Cambridge IGCSE

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

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

*2199140551*

**CHEMISTRY** **0620/42**

Paper 4 Theory (Extended) **February/March 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.


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**1** This question is about gases.

**(a)** The following substances are gases at room temperature.

| letter | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** |
|---|---|---|---|---|---|---|---|---|
| substance | $SO_2$ | Ar | CO | $Cl_2$ | $NH_3$ | $CO_2$ | $CH_4$ | $C_3H_8$ |

Identify, by letter:

**(i)** a gas which combines with water to form acid rain ..... [1]

**(ii)** **two** gases which exist as diatomic molecules ..... [2]

**(iii)** a gas which bleaches damp litmus paper ..... [1]

**(iv)** a gas which is used as an inert atmosphere in lamps ..... [1]

**(v)** **two** gases which are found in clean dry air ..... [2]

**(vi)** **two** gases which are found in refinery gas. ..... [2]

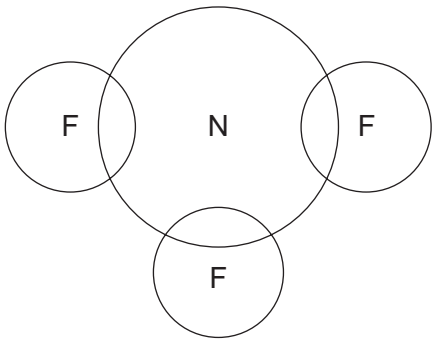
**(b)** $NF_3$ has covalent bonds.

**(i)** What is a covalent bond?

.....

..... [2]

**(ii)** Complete the dot-and-cross diagram to show the electron arrangement in a molecule of $NF_3$.
Show outer shell electrons only.




[3]

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**(c)** Air is a mixture. Nitrogen and oxygen are the two most common gases in air.

**(i)** What is meant by the term *mixture*?

.....

..... [1]

**(ii)** State the percentage of oxygen, to the nearest whole number, in clean dry air.

..... [1]

**(iii)** Describe the steps in the industrial process which enables nitrogen and oxygen to be separated from clean dry air.

Use scientific terms in your answer.

.....

.....

.....

.....

.....

.....

..... [3]

**(iv)** Which physical property of nitrogen and oxygen allows them to be separated?

..... [1]

[Total: 20]

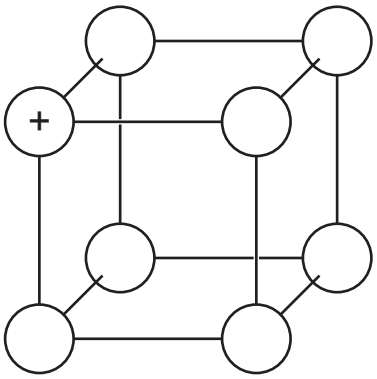
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**[Turn over**

**2** Sodium chloride is a typical ionic compound.

**(a)** The diagram shows part of a lattice of sodium chloride.

**(i)** Complete the diagram to show the ions present. Use '+' for $Na^+$ ions and '–' for $Cl^-$ ions. One ion has been completed for you.




[2]

**(ii)** How many electrons does a chloride ion have?

..... [1]

**(iii)** Identify an element which has atoms with the same number of electrons as a sodium ion.

..... [1]

**(b)** Electrolysis of concentrated aqueous sodium chloride is an important industrial process.

**(i)** What is meant by the term *electrolysis*?

.....

..... [2]

**(ii)** Name the products of the electrolysis of concentrated aqueous sodium chloride.

1 .....

2 .....

3 .....

[3]

**(iii)** Write an ionic half-equation for the reaction at the cathode.
Include state symbols.

..... [2]

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**(c)** Silver chloride can be made by reacting aqueous sodium chloride with aqueous silver nitrate. The other product of the reaction is sodium nitrate. The chemical equation for the reaction is shown.

$$NaCl(aq) + AgNO_3(aq) \rightarrow AgCl(s) + NaNO_3(aq)$$

A student attempted to make the maximum amount of **sodium nitrate** crystals. The process involved three steps.

**step 1** The student added aqueous sodium chloride to aqueous silver nitrate and stirred. Neither reagent was in excess.

**step 2** The student filtered the mixture. The student then washed the residue and added the washings to the filtrate.

**step 3** The student obtained sodium nitrate crystals from the filtrate.

**(i)** Describe what the student observed in **step 1**.

..... [1]

**(ii)** Why was the residue washed in **step 2**?

.....

..... [1]

**(iii)** Give the names of the **two** processes which occurred in **step 3**.

1 .....

2 .....
[2]

**(iv)** The student started with 20 $cm^3$ of 0.20 $mol/dm^3$ $NaCl(aq)$.

- Determine the amount of $NaCl(aq)$ used.

amount of $NaCl(aq)$ used = ..... mol

The yield of $NaNO_3$ crystals was 90%.

