AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.2.2 HOW BONDING AND STRUCTURE ARE RELATED TO THE PROPERTIES OF SUBSTANCES (PACK 1)

SCORE	PERCENTAGE
/377	%

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Q1.

This question is about mixtures.

(a) Substances are separated from a mixture using different methods.

Draw **one** line from each substance and mixture to the best method of separation.

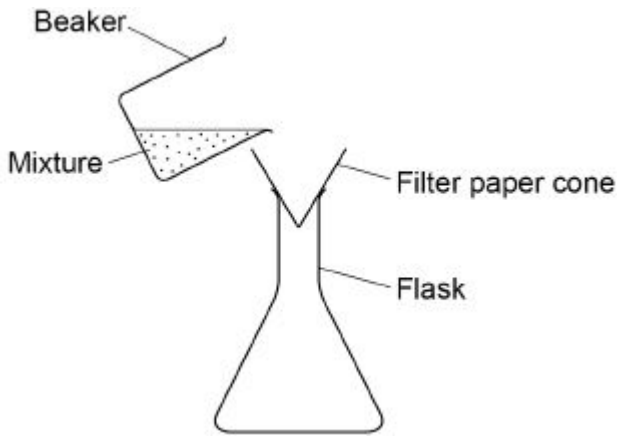
Substance and mixture	Method of separation
	Chromatography
Ethanol from ethanol and water	Crystallisation
Salt from sea water	Electrolysis
The different colours in black ink	Filtration
	Fractional distillation

(3)

(b) A student filters a mixture.

Figure 1 shows the apparatus.

Figure 1



Suggest **one** improvement to the apparatus.

_____

_____

(1)

(c) Complete the sentences.

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Choose answers from the box.

condense	evaporate	freeze	melt	solidify

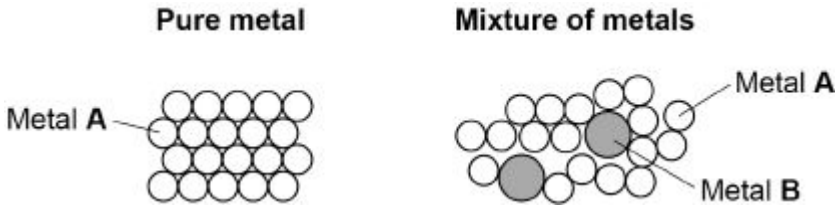
In simple distillation, the mixture is heated to make the liquid _____ .

The vapour is then cooled to make it _____ .

(2)

Figure 2 shows the arrangement of atoms in a pure metal and in a mixture of metals.

Figure 2



(d) Calculate the percentage of metal B atoms in the mixture of metals shown in **Figure 2**.

_____

_____

_____

Percentage of metal **B** atoms = _____ %

(2)

(e) What is a mixture of metals called?

Tick **one** box.

An alloy ☐

A compound ☐

A molecule ☐

A polymer ☐

(1)

(f) Why is the mixture of metals in **Figure 2** harder than the pure metal?

Tick **one** box.

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The atoms in the mixture are different shapes. ☐

The layers in the mixture are distorted. ☐

The layers in the mixture slide more easily. ☐

The mixture has a giant structure. ☐

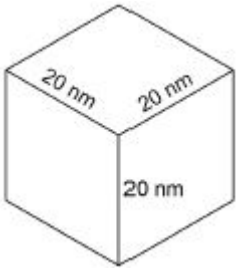
(1)

(g) A nanoparticle of pure metal **A** is a cube.

Each side of the cube has a length of 20 nm.

Figure 3 shows the cube.

Figure 3



What is the volume of the nanoparticle?

Tick **one** box.

20 nm^3 ☐

60 nm^3 ☐

400 nm^3 ☐

8000 nm^3 ☐

(1)

(Total 11 marks)

Q2.

This question is about Group 7 elements.

Chlorine is more reactive than iodine.

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(a) Name the products formed when chlorine solution reacts with potassium iodide solution.

_____

_____

(1)

(b) Explain why chlorine is more reactive than iodine.

_____

_____

_____

_____

_____

_____

(3)

(c) Chlorine reacts with hydrogen to form hydrogen chloride.

Explain why hydrogen chloride is a gas at room temperature.

Answer in terms of structure and bonding.

_____

_____

_____

_____

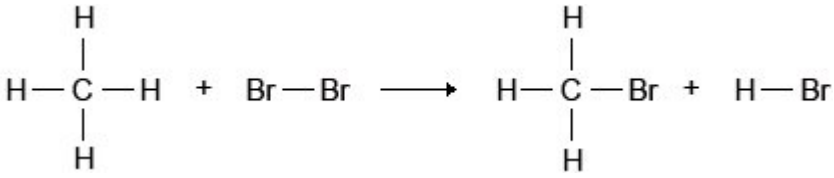
_____

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(3)

(d) Bromine reacts with methane in sunlight.

The diagram below shows the displayed formulae for the reaction of bromine with methane.



The table below shows the bond energies and the overall energy change in the reaction.

	C—H	**Br—Br**	**C—Br**	**H—Br**	**Overall**

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					energy change
Energy in kJ/mol	412	193	**X**	366	−51

Calculate the bond energy **X** for the C—Br bond.

Use the diagram and the table above.

_____

_____

_____

_____

_____

_____

_____

Bond energy **X** = _____ kJ/mol

(4)

(Total 11 marks)

Q3.

A student investigated the mass of copper oxide produced by heating copper carbonate.

This is the method used.

1. Weigh an empty test tube.
2. Weigh 2.00 g of copper carbonate into the test tube.
3. Heat the copper carbonate until there appears to be no further change.
4. Re-weigh the test tube and copper oxide produced.
5. Subtract the mass of the empty tube to find the mass of copper oxide.
6. Repeat steps 1−5 twice.
7. Repeat steps 1−6 with different masses of copper carbonate.

The table below shows the student's results.

Mass of copper carbonate in g	**Mass of copper oxide in g**			
	Trial 1	**Trial 2**	**Trial 3**	**Mean**
2.00	1.29	1.27	1.31	1.29
4.00	2.89	2.57	2.59	2.58

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6.00	3.85	3.90	3.87	3.87
8.00	5.12	5.15	5.09	**X**
10.00	6.42	6.45	6.45	6.44

The equation for the reaction is:

$$CuCO_3(s) \longrightarrow CuO(s) + CO_2(g)$$

(a) Complete the sentence.

The state symbol shows carbon dioxide is a _____ .

(1)

(b) Why do the contents of the test tube lose mass in the investigation?

_____

_____

(1)

(c) Calculate the mean mass **X** in the table above.

_____

_____

X = _____ g

(1)

(d) One of the results in the table above is anomalous.

Which result is anomalous?

Mass of copper carbonate _____ g Trial _____

(1)

(e) Suggest how the investigation could be improved to make sure the reaction is complete.

_____

_____

_____

_____

(2)

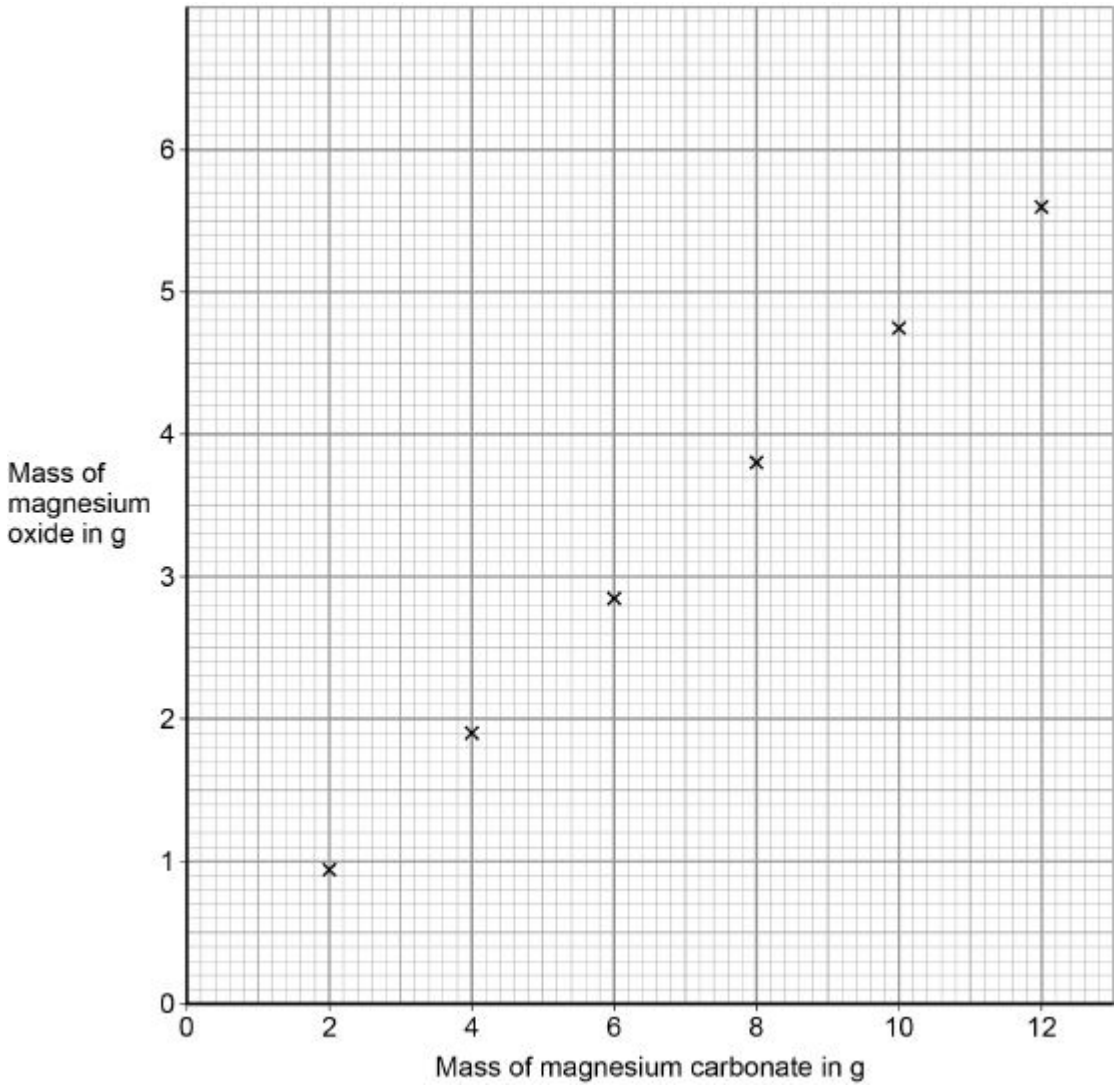
Another student repeated the investigation using magnesium carbonate instead of copper carbonate.

The word equation for the reaction is:

magnesium carbonate ⟶ magnesium oxide + carbon dioxide

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The graph below shows the results of the investigation.



(f) Draw a line of best fit on the graph above.

(1)

(g) Determine the mass of magnesium oxide produced by 8.4 g of magnesium carbonate.

Use the graph above.

Mass = _____ g

(1)

(h) Calculate the mass of magnesium oxide produced when 168 g of magnesium carbonate is heated.

Use your answer to part **(g)**

_____

_____

_____

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_____

Mass of magnesium oxide produced = _____ g

(2)

(Total 10 marks)

Q4.

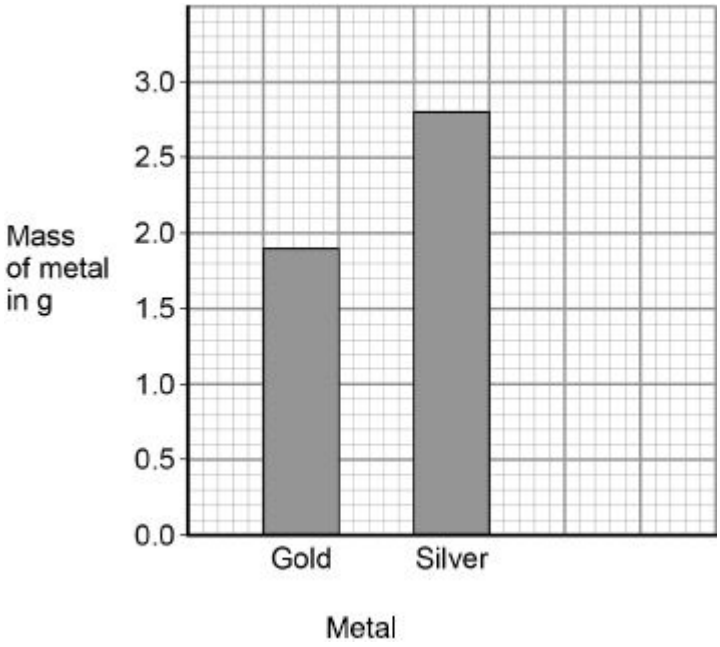
A 9 carat gold ring is made from a mixture of metals.

The table below shows the mass of different metals in the ring.

