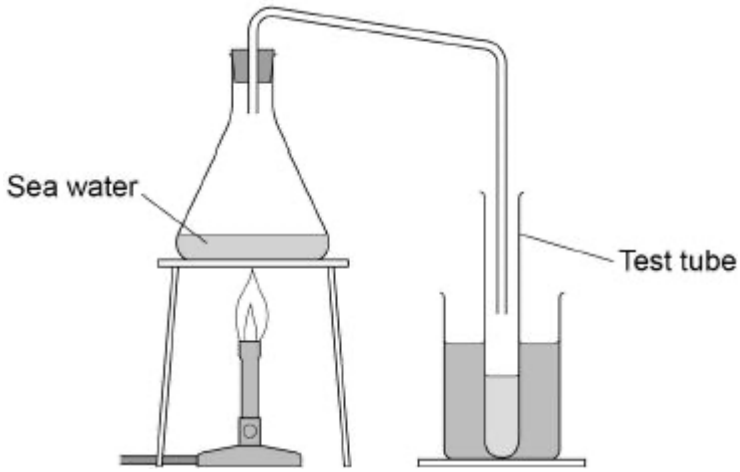
_____

Mean mass = _____ g

(3)

The student distilled a sample of sea water in the apparatus shown in **Figure 2**

Figure 2



(c) What change of state is happening at the surface of the sea water in **Figure 2**?

_____

(1)

(d) Describe how the water in the test tube in **Figure 2** is different from the sea water.

_____

_____

(1)

(e) Why does producing drinking water from sea water using distillation cost a lot of money?

_____

_____

(1)

(f) River water is filtered then sterilised to make drinking water.

Why are these **two** processes done?

Filtering _____

_____

Sterilising _____

_____

(2)

(Total 9 marks)

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Q5.

Fertilisers are formulations.

(a) What is a formulation?

_____

_____

(1)

(b) A bag of fertiliser contains 14.52 kg of ammonium nitrate (NH_4NO_3).

Relative formula mass (M_r): NH_4NO_3 = 80

Calculate the number of moles of ammonium nitrate in the bag of fertiliser.

Give your answer in standard form to 2 significant figures.

_____

_____

_____

_____

_____

_____

_____

_____

Moles of ammonium nitrate = _____ mol

(4)

(c) The fertiliser also contains potassium chloride.

Explain why potassium chloride has a high melting point.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

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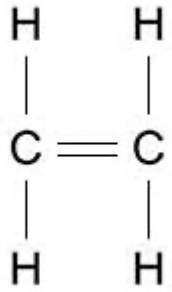
(Total 9 marks)

Q6.

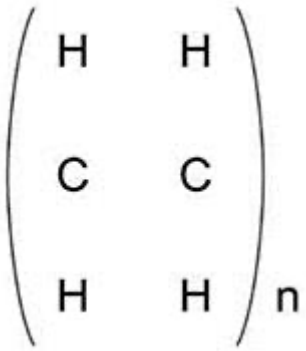
Supermarket carrier bags can be made from poly(ethene).

(a) Poly(ethene) is produced from ethene.

The structure of ethene is:



Complete the structure of poly(ethene).

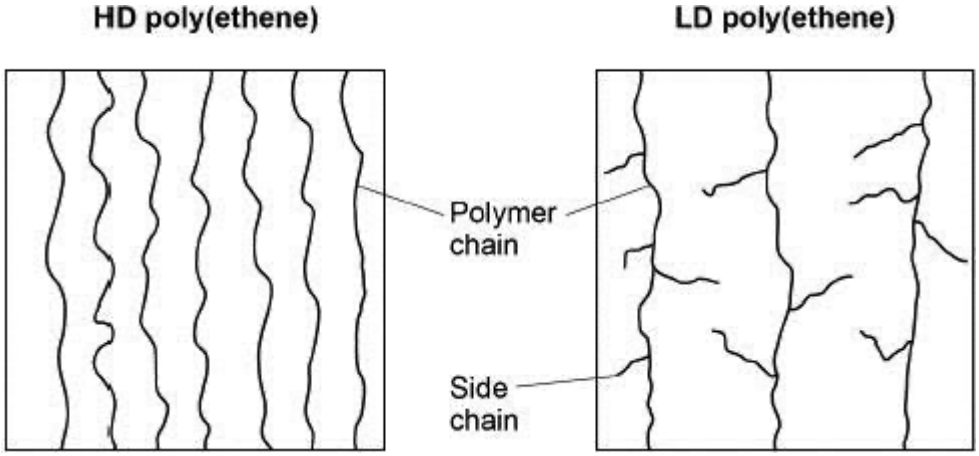


(2)

There are two types of poly(ethene): HD poly(ethene) and LD poly(ethene).

(b) **Figure 1** shows the polymer chains in HD poly(ethene) and LD poly(ethene).

Figure 1



Describe the differences in the structure and arrangement of the polymer chains in

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the two types of poly(ethene).

(2)

A student investigated how poly(ethene) extends when a force is applied.

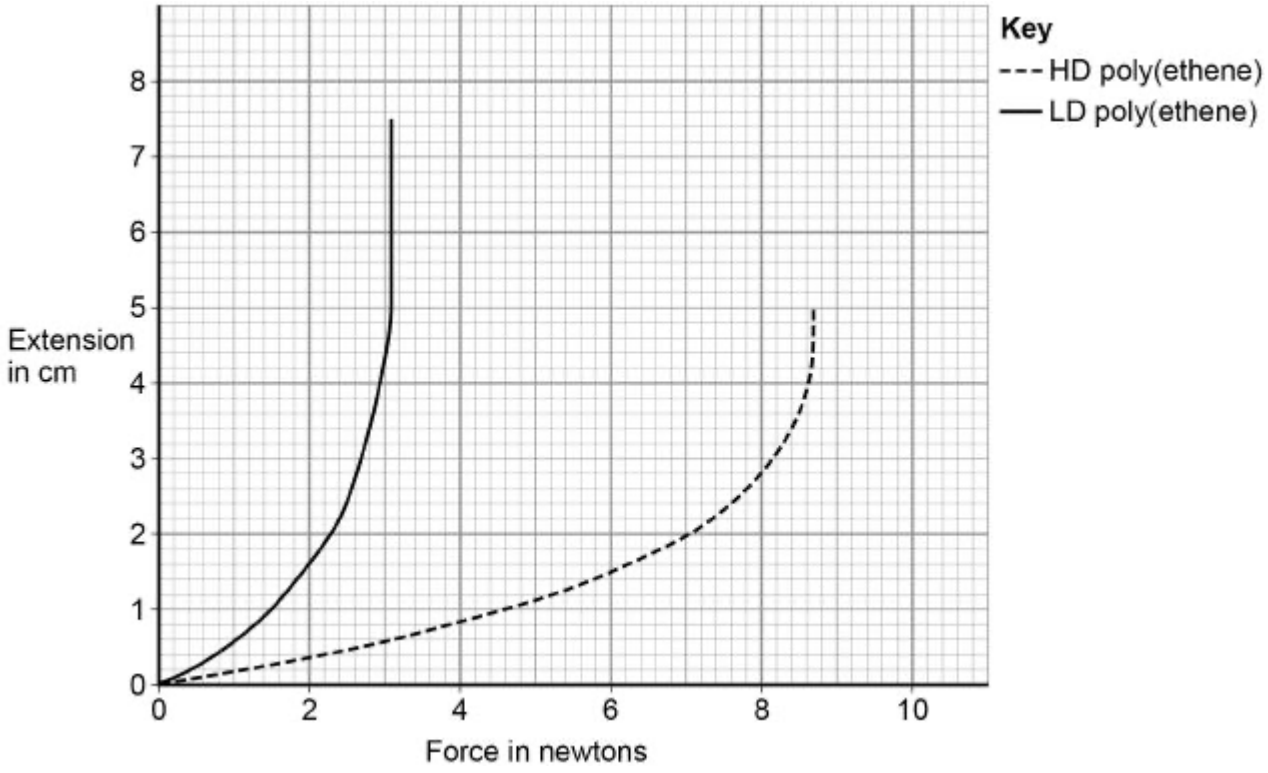
(c) Describe a method to investigate how the extension of poly(ethene) changes with the force applied.

(4)

Figure 2 shows the results for HD poly(ethene) and LD poly(ethene).

Figure 2

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(d) Give **two** comparisons between the results for HD poly(ethene) and for LD poly(ethene).

Use **Figure 2**.

1. _____

_____

2. _____

_____

(2)

(e) Carrier bags in supermarkets used to be provided free. Supermarkets now make customers pay for carrier bags.

When they were free, 8.0 billion new carrier bags were used each year.

After supermarkets started making customers pay for carrier bags, the use of new bags dropped by 85%.

Calculate how many carrier bags are now used each year.

_____

_____

_____

Number of bags = _____

(2)

(f) There are two types of carrier bag in common use:

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- disposable bags
- bags for life.

Bags for life can be returned to the supermarket when no longer usable.

The supermarket replaces the bag for life free of charge and arranges for the bag to be recycled.

The table below shows data from a life cycle assessment (LCA) for the two types of carrier bag.

	Disposable bag	**Bag for life**
Type of polymer	HD poly(ethene)	LD poly(ethene)
Raw material from which polymer is made	Crude oil	Crude oil
Mass of waste material per bag from production in grams	0.42	0.17
Mass of carbon dioxide emitted per bag during production and transport in grams	1.6	6.9
Mean number of times used	1	6
Possible disposal methods	Landfill Incineration Recycling	Landfill Incineration Recycling

Evaluate the use of each type of carrier bag.

Use data from the table above and your own knowledge.

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(6)

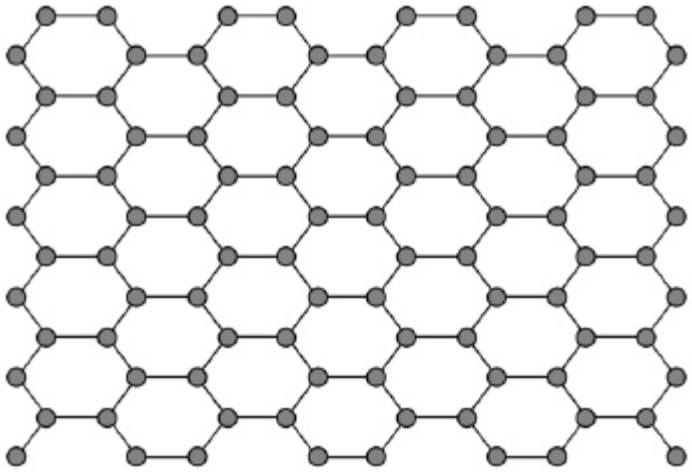
(Total 18 marks)

Q7.

This question is about structure and bonding.

(a) **Figure 1** shows part of one layer of graphene.

Figure 1



Which element is graphene made from?

Tick **one** box.

Carbon ☐

Copper ☐

Hydrogen ☐

Sodium ☐

(1)

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(b) Each atom in graphene has one delocalised electron.

Complete the sentence.

Choose the answer from the box.

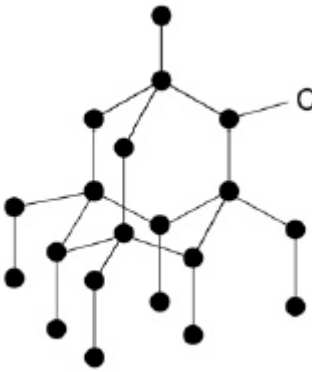
act as a lubricant	**be used as a fuel**
conduct electricity	**dissolve in water**

Delocalised electrons allow graphene to _____ .

