

How Bond + Structure Relate to Props

Question Paper 1

Level	GCSE (9-1)
Subject	Combined Science: Trilogy - Chemistry
Exam Board	AQA
Topic	5.2 Bonding Structure + Props Matter
Sub-Topic	How Bond + Structure Relate to Props
Difficulty Level	Silver Level
Booklet	Question Paper 1

Time Allowed: 60 minutes

Score: /59

Percentage: /100

Grade Boundaries:

Q1. 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.

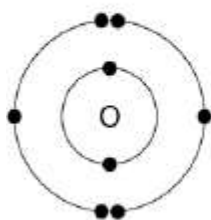
bonds	forces
ions	layers

Calcium oxide has a giant ionic lattice in which there are strong electrostatic of attraction in all directions.

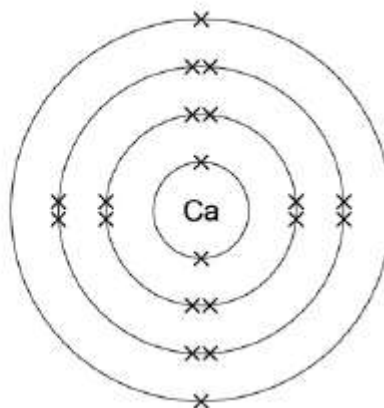
(1)

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

Oxygen atom



Calcium atom



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

You should give the charge on each ion formed.

.....

.....

.....

.....

.....

.....

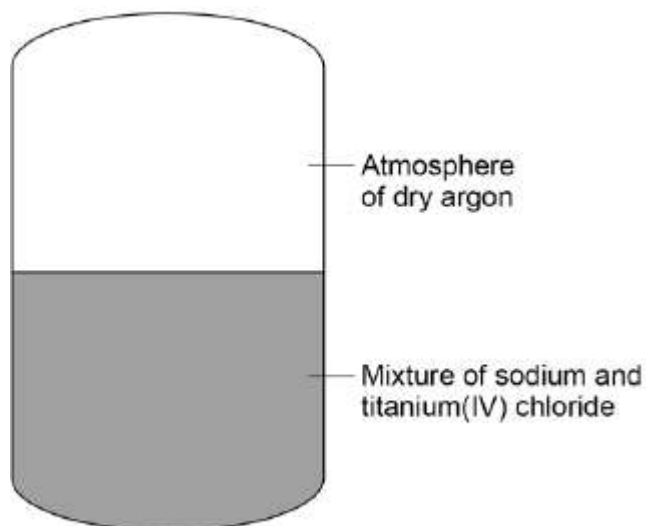
.....

.....

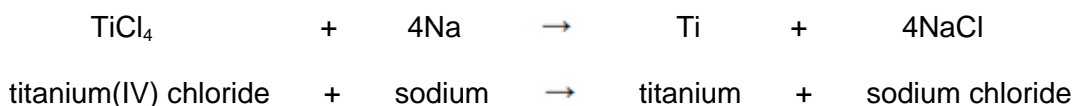
(4)
(Total 6 marks)

Q2.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:



(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.

.....

.....

Mass of titanium = kg

(1)

(b) The table below shows the solubility of sodium chloride in 100 cm³ of aqueous solution at different temperatures.

