



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE
NAME

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CHEMISTRY

0620/42

Paper 4 Theory (Extended)

October/November 2018

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

A copy of the Periodic Table is printed on page 16.

You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

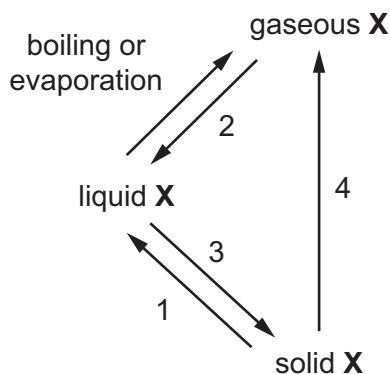
The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **13** printed pages and **3** blank pages.



2

1 Element **X** can undergo the following physical changes.



(a) (i) Give the scientific name for each of the numbered physical changes.

- 1 [4]
- 2
- 3
- 4

(ii) Explain why the changes shown are physical changes.

..... [1]

.....

(iii) One difference between boiling and evaporation is the rate at which the processes occur.
State **one** other difference between boiling and evaporation.

..... [1]

.....

(b) Describe the separation, arrangement and motion of particles of element **X** in the solid state.

separation

arrangement

motion [3]

(c) Element **X** is a Group I metal. It burns in air to form an oxide X_2O .

Write a chemical equation for this reaction.

..... [2]

[Total: 11]

3

2 Magnesium, calcium and strontium are Group II elements.

(a) Complete the table to show the arrangement of electrons in a calcium atom.

shell number	1	2	3	4
number of electrons				

[1]

(b) Describe how the arrangement of electrons in a strontium atom is:

(i) similar to the arrangement of electrons in a calcium atom

.....
.....

(ii) different from the arrangement of electrons in a calcium atom.

.....
.....

[2]

(c) Calcium reacts with cold water to form two products:

- a colourless gas, **P**, which 'pops' with a lighted splint
- a weakly alkaline solution, **Q**, which turns milky when carbon dioxide is bubbled through it.

(i) Name gas **P**.

..... [1]

(ii) Identify the ion responsible for making solution **Q** alkaline.

..... [1]

(iii) Suggest the pH of solution **Q**.

..... [1]

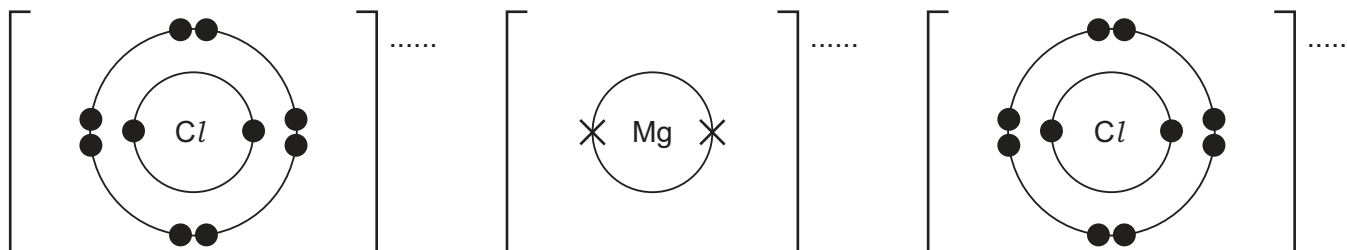
(iv) Write a chemical equation for the reaction of calcium with cold water.

..... [2]

4

(d) Magnesium reacts with chlorine to form magnesium chloride, MgCl_2 . Magnesium chloride is an ionic compound.

(i) Complete the diagrams to show the electronic structures of the ions in magnesium chloride. Show the charges on the ions.



[3]

(ii) Give **three** physical properties that are typical of ionic compounds such as MgCl_2 .

1

2

3

[3]

(e) Aqueous magnesium chloride is added to aqueous silver nitrate. A white precipitate forms.

Write an **ionic** equation for this reaction. Include state symbols.

..... [2]

[Total: 16]

5**3** Sulfur is an important element.

(a) Explain how burning fossil fuels containing sulfur leads to the formation of acid rain.

.....

.....

..... [2]

(b) Sulfuric acid is manufactured by the Contact process. One step in the Contact process involves a reversible reaction in which sulfur trioxide, SO_3 , is formed.

(i) Write a chemical equation for this reversible reaction. Include the correct symbol to show that the reaction is reversible.

..... [2]

(ii) State the conditions and name the catalyst used in this reversible reaction.

temperature

pressure

catalyst

[3]

(iii) Describe how the sulfur trioxide formed is converted into sulfuric acid in the next steps of the Contact process.

.....

.....