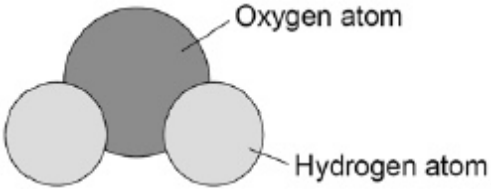
(1)

(c) Which structure is a fullerene?

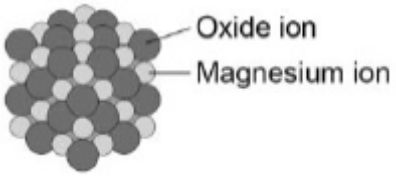
Tick **one** box.



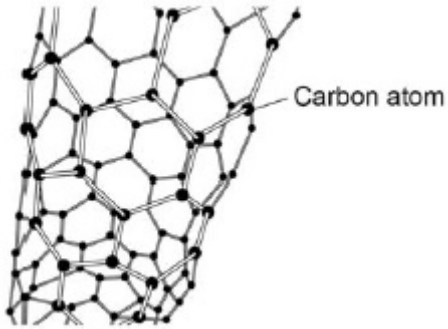
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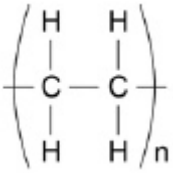
☐

(1)

Figure 2 shows part of a large hydrocarbon molecule.

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Figure 2



(d) Which **two** elements are in all hydrocarbons?

1. _____

2. _____

(2)

(e) Complete the sentence.

Choose the answer from the box.

an atom	**a metal**	**a polymer**	**a salt**

The large molecule represented in **Figure 2** is _____ .

(1)

(f) Complete the sentence.

Choose the answer from the box.

attract	**bond**	**slide**	**vibrate**

Metals can be stretched into wires

because the layers of atoms can _____ .

(1)

(Total 7 marks)

Q8.

This question is about compounds of fluorine.

(a) A fluorine atom has 7 electrons in the outer shell.

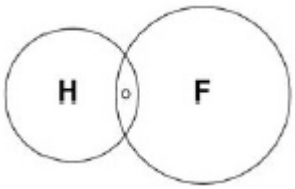
Figure 1 shows part of a dot and cross diagram of a molecule of hydrogen fluoride (HF).

Complete the dot and cross diagram in **Figure 1**.

You should show only the electrons in the outer shells.

Figure 1

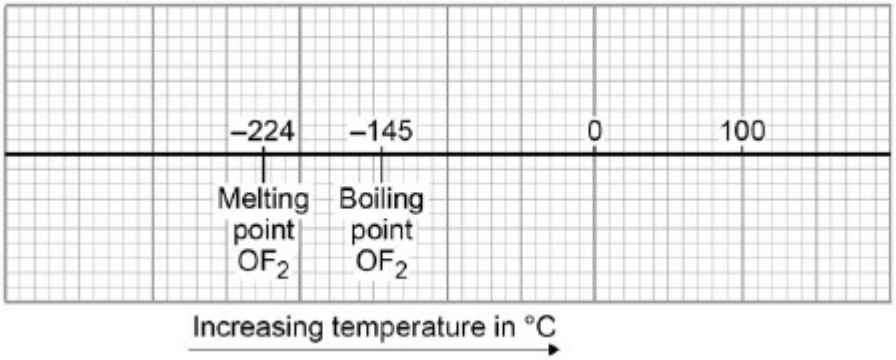
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(1)

Figure 2 shows the boiling point and melting point of oxygen difluoride (OF_2).

Figure 2



(b) What is the state of oxygen difluoride at –200 °C?

Tick **one** box.

Aqueous (aq) ☐

Gas (g) ☐

Liquid (l) ☐

Solid (s) ☐

(1)

(c) What change of state occurs when oxygen difluoride is cooled from –220 °C to –230 °C?

Tick **one** box.

Condensing ☐

Evaporating ☐

Freezing ☐

Melting ☐

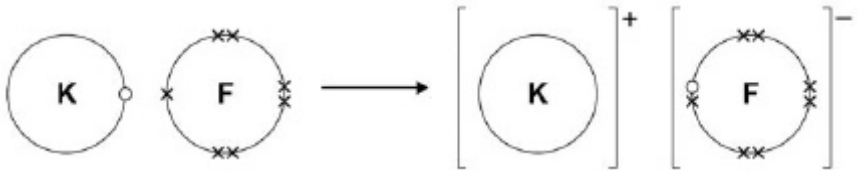
(1)

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Potassium reacts with fluorine to produce the ionic compound potassium fluoride (KF).

Figure 3 shows the transfer of electrons during the reaction.

Figure 3



(d) Describe what happens when potassium reacts with fluorine to produce potassium fluoride.

Write about electron transfer in your answer.

(5)

(e) Potassium fluoride is an ionic compound.

Explain why ionic compounds have high melting points.

Use the following words in your answer:
- attraction
- energy
- ions.

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_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 13 marks)

Q9.

Three substances are all solid at room temperature.

The table describes tests and the result of each test on the three substances.

Substance	**Effect of large force applied**	**Effect of heating gently at first, then strongly**	**Effect of passing electricity through solid**	**Effect of passing electricity through liquid**
A	Breaks into many pieces	Easily melts and then boils	Does not conduct	Does not conduct
B	Breaks into many pieces	No change	Does not conduct	Conducts
C	Becomes thinner	No change	Conducts	Conducts

(a) The covalent bonds in the molecules are not overcome when substance **A** is heated.

What forces are overcome when substance **A** melts?

_____

(1)

(b) What could substance **A** be?

Tick **one** box.

Graphite ☐

Iron ☐

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Sodium chloride ☐

Sulfur ☐

(1)

(c) Suggest why substance **B** conducts electricity as a liquid but does **not** conduct electricity as a solid.

_____

_____

_____

_____

_____

_____

(3)

(d) Suggest why substance **C** becomes thinner when a large force is applied.

_____

_____

_____

_____

(2)

(e) What could substance **C** be?

Tick **one** box.

Copper ☐

Diamond ☐

Iodine ☐

Magnesium oxide ☐

(1)

(Total 8 marks)

Q10.

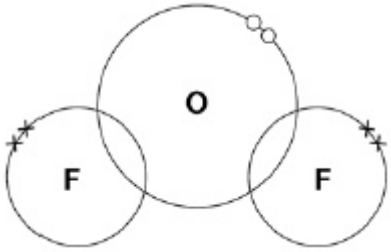
This question is about oxygen.

(a) One oxygen atom shares one pair of electrons with each fluorine atom in oxygen difluoride (OF_2).

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Complete the dot and cross diagram of oxygen difluoride below.

You should show only the electrons in the outer shells.



(2)

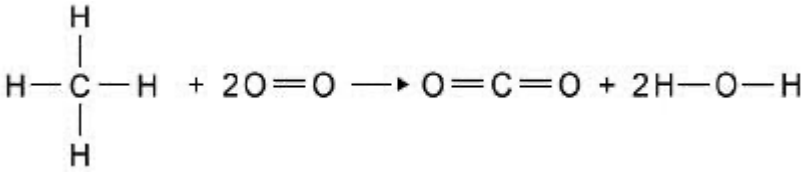
(b) Oxygen difluoride (OF_2) has a melting point of – 224 °C and a boiling point of –145 °C

What is the state of oxygen difluoride at room temperature?

Explain your answer in terms of structure and bonding.

(4)

(c) The equation shows the reaction of methane with oxygen.



The table shows the bond energies.

Bond	**C–H**	**O=O**	**C=O**	**O–H**
Bond dissociation energy in kJ per mole	412	496	803	463

Calculate the overall energy change for the combustion of one mole of methane.

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Energy change = _____ kJ mol^{-1}

(3)

(Total 9 marks)

Q11.

Tablets to cure indigestion contain a mixture that has been designed as a useful product.

(a) Complete the sentence.

Choose the answer from the box.

catalyst	**formulation**	**hydrocarbon**	**solvent**

Tablets to cure indigestion are an example of a _____ .

(1)

The table shows the substances in one tablet.

Substance	**Mass in mg**
Sodium hydrogencarbonate	64
Calcium carbonate	522
Magnesium carbonate	68

(b) The total mass of these substances in the tablet is 654 mg

What is the approximate fraction of magnesium carbonate in the total mass of these substances?

Tick **one** box.

$\frac{1}{10}$ ☐ $\frac{1}{100}$ ☐ $\frac{1}{1000}$ ☐ $\frac{1}{10\,000}$ ☐

(1)

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(c) The tablets also contain sugar.

Suggest why.

_____

_____

(1)

(d) Sodium hydrogencarbonate cures indigestion by reacting with acid in the stomach.

What type of reaction is this?

Tick **one** box.

Combustion ☐

Displacement ☐

Neutralisation ☐

(1)

A student adds an indigestion tablet to dilute hydrochloric acid.

(e) The gas produced is bubbled through limewater.

The gas turns the limewater milky.

Name the gas produced.

_____

(1)

(f) Water is also produced.

Which **two** statements are reasons why water is a liquid at room temperature?

Tick **two** boxes.

Water has a boiling point of 100 °C ☐

Water has a giant covalent structure ☐

Water has a melting point lower than room temperature ☐

Water has delocalised electrons ☐

Water is made of ions ☐

(2)

(g) Calcium chloride is also produced.

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- The formula for a calcium ion is Ca^{2+}
- The formula for a chloride ion is Cl^-

What is the formula of calcium chloride?

Tick **one** box.

$CaCl$ ☐ Ca_2Cl ☐ $CaCl_2$ ☐ Ca_2Cl_2 ☐

(1)

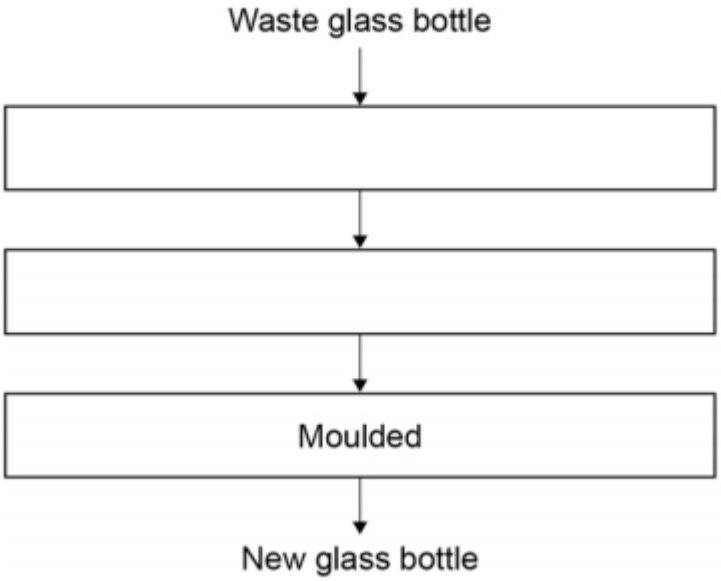
(h) The tablets are stored in glass bottles.

The flow chart shows part of a flowchart for recycling glass.

Complete the flow chart.

Choose the answers from the box.

crushed	**electrolysed**	**frozen**	**melted**	**oxidised**



(2)

(Total 10 marks)

Q12.

This question is about copper and its compounds.

(a) The table shows information about bioleaching and phytomining.

Bioleaching and phytomining are used to extract copper from low grade ores.