The mass of the ring is 5.0 g

Metal	Mass of metal in g
Gold	1.9
Silver	2.8
Copper	0.3

(a) Plot the data for copper from the table above on the graph below.



(2)

(b) The cost of gold is £30 per gram.

Calculate the cost of the gold used in the 9 carat gold ring.

Use the table above.

_____

_____

Cost of gold = £_____

(1)

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(c) Rings can be made from 22 carat gold.

The ratio of the mass of gold in 22 carat gold compared to 9 carat gold is 22 :9

Calculate the mass of gold in a 22 carat gold ring of mass 5.0 g

Use the table above.

_____

_____

_____

Mass of gold = _____ g

(2)

(d) Pure gold is 24 carats.

Suggest **two** reasons why silver and copper are mixed with gold to make 9 carat gold rings.

1. _____

_____

2. _____

_____

(2)

(e) Copper is obtained from copper ores or by recycling copper.

- Copper ores are non-renewable.
- Copper ores can be obtained by mining.
- Some scrap copper goes to landfill sites.

Give **three** reasons why we should use recycled copper instead of copper from copper ores.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(Total 10 marks)

Q5.

Titanium is a transition metal.

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Titanium is extracted from titanium dioxide in a two-stage industrial process.

Stage 1 $TiO_2 + 2\ C + 2\ Cl_2 \longrightarrow TiCl_4 + 2\ CO$

Stage 2 $TiCl_4 + 4\ Na \longrightarrow Ti + 4\ NaCl$

(a) Suggest **one** hazard associated with **Stage 1**.

_____

_____

(1)

(b) Water must be kept away from the reaction in **Stage 2**.

Give **one** reason why it would be hazardous if water came into contact with sodium.

_____

_____

(1)

(c) Suggest why the reaction in **Stage 2** is carried out in an atmosphere of argon and **not** in air.

_____

_____

_____

_____

(2)

(d) Titanium chloride is a liquid at room temperature.

Explain why you would **not** expect titanium chloride to be a liquid at room temperature.

_____

_____

_____

_____

_____

_____

_____

(3)

In **Stage 2**, sodium displaces titanium from titanium chloride.

(e) Sodium atoms are oxidised to sodium ions in this reaction.

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Why is this an oxidation reaction?

_____

_____

(1)

(f) Complete the half equation for the oxidation reaction.

$$Na \longrightarrow _____ + _____$$

(1)

(g) In Stage 2, 40 kg of titanium chloride was added to 20 kg of sodium.

The equation for the reaction is:

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

Relative atomic masses (A_r): Na = 23 Cl = 35.5 Ti = 48

Explain why titanium chloride is the limiting reactant.

You **must** show your working.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(h) For a **Stage 2** reaction the percentage yield was 92.3%

The theoretical maximum mass of titanium produced in this batch was 13.5 kg.

Calculate the actual mass of titanium produced.

_____

_____

_____

Mass of titanium = _____ kg

(2)

(Total 15 marks)

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Q6.

Sodium thiosulfate solution reacts with dilute hydrochloric acid.

The solution becomes cloudy as the reaction takes place.

(a) The equation for the reaction is:

$$Na_2S_2O_3(aq) + 2\,HCl(aq) \longrightarrow 2\,NaCl(aq) + SO_2(g) + H_2O(l) + S(s)$$

Explain why the solution becomes cloudy.

_____

_____

_____

_____

(2)

(b) Plan an investigation to show how the concentration of the sodium thiosulfate solution affects the rate of the reaction with dilute hydrochloric acid.

Your plan should give valid results.

_____

_____

_____

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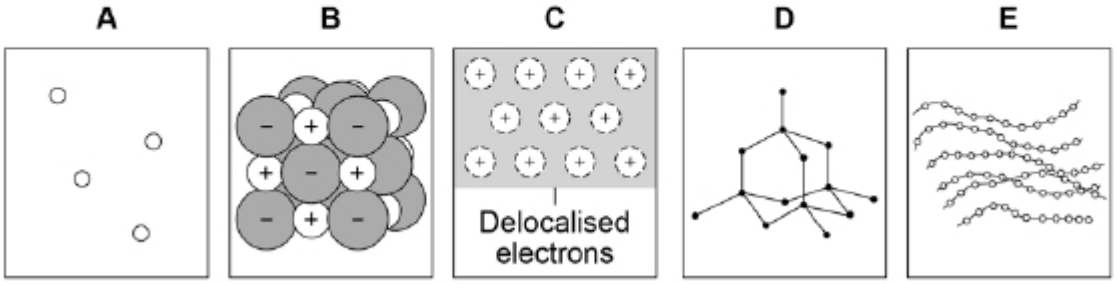
(6)

(Total 8 marks)

Q7.

Figure 1 shows the structure of five substances.

Figure 1



(a) Which diagram shows a gas?

Tick (✔) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(b) Which diagram shows the structure of diamond?

Tick (✔) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(c) Which diagram shows a metallic structure?

Tick (✔) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

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(d) Which diagram shows a polymer?

Tick (✔) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(e) A chlorine atom has 7 electrons in the outer shell.

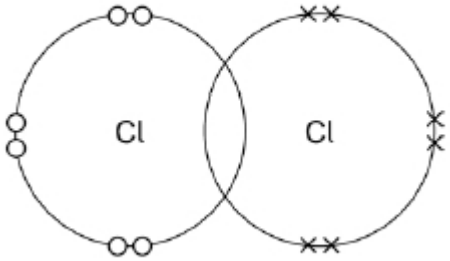
Two chlorine atoms covalently bond to form a chlorine molecule, Cl_2

Figure 2 is a dot and cross diagram showing the outer shells and some electrons in a chlorine molecule.

Complete the dot and cross diagram.

Show only the electrons in the outer shell.

Figure 2



(1)

(f) What is the reason for chlorine's low boiling point?

Tick (✔) **one** box.

Strong covalent bonds ☐

Strong forces between molecules ☐

Weak covalent bonds ☐

Weak forces between molecules ☐

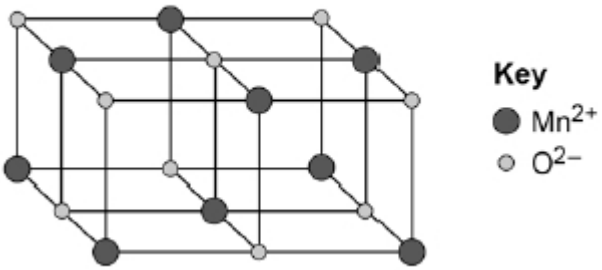
(1)

Figure 3 represents the structure of manganese oxide.

Manganese oxide is an ionic compound.

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Figure 3



(g) Determine the empirical formula of manganese oxide.

Use **Figure 3**.

_____

_____

Empirical formula = _____

(1)

(h) Why does manganese oxide conduct electricity as a liquid?

Tick (✔) **one** box.

Atoms move around in the liquid	☐
Electrons move around in the liquid	☐
Ions move around in the liquid	☐
Molecules move around in the liquid	☐

(1)

(Total 8 marks)

Q8.

A student investigated the law of conservation of mass.

The law of conservation of mass states that the mass of the products is equal to the mass of the reactants.

This is the method used.

1. Pour lead nitrate solution into a beaker labelled **A**.
2. Pour potassium chromate solution into a beaker labelled **B**.
3. Measure the mass of both beakers and contents.
4. Pour the solution from beaker **B** into beaker **A**.

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5. Measure the mass of both beakers and contents again.

When lead nitrate solution and potassium chromate solution are mixed, a reaction takes place.

This is the equation for the reaction:

$$Pb(NO_3)_2(aq) + K_2CrO_4(aq) \longrightarrow PbCrO_4(s) + 2KNO_3(aq)$$

(a) What would the student see when the reaction takes place?

_____

_____

(1)

(b) The table shows the student's results.

	Mass in g
Beaker **A** and contents before mixing	128.71
Beaker **B** and contents before mixing	128.97
Beaker **A** and contents after mixing	154.10
Beaker **B** after mixing	103.58

Show that the law of conservation of mass is true.

Use the data from the table above.

_____

_____

_____

_____

(2)

(c) What is the resolution of the balance used to obtain the results in the table?

Tick (✔) **one** box.

0.01 g ☐ 0.1 g ☐ 1 g ☐ 100 g ☐

(1)

(d) Calculate the relative formula mass (M_r) of lead nitrate $Pb(NO_3)_2$

Relative atomic masses (A_r): N = 14 O = 16 Pb = 207

_____

_____

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_____

_____

Relative formula mass = _____

(2)

(e) The formula of potassium chromate is K_2CrO_4

The charge on the potassium ion is +1

What is the formula of the chromate ion?

Tick (✔) **one** box.

CrO_4^+ ☐

CrO_4^{2+} ☐

CrO_4^- ☐

CrO_4^{2-} ☐

(1)

(f) Another student also tests the law of conservation of mass using the same method.

The student uses a different reaction.

This is the equation for the reaction.

$$Na_2CO_3(aq) + 2HCl(aq) \longrightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

Explain why this student's results would **not** appear to support the law of conservation of mass.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

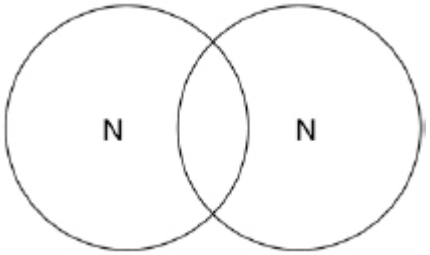
Q9.

This question is about structure and bonding.

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(a) Complete the dot and cross diagram to show the covalent bonding in a nitrogen molecule, N_2

Show only the electrons in the outer shell.



(2)

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

Answer in terms of nitrogen's structure.

_____

_____

_____

_____

_____

_____

(3)

(c) Graphite and fullerenes are forms of carbon.

Graphite is soft and is a good conductor of electricity.

Explain why graphite has these properties.

Answer in terms of structure and bonding.

_____

_____

_____

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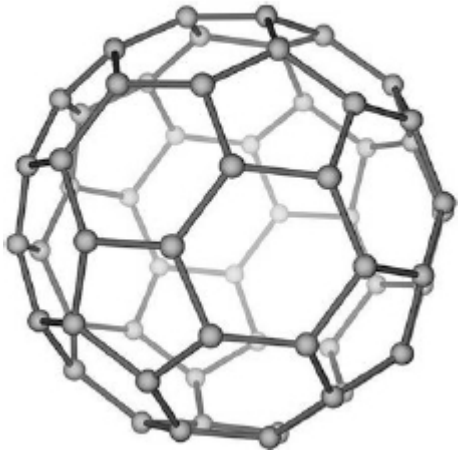
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(4)

(d) **Figure 1** shows a model of a Buckminsterfullerene molecule.

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Figure 1



A lubricant is a substance that allows materials to move over each other easily.

Suggest why Buckminsterfullerene is a good lubricant.

Use **Figure 1**.

_____

_____

_____

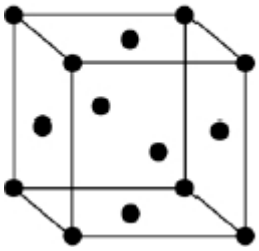
_____

(2)

Silver can form cubic nanocrystals.

Figure 2 represents a silver nanocrystal.

Figure 2



(e) A silver nanocrystal is a cube of side 20 nm

Calculate the surface area to volume ratio of the nanocrystal.

_____

_____

_____

_____

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_____

Surface area to volume ratio = _____

(3)

(f) Silver nanoparticles are sometimes used in socks to prevent foot odour.

Suggest why it is cheaper to use nanoparticles of silver rather than coarse particles of silver.

_____

_____

_____

_____

(2)

(Total 16 marks)

Q10.

This question is about alloys of copper.

(a) Complete the sentence.

Choose the answer from the box.

aluminium	**iron**	**magnesium**	**tin**

Bronze is an alloy of copper and _____.

(1)

Brass is an alloy of copper and zinc.

The table shows the percentage by mass of copper and zinc in two types of brass.

Type of brass	**Percentage (%) by mass**	
	Copper	**Zinc**
Red brass	90	10
Yellow brass	**X**	30

(b) Calculate value **X** in the table above.

_____

Percentage by mass **X** = _____ %

(1)

(c) Calculate the mass of copper in 1100 g of red brass.

_____

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_____

Mass = _____ g

(2)

(d) What is meant by an alloy?

_____

_____

(1)

(e) Brass contains layers of atoms which can slide over each other.

Explain why red brass is softer than yellow brass.

Use the table above and your own knowledge.

_____

_____

_____

_____

(2)

(f) Some musical instruments are made of brass.

Parts of these instruments can be gold plated.

What is the carat number of pure gold?

Tick (✔) **one** box.

9 ☐ **18** ☐ **22** ☐ **24** ☐

(1)

(Total 8 marks)

Q11.

A student investigates the effect of concentration on the rate of reaction.

The student reacts sodium thiosulfate solution with dilute hydrochloric acid.

This produces a cloudy mixture.

(a) The cloudiness is produced by the formation of solid sulfur.