..... [2]

(c) Dilute sulfuric acid is used to make salts known as sulfates.

A method consisting of three steps is used to make zinc sulfate from zinc carbonate.

step 1 Add an excess of zinc carbonate to 20 cm³ of 0.4 mol/dm³ dilute sulfuric acid until the reaction is complete.

step 2 Filter the mixture.

step 3 Heat the filtrate until a saturated solution forms and then allow it to crystallise.

(i) Name a suitable piece of apparatus for measuring 20 cm³ of dilute sulfuric acid in **step 1**.

..... [1]

(ii) State **two** observations which would show that the reaction is complete in **step 1**.

1

2 [2]

(iii) Why is it important to add an excess of zinc carbonate in **step 1**?

..... [1]

(iv) What is meant by the term *saturated solution* in **step 3**?

..... [2]

(v) The equation for the reaction is shown.



Complete the equation by inserting the state symbol for zinc sulfate. [1]

(vi) Name another zinc compound which could be used to make zinc sulfate from dilute sulfuric acid using this method.

..... [1]

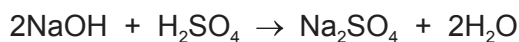
(vii) Suggest why this method would **not** work to make barium sulfate from barium carbonate and dilute sulfuric acid.

..... [1]

7

- (d) In a titration, a student added 25.0 cm^3 of 0.200 mol/dm^3 aqueous sodium hydroxide to a conical flask. The student then added a few drops of methyl orange to the solution in the conical flask.

Dilute sulfuric acid was then added from a burette to the conical flask. The volume of dilute sulfuric acid needed to neutralise the aqueous sodium hydroxide was 20.0 cm^3 .



- (i) What was the colour of the methyl orange in the aqueous sodium hydroxide?

..... [1]

- (ii) Determine the concentration of the dilute sulfuric acid in g/dm^3 .

- Calculate the number of moles of aqueous sodium hydroxide added to the conical flask.

..... mol

- Calculate the number of moles of dilute sulfuric acid added from the burette.

..... mol

- Calculate the concentration of the dilute sulfuric acid in mol/dm^3 .

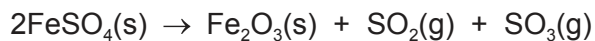
..... mol/dm^3

- Calculate the concentration of the dilute sulfuric acid in g/dm^3 .

..... g/dm^3
[4]

8

(e) Iron(II) sulfate decomposes when heated strongly.



15.20 g of $\text{FeSO}_4(\text{s})$ was heated and formed 4.80 g of $\text{Fe}_2\text{O}_3(\text{s})$.

[M_r , FeSO_4 = 152; M_r , Fe_2O_3 = 160]

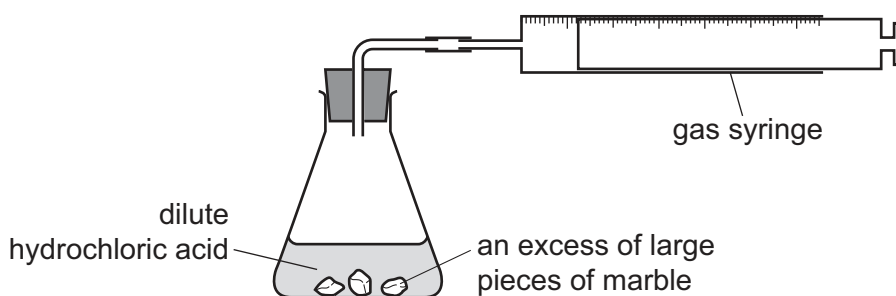
Calculate the percentage yield for this reaction.

..... % [3]

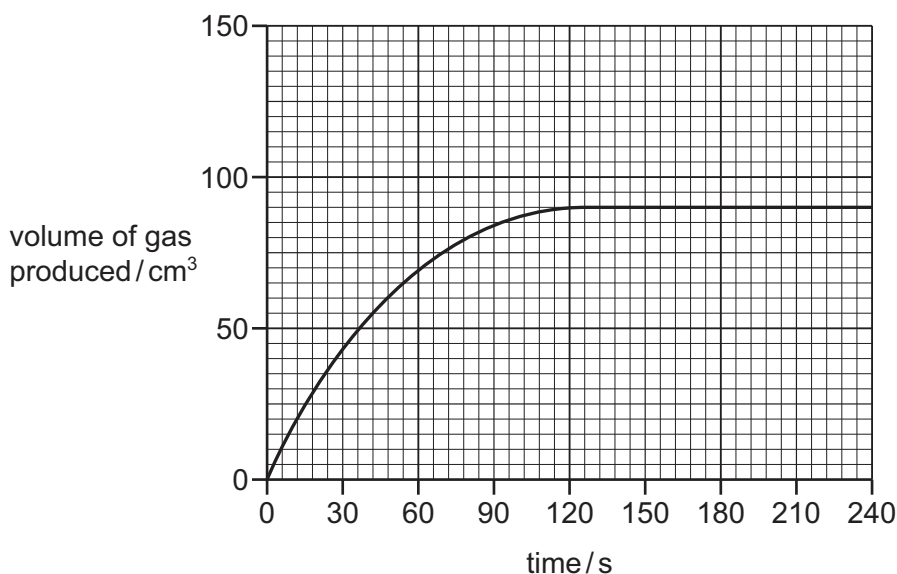
[Total: 26]