	Bioleaching	**Phytomining**
Metal extracted	Waste from quarrying	Contaminated ground

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from		
Speed of process	Very slow	Slow, made more efficient using quick-growing plants
Pollution	Produces a solution of toxic chemicals which may run off into rivers Takes a long time to stop the process if river pollution occurs	Involves combustion of plants but decontaminates polluted ground

Compare phytomining and bioleaching.

Use the information in the table.

(4)

(b) Describe how copper sulfate solution is obtained from the plants used in phytomining.

(2)

(c) Copper is displaced from a solution of copper sulfate using iron.

Write a balanced symbol equation for this reaction.

(2)

(d) How does this displacement reaction take place?

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Tick **one** box.

Electron sharing ☐

Electron transfer ☐

Proton transfer ☐

(1)

(e) Describe how copper conducts electricity.

_____

_____

_____

_____

(2)

(f) Suggest how anhydrous copper sulfate is used to test for water.

_____

_____

_____

_____

(2)

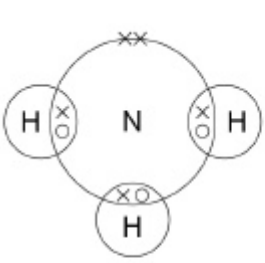
(Total 13 marks)

Q13.

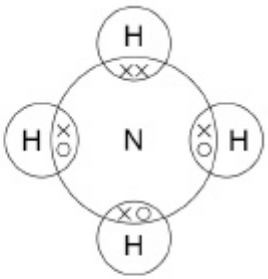
This question is about ammonia (NH_3) and compounds of ammonia.

(a) Which diagram shows the arrangement of outer shell electrons in a molecule of ammonia?

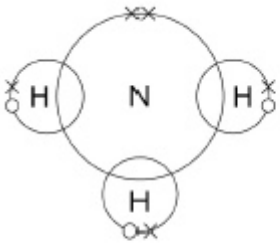
Tick **one** box.



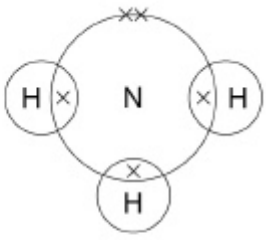
☐



☐



☐



☐

(1)

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(b) What type of bonding is present in ammonia?

Tick **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

(1)

Ammonia is produced by reacting nitrogen and hydrogen.

(c) Balance the equation for the reaction.

$$N_2 + 3H_2 \rightleftharpoons ___NH_3$$

(1)

(d) What does the sign $\rightleftharpoons$ represent?

_____

(1)

(e) Ammonia dissolves in water to form an alkaline solution.

Ammonia solution reacts with an acid to produce a salt, ammonium nitrate.

Which acid is used to produce ammonium nitrate?

Tick **one** box.

Citric acid ☐

Hydrochloric acid ☐

Nitric acid ☐

Sulfuric acid ☐

(1)

A student investigated the temperature change when ammonium nitrate is dissolved in water.

This is the method used.

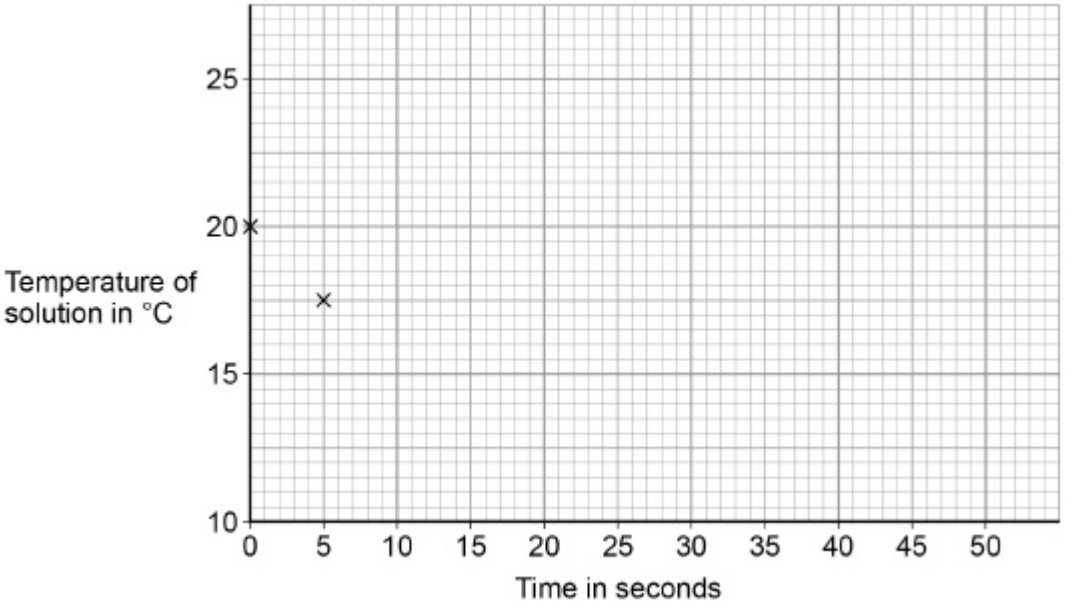
1. Add ammonium nitrate to water.
2. Stir the mixture.
3. Record the temperature of the solution every 5 seconds.

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The table shows the results.

Time in seconds	Temperature of solution in °C
0	20.0
5	17.5
10	15.5
15	14.0
20	13.0
25	12.5
30	12.0
35	12.0

The graph shows some of the student's results.



(f) Complete the graph.

- Plot the data from the table on the graph.
- Draw a line of best fit. Your line should be a smooth curve.

(3)

(g) Use the table to suggest a value for room temperature.

_____

(1)

(h) What is **one** use for the dissolving of ammonium nitrate in water?

Tick **one** box.

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Cold pack to treat injuries ☐

Glow sticks ☐

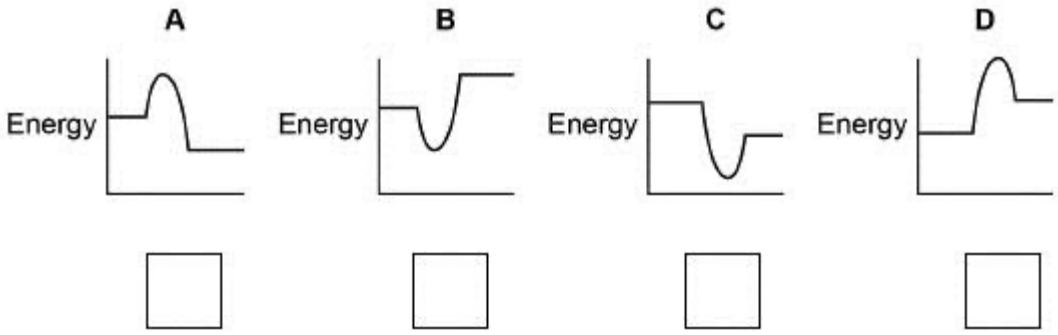
Hand warmers ☐

Self-heating can to warm food ☐

(1)

(i) Which reaction profile diagram represents the dissolving of ammonium nitrate in water?

Tick **one** box.



☐ ☐ ☐ ☐

(1)

(Total 11 marks)

Q14.

Figure 1 shows the information label from a hairdryer.

Figure 1

50 Hz	230 V	2100 W

(a) What is the power of the hairdryer?

Tick **one** box.

50 Hz ☐

230 V ☐

2100 W ☐

(1)

(b) What is the equation which links current, potential difference and power?

Tick **one** box.

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power = potential difference × current ☐

$$\text{power} = \frac{\text{potential difference}}{\text{current}}$$ ☐

$$\text{power} = \frac{\text{current}}{\text{potential difference}}$$ ☐

(1)

(c) The mains electricity supply in the UK is an alternating current (ac).

What is the frequency of the UK ac supply?

_____

(1)

(d) Some electrical appliances use batteries.

What type of current does a battery supply?

Tick **one** box.

Alternating current (ac) only ☐

Direct current (dc) only ☐

Both ac and dc ☐

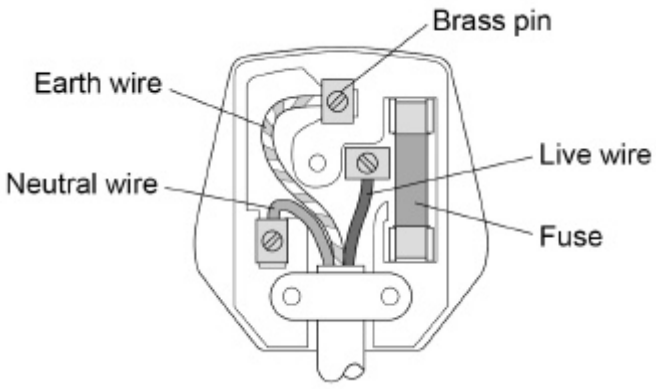
Not ac or dc ☐

(1)

The hairdryer is connected to the mains electricity supply by a plug.

Figure 2 shows the inside of a plug.

Figure 2



(e) Draw **one** line from each wire to the colour of insulation around the wire.

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Wire	Colour of insulation around wire
	Blue
Live	Brown
	Green
Neutral	White
	Yellow

(2)

(f) The insulation around the Earth wire has two colours.

What are the **two** colours?

_____ and _____

(1)

(g) Brass is an alloy of copper and zinc.

Give **two** properties of brass that make it suitable to use in the plug.

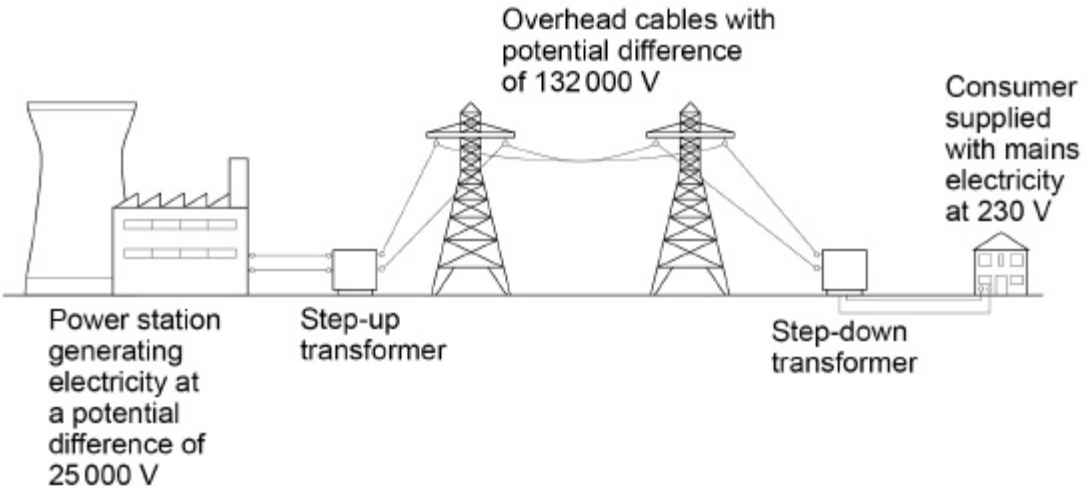
1. _____

2. _____

(2)

(h) **Figure 3** shows how the National Grid links power stations to consumers.

Figure 3



Describe how electrical power is transferred from power stations to consumers by

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the National Grid.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 13 marks)

Q15.

This question is about beryllium.

(a) Beryllium is in Group 2.

What does this tell you about the electronic structure of beryllium?

_____

_____

(1)

Beryllium is found in beryllium aluminium silicate.

