

1 Chemists have developed models for bonding and structure which are used to explain different properties.

(a) Ammonia, NH_3 , is a covalent compound.

(i) Explain what is meant by a *covalent bond*.

..... [1]

(ii) Draw a '*dot-and-cross*' diagram to show the bonding in NH_3 .

Show **outer** electrons only.

[1]

(iii) Name the shape of the ammonia molecule.

Explain, using your '*dot-and-cross*' diagram, why ammonia has this shape and has a bond angle of 107° .

shape:

explanation:

.....

.....

.....

.....

.....

..... [3]

(b) Ammonia reacts with hydrogen chloride, HCl , to form ammonium chloride, NH_4Cl .

NH_4Cl is an ionic compound containing NH_4^+ and Cl^- ions.

(i) Complete the electron configuration of the Cl^- ion.

$1s^2$ [1]

(ii) Draw a 'dot-and-cross' diagram to show the bonding in NH_4^+ .

Show **outer** electrons only.

[1]

(iii) State the shape of, and bond angle in, an NH_4^+ ion.

shape:

bond angle: [2]

(iv) A student investigated the conductivity of ammonium chloride.

She noticed that when the ammonium chloride was solid it did **not** conduct electricity. However, when ammonium chloride was dissolved in water, the resulting solution did conduct electricity.

Explain these observations.

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.....
..... [2]

(c) Ammonium compounds such as ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$, can be used as fertilisers.

(i) Write a balanced equation to show how ammonium sulfate could be formed by the reaction between aqueous ammonia and sulfuric acid.

..... [1]

(ii) Ammonium sulfate is an example of a salt formed when an acid is neutralised by a base.

Explain what is meant by the term *salt*.

.....
..... [1]

(iii) Why is ammonia acting as a base in this neutralisation?

.....
..... [1]

(iv) What is the relative formula mass of $(\text{NH}_4)_2\text{SO}_4$?

Give your answer to **one** decimal place.

..... [1]

[Total: 15]

2 This question is about Group 7 elements.

(a) Chlorine can be made by the redox reaction below.



Using oxidation numbers, show what has been oxidised and what has been reduced in this reaction.

Oxidised

.....

Reduced

.....

[2]

(b) Complete the electron configuration of a manganese atom.

1s² [1]

(c) Chlorine gas can be added to a cold, dilute alkaline solution to form bleach.

Write the equation for this reaction.

..... [1]

(d) A student bubbles chlorine gas through aqueous potassium iodide. A reaction takes place.

(i) State what the student would observe.

..... [1]

(ii) Write the ionic equation for this reaction.

Include state symbols.

..... [1]

(e) Chlorine gas reacts with methane. One of the products is dichloromethane, CH_2Cl_2 .

(i) Chlorine is more electronegative than carbon and hydrogen, which have approximately equal electronegativity values.

Explain what is meant by the term *electronegativity*.

.....
.....
..... [2]

(ii) Draw a 3-D diagram of a molecule of CH_2Cl_2 .

Use partial charges to indicate polar bonds.

[2]

(iii) Explain why a CH_2Cl_2 molecule is polar.

.....
.....
..... [1]

(f) Bromine has two isotopes, Br-79 and Br-81. The relative atomic mass of bromine is 79.9.

Calculate the percentage of Br-79 atoms in a sample of bromine.

Answer = % [1]

[Total: 12]

3 Antimony, Sb, has atomic number 51.

(a) Complete the table below to show where antimony is found in the Periodic Table.

Period	Block

[1]

(b) Antimony exists as a mixture of isotopes.

(i) What is meant by the term *isotopes*?

.....
..... [1]

(ii) Different isotopes of antimony have the same chemical properties.

Explain why.

.....
..... [1]

(iii) Complete the table below to show the atomic structure of ^{121}Sb .

Protons	Neutrons	Electrons

[1]

(c) The relative atomic mass of antimony is 121.8.

(i) Define the term *relative atomic mass*.

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.....
..... [3]

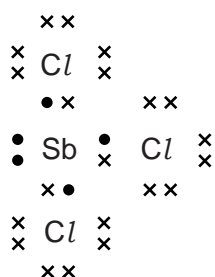
- (ii) A sample of antimony, $A_r = 121.8$, was analysed and was found to consist of 60% ^{121}Sb and one other isotope.

Determine the mass number of the other isotope in the sample of antimony.

mass number of the other antimony isotope = [1]

- (d) Antimony chloride, SbCl_3 , exists as simple covalent molecules.

A 'dot-and-cross' diagram of SbCl_3 is shown below.



- (i) Predict the shape of a molecule of SbCl_3 .

Explain your answer.

name of shape:

explanation:

.....

..... [3]

- (ii) SbCl_3 molecules are polar.

Explain why.

.....

.....

..... [2]

4 The Periodic Table is arranged in periods and groups.

(a) Elements in the Periodic Table show a periodic trend in atomic radius.

State and explain the trend in atomic radius from Li to F.



In your answer you should use appropriate technical terms, spelled correctly.

trend

explanation

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.....

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[3]

(b) (i) Complete the electron configuration of a bromide **ion**.

1s² [1]

(ii) A student adds a small volume of aqueous silver nitrate to an aqueous solution of bromide ions in a test-tube. The student then adds a similar volume of dilute aqueous ammonia to the same test-tube.

Describe what the student would see in the test-tube after the addition of aqueous ammonia.

..... [1]

(iii) Write an ionic equation for any precipitation reaction which occurs in the student's tests.

Include state symbols.

..... [1]

(c) The Group 7 element chlorine reacts with sodium hydroxide, NaOH, under different conditions to give different products.

(i) Chlorine reacts with aqueous sodium hydroxide to form bleach.

Write the equation and state the conditions for this reaction.

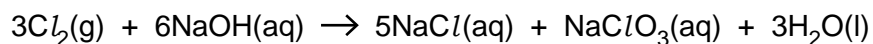
equation

conditions

[2]

(ii) Under different conditions, chlorine reacts differently with aqueous sodium hydroxide.

A disproportionation reaction takes place as shown below.



State what is meant by disproportionation and show that disproportionation has taken place in this reaction.

Use oxidation numbers in your answer.

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[3]

[Total: 11]