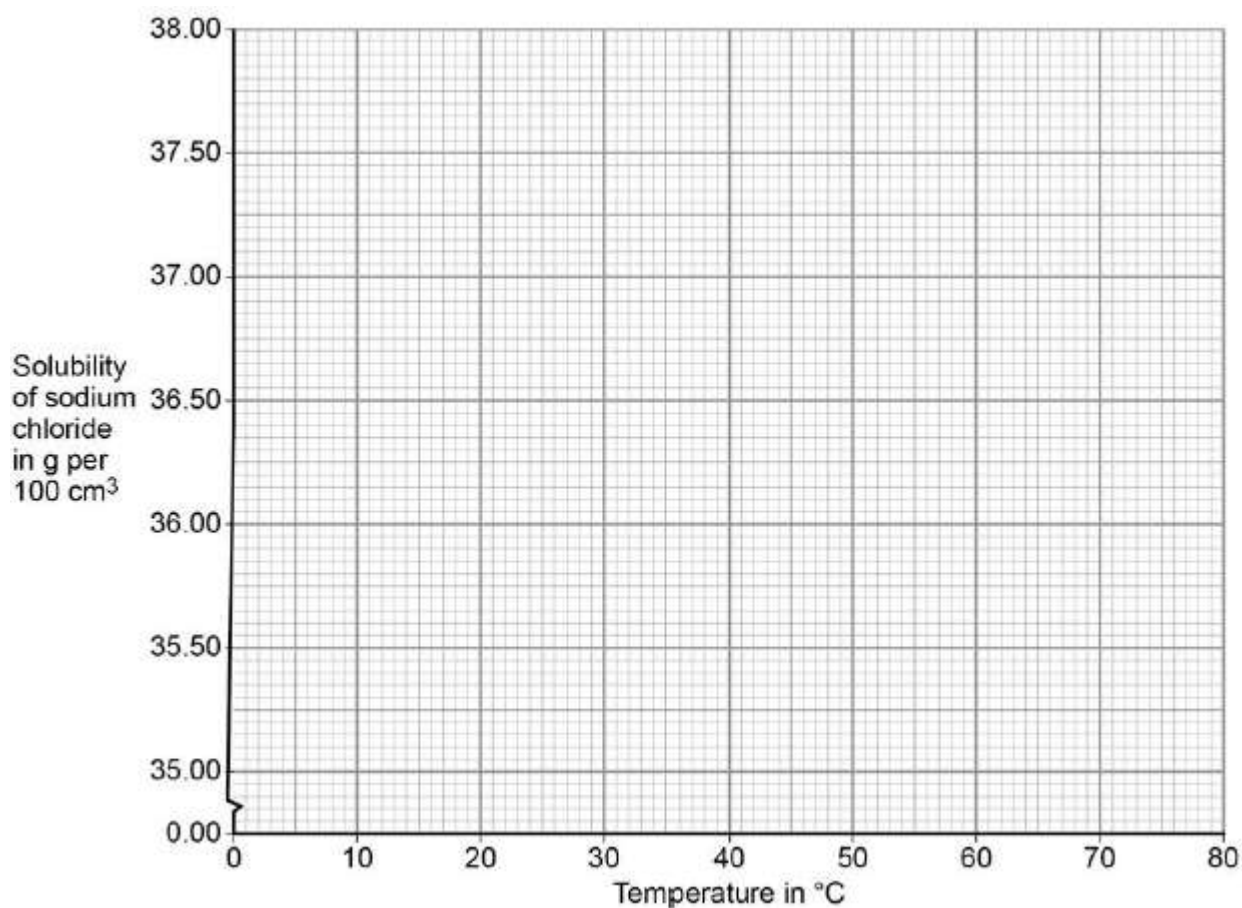
Solubility of sodium chloride in g per 100cm ³	Temperature in °C
35.72	10
35.89	20
36.09	30
37.37	40
36.69	50

37.04	60
-------	----

On **Figure 2**:

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

Figure 2



(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 dm³.

Calculate the minimum volume of water in dm³, at 30 °C, needed to dissolve 1989 kg sodium chloride.

.....

.....

.....

.....

Volume of water = dm³

(2)

- (d) Calculate the percentage by mass of titanium in titanium(IV) chloride (TiCl₄).

Give your answer to 3 significant figures.

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

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

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.

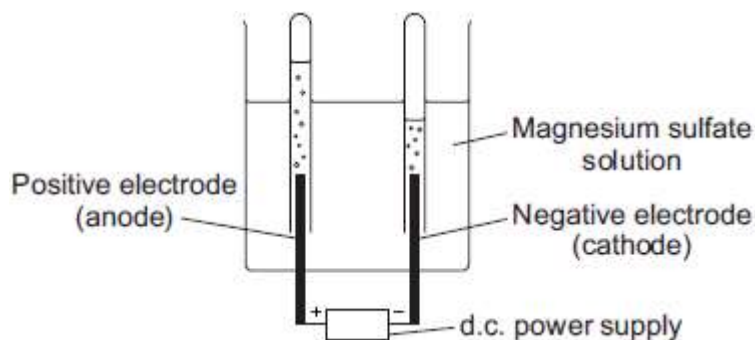
.....
.....
.....
.....
.....
.....