The formula of beryllium aluminium silicate is $Be_3Al_2(SiO_3)_6$

(b) What is the ratio of atoms of each element in beryllium aluminium silicate?

_____

Ratio of Be : Al : Si : O = ___ : ___ : ___ : ___

(1)

(c) What percentage by mass of beryllium is in beryllium aluminium silicate?

Give your answer to 2 significant figures.

Relative atomic mass (A_r) of Be = 9

Relative formula mass (M_r) of $Be_3Al_2(SiO_3)_6$ = 537

_____

_____

Percentage of beryllium = _____ %

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(2)

Beryllium can be extracted from beryllium chloride.

Beryllium chloride ($BeCl_2$) is heated with potassium to produce beryllium and potassium chloride (KCl).

(d) Complete the equation for the reaction.

Your equation should be balanced.

$BeCl_2$ + _____ → _____ + _____

(2)

(e) Explain why beryllium is produced when potassium is heated with beryllium chloride.

You should refer to reactivity in your answer.

_____

_____

_____

_____

(2)

(f) Describe a test to show that beryllium is a metal.

Give the result of the test.

Test _____

_____

Result _____

_____

(2)

(Total 10 marks)

Q16.

This question is about ammonia.

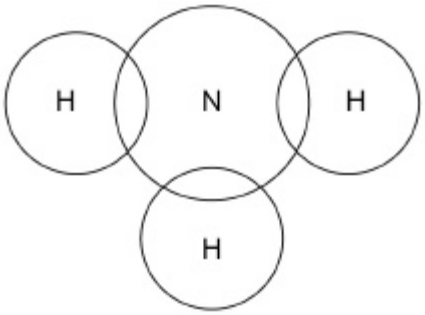
(a) **Figure 1** shows the outer electron shells in an ammonia molecule.

Complete **Figure 1** to show a dot and cross diagram for an ammonia molecule.

Show the outer shell electrons only.

Figure 1

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(2)

(b) Explain why ammonia is a gas at room temperature.

(3)

In industry, ammonia is produced by reacting nitrogen with hydrogen.

The equation for this reaction is:

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

(c) Calculate the minimum mass of nitrogen required to produce 72.0 grams of ammonia.

Assume all the nitrogen reacts to produce ammonia.

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

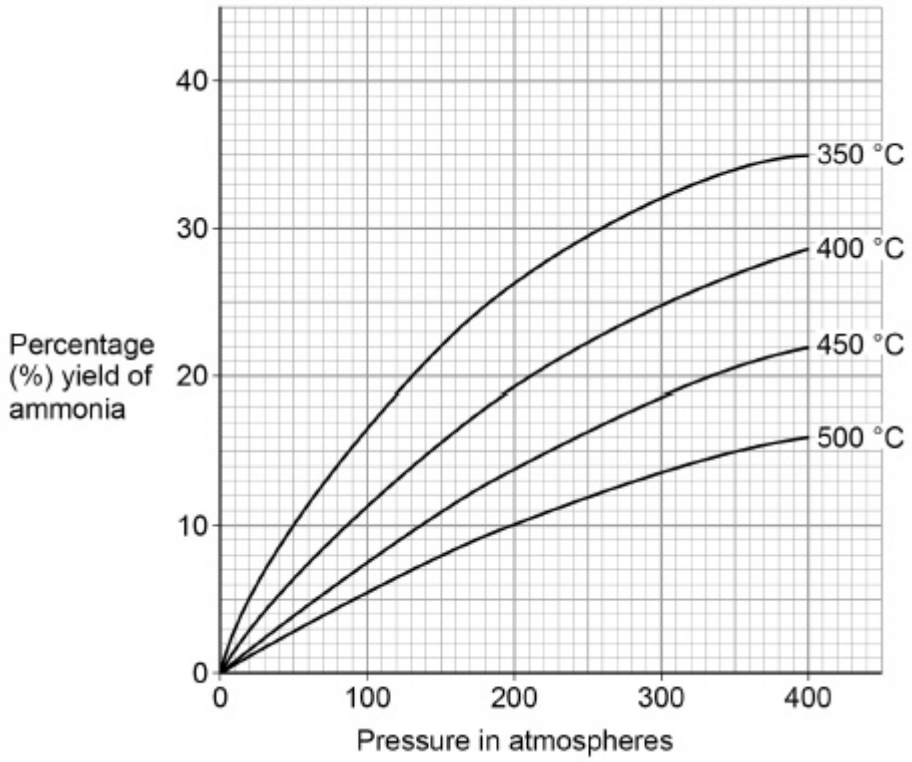
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Mass of nitrogen = _____ grams

(5)

Figure 2 shows information about the percentage yield of ammonia under varying conditions.

Figure 2



The conditions used in the industrial process to produce ammonia are:

- 200 atmospheres pressure
- 450 °C
- iron catalyst.

(d) What is the percentage yield of ammonia under these conditions?

Percentage of ammonia = _____ %

(1)

(e) Suggest reasons why these conditions are used in the industrial process.

You should use:

- the equation for the reaction
- information from **Figure 2**
- your knowledge of reversible reactions.

You should refer to **both** yield **and** rate of reaction in your answer.

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(6)

(Total 17 marks)

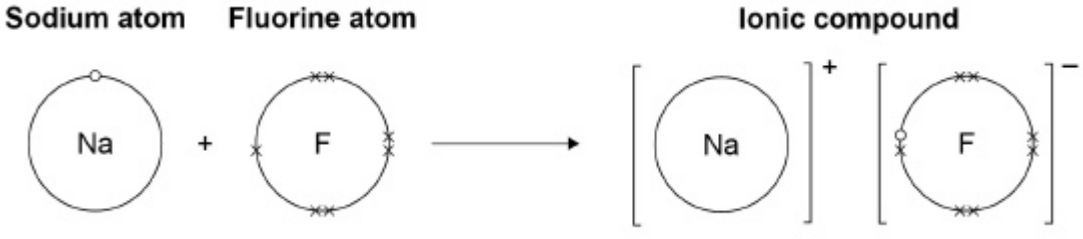
Q17.

A sodium atom and a fluorine atom react together to form an ionic compound.

Figure 1 shows the electron arrangements in the atoms and the ionic compound.

Only the outer shell electrons are shown.

Figure 1



(a) What is the name of the ionic compound shown in **Figure 1**?

Tick **one** box.

Sodium fluorate ☐

Sodium fluoride ☐

Sodium fluorine ☐

(1)

(b) What type of force acts between the ions in an ionic compound?

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Tick **one** box.

Electrostatic ☐

Frictional ☐

Gravitational ☐

Magnetic ☐

(1)

(c) What are **two** properties of ionic compounds?

Tick **two** boxes.

Conducts electricity when molten ☐

High melting point ☐

Low boiling point ☐

Small molecules ☐

Weak bonds between particles ☐

(2)

(d) Describe what happens when a sodium atom reacts with a fluorine atom to form an ionic compound.

Use **Figure 1**.

_____

_____

_____

_____

_____

_____

_____

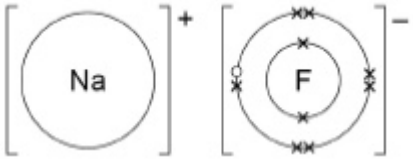
_____

(4)

(e) **Figure 2** shows the structure of the ionic compound formed in the reaction.

Figure 2

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Suggest **one** limitation of using **Figure 2** to show the structure of this compound.

_____

_____

(1)

(Total 9 marks)

Q18.

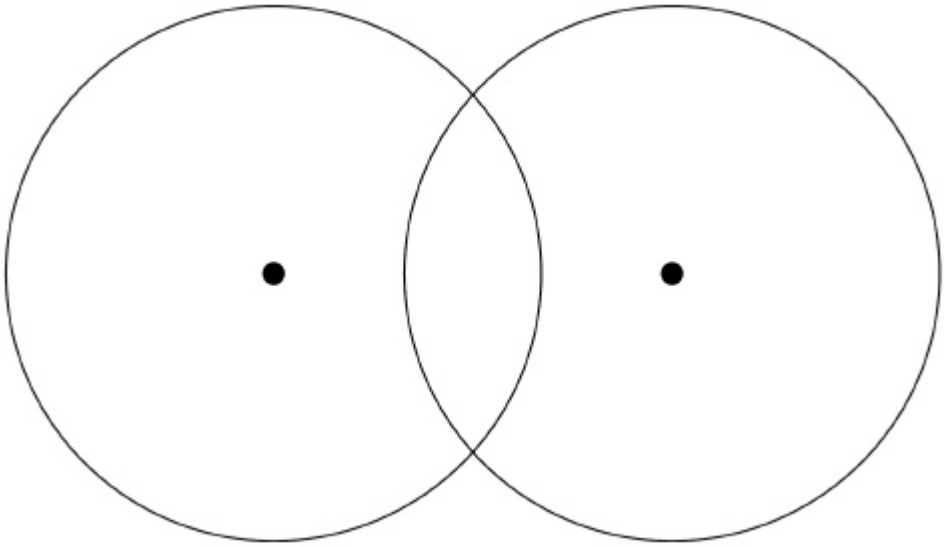
This question is about structure and bonding.

(a) Oxygen is in Group 6.

The diagram shows the outer shells in an oxygen molecule.

Complete the dot and cross diagram.

You should show only the electrons in the outer shell.



(2)

(b) Oxygen forms many compounds.

Which **two** compounds of oxygen are small molecules?

Tick **two** boxes.

Carbon dioxide ☐

Magnesium oxide ☐

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Potassium oxide	☐
Silicon dioxide	☐
Water	☐

(2)

(c) Explain why metals conduct electricity.

Refer to structure and bonding in your answer.

(4)

(Total 8 marks)

Q19.

The three states of matter are solid, liquid and gas.

(a) Lithium reacts with water to produce lithium hydroxide solution and hydrogen.

Use the correct state symbols from the box to complete the chemical equation.

aq	g	l	s

$2Li(s) + 2H_2O(l) \rightarrow 2LiOH(____) + H_2(____)$

lithium + water → lithium hydroxide + hydrogen

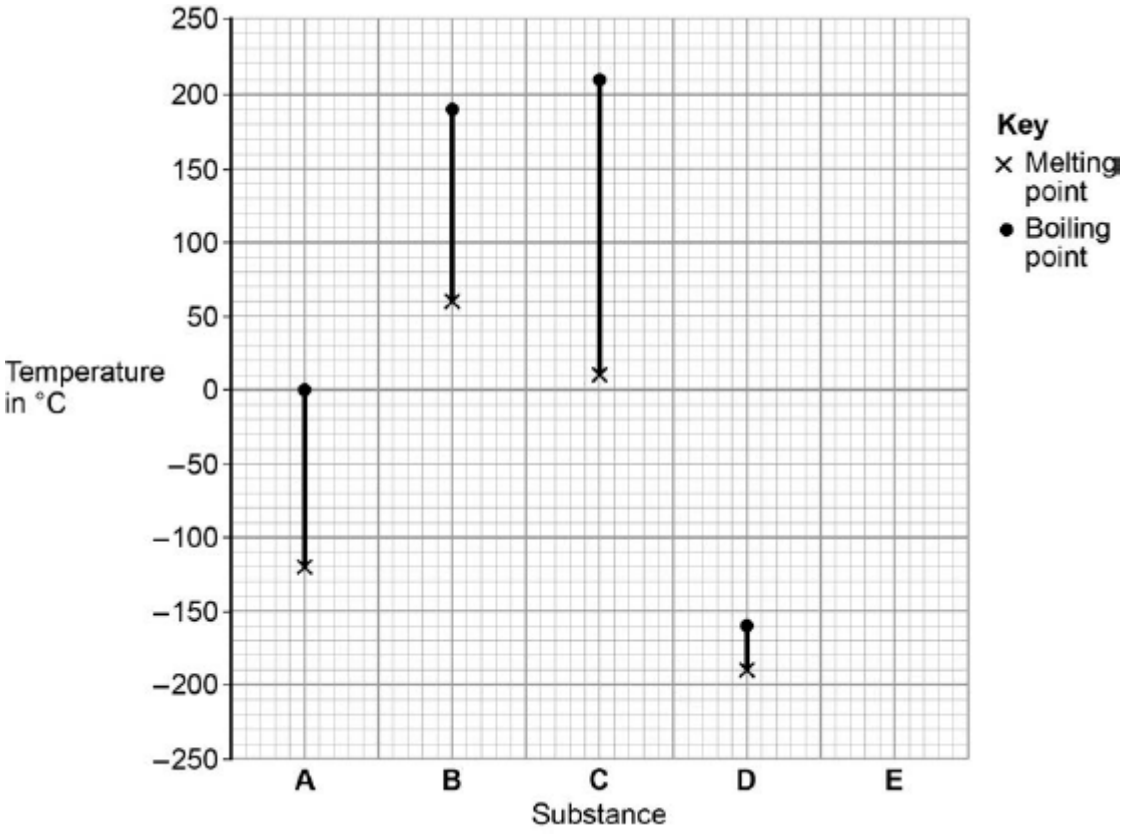
(2)

(b) **Figure 1** shows the melting points and the boiling points of four substances, **A**, **B**,

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C and **D**.