How should sulfur be written in the chemical equation for this reaction?

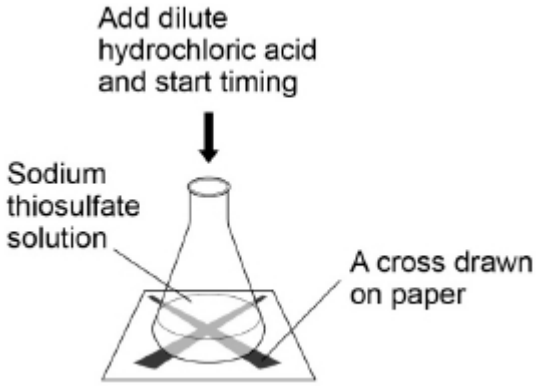
Tick (✔) **one** box.

S(aq) ☐ S(g) ☐ S(l) ☐ S(s) ☐

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(1)

The diagram shows some of the apparatus the student uses.



This is the method used.

1. Measure 40 cm^3 sodium thiosulfate solution into a conical flask.
2. Stand the flask on a piece of paper with a cross drawn on it.
3. Add 10 cm^3 of dilute hydrochloric acid to the flask.
4. Time how long it takes the cross to become no longer visible.
5. Repeat steps 1–4 twice more.
6. Repeat steps 1–5 with sodium thiosulfate solutions of different concentrations.

(1)

(b) Which apparatus could be used to measure 10 cm^3 of dilute hydrochloric acid?

Tick (✔) **one** box.

- Beaker ☐
- Boiling tube ☐
- Measuring cylinder ☐
- Test tube ☐

(1)

(c) Draw **one** line from each type of variable to the description of the variable.

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Type of variable	Description of the variable
	Concentration of sodium thiosulfate solution
Dependent variable	Size of conical flask
	Size of cross drawn on paper
Independent variable	Time for cross to become no longer visible
	Volume of hydrochloric acid

(2)

(d) The student draws a new cross for each experiment.

Suggest why this might give inaccurate results.

_____

_____

(1)

(e) The table shows the student's results for sodium thiosulfate solution with a concentration of 12 g / dm^3

Time for cross to become no longer visible in s			
Trial 1	**Trial 2**	**Trial 3**	**Mean**
43	78	41	**X**

Calculate value **X** in the tabble.

Do **not** use any anomalous results in your calculation.

_____

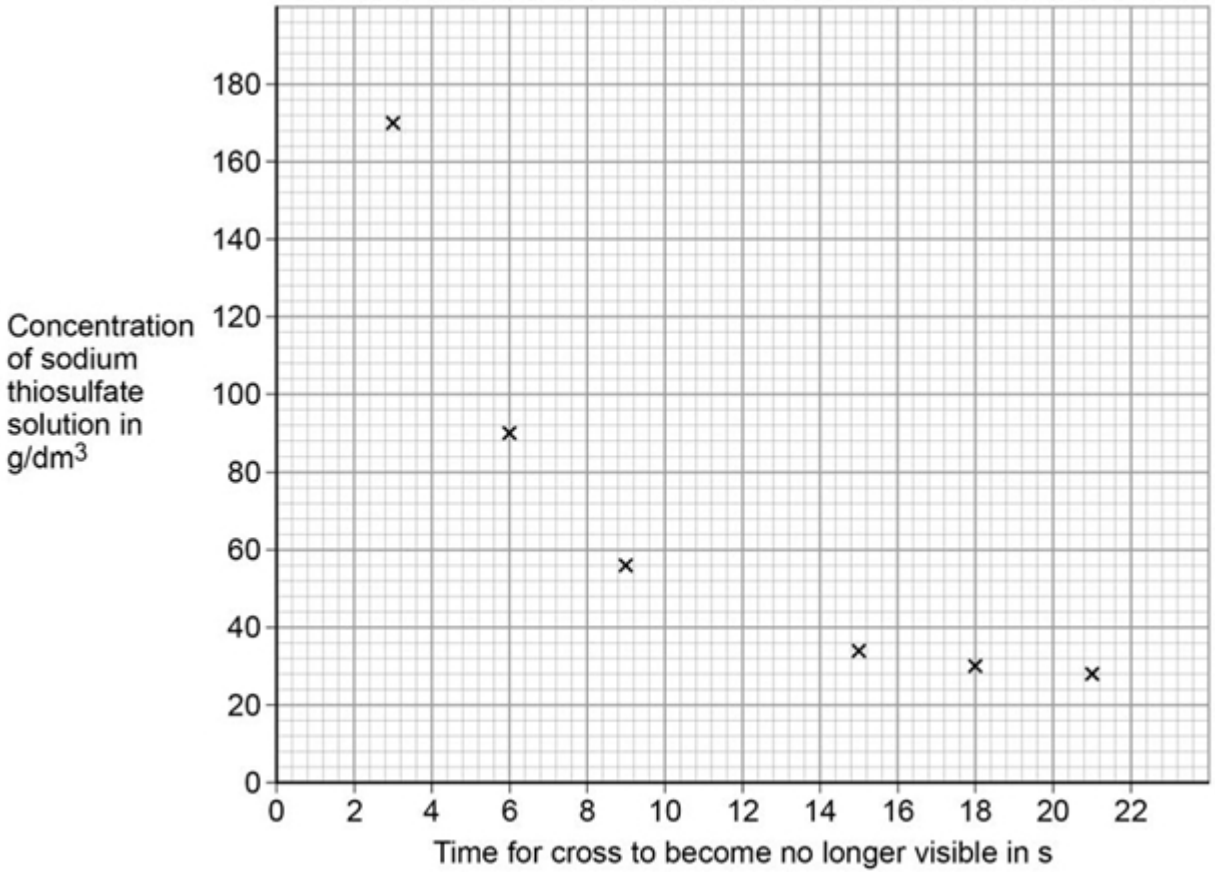
_____

X = _____ s

(2)

(f) The graph shows some of the student's results.

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Draw a smooth curve of best fit on the graph above.

(1)

(g) Another student does the same investigation.

Both students have a similar pattern in their results.

Which word describes investigations performed by different students, which give a similar pattern of results?

Tick (✔) **one** box.

Accurate ☐

Precise ☐

Reproducible ☐

Valid ☐

(1)

(h) The more concentrated the sodium thiosulfate solution, the less time is taken for the cross to become no longer visible.

Give **two** reasons why.

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Tick (✔) **two** boxes.

Particles are more spread out	☐
Particles collide more frequently	☐
Particles have more energy	☐
Particles move more quickly	☐
There are more particles in a fixed volume	☐

(2)

(Total 11 marks)

Q12.

The Haber Process is used to produce ammonia from nitrogen and hydrogen.

The equation for the reaction is:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(a) An ammonia molecule has the formula NH_3

How many atoms are there in one molecule of ammonia?

Tick (✔) **one** box.

2 ☐ 3 ☐ 4 ☐ 6 ☐

(1)

(b) What does the symbol ⇌ mean?

_____

(1)

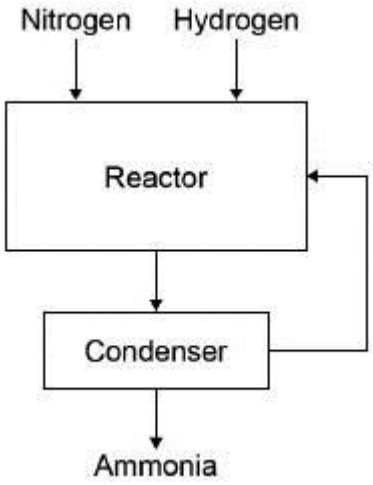
(c) Draw **one** line from each gas to the source of that gas.

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Gas	Source
	Air
Hydrogen	Alcohol
	Ammonia
Nitrogen	Iron
	Natural gas

(2)

The diagram shows the Haber process.



A mixture of ammonia, hydrogen and nitrogen gases leave the reactor.

Table 1 shows the boiling points of the gases.

Table 1

Gas	Boiling point in °C
Ammonia	– 33
Nitrogen	– 196
Hydrogen	– 253

(d) The mixture is cooled to a temperature at which **only** the ammonia condenses to a liquid.

Which temperature could be used?

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Tick (✔) **one** box.

− 20 °C ☐

− 40 °C ☐

− 200 °C ☐

− 260 °C ☐

(1)

(e) What happens to the unreacted nitrogen?

Tick (✔) **one** box.

Collected and sold ☐

Recycled to the reactor ☐

Released into the air ☐

Used as a catalyst ☐

(1)

Ammonia from the Haber process can be used to produce fertilisers.

Table 2 gives information about two compounds used in fertilisers.

Table 2

Fertiliser	Compound	Cost in £ / kg
A	Potassium chloride	0.24
B	Diammonium phosphate	0.35

(f) What type of bonding is present in potassium chloride?

Tick (✔) **one** box.

Covalent ☐

Ionic ☐

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Metallic ☐

(1)

(g) Diammonium phosphate has the chemical formula $(NH_4)_2HPO_4$

Which **two** elements in $(NH_4)_2HPO_4$ improve agricultural productivity?

Tick (✔) **two** boxes.

Chlorine ☐

Hydrogen ☐

Nitrogen ☐

Oxygen ☐

Phosphorus ☐

A farmer uses fertilisers **A** and **B** on a field with an area of 0.05 km^2

(2)

(h) 50 kg of fertiliser A will cover an area of 0.01 km^2

Calculate the cost of fertilising a field with an area of 0.05 km^2 with fertiliser **A**.

Use **Table 2**.

_____

_____

Cost = £ _____

(2)

(i) Fertiliser **B** is more expensive than fertiliser **A**.

Suggest why the farmer uses **both** fertilisers.

_____

_____

(1)

(Total 12 marks)

Q13.

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When sodium thiosulfate solution reacts with dilute hydrochloric acid, the solution becomes cloudy.

The equation for the reaction is:

$$Na_2S_2O_3(aq) + 2\,HCl(aq) \longrightarrow 2\,NaCl(aq) + SO_2(g) + H_2O(l) + S(s)$$

(a) Why does the solution become cloudy?

_____

_____

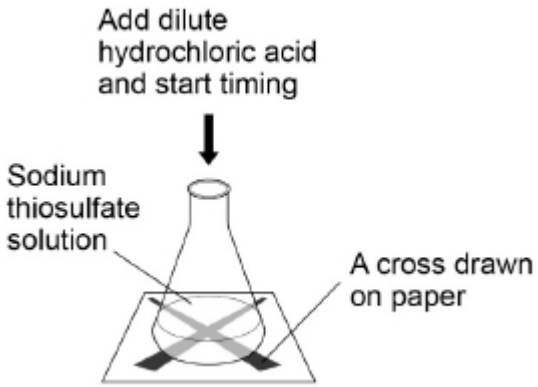
_____

_____

(2)

Some students used this reaction to investigate the effect of concentration on rate of reaction.

The diagram shows the apparatus used.



This is the method used.

1. Measure 25 cm^3 sodium thiosulfate solution into a conical flask.
2. Stand the conical flask on a cross drawn on paper.
3. Add 10 cm^3 of dilute hydrochloric acid.
4. Time how long it takes the cross to become no longer visible.
5. Repeat steps 1–4 with sodium thiosulfate solutions of different concentrations.

(b) The students used a measuring cylinder to measure 25 cm^3 of sodium thiosulfate solution.

Suggest a more accurate way of measuring 25 cm^3 of sodium thiosulfate solution.

_____

_____

(1)

(c) Name one control variable the students should use in this investigation.

_____

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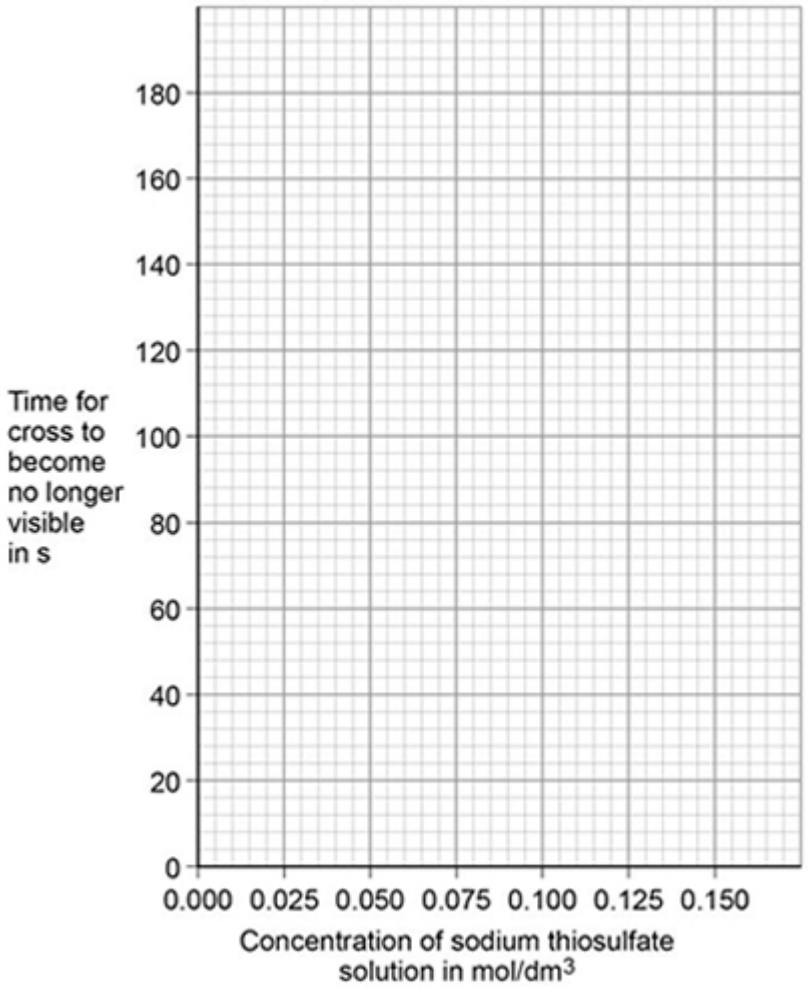
(1)

The table shows the students' results.

