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# AS-LEVEL CHEMISTRY

## AS ASSESSMENT POINT 1

Answer all questions

Max 73 marks

| |
|---|
| Name ..... |
| Mark ...../73 .....% Grade ..... |

Answer **all** the questions.

1 Carbon occurs in a wide range of compounds and is essential to living systems.

**(a)** Two isotopes of carbon are $^{12}C$ and $^{13}C$.

**(i)** State what is meant by the term *isotopes*.

.....

..... [1]

**(ii)** Isotopes of carbon have the same chemical properties.

Explain why.

.....

..... [1]

**(iii)** The $^{12}C$ isotope is used as the standard measurement of relative masses.

Define the term *relative isotopic mass*.

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..... [2]

Answer **all** the questions.

1 The Group 2 element magnesium was first isolated by Sir Humphry Davy in 1808.

(a) Magnesium has three stable isotopes, which are $^{24}Mg$, $^{25}Mg$ and $^{26}Mg$.

(i) Complete the table below to show the atomic structures of $^{24}Mg$ and $^{25}Mg$.

| | **protons** | **neutrons** | **electrons** |
|---|---|---|---|
| $^{24}Mg$ | | | |
| $^{25}Mg$ | | | |

**[2]**

(ii) A sample of magnesium contained $^{24}Mg$: 78.60%; $^{25}Mg$: 10.11%; $^{26}Mg$: 11.29%.

Calculate the relative atomic mass of this sample of Mg.

Give your answer to **four** significant figures.

answer = ..... **[2]**

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

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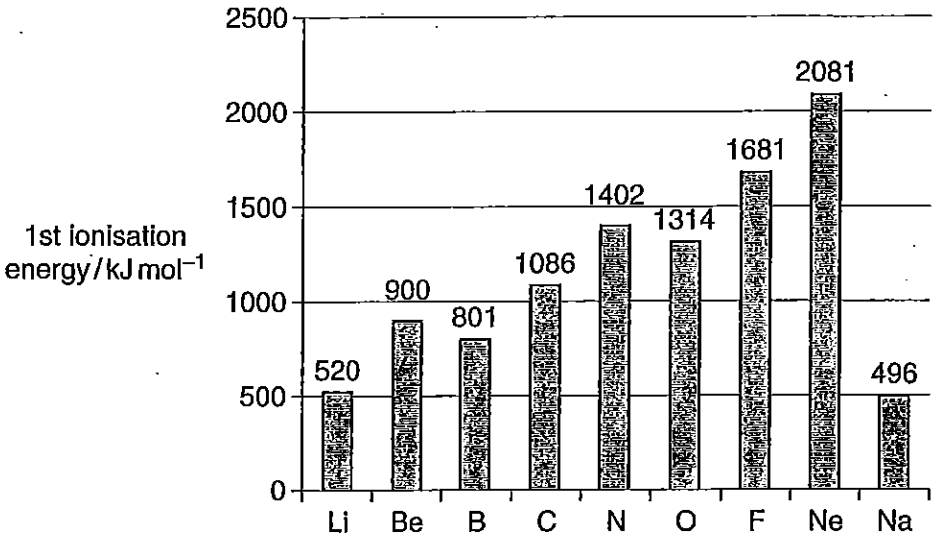
..... **[3]**

4 Ionisation energies have been used to develop the model of the atom.

The first ionisation energies of the elements Li to Na are shown in the figure below.




**(a)** Define the term *first ionisation energy*.

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

**(b)** **(i)** Explain why the first ionisation energies show a general increase from Li to Ne.

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

(ii) Explain the difference between the first ionisation energies of Li and Na.

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

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..... [3]

(c) The first ionisation energy of oxygen is 1314 kJ mol$^{-1}$ and the second ionisation energy of oxygen is 3388 kJ mol$^{-1}$.

(i) Write an equation to represent the **second** ionisation energy of oxygen.

Include state symbols.

..... [1]

(ii) Suggest why the second ionisation energy of oxygen has a greater value than the first ionisation energy of oxygen.

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..... [1]

**[Total: 11]**

5 The Periodic Table is a table of elements arranged in order of atomic number. The elements are classified into blocks.

(a) (i) State what is meant by the term *atomic number*.

..... [1]

(ii) Complete the full electron configuration for a titanium atom.

$1s^2$ ..... [1]

(iii) Identify the **seventh** element in the **fourth** period.

State which block this element is in.

element ..... block ..... [1]



4 The table below shows the melting points and atomic radii of the elements in Period 3, Na to Cl.

| element | Na | Mg | Al | Si | P | S | Cl |
|---|---|---|---|---|---|---|---|
| melting point/°C | 98 | 639 | 660 | 1410 | 44 | 113 | –101 |
| atomic radius/pm | 186 | 160 | 143 | 118 | 110 | 102 | 99 |

$1\,pm = 1 \times 10^{-12}\,m$

(b) Explain the decrease in the atomic radii across the period from Na to Cl.