Figure 1



Which substance is liquid over the greatest temperature range?

Tick **one** box.

A ☐

B ☐

C ☐

D ☐

(1)

(c) Which **two** substances are gases at 50 °C?

Tick **one** box.

A and **B** ☐

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B and **C** ☐

C and **D** ☐

A and **D** ☐

(1)

(d) A different substance, **E**, has:

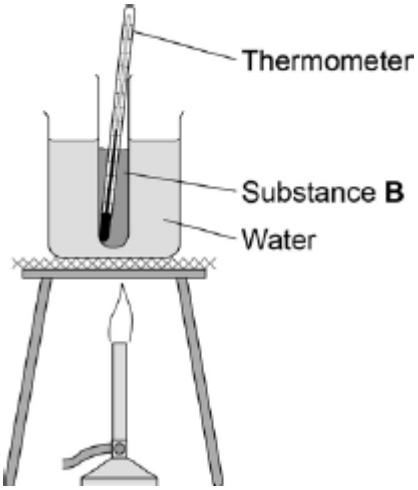
- a melting point of −50 °C
- a boiling point of +120 °C

Plot these two values on **Figure 1**.

(2)

(e) **Figure 2** shows the apparatus a student used to determine the melting point and the boiling point of substance **B** in **Figure 1**.

Figure 2



Explain why the student could not use this apparatus to determine the boiling point of substance **B**.

_____

_____

_____

_____

(2)

(f) Suggest **one** reason why the student could not use this apparatus to determine the exact melting point of substance **B**.

_____

_____

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(1)

(Total 9 marks)

Q20.

This question is about calcium.

(a) What type of compound is calcium oxide?

Tick **one** box.

An acid ☐

A base ☐

A carbonate ☐

A salt ☐

(1)

(b) Ionic compounds, such as calcium oxide, have high melting points.

Complete the sentences. Use words from the box.

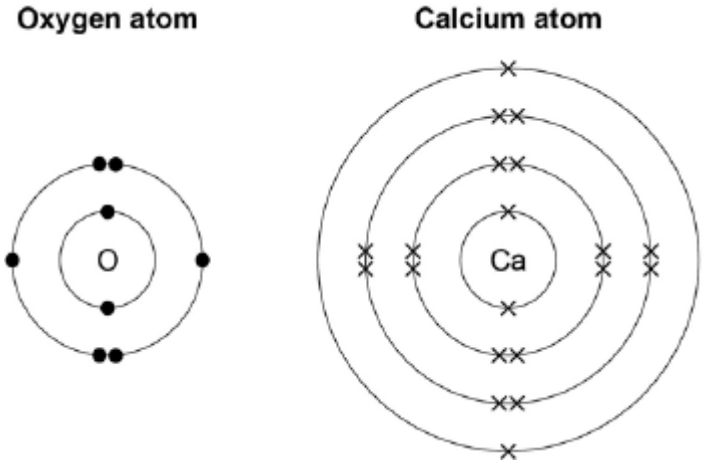
bonds	**forces**	**ions**
	layers	

Calcium oxide has a giant ionic lattice in which there are strong electrostatic

_____ of attraction in all directions.

(1)

(c) The figure below shows the electronic structure of an oxygen atom and a calcium atom.



Describe how the calcium atom and the oxygen atom forms calcium oxide.

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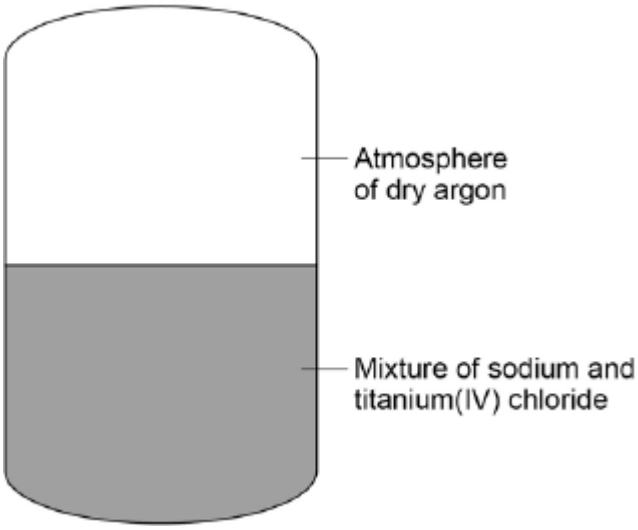
You should give the charge on each ion formed.

(4)
(Total 6 marks)

Q21.

Figure 1 shows a reactor used to produce titanium from titanium(IV) chloride.

Figure 1



The chemical equation for the reaction of titanium(IV) chloride with sodium is:

$$TiCl_4 + 4Na \rightarrow Ti + 4NaCl$$

titanium(IV) chloride + sodium → titanium + sodium chloride

(a) For one reaction:

- 1615 kg titanium(IV) chloride reacted completely with 782 kg sodium
- 1989 kg sodium chloride was produced.

Calculate the mass of titanium produced from this reaction.

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Mass of titanium = _____ kg

(1)

(b) The table below shows the solubility of sodium chloride in 100 cm^3 of aqueous solution at different temperatures.

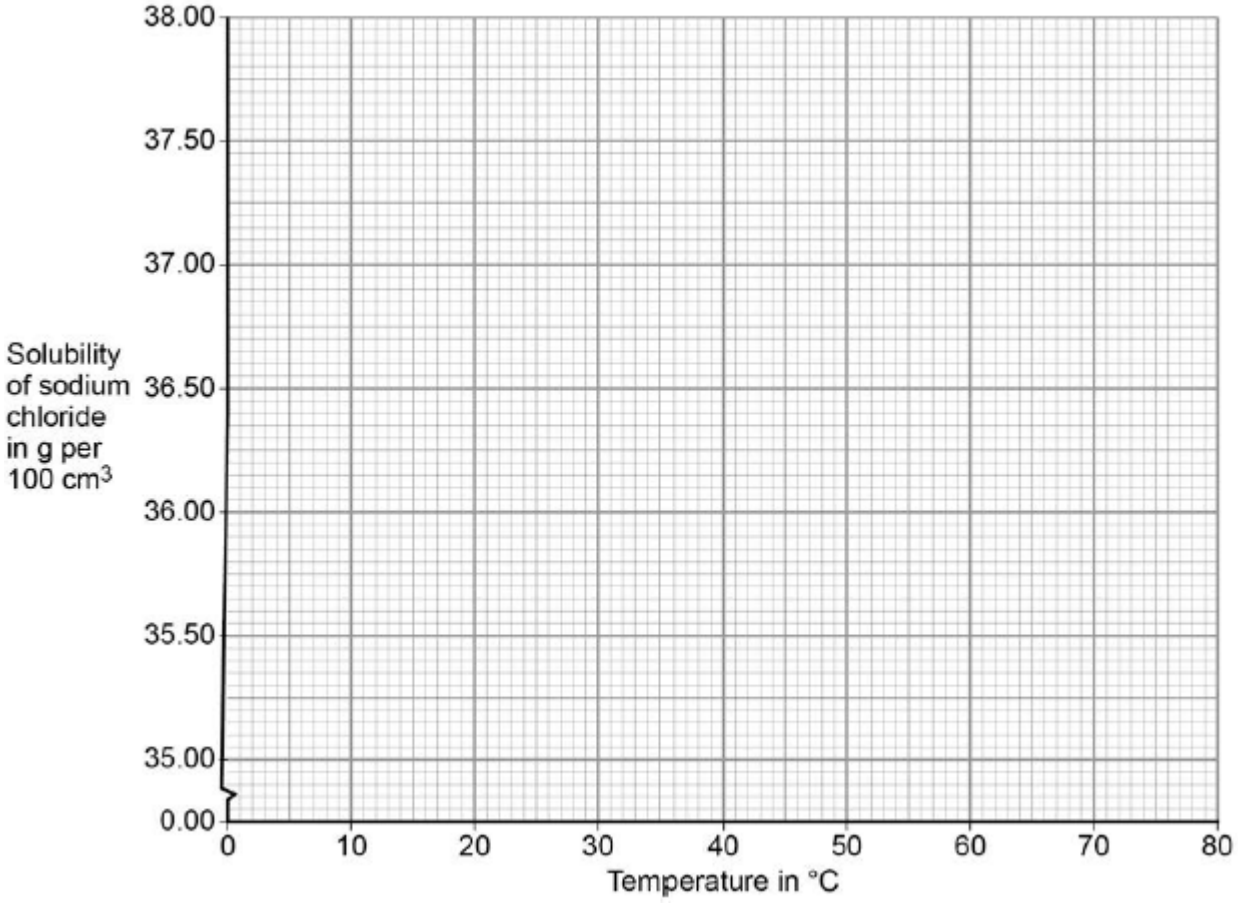
Solubility of sodium chloride in g per 100cm^3	**Temperature in °C**
35.72	10
35.89	20
36.09	30
37.37	40
36.69	50
37.04	60

On **Figure 2**:

- plot this data on the grid
- draw a line of best fit.

Figure 2

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(3)

(c) The product sodium chloride is dissolved in water to separate it from titanium.

At 30 °C the solubility of sodium chloride is 36 kg per 100 dm^3.

Calculate the minimum volume of water in dm^3, at 30 °C, needed to dissolve 1989 kg sodium chloride.

Volume of water = _____ dm^3

(2)

(d) Calculate the percentage by mass of titanium in titanium(IV) chloride ($TiCl_4$).

Give your answer to 3 significant figures.

Relative atomic masses (A_r): Cl = 35.5; Ti = 48

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Percentage of titanium by mass = _____ %

(3)

(e) Suggest why the reaction is done in an atmosphere of dry argon instead of air containing water vapour.