Concentration of sodium thiosulfate solution in mol / dm^3	**Time for cross to become no longer visible in s**
0.020	170
0.040	90
0.060	82
0.080	42
0.100	34
0.120	30
0.140	28

(d) Plot the data from the table above on the graph below.

Draw a line of best fit.



(3)

The students repeated the investigation two more times.

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They obtained similar results each time.

(e) What word describes an investigation by the same students which gives similar results each time?

_____

(1)

(f) Describe how the students can use their results to improve the accuracy of the investigation.

_____

_____

_____

_____

(2)

(g) The students analysed their results to give a conclusion and an explanation for their investigation.

Conclusion: 'The higher the concentration, the lower the rate of reaction.'

Explanation: 'At higher concentrations, the particles have more energy, so they are moving faster. Therefore the collisions are more energetic.'

The students are not correct.

Give a **correct** conclusion **and** explanation for the results of the investigation.

Conclusion _____

_____

_____

Explanation _____

_____

_____

_____

_____

(3)

(h) A solution containing 0.18 g of sodium thiosulfate reacts with dilute hydrochloric acid in 2 minutes.

Calculate the mean rate of reaction in g / s.

Give your answer in standard form.

_____

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_____

_____

_____

Mean rate of reaction = _____ g / s

(3)

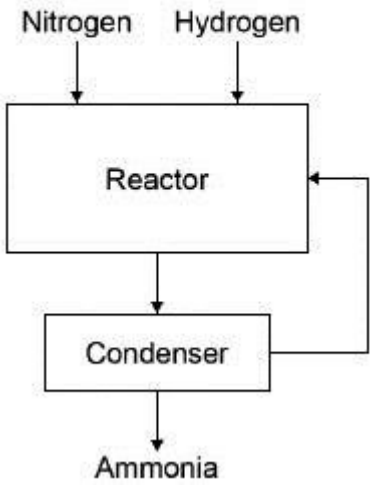
(Total 16 marks)

Q14.

Nitrogen and hydrogen react to produce ammonia in the Haber process.

Figure 1 shows the Haber process.

Figure 1



A gaseous mixture of ammonia, hydrogen and nitrogen leaves the reactor.

Table 1 shows the boiling points of the gases.

Table 1

Gas	Boiling point in °C
Ammonia	−33
Nitrogen	−196
Hydrogen	−253

(a) Suggest how ammonia is separated from the other gases.

_____

_____

_____

_____

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_____

(2)

(b) What happens to the unreacted hydrogen and nitrogen?

_____

_____

(1)

The equation for the reaction is:

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

The forward reaction is exothermic.

(c) Calculate the volume of ammonia produced from the complete reaction of 825 dm^3 of hydrogen.

_____

_____

_____

_____

Volume of ammonia = _____ dm^3

(2)

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

Why are these conditions used?

Tick **two** boxes.

- A higher pressure is maintained using less energy ☐
- A higher temperature would increase the equilibrium yield ☐
- A lower pressure would decrease the equilibrium yield ☐
- A lower temperature would make the reaction too slow ☐
- There are more product molecules than reactant molecules ☐

(2)

Most of the ammonia produced is used to make fertilisers.

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Table 2 shows information about compounds used as fertilisers.

Table 2

Compound	Formula	Cost in £ / tonne
A	NH_4NO_3	220
B	$(NH_4)_2HPO_4$	350
C	KCl	235

(e) Which element in compound A improves agricultural productivity?

_____

(1)

(f) Which **two** compounds can be mixed to make a fertiliser containing three elements that improve agricultural productivity?

Give a reason why you have chosen these compounds.

Compounds _____ and _____

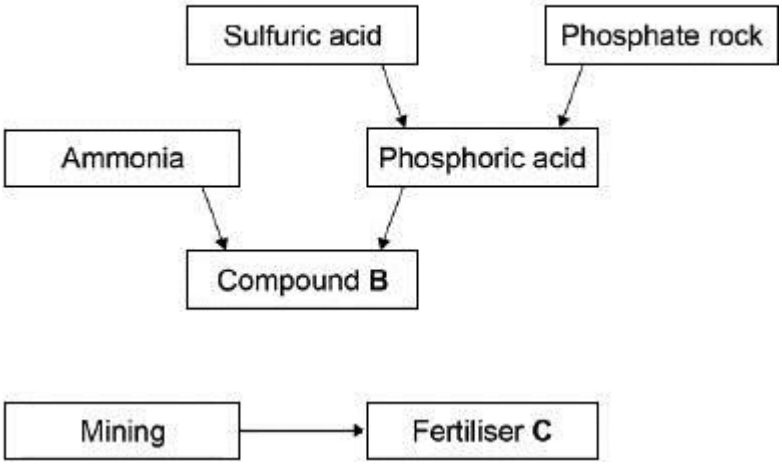
Reason _____

_____

(2)

(g) **Figure 2** shows a flow chart for the production of compounds B and C.

Figure 2



Suggest **two** possible reasons for the difference in cost between compounds **B** and **C**.

1. _____

_____

2. _____

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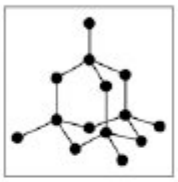
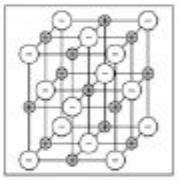
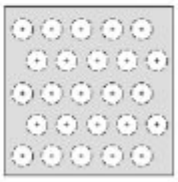
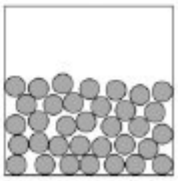
(2)

(Total 12 marks)

Q15.

This question is about different substances and their structures.

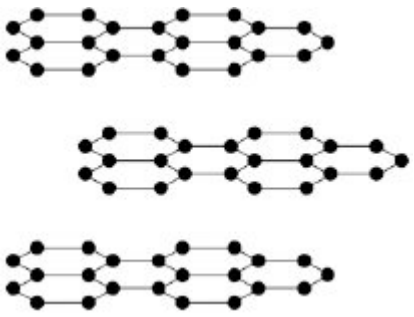
(a) Draw **one** line from each statement to the diagram which shows the structure.

Statement	Structure
The substance is a gas	
The substance is a liquid	
The substance is ionic	
The substance is a solid metal	
	

(4)

(b) **Figure 1** shows the structure of an element.

Figure 1



What is the name of this element?

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Tick **one** box.

Carbon ☐

Chloride ☐

Nitrogen ☐

Xenon ☐

(1)

(c) Why does this element conduct electricity?

Tick **one** box.

It has delocalised electrons ☐

It contains hexagonal rings ☐

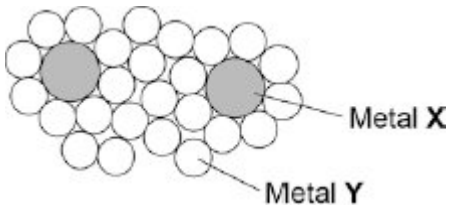
It has weak forces between the layers ☐

It has ionic bonds ☐

(1)

(d) **Figure 2** shows the structure of an alloy.

Figure 2



Explain why this alloy is harder than the pure metal **Y**.

_____

_____

_____

_____

(2)

(e) What percentage of the atoms in the alloys are atoms of **X**?

_____

_____

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_____

_____

(2)

(f) What type of substance is an alloy?

Tick **one** box.

Compound ☐

Element ☐

Mixture ☐

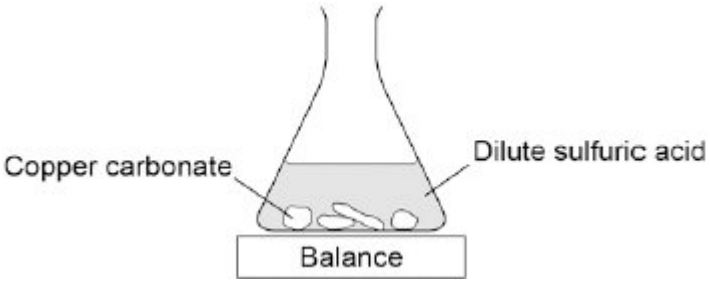
(1)

(Total 11 marks)

Q16.

A student investigated the reaction of copper carbonate with dilute sulfuric acid.

The student used the apparatus shown in the figure below.



(a) Complete the state symbols in the equation.

$$CuCO_3 (___) + H_2SO_4 (aq) \rightarrow CuSO_4 (aq) + H_2O (___) + CO_2 (g)$$

(2)

(b) Why did the balance reading decrease during the reaction?

Tick **one** box.

The copper carbonate broke down. ☐

A salt was produced in the reaction. ☐

A gas was lost from the flask. ☐

Water was produced in the reaction. ☐

(1)

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(c) Describe a safe method for making pure crystals of copper sulfate from copper carbonate and dilute sulfuric acid. Use the information in the figure above to help you.

In your method you should name all of the apparatus you will use.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(d) The percentage atom economy for a reaction is calculated using:

$$\frac{\text{Relative formula mass of desired product from equation}}{\text{Sum of relative formula masses of all reactants from equation}} \times 100$$

The equation for the reaction of copper carbonate and sulfuric acid is:

$$CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$$

Relative formula masses : $CuCO_3$ = 123.5; H_2SO_4 = 98.0; $CuSO_4$ = 159.5

Calculate the percentage atom economy for making copper sulfate from copper carbonate.

_____

_____

_____

_____

_____

Atom economy = _____ %

(3)

(e) Give **one** reason why is it important for the percentage atom economy of a reaction to be as high as possible.

_____

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_____

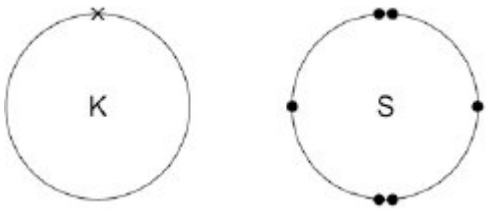
(1)

(Total 13 marks)

Q17.

Figure 1 shows the outer electrons in an atom of the Group 1 element potassium and in an atom of the Group 6 element sulfur.

Figure 1



(a) Potassium forms an ionic compound with sulfur.

Describe what happens when **two** atoms of potassium react with **one** atom of sulfur.

Give your answer in terms of electron transfer.

Give the formulae of the ions formed.

_____

_____

_____

_____

_____

_____

_____

_____

_____

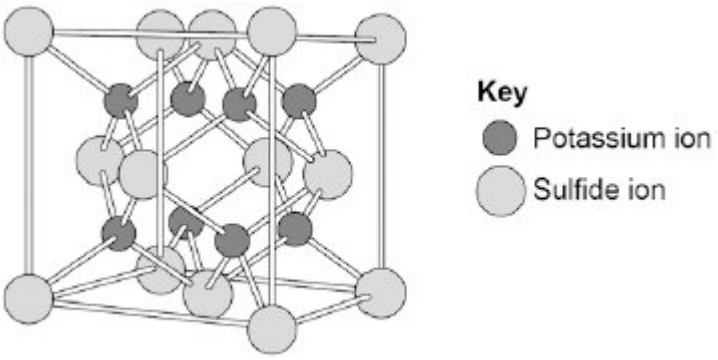
_____

(5)

(b) The structure of potassium sulfide can be represented using the ball and stick model in **Figure 2**.

Figure 2

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The ball and stick model is **not** a true representation of the structure of potassium sulfide.

Give **one** reason why.

_____

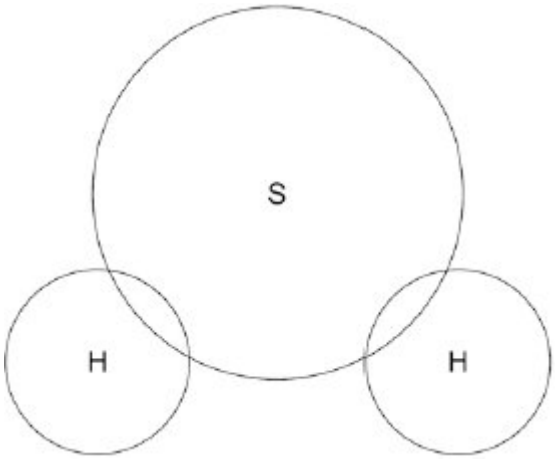
_____

(1)

(c) Sulfur can also form covalent bonds.

