

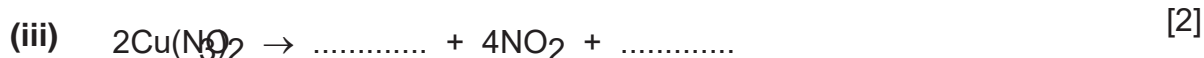
1 The law of constant composition states that all pure samples of a compound contain the same elements in the same proportion by weight.

A typical experiment to test this law is to prepare the same compound by different methods and then show that the samples have the same composition.

Methods of making copper(II) oxide include:

- heating copper carbonate,
- heating copper hydroxide,
- heating copper nitrate,
- heating copper foil in air.

(a) Complete the following equations.



(b) Copper oxide can be reduced to copper by heating in hydrogen.

(i) What colour change would you observe during the reduction?

.....  
[1]

(ii) Explain why the copper must be allowed to cool in hydrogen before it is exposed to air.

.....  
[2]

(iii) Name another gas which can reduce copper(II) oxide to copper.

.....  
[1]

(iv) Name a solid which can reduce copper(II) oxide to copper.

(c) The table below shows the results obtained by reducing the copper(II) oxide

(ci) produced by different methods to copper.

(i) Complete the table.

source of copper(II) oxide	mass of copper(II) oxide/g	mass of copper/g	percentage copper/%
$\text{CuCO}_3$	2.37	1.89	79.7
$\text{Cu(OH)}_2$	2.51	1.99	
$\text{Cu(NO}_3)_2$	2.11	1.68	
Cu and $\text{O}_2$	2.29	1.94	

[2]

(ii) One of the samples of copper(II) oxide is impure.

Identify this sample and suggest an explanation why the percentage of copper in this sample is bigger than in the other three samples.

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

[Total: 13]

2 (a) A compound **X** contains 82.76% of carbon by mass and 17.24% of hydrogen by mass.

(i) Calculate the empirical formula of compound **X**.

[2]

(ii) Compound **X** has a relative molecular mass of 58.

Deduce the molecular formula of compound **X**.

[2]

(b) Alkenes are unsaturated hydrocarbons.

(i) State the general formula of alkenes.

..... [1]

(ii) State the empirical formula of alkenes.

..... [1]

(c) What is meant by the term *unsaturated hydrocarbon*?

*unsaturated* .....

.....

*hydrocarbon* .....

.....

[2]

(d) Describe a test that would distinguish between saturated and unsaturated hydrocarbons.

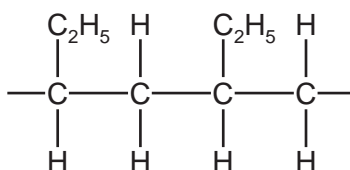
reagent .....

observation (saturated hydrocarbon) .....

observation (unsaturated hydrocarbon) .....

[3]

(e) Addition polymers can be made from alkenes. The diagram shows part of an addition polymer.



(i) Draw a circle on the diagram to show one repeat unit in this polymer. [1]

(ii) Give the structure and the name of the monomer used to make this polymer.

structure

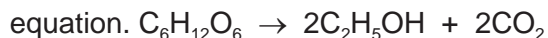
name ..... [2]

(iii) Give the structure of an isomer of the alkene in (e)(ii).

[1]

[Total: 15]

3 Ethanol is manufactured from glucose,  $C_6H_{12}O_6$ , by fermentation according to the following



(a) State the conditions required for this reaction.

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

(b) In an experiment, 30.0 g of glucose was fermented.

(i) Calculate the number of moles of glucose in 30.0 g.

..... mol [2]

(ii) Calculate the maximum mass of ethanol that could be obtained from 30.0 g of glucose.

..... g [2]

(iii) Calculate the volume of carbon dioxide at room temperature and pressure that can be obtained from 30.0 g of glucose.

.....  $dm^3$  [1]

(c) Ethanol can also be manufactured from ethene.

(i) Name the raw material which is the source of ethene.

..... [1]

(ii) Write a balanced equation for the manufacture of ethanol from ethene.

..... [1]

[Total: 9]

4 (a) Define the following

(i) the mole

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

(ii) the Avogadro constant

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

(b) Which **two** of the following contain the same number of molecules?  
Show how you arrived at your answer.

2.0g of methane, CH<sub>4</sub>

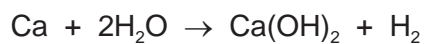
8.0g of oxygen, O<sub>2</sub>

2.0g of ozone, O<sub>3</sub>

8.0g of sulfur dioxide, SO<sub>2</sub>

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

(c) 4.8 g of calcium is added to 3.6 g of water. The following reaction occurs.



(i) the number of moles of Ca = .....

the number of moles of H<sub>2</sub>O = ..... [1]

(ii) Which reagent is in excess? Explain your choice.

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

(iii) Calculate the mass of the reagent named in (ii) which remained at the end of the experiment.

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

[Total: 8]

5 Quantities of chemicals, expressed in moles, can be used to find the formula of a compound, to establish an equation and to determine reacting masses.

(a) A compound contains 72% magnesium and 28% nitrogen. What is its empirical formula?

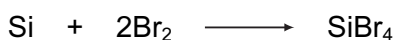
.....  
.....  
.....  
..... [2]

(b) A compound contains only aluminium and carbon. 0.03 moles of this compound reacted with excess water to form 0.12 moles of  $Al(OH)_3$  and 0.09 moles of  $CH_4$ .

Write a balanced equation for this reaction.

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

(c) 0.07 moles of silicon reacts with 25 g of bromine.



(i) Which one is the limiting reagent? Explain your choice.

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

(ii) How many moles of  $SiBr_4$  are formed?

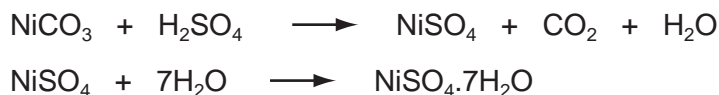
..... [1]

[Total: 8]



6 (a) The following method is used to make crystals of hydrated nickel sulphate.

An excess of nickel carbonate, 12.0 g, was added to 40 cm<sup>3</sup> of sulphuric acid, 2.0 mol/dm<sup>3</sup>. The unreacted nickel carbonate was filtered off and the filtrate evaporated to obtain the crystals.



Mass of one mole of NiSO<sub>4</sub>·7H<sub>2</sub>O = 281 g

Mass of one mole of NiCO<sub>3</sub> = 119 g

(i) Calculate the mass of unreacted nickel carbonate.

Number of moles of H<sub>2</sub>SO<sub>4</sub> in 40 cm<sup>3</sup> of 2.0 mol/dm<sup>3</sup> acid = 0.08

Number of moles of NiCO<sub>3</sub> reacted = .....

Mass of nickel carbonate reacted = ..... g

Mass of unreacted nickel carbonate = ..... g [3]

(ii) The experiment produced 10.4 g of hydrated nickel sulphate. Calculate the percentage yield.

The maximum number of moles of NiSO<sub>4</sub>·7H<sub>2</sub>O that could be formed =

.....

The maximum mass of NiSO<sub>4</sub>·7H<sub>2</sub>O that could be formed = ..... g

The percentage yield = ..... % [3]

(b) In the above method, a soluble salt was prepared by neutralising an acid with an insoluble base. Other salts have to be made by different methods.

(i) Give a brief description of how the soluble salt, rubidium sulphate could be made from the soluble base, rubidium hydroxide.

.....

.....

.....

..... [3]

(ii) Suggest a method of making the insoluble salt, calcium fluoride.

.....

.....

.....

..... [3]