(3)

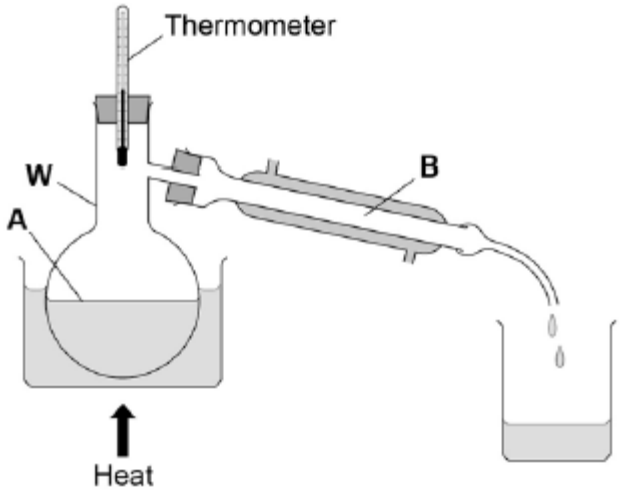
(f) Explain why titanium conducts electricity.

(3)

(Total 15 marks)

Q22.

The apparatus in the figure below is used to separate a mixture of liquids in a fuel.



(a) What is apparatus **W** on above the figure above?

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Tick **one** box.

Beaker ☐

Boiling Tube ☐

Flask ☐

Jug ☐

(1)

(b) What is the name of this method of separation?

Tick **one** box.

Crystallisation ☐

Electrolysis ☐

Filtration ☐

Distillation ☐

(1)

(c) Name the changes of state taking place at **A** and **B** in the figure above.

Use words from the box.

boiling	**condensing**	**freezing**	**melting**

Change of state at **A**: _____

Change of state at **B**: _____

(2)

(d) **Table 1** shows the boiling points of the hydrocarbons in the fuel.

Table 1

Hydrocarbon	**Boiling point in °C**
Pentane	36
Hexane	69

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Heptane	98
Octane	125

Which hydrocarbon will be the last to collect in the beaker?

Tick **one** box.

Pentane ☐

Hexane ☐

Heptane ☐

Octane ☐

(1)

(e) The fuel is a mixture of liquids that has been designed as a useful product.

What name is given to this type of mixture?

Tick **one** box.

Catalyst ☐

Formulation ☐

Polymer ☐

Solvent ☐

(1)

(f) Describe how this fuel is different from crude oil.

_____

_____

_____

_____

(2)

(g) A student measured the melting point of a solid hydrocarbon four times.

The student's results are in **Table 2**.

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Table 2

	Trial 1	Trial 2	Trial 3	Trial 4
Melting point in °C	35	48	37	37

Calculate the mean melting point of the hydrocarbon, leaving out any anomalous result.

Give your answer to two significant figures.

_____

_____

Mean melting point = _____ °C

(2)

(Total 10 marks)

Q23.

Sulfur dioxide (SO_2) is used to manufacture sulfuric acid.

(a) Explain why sulfur dioxide has a low boiling point.

_____

_____

_____

_____

_____

_____

(3)

(b) The equation shows one stage in the manufacture of sulfuric acid from sulfur dioxide.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The reaction is exothermic in the forward direction.

Use Le Chatelier's Principle to predict the effect of increasing the temperature on the amount of sulfur trioxide (SO_3) produced at equilibrium.

Give a reason for your answer.

_____

_____

_____

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(2)

(c) Use Le Chatelier's Principle to predict the effect of increasing the pressure on the amount of sulfur trioxide (SO_3) produced at equilibrium.

Give a reason for your answer.

(2)

(Total 7 marks)

Q24.

Hydrocarbons are used to make useful products.

(a) What are the elements in hydrocarbons?

Tick **one** box.

Carbon and hydrogen only ☐

Carbon, hydrogen and oxygen ☐

Carbon and nitrogen only ☐

Carbon, nitrogen and oxygen ☐

(1)

(b) **Table 1** gives some information about four hydrocarbons.

Table 1

Hydrocarbon	Melting point in °C	Boiling point in °C
Methane	–183	–162
Ethene	–169	–104
Octane	–57	+126
Decane	–30	+174

What are two correct statements about the four compounds?

Tick **two** boxes.

Methane has the lowest boiling point and decane has the highest melting point ☐

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Methane and decane are both gases at 20 °C	☐
Ethene and octane are both alkanes	☐
Decane and ethene are both liquids at 0 °C	☐
Octane is liquid over a larger temperature range than methane	☐

(2)

(c) Ethene can be produced from long-chain hydrocarbons by cracking.

Give the conditions needed for cracking.

_____

_____

_____

_____

(2)

(d) Poly(ethene) is a polymer made from ethene. Poly(ethene) is used to make plastic bags.

Table 2 is from a life cycle assessment comparing paper bags and plastic bags.

Table 2

	Paper bag	**Plastic bag**
Raw material	Wood (renewable)	Oil or gas (non-renewable)
Energy used to make in MJ	1.7	1.5
Solid waste produced in g	50	14
Carbon dioxide produced in kg	0.23	0.53

Evaluate which type of bag is more environmentally friendly.

Use data from **Table 2** and your own knowledge to support your answer.

_____

_____

_____

_____

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(6)
(Total 11 marks)

Q25.

The elements in Group 1 of the periodic table are metals.

(a) The elements in Group 1 are called the alkali metals.

Why are they called the alkali metals?

(2)

(b) Explain the increase in reactivity of elements further down the group.

(4)

(c) Lithium oxide is an ionic compound.

Draw a dot and cross diagram to show how lithium and oxygen combine to form lithium oxide.

Only show the electrons in the outer shell of each atom.

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Give the charges on the ions formed.

(4)

(Total 10 marks)

Q98.

The Mary Rose was a wooden warship. The Mary Rose sank in 1545 but was lifted from the sea bed in 1982. Scientists are now preserving the ship.

The image shows the Mary Rose being supported on poles. As part of the preservation process, the ship was sprayed with water for a long time.



By Mary Rose Trust (MR Trust) [CC BY-SA 3.0] via Wikimedia Commons

(a) (i) The table below gives information about two materials. These materials could have been used to make the poles to support the Mary Rose.

Material	Density in g / cm^3	Relative strength	Cost in £ per kg
Steel	7.85	1	4
Titanium	4.51	3.9	4000

Give **two** advantages and **one** disadvantage of using titanium rather than steel.

Use **only** the information from the table above to answer this question.

Advantage 1 _____

Advantage 2 _____

Disadvantage _____

(3)

(ii) The preserving process used titanium poles.

Tick (✓) **one** other property of titanium which made titanium a suitable choice for the poles.

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Property	Tick (✓)
Electrical insulator	
High resistance to corrosion	
Shiny	

(1)

(b) Some metal objects found on the Mary Rose were made of gold or iron.

Draw **one** line from each metal to its usual method of extraction.

Metal	Method of extraction
	Electrolysis of molten compound
Gold	
	Mined as the pure metal from the ground
Iron	
	Reduction of metal oxide with carbon

(2)

(c) Another metal found on the Mary Rose has the chemical symbol Ag.

Name the metal with the chemical symbol Ag.

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

_____

(1)

(d) The Mary Rose had bronze cannons.

Bronze is an alloy made from two metals, copper and tin.

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

compound	mixture	polymer

An alloy is a _____ of metals.

(1)

(ii) 88% of a bronze alloy is copper. What percentage of the alloy is tin?

_____

Percentage of tin = _____ %

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(1)

(iii) Phytomining is used to extract copper from the ground.

What are used in phytomining?

Draw a ring around the correct answer.

bacteria **fossils** **plants**

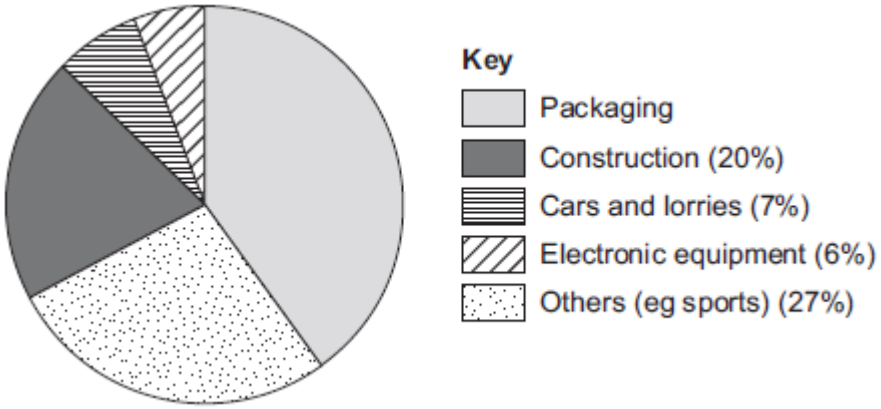
(1)

(Total 10 marks)

Q99.

Polymers have many important uses.

The pie chart shows the percentage (%) of polymers used in different ways.



(a) What is the percentage of polymers used for packaging?

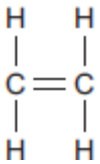
_____

Percentage of polymers used for packaging = _____ %

(1)

(b) (i) Shrink-wrap is a form of poly(ethene). Poly(ethene) is produced from ethene.

The displayed structure of a molecule of ethene is



What is the chemical formula of a molecule of ethene?

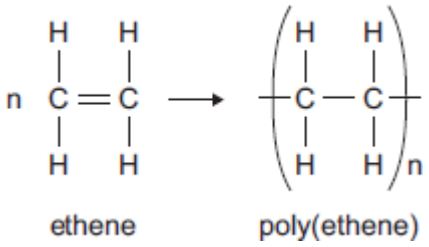
_____

(1)

(ii) Poly(ethene) is produced from ethene in a polymerisation reaction.

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The equation for the reaction is



Which **two** statements about the polymerisation reaction to form poly(ethene) are correct?

Tick (✓) **two** boxes.

	Tick (✓)
A polymer is a small molecule.	
Many ethene molecules join together.	
Poly(ethene) contains a double bond.	
The monomer is ethene.	

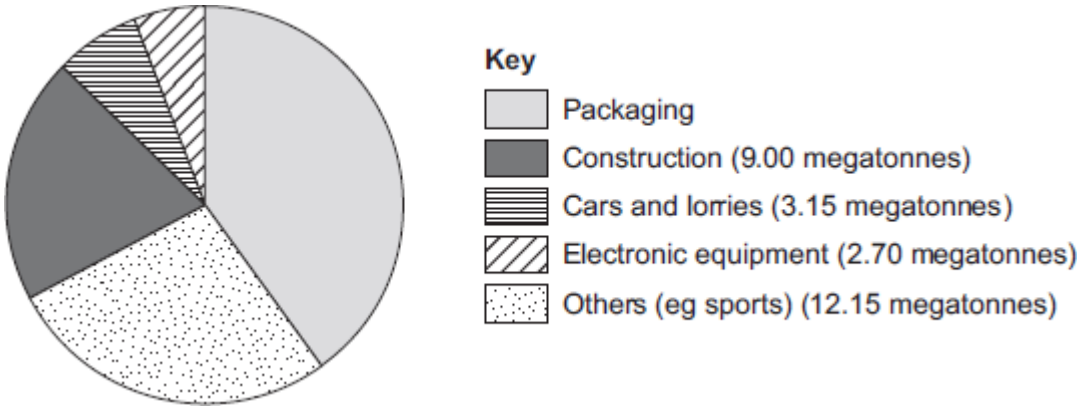
(2)

(Total 4 marks)

Q100.

Polymers have many important uses. Each year 45 megatonnes of polymers are used.

The pie chart below shows the mass in megatonnes of polymers used in different ways.



