Stoichiometry – 2021 IGCSE 0620

1. Nov/2021/Paper_11,12&13/No.9

The formula of sodium chlorate(V) is $NaClO_3$.

What is the relative formula mass of sodium chlorate(V), $NaClO_3$?

A 52.0 **B** 74.5 **C** 106.5 **D** 223.5

2. Nov/2021/Paper_21/No.6

The equation for the reaction of iron(III) oxide with carbon monoxide is shown.

$$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$$

What is the maximum mass of iron that can be made from 480 g of iron(III) oxide?

A 56 g **B** 112 g **C** 168 g **D** 336 g

3. Nov/2021/Paper_22/No.9

The equation for the reaction of sodium with water is shown.

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

What is the volume of hydrogen gas, measured at r.t.p., produced when 18.4 g of sodium reacts with excess water?

A 9.6 dm^3 **B** 15.0 dm^3 **C** 19.2 dm^3 **D** 30.0 dm^3

4. Nov/2021/Paper_23/No.13

What is the concentration of the solution when 31.8 g of sodium carbonate, Na_2CO_3, is dissolved in water to make a solution of 250 cm^3?

A 0.075 mol / dm^3

B 0.30 mol / dm^3

C 1.2 mol / dm^3

D 1.5 mol / dm^3

5. Nov/2021/Paper_31/No.2

The table shows the masses of some of the ions in 1000 cm^3 of rainwater.

name of ion	formula of ion	mass of ion in 1000 cm^3 of rainwater / mg
	NH_4^+	0.08
calcium	Ca^{2+}	0.13
chloride	Cl^-	1.30
magnesium	Mg^{2+}	0.08
nitrate	NO_3^-	0.70
potassium	K^+	0.08
sodium	Na^+	0.80
	SO_4^{2-}	1.60

(a) Answer these questions using only the information in the table.

(i) State which of the positive ions has the highest concentration.

..... [1]

(ii) Name the compound containing NH_4^+ and SO_4^{2-} ions.

..... [1]

(iii) Calculate the mass of magnesium ions in 400 cm^3 of rainwater.

mass = ... mg [1]

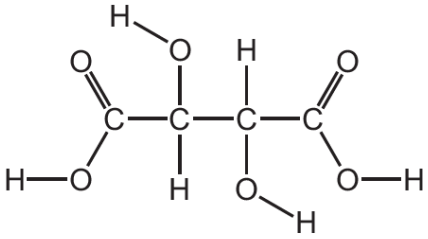
(b) Describe a test for chloride ions.

test .....

observations .....

[2]

(c) Small amounts of carboxylic acids are also present in rainwater.
The structure of tartaric acid is shown.



(i) On the structure draw a circle around one alcohol functional group. [1]

(ii) Deduce the formula of tartaric acid to show the number of carbon, hydrogen and oxygen atoms.

..... [1]

(d) Tartaric acid can be converted into compound **A**.
The formula of compound **A** is $C_3H_4O_3$.

Complete the table to calculate the relative molecular mass of compound **A**.

type of atom	number of atoms	relative atomic mass	
carbon	3	12	$3 \times 12 = 36$
hydrogen		1	
oxygen		16	

relative molecular mass = ...
[2]

[Total: 9]

6. Nov/2021/Paper_32/No.2

The table shows the masses of some of the ions in 1000 cm^3 of water taken from a lake.

name of ion	formula of ion	mass of ion in 1000 cm^3 of lake water / mg
calcium	Ca^{2+}	0.41
chloride	Cl^-	4.40
magnesium	Mg^{2+}	0.39
	NO_3^-	0.03
potassium	K^+	0.30
silicate	SiO_3^{2-}	0.02
	Na^+	2.90
sulfate	SO_4^{2-}	2.80

(a) Answer these questions using only the information in the table.

(i) State which of the negative ions has the lowest concentration.

..... [1]

(ii) Name the compound containing Na^+ and NO_3^- ions.

..... [1]

(iii) Calculate the mass of chloride ions in 250 cm^3 of lake water.

mass = ... mg [1]

(b) Describe a test for sulfate ions.

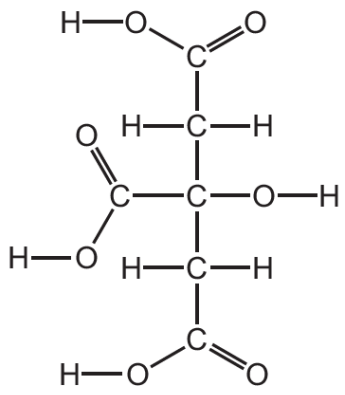
test .....

observations .....

[2]

(c) Citric acid is also present in the lake water.

The structure of citric acid is shown.



(i) Deduce the number of carboxylic acid groups in one molecule of citric acid.

..... [1]

(ii) The formula of citric acid is $C_6H_8O_7$.