Complete the dot and cross diagram to show the covalent bonding in a molecule of hydrogen sulfide.

Show the outer shell electrons only.



(2)

(d) Calculate the relative formula mass (M_r) of aluminium sulfate $Al_2(SO_4)_3$

Relative atomic masses (A_r): oxygen = 16; aluminium = 27; sulfur = 32

_____

_____

_____

Relative formula mass = _____

(2)

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(e) Covalent compounds such as hydrogen sulfide have low melting points and do **not** conduct electricity when molten.

Draw **one** line from each property to the explanation of the property.

Property	**Explanation of property**
Low melting point	Electrons are free to move
	There are no charged particles free to move
	Ions are free to move
	Weak intermolecular forces of attraction
Does not conduct electricity when molten	
	Bonds are weak
	Bonds are strong

(2)

(f) Ionic compounds such as potassium sulfide have high boiling points and conduct electricity when dissolved in water.

Draw **one** line from each property to the explanation of the property.

Property	**Explanation of property**
	Electrons are free to move
	There are no

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High boiling point	charged particles free to move
	Ions are free to move
	Weak intermolecular forces of attraction
Conduct electricity when molten	
	Bonds are weak
	Bonds are strong

(2)

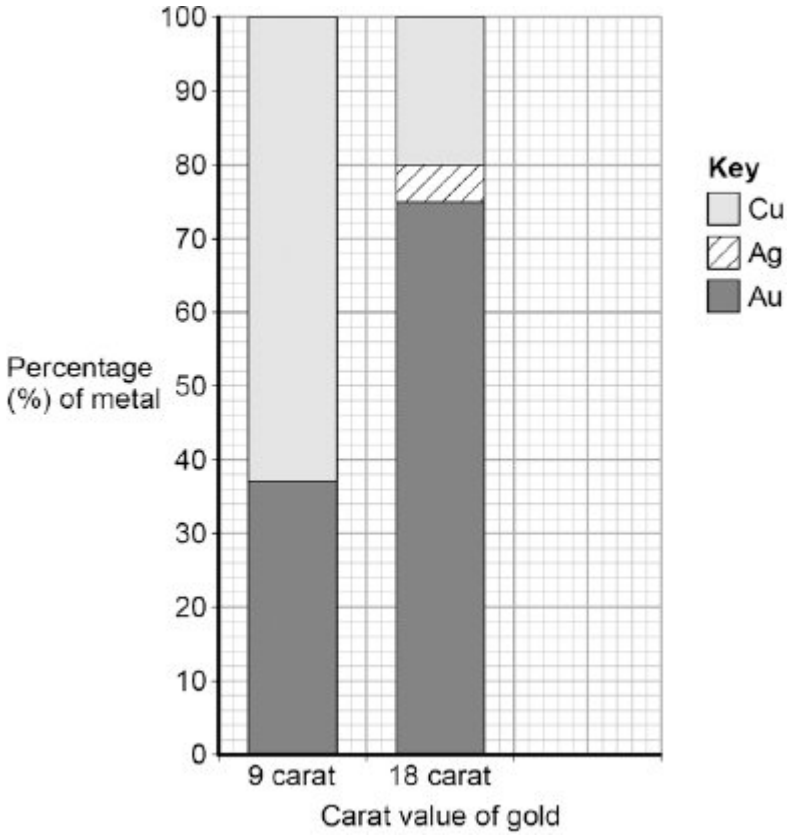
(Total 14 marks)

Q18.

Gold is mixed with other metals to make jewellery.

The figure below shows the composition of different carat values of gold.

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(a) What is the percentage of gold in 12 carat gold?

Tick **one** box.

12 % ☐ **30 %** ☐ **50 %** ☐ **80 %** ☐

(1)

(b) Give the percentage of silver in 18 carat gold.

Use the figure above to answer this question.

Percentage = _____ %

(1)

(c) Suggest **two** reasons why 9 carat gold is often used instead of pure gold to make jewellery.

1. _____

_____

2. _____

_____

(2)

(Total 4 marks)

Q19.

This question is about halogens and their compounds.

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The table below shows the boiling points and properties of some of the elements in Group 7 of the periodic table.

Element	Boiling point in °C	Colour in aqueous solution
Fluorine	−188	colourless
Chlorine	−35	pale green
Bromine	X	orange
Iodine	184	brown

(a) Why does iodine have a higher boiling point than chlorine?

Tick **one** box.

Iodine is ionic and chlorine is covalent ☐

Iodine is less reactive than chlorine ☐

The covalent bonds between iodine atoms are stronger ☐

The forces between iodine molecules are stronger ☐

(1)

(b) Predict the boiling point of bromine.

_____

(1)

(c) A redox reaction takes place when aqueous chlorine is added to potassium iodide solution.

The equation for this reaction is:

$$Cl_2(aq) + 2KI(aq) \rightarrow I_2(aq) + 2KCl(aq)$$

Look at table above.

What is the colour of the final solution in this reaction?

Tick **one** box.

Brown ☐

Orange ☐

Pale green ☐

Colourless ☐

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(1)

(d) What is the ionic equation for the reaction of chlorine with potassium iodide?

Tick **one** box.

$Cl_2 + 2K \rightarrow 2KCl$ ☐

$2I^- + Cl_2 \rightarrow I_2 + 2Cl^-$ ☐

$I^- + Cl \rightarrow I + Cl^-$ ☐

$I^- + K^+ \rightarrow KI$ ☐

(1)

(e) Why does potassium iodide solution conduct electricity?

Tick **one** box.

It contains a metal ☐

It contains electrons which can move ☐

It contains ions which can move ☐

It contains water ☐

(1)

(f) What are the products of electrolysing potassium iodide solution?

Tick **one** box.

Product at cathode	**Product at anode**	
hydrogen	iodine	☐
hydrogen	oxygen	☐
potassium	iodine	☐
potassium	oxygen	☐

(1)

(Total 6 marks)

Q20.

The table below gives information about four alcohols.

Alcohol	**Formula**	**Melting point**	**Boiling point**

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		in °C	in °C
Methanol	CH_3OH	−94	65
Ethanol	CH_3CH_2OH	−118	78
Propanol	$CH_3CH_2CH_2OH$	−129	97
Butanol	$CH_3CH_2CH_2CH_2OH$	−89	118

(a) Which alcohol in the table is liquid over the greatest temperature range?

_____

(1)

(b) Which statement is correct?

Tick **one** box.

A molecule of ethanol has 5 hydrogen atoms ☐

Butanol has the highest boiling point ☐

Methanol has the largest molecules ☐

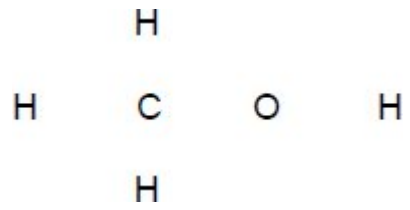
Propanol has the highest melting point ☐

(1)

(c) A molecule of methanol has five single covalent bonds.

Draw the missing bonds in **Figure 1** to complete the displayed formula for methanol.

Figure 1

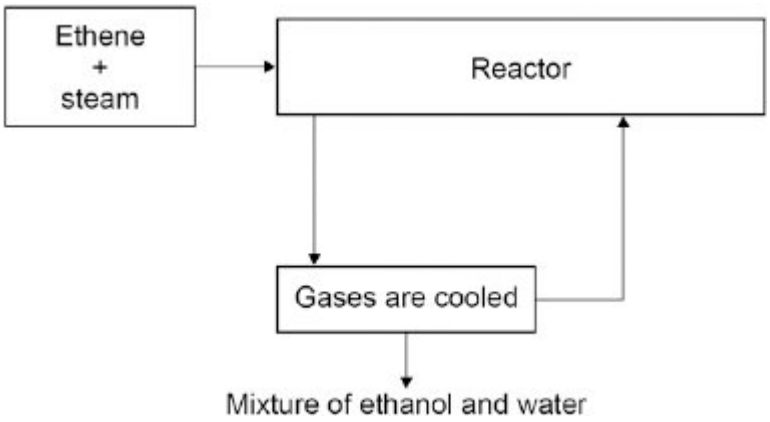


(1)

(d) **Figure 2** shows a flow diagram of the process to produce ethanol.

Figure 2

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Complete the word equation for the reaction to produce ethanol.

_____ + _____ → ethanol

(1)

(e) What happens to the unreacted ethene?

_____

_____

(1)

(f) Wine contains ethanol.
A bottle of wine was left open in air.
After a few days, the wine tasted of vinegar.
Vinegar is a solution of ethanoic acid in water.

Explain how oxidation causes the wine to taste of vinegar after a few days.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q21.

Metals are extracted from ores in the Earth's crust.

(a) Why is copper used in the manufacture of computers?

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Tick (✔) **one** box.

Because it has a high density. ☐

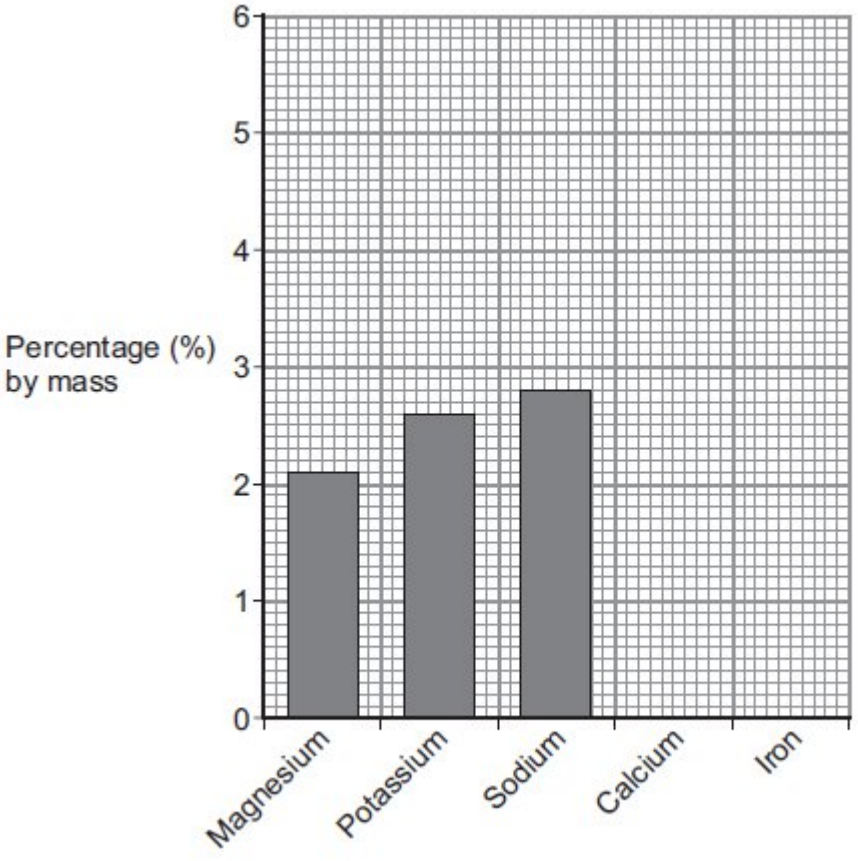
Because it does not react with water. ☐

Because it is a good conductor of electricity. ☐

(1)

(b) **Figure 1** shows the percentage (%) by mass of some metals in the Earth's crust.

Figure 1



(i) What is the percentage by mass of magnesium in the Earth's crust?

_____ %

(1)

(ii) On **Figure 1** draw the bars for:

- calcium at 3.6% by mass
- iron at 5.0% by mass.

(2)

(c) An ore of zinc contains zinc carbonate.

The equation for the reaction when zinc carbonate is heated is:

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$$\underset{\text{zinc carbonate}}{ZnCO_3} \longrightarrow \underset{\text{zinc oxide}}{ZnO} + \underset{\text{carbon dioxide}}{CO_2}$$

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

Tick (✔) **one** box.

corrosion ☐

decomposition ☐

electrolysis ☐

(1)

(ii) Which substance in the equation is a gas at room temperature (20 °C)?

Tick (✔) **one** box.

zinc carbonate ☐

zinc oxide ☐

carbon dioxide ☐

(1)

(iii) Complete the table below to show the number of atoms of carbon and oxygen in the formula of zinc carbonate.

Element	**Number of atoms in the formula $ZnCO_3$**
zinc, Zn	1
carbon, C	
oxygen, O	

(2)

(iv) When 125 g zinc carbonate is heated, 81 g zinc oxide is produced.

Calculate the mass of carbon dioxide produced.

