Cambridge IGCSE

**Cambridge International Examinations**
Cambridge International General Certificate of Secondary Education

| | |
|---|---|
| CANDIDATE NAME | |
| CENTRE NUMBER | |
| CANDIDATE NUMBER | |

*3843148954*

**CHEMISTRY** **0620/41**

Paper 4 Theory (Extended) **May/June 2017**

**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 **14** printed pages and **2** blank pages.


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**1** This question is about subatomic particles.

**(a)** Define the terms

*proton number*, .....

.....

*nucleon number*. .....

.....

[3]

**(b)** Why is the $^{1}_{1}H$ hydrogen atom the **only** atom to have an identical proton number and nucleon number?

.....

..... [1]

**(c)** Complete the table to show the number of protons, neutrons and electrons in the atoms and ions given.

| | number of protons | number of neutrons | number of electrons |
|---|---|---|---|
| $^{19}F$ | | | 9 |
| $^{26}Mg$ | 12 | | |
| $^{31}P^{3-}$ | | | |
| $^{87}Sr^{2+}$ | | | |

[6]

**(d)** **(i)** Write the formula of the compound formed from fluorine and magnesium.

..... [1]

**(ii)** Write the formula of the compound formed from $Sr^{2+}$ and $P^{3-}$.

..... [1]

[Total: 12]

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**2** Some oxides of some elements are listed.

$CO$ $CO_2$ $Na_2O$ $MgO$ $Al_2O_3$

$SiO_2$ $P_4O_{10}$ $SO_2$ $Cl_2O_7$ $Cr_2O_3$

**(a)** Answer the following questions using only oxides from the list. Each oxide may be used once, more than once or not at all.

Give the formula of an oxide

**(i)** which is the main cause of acid rain, .....

**(ii)** which would give a solution of pH 14 when added to water, .....

**(iii)** which is coloured, .....

**(iv)** which is the major impurity in iron ore, .....

**(v)** which is amphoteric, .....

**(vi)** which is neutral. .....

[6]

**(b)** Amphoteric oxides and neutral oxides are different from each other.

**(i)** What is meant by the term *amphoteric oxide*?

.....

..... [1]

**(ii)** What is meant by the term *neutral oxide*?

.....

..... [1]

[Total: 8]

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**[Turn over**

**3** Magnesium sulfate and lead(II) sulfate are examples of salts.

**(a)** A student prepared magnesium sulfate crystals starting from magnesium carbonate. The student carried out the experiment in four steps.

**step 1** The student added excess magnesium carbonate to a small volume of dilute sulfuric acid until no more magnesium carbonate would react.

**step 2** The student filtered the mixture.

**step 3** The student heated the filtrate obtained from **step 2** until it was saturated.

**step 4** The student allowed the hot filtrate to cool to room temperature and then removed the crystals which formed.

**(i)** How did the student know when the reaction had finished in **step 1**?

..... [1]

**(ii)** Name the residue in **step 2**.

..... [1]

**(iii)** A saturated solution forms in **step 3**.

What is a saturated solution?

.....

..... [2]

**(iv)** Explain why magnesium sulfate crystals form during **step 4**.

.....

..... [1]

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**(b)** Magnesium sulfate crystals are hydrated. Another student heated some hydrated magnesium sulfate crystals in a crucible and obtained the following results.

mass of hydrated magnesium sulfate crystals = 4.92 g

mass of water removed = 2.52 g

**(i)** Calculate the number of moles of water removed.

moles of water = ..... mol [1]

**(ii)** Calculate the number of moles of anhydrous magnesium sulfate remaining in the crucible. The $M_r$ of anhydrous magnesium sulfate is 120.

moles of anhydrous magnesium sulfate = ..... mol [1]

**(iii)** Calculate the ratio of moles of anhydrous magnesium sulfate **:** moles of water. Give your answer as whole numbers.

ratio = ..... **:** ..... [1]

**(iv)** Suggest the formula of hydrated magnesium sulfate crystals.

formula of hydrated magnesium sulfate crystals = ..... [2]

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**[Turn over**

**(c)** Lead(II) sulfate, $PbSO_4$, is insoluble.

Describe how you would prepare a pure dry sample of lead(II) sulfate crystals starting from solutions of lead(II) nitrate and sodium sulfate.
Include a series of key steps in your answer.