9

- 4 A student investigated the progress of the reaction between dilute hydrochloric acid, HCl , and an excess of large pieces of marble, CaCO_3 , using the apparatus shown.



- (a) A graph of the volume of gas produced against time is shown.



- (i) How does the shape of the graph show that the rate of reaction decreased as the reaction progressed?

.....
 [1]

- (ii) Why did the rate of reaction decrease as the reaction progressed?

..... [1]

- (iii) After how many seconds did the reaction finish?

..... s [1]

- (b) The experiment was repeated using the same mass of smaller pieces of marble. All other conditions were kept the same.

Draw a graph **on the grid** to show the progress of the reaction using the smaller pieces of marble. [2]

10

- (c)** The original experiment was repeated at a higher temperature. All other conditions were kept the same.

Describe and explain, in terms of collisions between particles, the effect of using a higher temperature on the time taken for the reaction to finish.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 10]

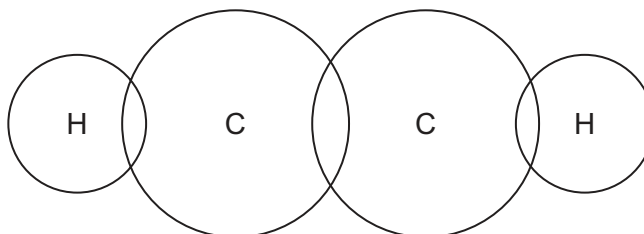
- 5 Alkynes are a homologous series of unsaturated hydrocarbons. All members contain a $C\equiv C$ triple bond.

(a) Complete the table showing information about the first **three** alkynes.

formula	C_2H_2	C_3H_4	
structure	$H-C\equiv C-H$	$H-C\equiv C-CH_3$	$H-C\equiv C-CH_2-CH_3$
name	ethyne		butyne

[2]

- (b) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of ethyne, $H-C\equiv C-H$. Show outer shell electrons only.



[2]

- (c) Compounds in the same homologous series have the same general formula.

(i) Give **two** other characteristics of members of a homologous series.

1

2

[2]

(ii) Use the information in the table in (a) to deduce the general formula of alkynes.

..... [1]

- (d) Alkynes are unsaturated.

Describe a test for unsaturation.

test

result

[2]

12

- (e) (i) Name an oxidising agent which can be used to oxidise ethanol to ethanoic acid.

..... [2]

- (ii) Draw the structure of ethanoic acid. Show all of the atoms and all of the bonds.

[1]

- (f) Carboxylic acids can be converted into esters.

- (i) The ester formed by reacting propanoic acid and methanol has the molecular formula $C_4H_8O_2$.

Name this ester and draw its structure. Show all of the atoms and all of the bonds.

name of the ester

structure of the ester

[2]

- (ii) Name another ester with the molecular formula $C_4H_8O_2$.

..... [1]

- (g) Polyesters are polymers.

- (i) What type of polymerisation is used in the manufacture of polyesters?

..... [1]

- (ii) Name a polyester.

..... [1]

[Total: 17]

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Group

57	La	lanthanum	139	58	Ce	cerium	140	59	Pr	praseodymium	141	60	Nd	neodymium	144	61	Pm	promethium	—	62	Sm	samarium	150	63	Eu	euporium	152	64	Gd	gadolinium	157	65	Tb	terbium	159	66	Dy	dysprosium	163	67	Ho	holmium	165	68	Er	erbium	167	69	Tm	thulium	169	70	Yb	ytterbium	173	71	Lu	lutetium	175
89	Ac	actinium	—	90	Th	thorium	232	91	Pa	protactinium	231	92	U	uranium	238	93	Np	neptunium	—	94	Pu	plutonium	—	95	Am	americium	—	96	Cm	curium	—	97	Bk	berkelium	—	98	Cf	californium	—	99	Es	einsteinium	—	100	Fm	fermium	—	101	Md	mendelevium	—	102	No	nobelium	—	103	Lr	lawrencium	—

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).