_____

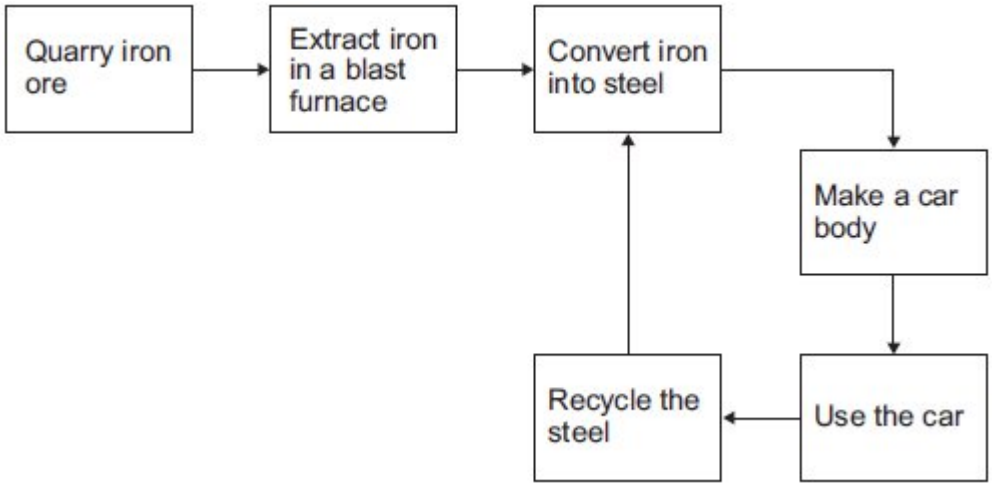
Mass of carbon dioxide = _____g

(1)

(d) **Figure 2** shows a simple life cycle of a car body.

Figure 2

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(i) What is **one** reason why iron from the blast furnace is converted into steel?

Tick (✔) **one** box.

To make the iron pure. ☐

To make the iron more brittle. ☐

To make alloys for specific uses. ☐

(1)

(ii) Apart from cost, give **three different** reasons why steel should be recycled.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(Total 13 marks)

Q22.

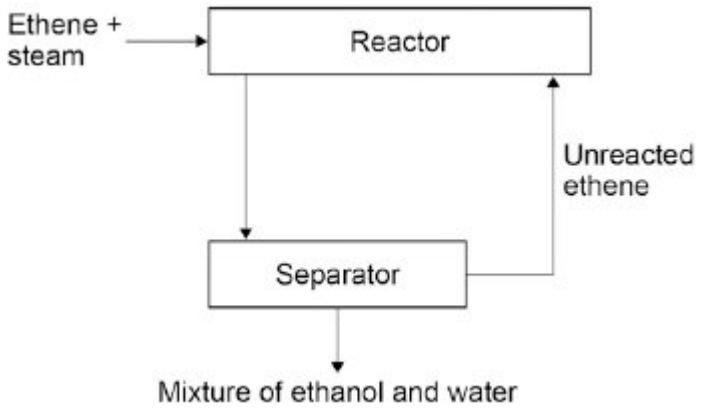
In industry ethanol is produced by the reaction of ethene and steam at 300°C and 60 atmospheres pressure using a catalyst.

The equation for the reaction is:

$$C_2H_4\ (g) + H_2O\ (g) \rightleftharpoons C_2H_5OH\ (g)$$

The figure below shows a flow diagram of the process.

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(a) Why does the mixture from the separator contain ethanol and water?

_____

_____

(1)

(b) The forward reaction is exothermic.

Use Le Chatelier's Principle to predict the effect of increasing temperature on the amount of ethanol produced at equilibrium.

Give a reason for your prediction.

_____

_____

_____

_____

(2)

(c) Explain how increasing the pressure of the reactants will affect the amount of ethanol produced at equilibrium.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q23.

This question is about substances containing carbon atoms.

(a) Diamond is made of carbon atoms.

(i) Diamond is used for tips of drills.

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Figure 1 shows a drill.

Figure 1



© Kershawj/iStock

Give **one** reason why diamond is used for tips of drills.

_____

_____

(1)

(ii) Diamond nanoparticles can be made.

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

hundred	**million**	**thousand**

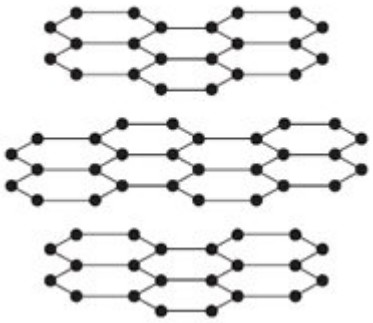
Nanoparticles contain a few _____ atoms.

(1)

(b) Graphite is made of carbon atoms.

Figure 2 shows the structure of graphite.

Figure 2



(i) What type of bonding does graphite have?

Tick (✔) **one** box.

Covalent ☐

Ionic ☐

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Metallic ☐

(1)

(ii) How many carbon atoms does each carbon atom bond to in graphite?

Tick (✔) **one** box.

1 ☐

2 ☐

3 ☐

4 ☐

(1)

(iii) What is a property of graphite?

Tick (✔) **one** box.

Dissolves in water ☐

Has a low melting point ☐

Soft and slippery ☐

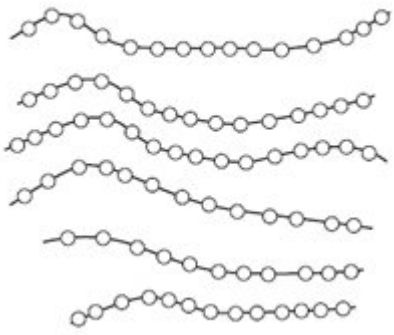
(1)

(c) Poly(ethene) is made of carbon and hydrogen atoms.

Poly(ethene) is a thermosoftening polymer.

Figure 3 shows the structure of a thermosoftening polymer.

Figure 3



(i) Complete the sentence.

Between the polymer chains in a thermosoftening polymer there are no _____ .

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(1)

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

condense	dissolve	melt

Heating would cause a thermosoftening polymer to

_____ .

(1)

(iii) Many ethene molecules react together to make poly(ethene).

Different types of poly(ethene) can be made by changing the conditions for the reaction.
Suggest **two** conditions that could be changed.

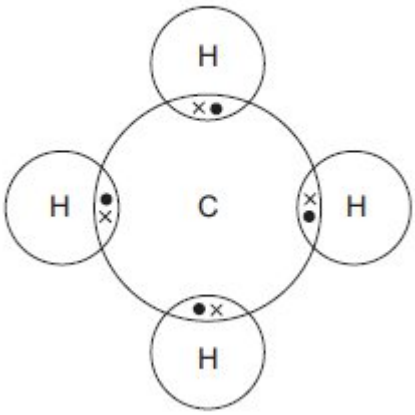
1. _____

2. _____

(2)

(d) **Figure 4** shows how the atoms are bonded in methane.

Figure 4



(i) What is the formula for methane?

Tick (✔) **one** box.

C_4H ☐

CH_4 ☐

C_4H_4 ☐

(1)

(ii) Methane has a low boiling point.

What does methane consist of?

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Tick (✔) **one** box.

Charged ions ☐

A giant lattice ☐

Small molecules ☐

(1)

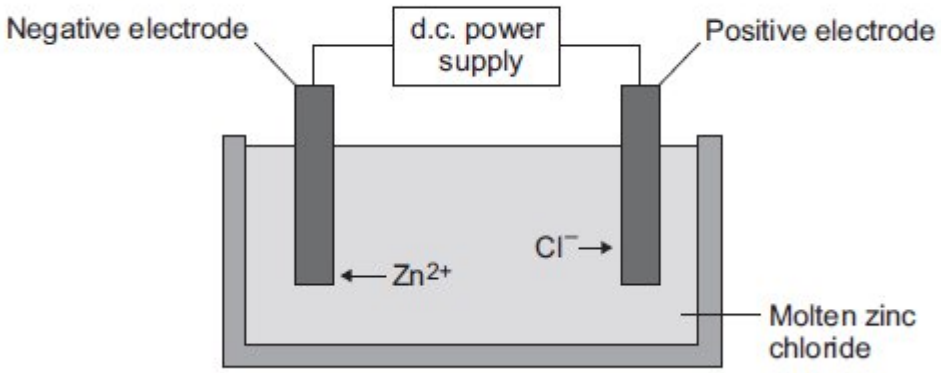
(Total 11 marks)

Q24.

This question is about zinc.

Figure 1 shows the electrolysis of molten zinc chloride.

Figure 1



(a) Zinc chloride is an ionic substance.
Complete the sentence.

When zinc chloride is molten, it will conduct _____ .

(1)

(b) Zinc ions move towards the negative electrode where they gain electrons to produce zinc.

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

_____

(1)

(ii) Explain why zinc ions move towards the negative electrode.

_____

_____

_____

_____

(2)

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(iii) What type of reaction occurs when the zinc ions gain electrons?

Tick (✔) **one** box.

Neutralisation ☐

Oxidation ☐

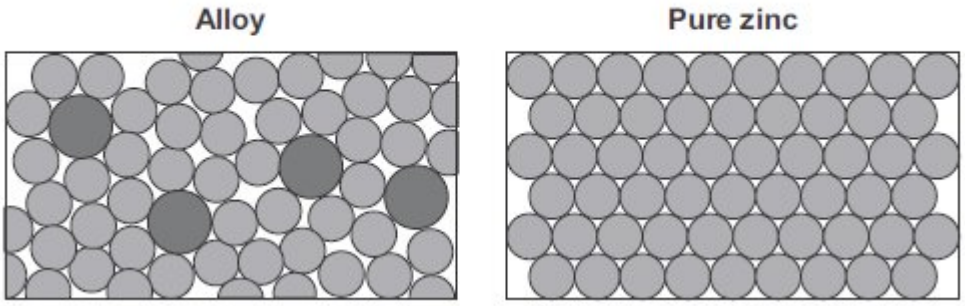
Reduction ☐

(1)

(c) Zinc is mixed with copper to make an alloy.

(i) **Figure 2** shows the particles in the alloy and in pure zinc.

Figure 2



Use **Figure 2** to explain why the alloy is harder than pure zinc.

_____

_____

_____

_____

(2)

(ii) Alloys can be bent. Some alloys return to their original shape when heated.

What name is used for these alloys?

_____

(1)

(Total 8 marks)

Q25.

This question is about magnesium and magnesium chloride.

(a) Magnesium chloride contains magnesium ions (Mg^{2+}) and chloride ions (Cl^{-}).

Describe, in terms of electrons, what happens when a magnesium atom reacts with chlorine atoms to produce magnesium chloride.

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_____

_____

_____

_____

_____

_____

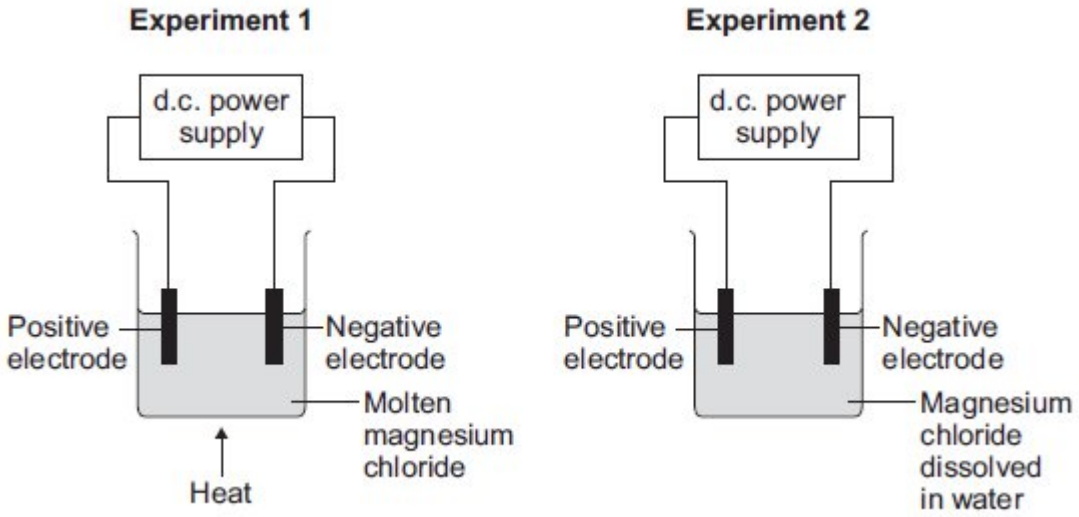
_____

_____

(4)

(b) Magnesium chloride can be electrolysed.

The diagram below shows two experiments for electrolysing magnesium chloride.



(i) Explain why magnesium chloride must be molten or dissolved in water to be electrolysed.

_____

_____

_____

_____

(2)

(ii) Explain how magnesium is produced at the negative electrode in **Experiment 1**.

_____

_____

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_____

_____

_____

_____

(3)

(iii) In **Experiment 2** a gas is produced at the negative electrode.
Name the gas produced at the negative electrode.

_____

(1)

(iv) Suggest why magnesium is **not** produced at the negative electrode in **Experiment 2**.