.....

.....

.....

.....

.....

.....

.....

..... [4]

**(d)** Write the ionic equation for the reaction which takes place between solutions of lead(II) nitrate and sodium sulfate.
Include state symbols.

..... [2]

[Total: 16]

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**4** Zinc is a very important metal.

**(a)** Zinc is extracted from its ore, zinc blende. Zinc blende contains zinc sulfide, ZnS.

Zinc sulfide is converted to zinc oxide in an industrial process.

**(i)** Describe how zinc sulfide is converted to zinc oxide in this industrial process.

.....

..... [1]

**(ii)** Write the chemical equation for this reaction.

..... [2]

**(b)** Zinc oxide is then reduced in a furnace.

**(i)** Name the substance added to the furnace to reduce the zinc oxide.

..... [1]

**(ii)** Describe how the pure zinc is removed from the furnace and collected.

.....

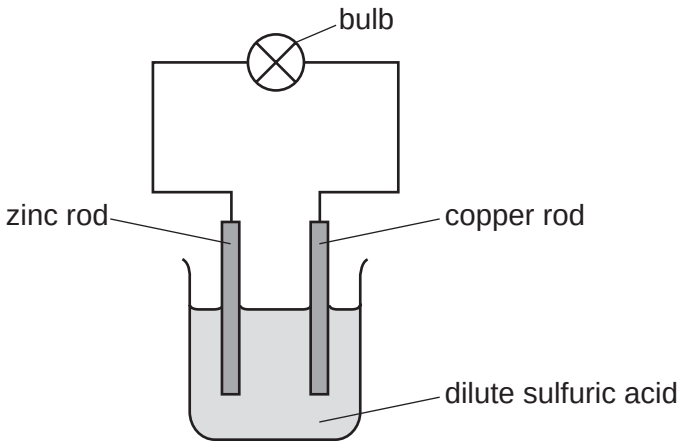
.....

..... [2]

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**[Turn over**

**(c)** When rods of zinc and copper are placed into dilute sulfuric acid as shown, electricity is generated.




**(i)** Write the ionic half-equation for the reaction occurring at the zinc rod.

..... [2]

**(ii)** Write the ionic half-equation for the reaction occurring at the copper rod.

..... [2]

**(iii)** The copper rod was replaced by an iron rod.

Suggest the change, if any, in the intensity of the light emitted from the bulb and give a reason for your answer.

change .....

reason .....

.....
[2]

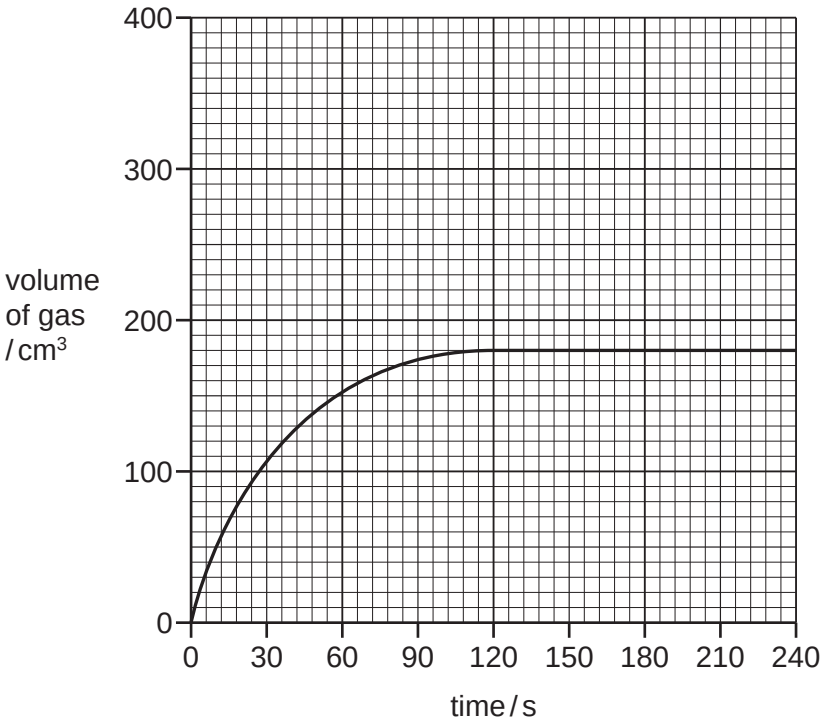
[Total: 12]

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**5** When barium carbonate is added to dilute hydrochloric acid, carbon dioxide gas is formed.