(3)

(Total 15 marks)

Q3.Diagram 1 shows the apparatus used to electrolyse magnesium sulfate solution.

Diagram 1



Gases were given off at both electrodes.

- (a) The gas collected at the anode was oxygen.

Draw **one** line from the test for oxygen to the correct result.

Test	Result
	The splint relights
Place a glowing splint in the tube of the gas	The splint goes out
	There is a squeaky pop

(1)

- (b) (i) The gas collected at the cathode was hydrogen.

Describe how to test the gas to show that it is hydrogen.

Test

.....

Result

.....

(2)

- (ii) Why is hydrogen, and **not** magnesium, produced at the cathode?

.....

.....

(1)

- (c) A student wanted to use electrolysis to silver plate a metal spoon.

- (i) Give **one** reason why metal spoons are sometimes silver plated.

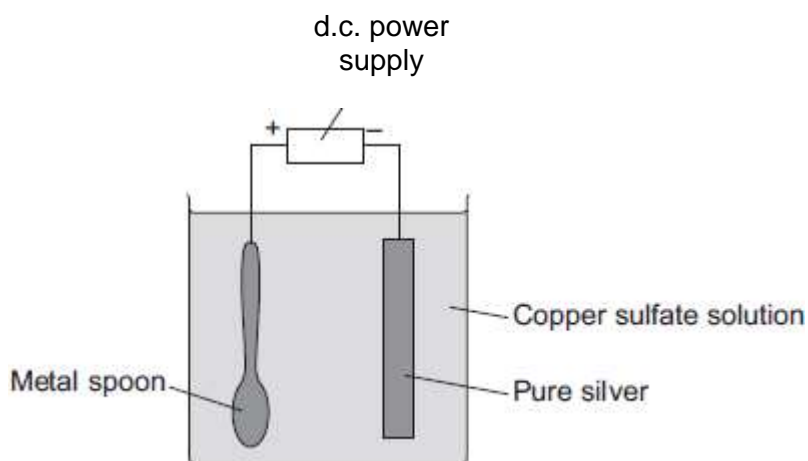
.....

.....

(1)

- (ii) **Diagram 2** shows the apparatus the student used. The student did **not** set the apparatus up correctly.

Diagram 2



The student found that the metal spoon eroded and a thin layer of copper formed on the pure silver electrode.

Suggest **two** changes that the student must make to his apparatus to be able to silver plate the metal spoon. Give a reason for each change.

.....

.....

.....

.....

.....

.....

.....

(4)

(iii) Why is it difficult to electroplate plastic spoons?

.....

.....

(1)


(Total 10 marks)

Q4. Read the information

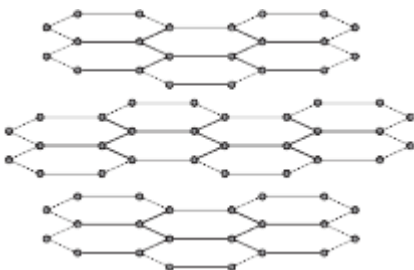
Graphene

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

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



Graphene



Graphite

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

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

Choose the correct answer to complete each sentence.

(i)

ionic

covalent

metallic

The bonds between the atoms in graphene are

(1)

(ii)

chromium	carbon	chlorine
----------	--------	----------

Graphene is made of atoms.

(1)

(iii)

2	3	4
---	---	---

In graphene each atom bonds to other atoms.

(1)

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

Graphite is used in pencils.

Explain why. Use the diagrams to help you.

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

(2)

(Total 5 marks)

Q5. (a) Magnesium metal is shaped to make magnesium ribbon.



Explain why metals can be shaped.

.....

.....

.....

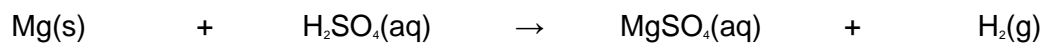
.....

.....

(2)

(b) Magnesium sulfate is a salt of magnesium.

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



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

..... acid

(1)

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

.....

.....

.....

.....

.....

(2)

(iii) The magnesium sulfate is in solution.

How could you obtain solid magnesium sulfate from this solution?

.....

.....

(1)

(Total 6 marks)

Q6. Read the information in the box.