_____

_____

(1)

(v) Complete and balance the half equation for the reaction at the positive electrode.

_____ Cl^- $\longrightarrow$ Cl_2 + _____

(1)

(c) Magnesium is a metal.

Explain why metals can be bent and shaped.

_____

_____

_____

_____

(2)

(Total 14 marks)

Q26.

This question is about the properties and uses of materials.

Use your knowledge of structure and bonding to answer the questions.

(a) Explain how copper conducts electricity.

_____

_____

_____

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_____

_____

(2)

(b) Explain why diamond is hard.

_____

_____

_____

_____

_____

(2)

(c) Explain why thermosetting polymers are better than thermosoftening polymers for saucepan handles.

_____

_____

_____

_____

_____

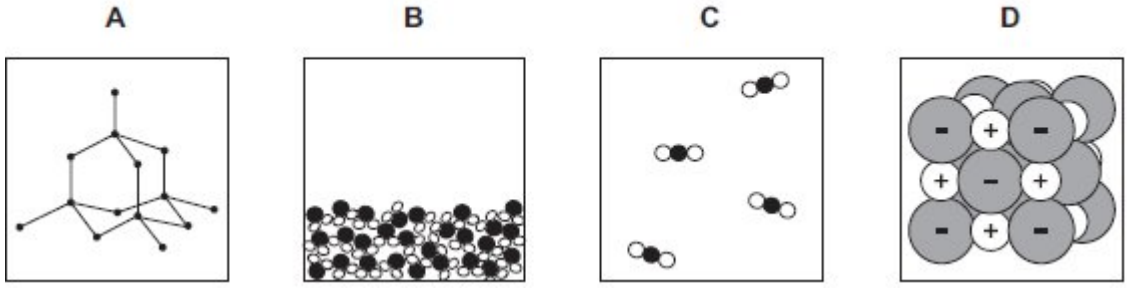
(2)

(Total 6 marks)

Q27.

The structures of four substances, **A**, **B**, **C** and **D**, are represented in **Figure 1**.

Figure 1



(a) Use the correct letter, **A**, **B**, **C** or **D**, to answer each question.

(i) Which substance is a gas? ☐

(1)

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(ii) Which substance is a liquid? ☐

(1)

(iii) Which substance is an element? ☐

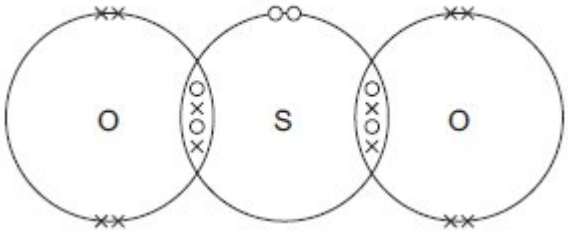
(1)

(iv) Which substance is made of ions? ☐

(1)

(b) **Figure 2** shows the bonding in substance **C**.

Figure 2



(i) What is the formula of substance **C**?

Draw a ring around the correct answer.

SO_2 **SO^2** **S_2O**

(1)

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

delocalised	**shared**	**transferred**

When a sulfur atom and an oxygen atom bond to produce substance **C**,

electrons are _____

(1)

(iii) What is the type of bonding in substance **C**?

Draw a ring around the correct answer.

covalent **ionic** **metallic**

(1)

(Total 7 marks)

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Q28.

This question is about copper.

(a) Copper can be extracted by smelting copper-rich ores in a furnace.

The equation for one of the reactions in the smelting process is:

$$Cu_2S(s) + O_2(g) \longrightarrow 2\,Cu(s) + SO_2(g)$$

Explain why there would be an environmental problem if sulfur dioxide gas escaped into the atmosphere.

_____

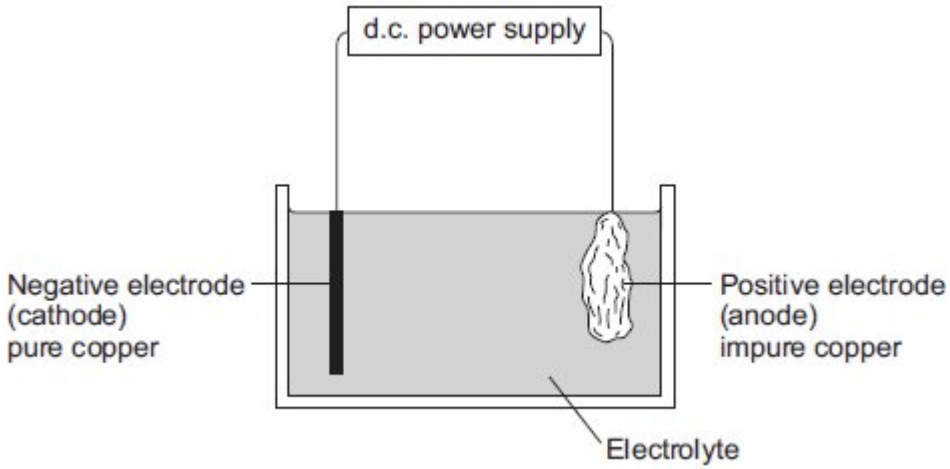
_____

_____

_____

(2)

(b) The impure copper produced by smelting is purified by electrolysis, as shown below.



Copper atoms are oxidised at the positive electrode to Cu^{2+} ions, as shown in the half equation.

$$Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$$

(i) How does the half equation show that copper atoms are oxidised?

_____

_____

(1)

(ii) The Cu^{2+} ions are attracted to the negative electrode, where they are reduced to produce copper atoms.

Write a balanced half equation for the reaction at the negative electrode.

_____

(1)

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(iii) Suggest a suitable electrolyte for the electrolysis.

_____

(1)

(c) Copper metal is used in electrical appliances.

Describe the bonding in a metal, and explain why metals conduct electricity.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(d) Soil near copper mines is often contaminated with low percentages of copper compounds.

Phytomining is a new way to extract copper compounds from soil.

Describe how copper compounds are extracted by phytomining.

_____

_____

_____

_____

_____

_____

(3)

(e) A compound in a copper ore has the following percentage composition by mass:

55.6% copper, 16.4% iron, 28.0% sulfur.

Calculate the empirical formula of the compound.

Relative atomic masses (A_r): S = 32; Fe = 56; Cu = 63.5

You must show all of your working.

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_____

_____

_____

_____

_____

_____

_____

_____

Empirical formula = _____

(4)

(Total 16 marks)

Q29.

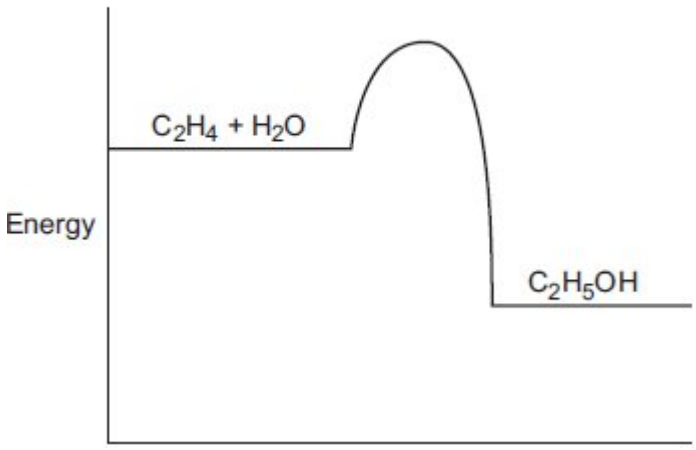
This question is about ethanol.

(a) Ethanol is produced by the reaction of ethene and steam:

$$C_2H_4 + H_2O \longrightarrow C_2H_5OH$$

(i) **Figure 1** shows the energy level diagram for the reaction.

Figure 1



How does the energy level diagram show that the reaction is exothermic?

_____

_____

(1)

(ii) A catalyst is used for the reaction.

Explain how a catalyst increases the rate of the reaction.

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_____

_____

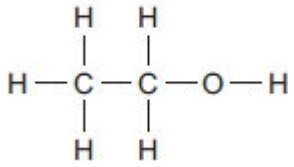
_____

_____

(2)

(b) **Figure 2** shows the displayed structure of ethanol.

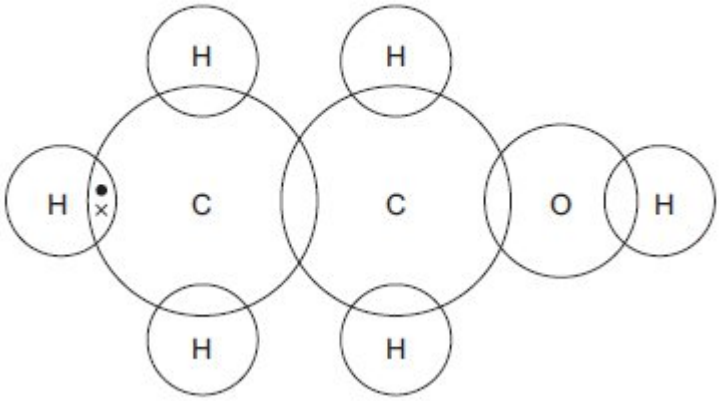
Figure 2



Complete the dot and cross diagram in **Figure 3** to show the bonding in ethanol.

Show the outer shell electrons only.

Figure 3

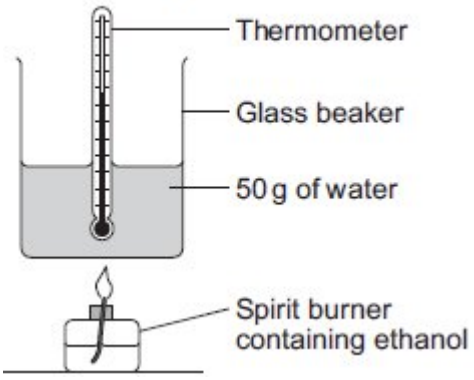


(2)

(c) A student burned some ethanol.

Figure 4 shows the apparatus the student used.

Figure 4



(i) The student recorded the temperature of the water before and after heating.

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His results are shown in **Table 1**.

Table 1

Temperature before heating	20.7 °C
Temperature after heating	35.1 °C

Calculate the energy used to heat the water.

Use the equation $Q = m \times c \times \Delta T$

The specific heat capacity of water = 4.2 J / g / °C

_____

_____

_____

_____

_____

Energy used = _____ J

(3)

(ii) **Table 2** shows the mass of the spirit burner before the ethanol was burned and after the ethanol was burned.

Table 2

Mass of spirit burner before ethanol was burned	72.80 g
Mass of spirit burner after ethanol was burned	72.10 g

Calculate the number of moles of ethanol (C_2H_5OH) that were burned.

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

_____

_____

_____

_____

_____

Number of moles burned = _____

(3)

(iii) Calculate the energy released in joules per mole.

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You should assume that all the energy from the ethanol burning was used to heat the water.

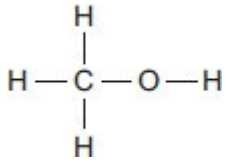
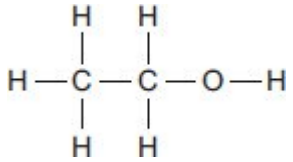
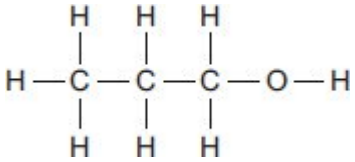
_____

Energy = _____ J / mole

(1)

(d) The names, structures and boiling points of ethanol and two other alcohols are shown in **Table 3**.

Table 3

Name	**Methanol**	**Ethanol**	**Propanol**
Structure			
Boiling point in °C	65	78	97

Use your knowledge of structure and bonding to suggest why the boiling points increase as the number of carbon atoms increases.

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 15 marks)

Q30.

This question is about salts.

(a) Salt (sodium chloride) is added to many types of food.

Sodium chloride is produced by reacting sodium with chlorine.

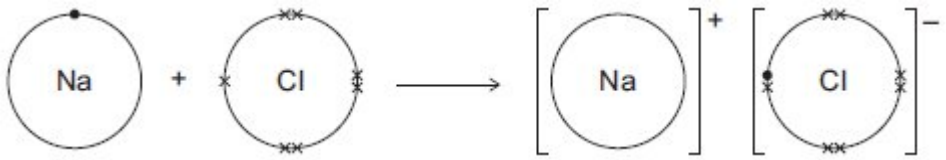
sodium + chlorine ⟶ sodium chloride

The diagram shows what happens to atoms of sodium and chlorine in this reaction.

The dots (•) and crosses (×) represent electrons.

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Only the outer electrons are shown.



Describe, in terms of electrons, what happens when a sodium atom reacts with a chlorine atom to produce sodium chloride.

_____

_____

_____

_____

_____

_____

(3)

(b) Lack of iodine can affect the learning ability of children.

One idea is that salt (sodium chloride) should have iodine added.

(i) Iodine consists of simple molecules.

What is a property of substances that have simple molecules?

Tick (✓) **one** box.

Have no overall electric charge ☐

Have high boiling points ☐

Have giant covalent structures ☐

(1)

(ii) Which one of the following questions cannot be answered by science alone?