(a) What percentage of polymers is used in packaging?

_____

_____

_____

_____

Percentage of polymers used in packaging = _____ %

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(2)

(b) (i) Poly(ethene) is often used for packaging. Poly(ethene) is made from ethene.

Ethene is an alkene with the chemical formula C_2H_4

Draw the displayed structure for ethene.

(1)

(ii) Poly(ethene) is formed from ethene in a polymerisation reaction.

Describe, in terms of molecules, what happens in a polymerisation reaction.

_____

_____

_____

_____

_____

_____

(3)

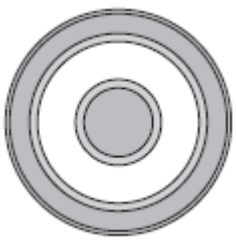
(Total 6 marks)

Q101.

Scientists in the 16th century used the symbol shown in **Figure 1** for gold.

Figure 1

Gold



The scientists thought platinum was made from gold and silver, so they used the symbol

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for gold in the symbol for platinum. The symbol for platinum is shown in **Figure 2**.

Figure 2

Platinum



(a) Gold and platinum are elements.

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

(i) An element contains only one sort of

atom. **ion.** **molecule.**

(1)

(ii) Elements are different from each other because they have different numbers of

ions. **molecules.** **protons.**

(1)

(b) Complete the following sentence.

Modern scientists call a mixture of gold and silver an alloy.

An alloy is a mixture of _____ .

(1)

(c) The formula of the compound silver oxide is Ag_2O

Give the name and number of the atoms which have joined together to make the compound Ag_2O

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

_____

_____

_____

_____

_____

_____

(3)

(Total 6 marks)

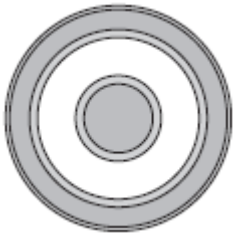
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Q102.

Scientists in the 16th century used the symbol shown in **Figure 1** for gold.

Figure 1

Gold



The scientists thought platinum was made from gold and silver, so they used the symbol for gold in the symbol for platinum. The symbol for platinum is shown in **Figure 2**.

Figure 2

Platinum



(a) Gold and platinum are elements.

What is meant by the term **element**?

_____

_____

(1)

(b) Why is it incorrect to represent platinum as shown in **Figure 2**?

_____

_____

(1)

(c) Scientists now use a formula such as Ag_2O to represent a substance.

What does the formula Ag_2O tell you about this substance?

_____

_____

_____

_____

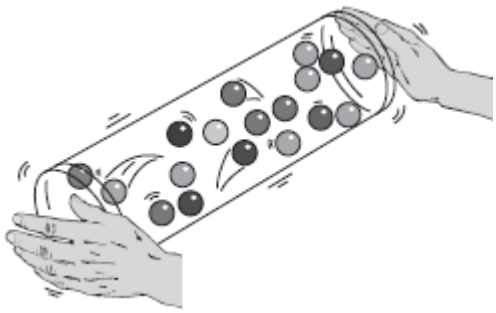
(2)

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(Total 4 marks)

Q103.

A student shakes a tube containing small balls to model the movement of particles in a gas.



(a) Why is this a good model for the movement of particles in a gas?

Tick (✓) **two** boxes.

The balls move slowly.	☐
The balls are far apart from each other.	☐
The balls are different colours.	☐
The balls move randomly.	☐

(2)

(b) For a given material, in which state of matter:

are the particles in a regular arrangement?

_____

do the particles have the most kinetic energy?

_____

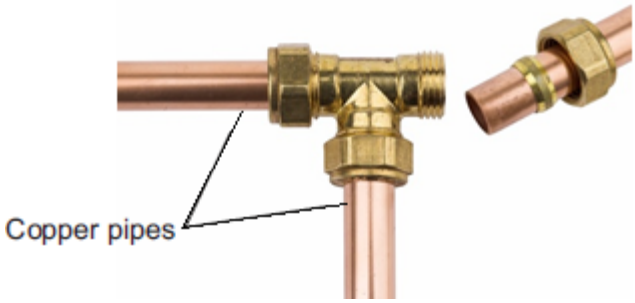
(2)

(Total 4 marks)

Q104.

Copper is used in plumbing.

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© Dave White/iStock

(a) Complete the following sentence.

Elements in the central block of the periodic table, eg copper, iron and zinc, are called _____ metals.

(1)

(b) State three properties that make copper suitable for use in plumbing.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

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

Copper can be extracted from copper ores by two methods:

Method 1 or	mining and smelting
Method 2	phytomining.

The main stages in the two methods are shown in the flow diagrams.

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Mining and smelting



© Dale Baxter/iStock

The copper ore is mined from the earth.

↓

The copper ore is heated in a furnace with carbon (smelting).

This produces impure copper.

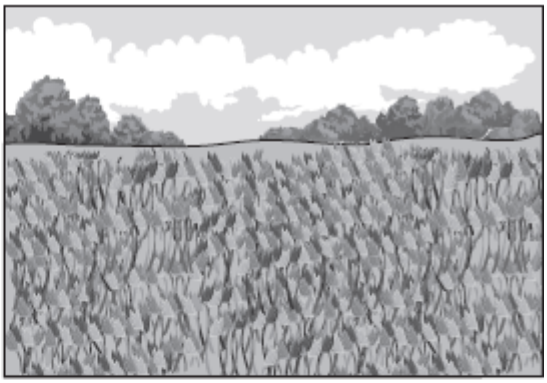
↓

The copper is purified by electrolysis.

↓

Pure copper is produced.

Phytomining



Plants are grown on soil containing low grade ores.

↓

The plants absorb copper compounds from the soil.

↓

The plants are burned.

The ash contains copper compounds.

↓

Copper is extracted from a solution made from the ash by electrolysis.

↓

Pure copper is produced.

Use information from the flow diagrams and your own knowledge to evaluate **both** methods of copper extraction.

Give the advantages **and** disadvantages of **both** methods.

Remember to include a conclusion in your answer.

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(6)
(Total 10 marks)

Q105.

(a) **Table 1** shows the percentages of gases in the atmospheres of Earth and Mars.

Table 1

Gas	Percentage of gas (%)	
	Earth	**Mars**
Carbon dioxide	0.04	95
Nitrogen	78	3
Oxygen	21	0.13

Using **Table 1**, describe how the atmosphere of the Earth is different from the atmosphere of Mars.

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_____

_____

_____

(2)

(b) **Table 2** shows the mean surface temperature of three planets.

Table 2

	Earth	**Mars**	**Venus**
Mean surface temperature in °C	20	-23	460

Oceans cover 71% of the Earth's surface.

Mars and Venus have water vapour in their atmospheres.

Why does the water vapour **not** form oceans on their surfaces?

Mars: _____

_____

Venus: _____

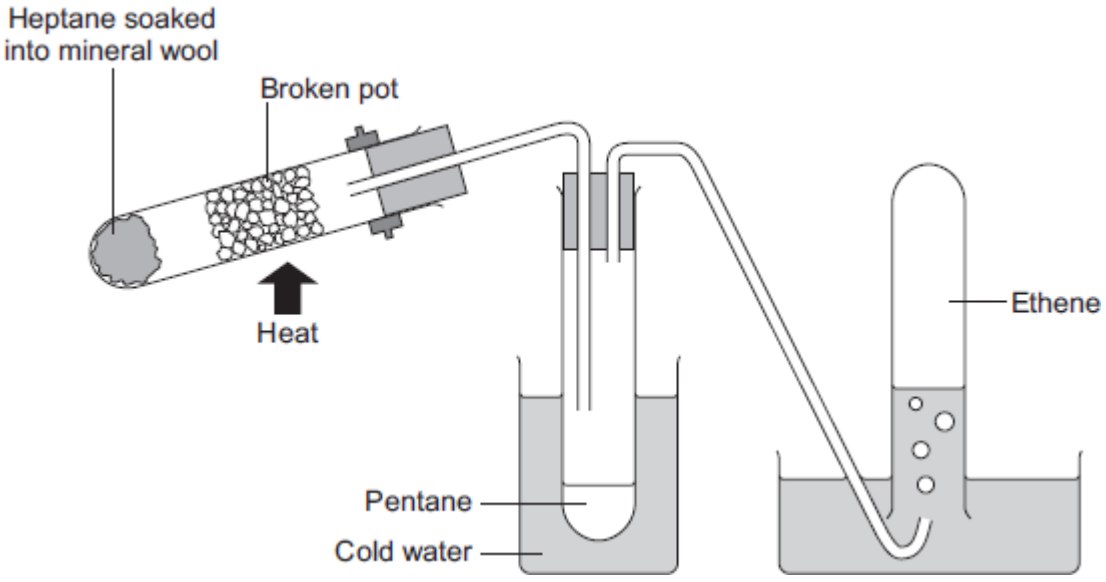
_____

(2)

(Total 4 marks)

Q106.

In the laboratory, ethene can be made using the apparatus shown.



(a) (i) Complete the symbol equation for this reaction.

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C_7H_{16} (heptane) $\rightarrow$ _____ (pentane) + C_2H_4 (ethene)

(1)

(ii) Explain how you can tell pentane has a higher boiling point than ethene.

Use information from the diagram.

_____

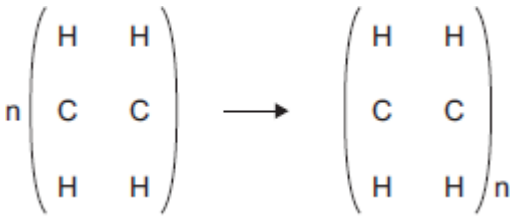
_____

(1)

(b) Ethene molecules are polymerised to form poly(ethene).

Complete the displayed (structural) formula of ethene and poly(ethene) in the equation to show this reaction.

Draw lines to represent each bond.



Ethene **Poly(ethene)**

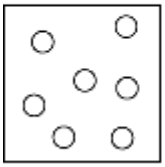
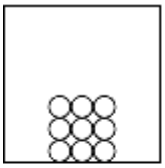
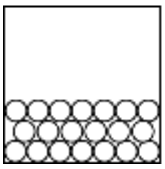
(3)
(Total 5 marks)

Q107.

The diagrams below show the three states of matter.

(a) Draw **one** line from each diagram in **List A** to the correct state of matter in **List B**.

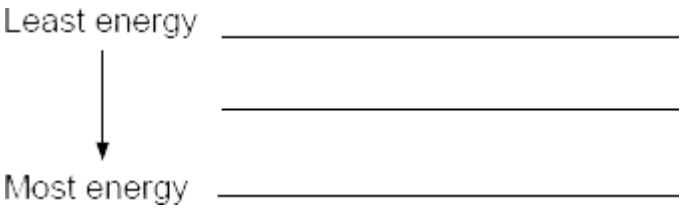
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List A	List B State of matter
	Solid
	Gas
	Liquid

(2)

(b) The particles in the three states of matter have different amounts of energy.

List the **three** states of matter in order of increasing energy.



(2)
(Total 4 marks)

Q108.

Solder is an alloy of lead and tin.

The table shows how the percentage of tin affects some of the properties of solder.

Percentage (%) of tin	Tensile strength in MPa	Melting point in °C	Density in g per cm^3
0	12	347	11.35
20	33	257	10.40
40	37	187	9.28
60	52	153	8.52

Tensile strength is the ability to support a load without breaking.

Use information from the table to answer these questions.

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(a) What is the density of pure lead?