A student carried out an experiment to measure the volume of gas formed as a reaction proceeds. The student added a small mass of powdered barium carbonate to an excess of 0.1 mol / $dm^3$ hydrochloric acid. A graph of the results was drawn.

The graph is shown.




**(a)** Name the **two** pieces of apparatus needed to take the measurements shown on the graph.

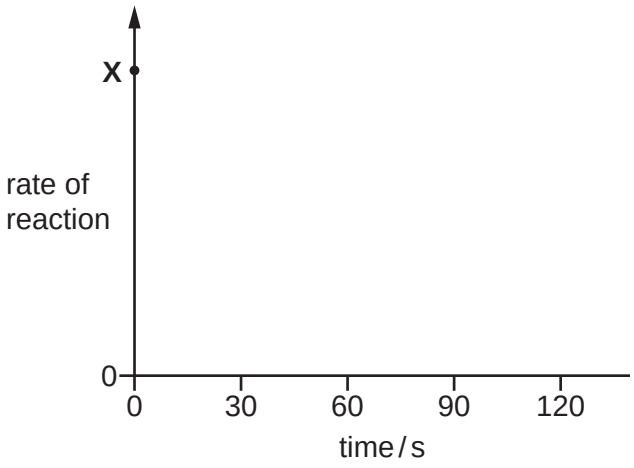
1 .....

2 .....

[1]

**(b)** On the axes below, sketch a graph to show how the rate of reaction changes as the reaction proceeds.

Assume the initial rate of reaction is represented by the point at **X**.




[2]

**(c)** The total volume of gas collected was 180 $cm^3$ at room temperature and pressure.

Calculate the mass, in grams, of barium carbonate used.

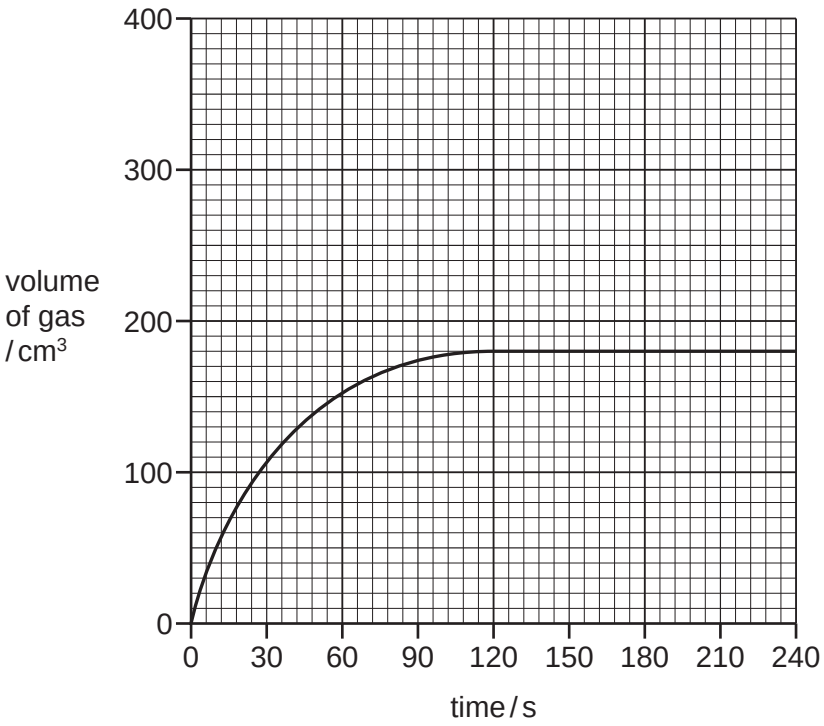
$$BaCO_3 + 2HCl \rightarrow BaCl_2 + H_2O + CO_2$$

mass of barium carbonate = ..... g [3]

**(d)** The original graph has been drawn again.

On the grid, draw the graph expected if the same mass of barium carbonate is added as large lumps instead of as a powder. All other conditions are the same as in the original experiment.

