Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education (9–1)

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

0969174347

CHEMISTRY **0971/42**

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.

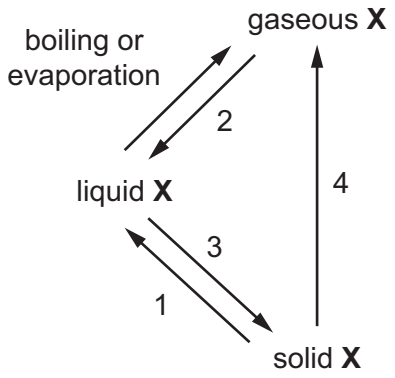
Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

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.

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

CAMBRIDGE International Examinations

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



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

1 .....

2 .....

3 .....

4 .....

[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 $\mathbf{X}_2O$.

Write a chemical equation for this reaction.

..... [2]

[Total: 11]

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]

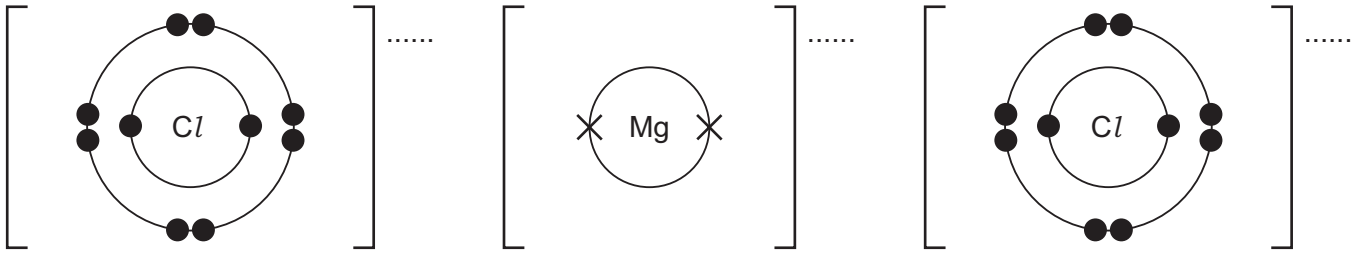
(iv) Write a chemical equation for the reaction of calcium with cold water.

..... [2]

[Turn over

(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]

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]

[Turn over

(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 cm^3 of 0.4 mol / dm^3 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 cm^3 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.

$$ZnCO_3(s) + H_2SO_4(aq) \rightarrow ZnSO_4(.....) + H_2O(l) + CO_2(g)$$

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]

(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.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

(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]

[Turn over

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

$$2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$$

15.20 g of $FeSO_4(s)$ was heated and formed 4.80 g of $Fe_2O_3(s)$.

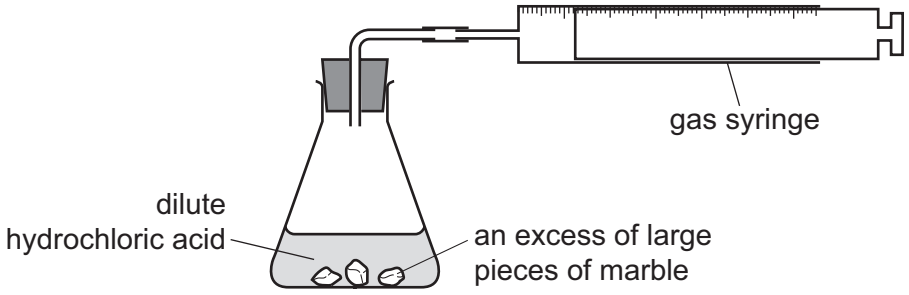
[M_r, $FeSO_4$ = 152; M_r, Fe_2O_3 = 160]

Calculate the percentage yield for this reaction.

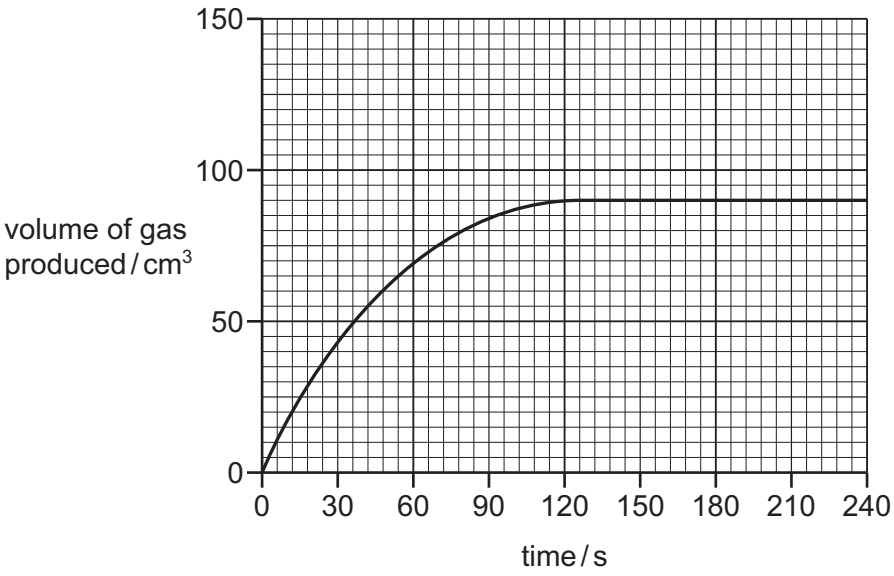
..... % [3]

[Total: 26]

4 A student investigated the progress of the reaction between dilute hydrochloric acid, HC*l*, 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]

(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]

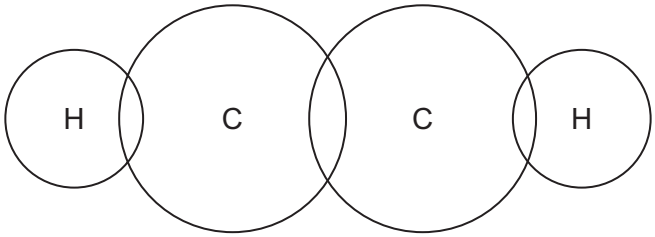
5 Alkynes are a homologous series of unsaturated hydrocarbons.
All members contain a C≡C triple bond.

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

formula	C_2H_2	C_3H_4	
structure	H–C≡C–H	H–C≡C–CH_3	H–C≡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≡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]

(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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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	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 europium 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
actinoids	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.).