Density = _____ g per cm^3

(1)

(b) How does increasing the percentage of tin affect the properties of solder?

_____

_____

_____

_____

_____

_____

(3)

(c) Solder was used when plumbers joined lead pipes together. Solder, not pure lead, was used to make the joints.

Suggest **one** reason why.

_____

_____

(1)

(Total 5 marks)

Q109.

Gold, silver and bronze medals were made for a competition.



Photograph supplied by iStockphoto/Thinkstock

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

(i) Gold is found as a pure metal in the Earth because gold is

coloured.

reactive.

unreactive.

(1)

(ii) Gold is an element because all of its

atoms

molecules

symbols

are the same.

(1)

(b) The atomic number of silver is 47.
The mass number of a silver atom is 108.

Use this information to work out the number of protons and neutrons in a silver atom.

Draw **one** line from each particle in **List A** to the correct number in **List B**.

List A Particle	**List B Number**
	47
Proton	
	61
Neutron	
	108

(2)

(c) Bronze is an alloy of copper and tin.

(i) What is an alloy?

_____

_____

(1)

(ii) Medals made of copper or bronze cost the same.

Bronze is used to make medals instead of pure copper.

Give **one** reason why.

_____

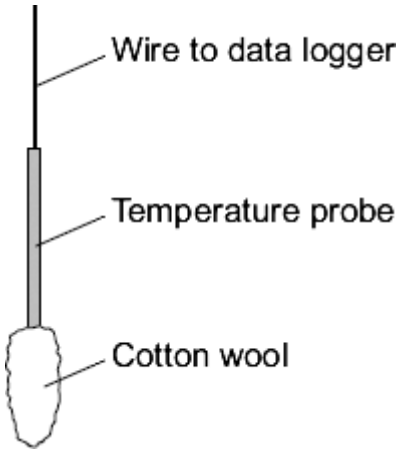
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(1)

(Total 6 marks)

Q110.

A student investigated the evaporation of three different liquids using the apparatus shown.



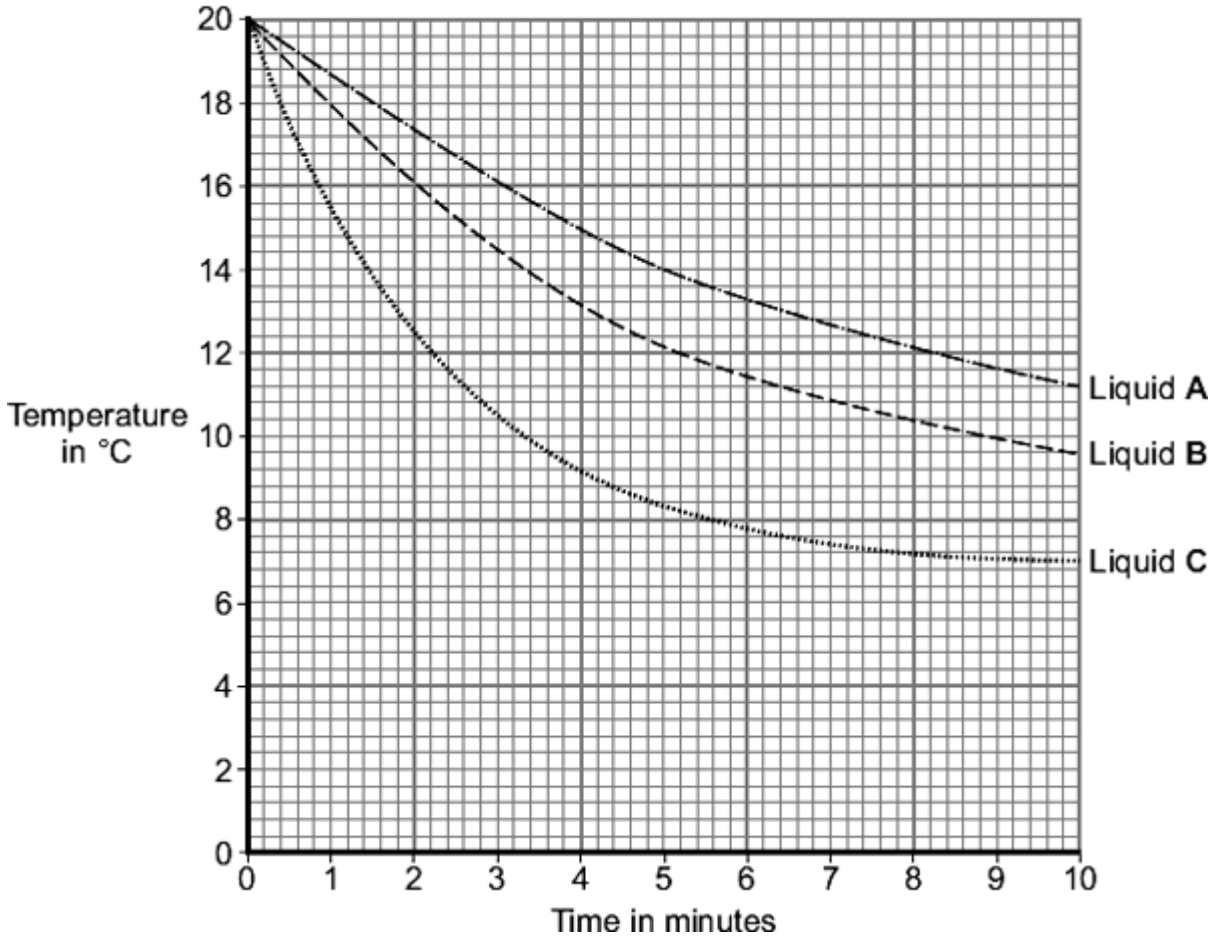
Identical pieces of cotton wool were soaked in one of three liquids, **A**, **B** or **C**, that have different boiling points. The same volume of liquid, at the same starting temperature, was used each time.

The temperature of the cotton wool was measured during a ten minute period.

The results are shown on **Graph 1**.

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Graph 1



(a) Which liquid has the lowest boiling point?

Explain your choice.

Liquid _____

Explanation _____

_____

_____

_____

(2)

(b) Room temperature is 20 °C.

The line for liquid **C** reached a lower limit of 7 °C.

Explain why the temperature did **not** fall below 7 °C.

_____

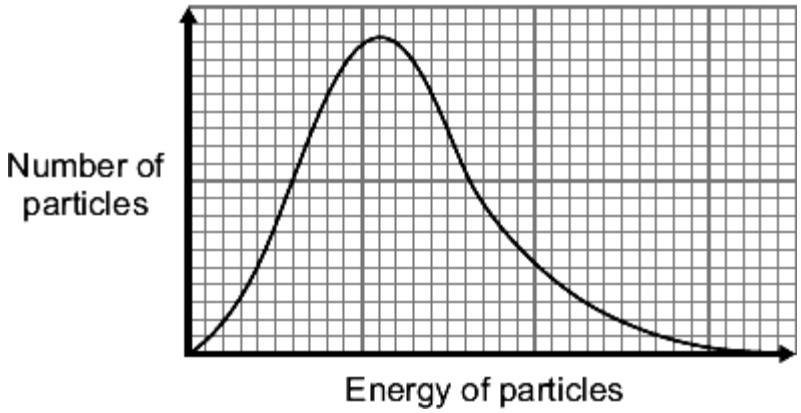
_____

(1)

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(c) **Graph 2** shows the distribution of energy among particles in a liquid.

Graph 2



Explain, in terms of the particles in a liquid, why evaporation causes cooling.

You may use information from **Graph 2** to help you with your answer.

_____

_____

_____

_____

_____

_____

_____

_____

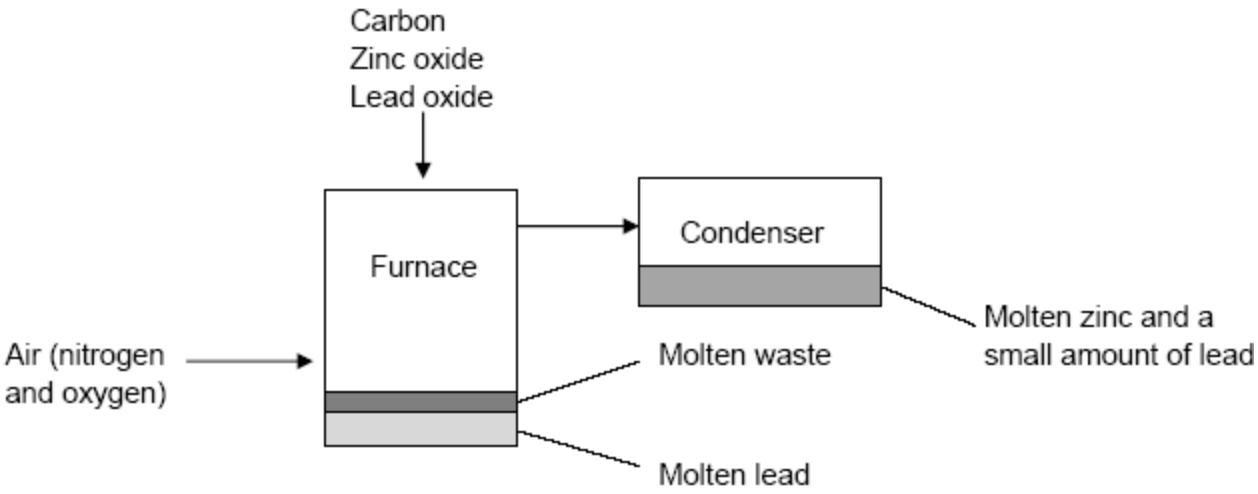
(4)

(Total 7 marks)

Q111.

Nearly all zinc is obtained from ores that also contain lead. The metals zinc and lead can be extracted by reducing their oxides using carbon.

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(a) Complete the following sentence.

Zinc oxide is reduced by carbon, which takes away _____ to leave zinc metal.

(1)

(b) The melting points and boiling points of lead and zinc are given in the table.

Metal	Lead	Zinc
Melting point in °C	328	420
Boiling point in °C	1740	907
Density in g per cm^3	11.34	7.14

The furnace operates at a temperature of 1200 °C.

(i) Explain why only lead metal remains in the furnace.

_____

_____

_____

(2)

(ii) Suggest how zinc can be separated from the lead in the condenser.

_____

_____

_____

(2)

(Total 5 marks)

Q112.

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Crude oil is a mixture of alkanes from which useful fuel fractions can be obtained.

Fraction	A hydrocarbon in this fraction	Boiling point of alkane in °C
petroleum gases	Propane	–42
petrol (gasoline)	Octane	+126
paraffin (kerosene)	Dodecane	+216
diesel	Eicosane	+344

(a) (i) Suggest the lowest temperature to which crude oil needs to be heated to vaporise all of these fuel fractions.

Temperature _____ °C

(1)

(ii) Dodecane boils at +216 °C. At what temperature will dodecane gas condense to liquid?

Temperature _____ °C

(1)

(iii) Describe what happens in a fractionating column that allows these fractions to be collected.

_____

_____

_____

_____

_____

_____

(3)

(b) Propane is a fuel because it burns in air releasing heat energy.

(i) Complete the balancing of the two chemical equations for propane burning in air.

$2C_3H_8$ + _____ O_2 → _____ CO_2 + _____ H_2O

$2C_3H_8$ + _____ O_2 → _____ CO + _____ H_2O

(2)

(ii) The products of the two chemical reactions in (b)(i) are different.

Explain why.

_____

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_____

_____

_____

_____

(2)

(Total 9 marks)

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