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

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..... [3]

**(c)** In the sixteenth century, a large deposit of graphite was discovered in the Lake District.

People at the time thought that the graphite was a form of lead.

Nowadays, graphite is used in pencils but it is still referred to as 'pencil lead'.

A student decided to investigate the number of carbon atoms in a 'pencil lead'. He found that the mass of the 'pencil lead' was 0.321 g.

**(i)** Calculate the amount, in mol, of carbon atoms in the student's pencil lead.

Assume that the 'pencil lead' is pure graphite.

answer = ..... mol **[1]**

**(ii)** Using the Avogadro constant, $N_A$, calculate the number of carbon atoms in the student's 'pencil lead'.

number of carbon atoms = ..... **[1]**

5 The Group 2 element barium, Ba, is silvery white when pure but blackens when exposed to air. The blackening is due to the formation of both barium oxide and barium nitride. The nitride ion is $N^{3-}$.

**(a)** Predict the formula of:

barium oxide ..... barium nitride ..... **[2]**

**(b)** A 0.11 g sample of pure barium was added to 100 $cm^3$ of water.

$$Ba(s) + 2H_2O(l) \rightarrow Ba(OH)_2(aq) + H_2(g)$$

**(i)** Show that $8.0 \times 10^{-4}$ mol of Ba were added to the water.

**[1]**

**(ii)** Calculate the volume of hydrogen, in $cm^3$, produced at room temperature and pressure.

volume = ..... $cm^3$ **[1]**

**(iii)** Calculate the concentration, in mol $dm^{-3}$, of the $Ba(OH)_2(aq)$ solution formed.

concentration = ..... mol $dm^{-3}$ **[1]**

3 Calcium carbonate, $CaCO_3$, reacts with hydrochloric acid as shown in the equation below.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

(a) $7.50 \times 10^{-3}$ mol $CaCO_3$ reacts with 0.200 mol $dm^{-3}$ HCl.

(i) Calculate the volume, in $cm^3$, of 0.200 mol $dm^{-3}$ HCl required to react with $7.50 \times 10^{-3}$ mol $CaCO_3$.

answer = ..... $cm^3$ [2]

(ii) Calculate the volume, in $cm^3$, of $CO_2$ formed at room temperature and pressure.

answer = ..... $cm^3$ [1]

(c) Calcium oxide reacts with water and with nitric acid.

State the formula of the calcium compound formed when:

(i) calcium oxide reacts with water, ..... [1]

(ii) calcium oxide reacts with nitric acid. ..... [1]

(c) Ammonium compounds such as ammonium sulfate, $(NH_4)_2SO_4$, 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?

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..... [1]

(iv) What is the relative formula mass of $(NH_4)_2SO_4$?

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

..... [1]

**(c)** Epsom salts can be used as bath salts to help relieve aches and pains.

Epsom salts are crystals of hydrated magnesium sulfate, $MgSO_4 \cdot xH_2O$.

A sample of Epsom salts was heated to remove the water. 1.57 g of water was removed leaving behind 1.51 g of anhydrous $MgSO_4$.

**(i)** Calculate the amount, in mol, of anhydrous $MgSO_4$ formed.

amount = ..... mol **[2]**

**(ii)** Calculate the amount, in mol, of $H_2O$ removed.

amount = ..... mol **[1]**

**(iii)** Calculate the value of ***x*** in $MgSO_4 \cdot xH_2O$.

***x*** = ..... **[1]**

**[Total: 15]**



**(ii)** Chloric(V) acid has the following percentage composition by mass:

H, 1.20%; C*l*, 42.0%; O, 56.8%.

Using this information, calculate the empirical formula of chloric(V) acid.

Show **all** of your working.

empirical formula = ..... **[2]**

2 This question compares the bonding, structure and properties of sodium and sodium oxide.

**(a)** Sodium, Na, is a metallic element.

Explain, with the aid of a labelled diagram, what is meant by the term *metallic bonding*.

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..... [3]

**(b)** Sodium reacts with oxygen to form sodium oxide, $Na_2O$, which is an ionic compound.

**(i)** Write the equation for the reaction of sodium with oxygen to form sodium oxide.

..... [1]

**(ii)** State what is meant by the term *ionic bond*.

.....

..... [1]

**(iii)** Draw a '*dot-and-cross*' diagram to show the bonding in $Na_2O$.

Show **outer** electrons only.

[2]

(c) Compare and explain the electrical conductivities of sodium and sodium oxide in the solid and liquid states.

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..... [5]

**(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]**

2 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: .....

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..... [3]