Tick (✓) **one** box.

How much sodium chloride is in food? ☐

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What harm does a lack of iodine do? ☐

Should iodine be added to salt in food? ☐

Give **one** reason why this question cannot be answered by science alone.

_____

_____

(2)

(c) A student produced the salt ammonium nitrate by adding an acid to ammonia solution.

(i) Name the acid used.

_____

(1)

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

an acid	**an alkali**	**a salt**

Ammonia solution (ammonium hydroxide) is _____ .

(1)

(iii) The student added a few drops of a solution which changed colour when the reaction was complete.

Complete the sentence.

The solution added is an _____ .

(1)

(d) Farmers buy solid ammonium nitrate in poly(ethene) sacks.

(i) How is solid ammonium nitrate made from a solution of ammonium nitrate?

Tick (✓) **one** box.

Crystallisation ☐

Decomposition ☐

Electrolysis ☐

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(1)

(ii) Why do farmers use ammonium nitrate on their fields?

_____

_____

(1)

(iii) The properties of poly(ethene) depend on the reaction conditions when it is made.

State **one** reaction condition that can be changed when making poly(ethene).

_____

_____

(1)

(Total 12 marks)

Q31.

This question is about electrolysis.

(a) Metal spoons can be coated with silver.
This is called electroplating.

Suggest **one** reason why spoons are electroplated.

_____

_____

(1)

(b) When sodium chloride solution is electrolysed the products are hydrogen and chlorine.

(i) What is made from chlorine?

Tick (✓) **one** box.

Bleach ☐

Fertiliser ☐

Soap ☐

(1)

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

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Why is hydrogen produced at the negative electrode and **not** sodium?

Tick (✓) **one** box.

Hydrogen is a gas. ☐

Hydrogen is less reactive than sodium. ☐

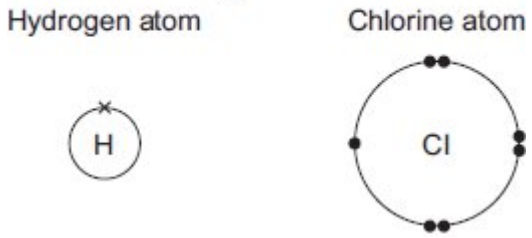
Hydrogen ions move faster than sodium ions. ☐

(1)

(iii) Hydrogen and chlorine can be used to produce hydrogen chloride.

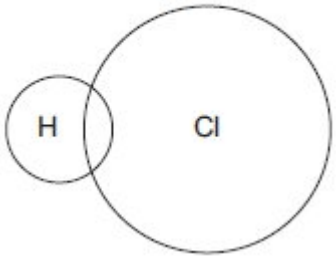
The diagrams in **Figure 1** show how the outer electrons are arranged in an atom of hydrogen and an atom of chlorine.

Figure 1



Complete **Figure 2** to show how the outer electrons are arranged in a molecule of hydrogen chloride (HCl).

Figure 2



(1)

(iv) What is the type of bond in a molecule of hydrogen chloride?

Tick (✓) **one** box.

Covalent ☐

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Ionic ☐

Metallic ☐

(1)

(v) Why is hydrogen chloride a gas at room temperature (20 °C)?

Tick (✓) **two** boxes.

Hydrogen chloride has a low boiling point. ☐

Hydrogen chloride has a high melting point. ☐

Hydrogen chloride is made of simple molecules. ☐

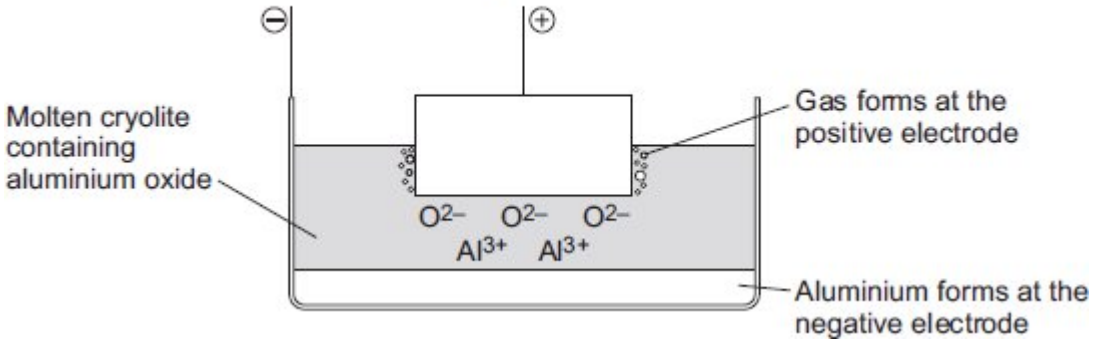
Hydrogen chloride does not conduct electricity. ☐

Hydrogen chloride has a giant structure. ☐

(2)

(c) Aluminium is produced by electrolysis of a molten mixture of aluminium oxide and cryolite.
This is shown in **Figure 3**.

Figure 3



(i) Name a gas produced at the positive electrode.

_____

(1)

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(ii) Aluminium ions move to the negative electrode.

Explain why.

_____

_____

_____

_____

(2)

(iii) At the negative electrode, the aluminium ions gain electrons to produce aluminium.

What is this type of reaction called?

Tick (✓) **one** box.

Combustion ☐

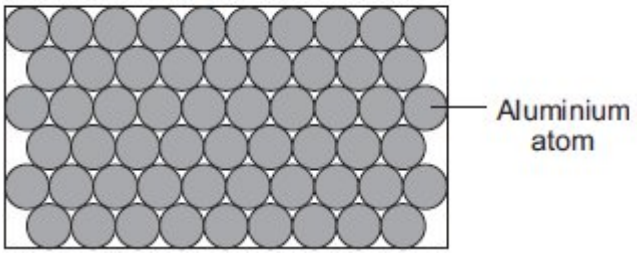
Oxidation ☐

Reduction ☐

(1)

(iv) Aluminium has layers of atoms, as shown in **Figure 4**.

Figure 4



Complete the sentence.

Metals can be bent and shaped because the layers of atoms can _____

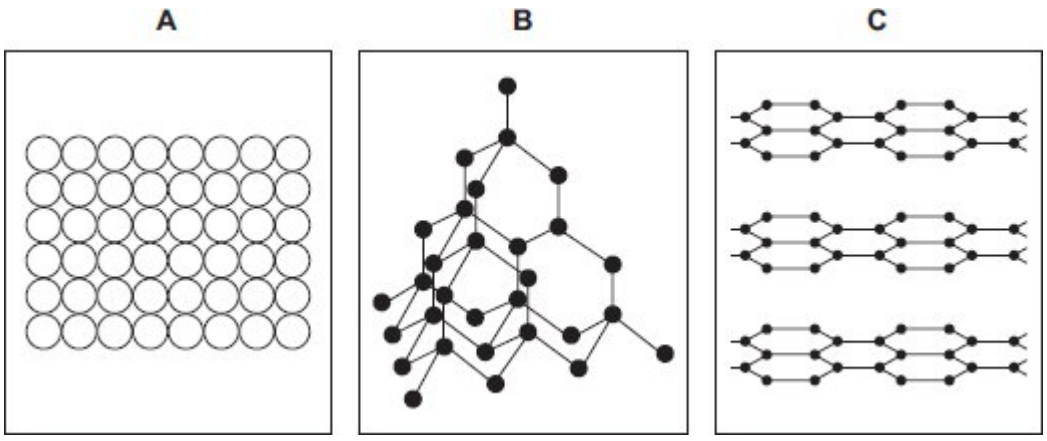
_____

(1)

(d) Electrodes used in the production of aluminium are made from graphite.

(i) Which diagram, **A, B** or **C**, shows the structure of graphite?

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The structure of graphite is shown in diagram ☐

(1)

(ii) The temperature for the electrolysis is 950 °C.

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

cross links	**a giant ionic lattice**	**strong covalent bonds**

The graphite does not melt at 950 °C because

graphite has _____ .

(1)

(Total 14 marks)

Q32.

This question is about metals and alloys.

(a) Explain how electricity is conducted in a metal.

To gain full marks you must include a description of the structure and bonding of a metal.

_____

_____

_____

_____

_____

_____

_____

_____

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(4)

(b) Describe how the structure of an alloy is different from the structure of a pure metal.

_____

_____

_____

_____

(2)

(c) Alloys are used to make dental braces and coins.

(i) Nitinol is an alloy used in dental braces.

Why is Nitinol used in dental braces?

_____

_____

(1)

(ii) Suggest **one** reason why coins are not made of pure copper.

Do **not** give cost as a reason.

_____

_____

(1)

(iii) Some coins are made from an alloy of aluminium.

Complete the sentence.

Aluminium is manufactured by the electrolysis of a molten mixture of cryolite and _____ .

(1)

(iv) Banks keep coins in poly(ethene) bags. These bags are made from low density poly(ethene).

High density poly(ethene) can also be made from the same monomer.

How can the same reaction produce two different products?

_____

_____

(1)

(d) Give **two** reasons why instrumental methods of analysis are used to detect impurities in metals.

_____

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_____

_____

(1)

(Total 11 marks)

Q33.

This question is about sodium chloride and iodine.

(a) Describe the structure and bonding in sodium chloride.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) When sodium chloride solution is electrolysed, one product is chlorine.

Name the **two** other products from the electrolysis of sodium chloride solution.

_____

_____

(2)

(c) Many people do not have enough iodine in their diet.

Sodium chloride is added to many types of food. Some scientists recommend that sodium chloride should have a compound of iodine added.

Give **one** ethical reason why a compound of iodine should **not** be added to sodium chloride used in food.

_____

_____

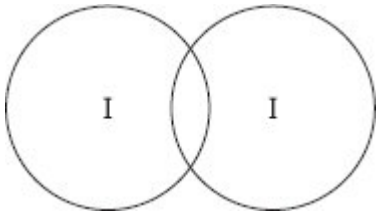
(1)

(d) The bonding in iodine is similar to the bonding in chlorine.

(i) Complete the diagram below to show the bonding in iodine.

Show the outer electrons only.

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(2)

(ii) Explain why iodine has a low melting point.

_____

_____

_____

_____

_____

_____

(3)

(iii) Explain, in terms of particles, why liquid iodine does not conduct electricity.

_____

_____

_____

_____

(2)

(Total 14 marks)

Q34.

This question is about compounds.

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

Soluble compounds
All potassium and sodium salts
All nitrates
Chlorides, bromides and iodides, except those of silver and lead

Use information from the table to answer these questions.

(i) Name a soluble compound that contains silver ions.

_____

(1)

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(ii) Name a soluble compound that contains carbonate ions.

_____

(1)

(b) Metal oxides react with acids to make salts.

What type of compound is a metal oxide?

_____

(1)

(c) Lead nitrate solution is produced by reacting lead oxide with nitric acid.

(i) State how solid lead nitrate can be obtained from lead nitrate solution.

_____

_____

(1)

(ii) Balance the equation for the reaction.

$$PbO + HNO_3 \longrightarrow Pb(NO_3)_2 + H_2O$$

(1)

(iii) Give the total number of atoms in the formula $Pb(NO_3)_2$

_____

(1)

(d) An oxide of lead that does **not** have the formula PbO contains 6.21 g of lead and 0.72 g of oxygen.

Calculate the empirical formula of this lead oxide.

Relative atomic masses (A_r): O = 16; Pb = 207

You must show your working to gain full marks.

_____

_____

_____

_____

_____

_____

Empirical formula = _____

(4)

(Total 10 marks)

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Q35.

Iron is extracted from iron oxide in the blast furnace.

(a) The equation for one of the reactions in the blast furnace is:

$$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$$

(i) Complete the word equation for this reaction.

iron oxide + carbon monoxide ⟶ _____ + _____

(2)

(ii) Oxygen is removed from iron oxide in the blast furnace.

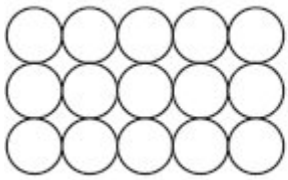
Draw a ring around the correct answer to complete the sentence.

The iron oxide is

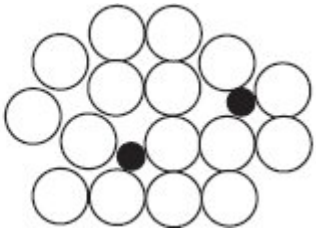
neutralised.
oxidised.
reduced.

(1)

(b) The diagrams represent pure iron and iron from the blast furnace.



Pure iron



Iron from the blast furnace

(i) Draw **one** line from each statement to the correct explanation.

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Statement	Explanation
Pure iron is an element because	it is made of one sort of atom only.
	it contains two elements not chemically combined.
Iron from the blast furnace is a mixture because	every atom has the same number of neutrons.
	it contains two elements chemically combined.

(2)

(ii) Explain why iron from the blast furnace is harder than pure iron.

Use the diagrams on page 4 to help you.

_____

_____

_____

_____

(2)

(Total 7 marks)

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