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



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

The flash powder is placed on stage in a special container. At the bottom of the container there is a thin piece of wire. When the flash is needed, electricity

is passed through the wire. The wire gets hot and starts the aluminium burning.

By russellsmith [CC BY 2.0], via Flickr

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

What is the meaning of *exothermic*?

.....
.....

(1)

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

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

..... energy

(1)

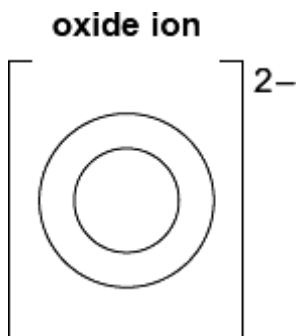
- (c) The white smoke produced is aluminium oxide.

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

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

The atomic number of oxygen = 8

Use crosses (x) to represent the electrons.



(1)

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

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

.....

(1)
(Total 4 marks)

Q7. Lead compounds have been used for thousands of years as colours in paint.



Johannes Vermeer [Public domain], via Wikimedia Commons

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

Calculate the empirical (simplest) formula of this compound.

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

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

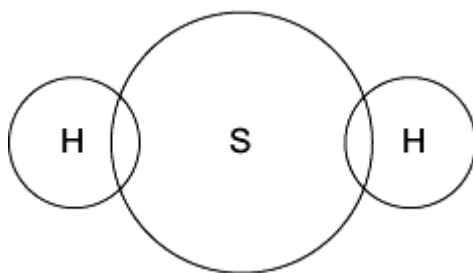
.....

(4)

- (b) A problem with lead compounds is that they slowly react with hydrogen sulfide in the air. This produces lead sulfide which is black.
- (i) Hydrogen sulfide has the formula H_2S . The bonding in a molecule of hydrogen sulfide can be represented as:



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



(1)

- (ii) Hydrogen sulfide has a low boiling point.

Explain why.

.....

.....

.....

.....

(2)

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

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

Balance the equation for the reaction between lead sulfide and hydrogen

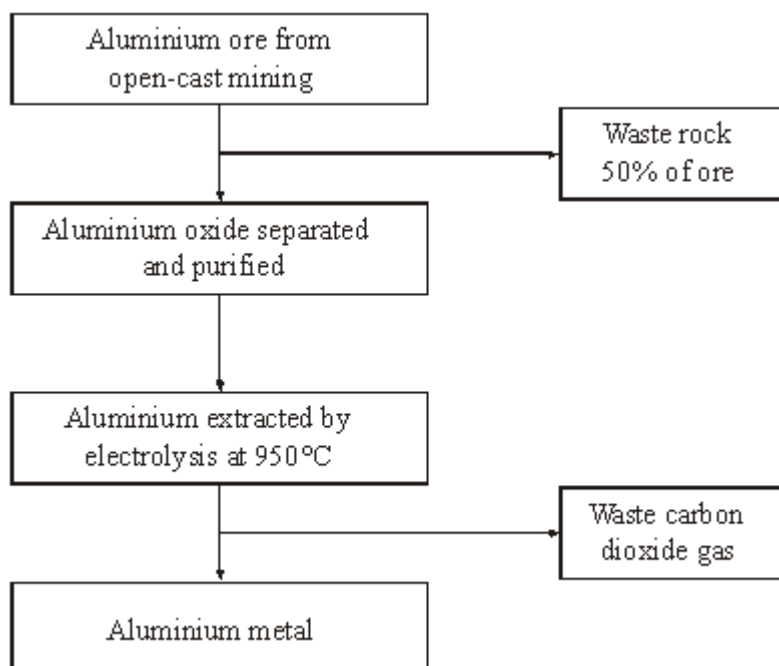
peroxide (H_2O_2).



(1)
(Total 8 marks)

Q8. Aluminium has many uses because of its low density, good electrical conductivity, flexibility and resistance to corrosion.

The main steps in the extraction of aluminium are shown in the flow chart.



(a) Use the information in the flow chart to suggest the benefits of recycling aluminium.

.....

.....

.....

.....

.....

.....

(3)

- (b) Pure aluminium is rarely used for the construction of large objects. Small amounts of other metals are usually mixed with aluminium.

Explain why.

.....

.....

.....

.....

(2)
(Total 5 marks)