Complete the table to calculate the relative molecular mass of citric acid.

type of atom	number of atoms	relative atomic mass	
carbon	6	12	$6 \times 12 = 72$
hydrogen		1	
oxygen		16	

relative molecular mass = ...
[2]

[Total: 8]

7. Nov/2021/Paper_33/No.2

The table shows the masses of some of the ions in 1000 cm^3 of water from a river.

name of ion	formula of ion	mass of ion in 1000 cm^3 of river water / mg
ammonium	NH_4^+	1.0
	Ca^{2+}	16.5
chloride	Cl^-	7.0
iron(III)	Fe^{3+}	0.5
magnesium	Mg^{2+}	4.0
	NO_3^-	0.5
potassium	K^+	3.5
silicate	SiO_3^{2-}	7.5
sodium	Na^+	6.0
sulfate	SO_4^{2-}	11.0

(a) Answer these questions using only the information in the table.

(i) State which positive ion has the lowest concentration.

..... [1]

(ii) Name the compound containing Ca^{2+} and NO_3^- ions.

..... [1]

(iii) Calculate the mass of sulfate ions in 500 cm^3 of river water.

mass = ... mg [1]

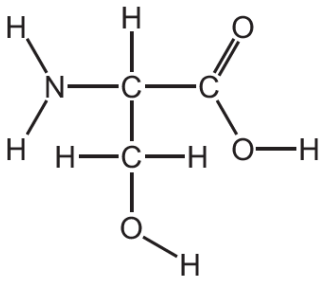
(b) Describe a test for iron(III) ions.

test .....

observations .....

[2]

(c) Compound **A** is found in river water.
The structure of compound **A** is shown.



(i) On the structure draw a circle around the alcohol functional group. [1]

(ii) Deduce the formula of compound **A** to show the number of carbon, hydrogen, oxygen and nitrogen atoms.

..... [1]

(iii) Another compound found in river water has the formula $C_4H_8O_2$.

Complete the table to calculate the relative molecular mass of this compound.

type of atom	number of atoms	relative atomic mass	
carbon	4	12	$4 \times 12 = 48$
hydrogen		1	
oxygen		16	

relative molecular mass = ...
[2]

[Total: 9]

8. Nov/2021/Paper_41/No.2

This question is about copper and its compounds.

(a) Copper has two different naturally occurring atoms, ^{63}Cu and ^{65}Cu.

(i) State the term used for atoms of the same element with different nucleon numbers.

..... [1]

(ii) The atomic number of copper is 29.

Complete the table to show the number of protons, neutrons and electrons in the particles of copper shown.

	^{63}Cu	$^{65}Cu^{2+}$
protons		
neutrons		
electrons		

[3]

(iii) Relative atomic mass is the average mass of naturally occurring atoms of an element.

The percentage of the naturally occurring atoms in a sample of copper is shown.

^{63}Cu	^{65}Cu
70%	30%

Deduce the relative atomic mass of copper in this sample.

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

relative atomic mass = ... [2]

(b) Anhydrous copper(II) sulfate is used to test for the presence of water. When this test is positive, hydrated copper(II) sulfate is formed.

(i) State the colour change seen during this test.

from ..... to ..... [2]

(ii) Complete the chemical equation to show the reaction that takes place.

$CuSO_4$ + ... $\rightleftharpoons$ $CuSO_4 \cdot 5H_2O$ [1]

(iii) State how hydrated copper(II) sulfate can be turned back into anhydrous copper(II) sulfate.

..... [1]

(iv) Describe a test for pure water.

.....

..... [2]

(c) Aqueous copper(II) sulfate contains $Cu^{2+}(aq)$ ions.

(i) Describe what is seen when aqueous copper(II) sulfate is added to aqueous sodium hydroxide, NaOH(aq).

..... [1]

(ii) Write the ionic equation for the reaction between aqueous copper(II) sulfate and aqueous sodium hydroxide.

Include state symbols.

..... [3]

(d) When solid copper(II) nitrate is heated copper(II) oxide, nitrogen dioxide and oxygen are formed.

$$2Cu(NO_3)_2 \rightarrow 2CuO + 4NO_2 + O_2$$

Calculate the volume of nitrogen dioxide formed at room temperature and pressure when 4.7 g of $Cu(NO_3)_2$ is heated.

Use the following steps:

- calculate the mass of one mole of $Cu(NO_3)_2$

..... g

- calculate the number of moles of $Cu(NO_3)_2$ used

..... moles

- determine the number of moles of nitrogen dioxide formed

..... moles

- calculate the volume of nitrogen dioxide formed at room temperature and pressure.

..... dm^3

[4]

(e) Write the chemical equation to show the action of heat on sodium nitrate, $NaNO_3$.

..... [2]

[Total: 22]

9. Nov/2021/Paper_43/No.4

Carbon is an important element.

(a) Carbon exists as the isotopes $^{12}_{6}C$ and $^{13}_{6}C$.

Complete the table.

isotope	number of protons in one atom	number of electrons in one atom	number of neutrons in one atom
$^{12}_{6}C$			
$^{13}_{6}C$			

[2]

(b) Name **two** forms of the element carbon which have giant covalent structures.

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

(c) The Avogadro constant is the number of particles in 1 mole.

The numerical value of the Avogadro constant is 6.02×10^{23}.

(i) Calculate the number of molecules in 22.0 g of carbon dioxide, CO_2.

..... molecules [2]

(ii) Calculate the number of molecules in 6.00 dm^3 of carbon dioxide gas at room temperature and pressure.

..... molecules [1]

[Total: 6]