Explain why your graph is different from the original graph.




.....

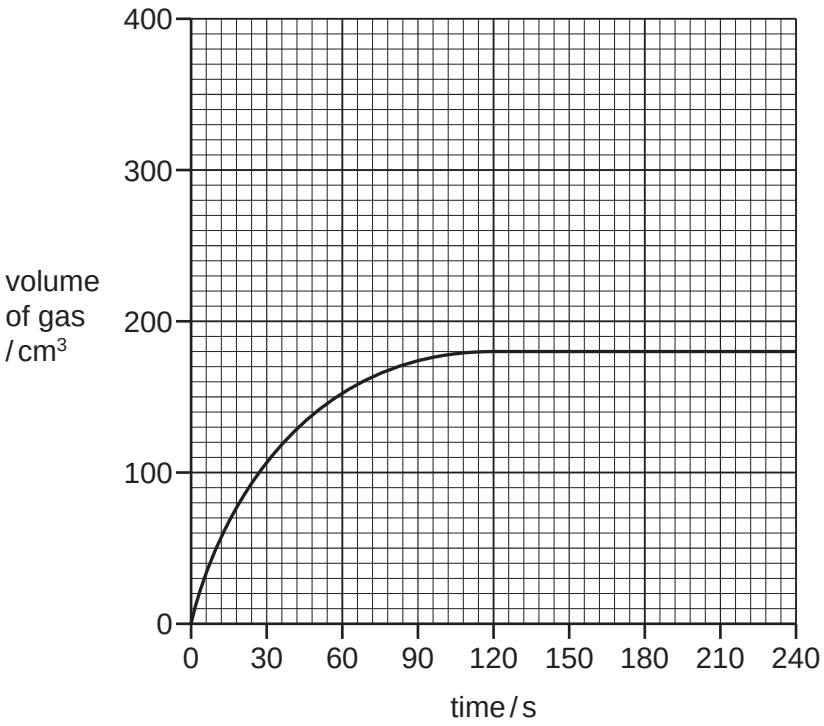
.....

..... [2]

**(e)** The original graph has been drawn again.

On the grid, draw the graph expected if the concentration of dilute hydrochloric acid is changed from 0.1 mol / $dm^3$ to 0.2 mol / $dm^3$. All other conditions are the same as in the original experiment.

Explain, in terms of particles, why your graph is different from the original graph.




.....

.....

.....

..... [4]

**(f)** The experiment is changed and the mass of powdered barium carbonate is doubled. All other conditions are the same as in the original experiment. The acid is still in excess.

Deduce the volume of gas formed at room temperature and pressure, in $cm^3$, in this experiment.

volume of gas = ..... $cm^3$ [1]

[Total: 13]

**6** The alkenes and alkanes are both examples of homologous series which are hydrocarbons.

**(a)** What is meant by the term *hydrocarbon*?

.....

..... [2]

**(b)** Give **three** characteristics of an homologous series.

1 .....

2 .....

3 .....

[3]

**(c)** Name and draw the structure of the second member of the alkene homologous series.
Show all of the atoms and all of the bonds.

name .....

structure

[2]

**(d)** Alcohols can be made from alkenes.

Name the reagent and conditions needed to convert an alkene into an alcohol.

.....

..... [2]

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**(e)** The alcohol butanol, $CH_3CH_2CH_2CH_2OH$, can be converted into a carboxylic acid with four carbon atoms.

**(i)** Name the carboxylic acid formed from butanol and draw its structure. Show all of the atoms and all of the bonds.

name .....

structure

[2]

**(ii)** Ethanoic acid can be formed from ethanol by fermentation. It can also be formed by the addition of a suitable chemical reagent.

Name the reagent needed to convert ethanol into ethanoic acid.

..... [2]

**(iii)** State the type of chemical change which occurs when ethanol is converted into ethanoic acid.

..... [1]

**(f)** Describe how a student could prepare the ester methyl ethanoate in a school laboratory.
In your description give

- the names of the **two** starting organic chemicals,
- the essential reaction conditions needed,
- a chemical equation for the reaction.

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 19]

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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.).