- Calculate the mass of $NaNO_3$ crystals made.

mass of $NaNO_3$ crystals = ..... g
[4]

**(v)** Write a chemical equation for the action of heat on sodium nitrate crystals.

..... [2]

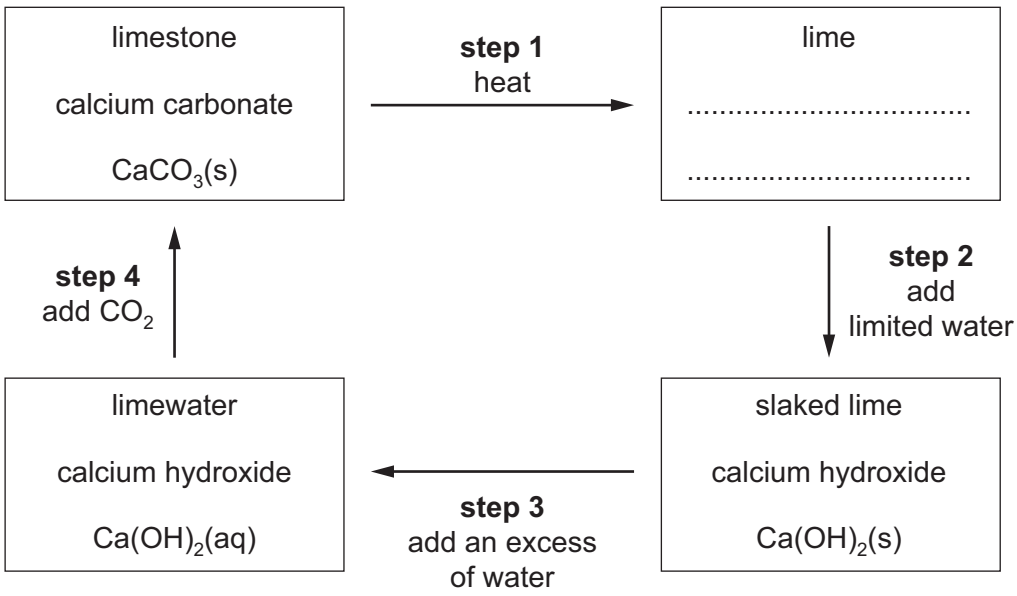
[Total: 21]

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**[Turn over**

**3** Limestone rock is mainly calcium carbonate, $CaCO_3$.

**(a)** The 'limestone cycle' is shown. Each step is numbered.




**(i)** Complete the box to give the chemical name and formula of lime. [2]

**(ii)** Which step involves a physical change?

..... [1]

**(iii)** What type of reaction is **step 1**?

..... [1]

**(iv)** Suggest how **step 2** could be reversed.

..... [1]

**(v)** Write a chemical equation for **step 4**.

..... [1]

**(vi)** Explain why **step 4** is a neutralisation reaction. Refer to the substances reacting in your answer.

.....

..... [2]

**(b)** Dolomite is a similar rock to limestone. Dolomite contains magnesium carbonate, $MgCO_3$.

Write a chemical equation for the reaction between magnesium carbonate and dilute nitric acid.

..... [2]

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**(c)** Forsterite is another rock which contains a magnesium compound.

A sample of forsterite has the following composition by mass: Mg, 2.73 g; Si, 1.58 g; O, 3.60 g.

Calculate the empirical formula of forsterite.

empirical formula = ..... [2]

[Total: 12]

**4** Ammonia is an important chemical.

**(a)** Ammonia is a base.

**(i)** In chemistry, what is meant by the term *base*?

.....

..... [1]

**(ii)** Write a word equation to show ammonia behaving as a base.

.....

..... [2]

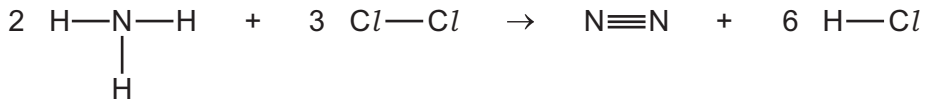
**(b)** Ammonia reacts with chlorine. The chemical equation is shown.

$$2NH_3(g) + 3Cl_2(g) \rightarrow N_2(g) + 6HCl(g)$$

**(i)** Calculate the volume of chlorine, measured at room temperature and pressure, needed to react completely with 0.68 g of ammonia.

volume of chlorine = ..... $cm^3$ [3]

**(ii)** The chemical equation can be represented as shown.



Use the bond energies in the table to determine the energy change, $\Delta H$, for the reaction between ammonia and chlorine.

| bond | bond energy in kJ / mol |
|---|---|
| N–H | 390 |
| C*l*–C*l* | 240 |
| N≡N | 945 |
| H–C*l* | 430 |

- energy needed to break bonds

..... kJ

- energy released when bonds are formed

..... kJ

- energy change, $\Delta H$, for the reaction between ammonia and chlorine

..... kJ
[3]

**(iii)** Is the reaction endothermic or exothermic? Explain your answer.

.....

..... [1]

**(c)** Ammonia reacts with oxygen at high temperatures in the presence of a suitable catalyst to form nitric oxide, NO.

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

**(i)** Explain how this chemical equation shows ammonia acting as a reducing agent.

.....

..... [1]

**(ii)** Suggest a suitable catalyst for the reaction from the list of metals. Give a reason for your answer.

**aluminium** **calcium** **platinum** **potassium** **sodium**

suitable catalyst .....

reason .....
[2]

[Total: 13]

**5** Alcohols are a 'family' of organic molecules which have the same general formula.

**(a)** What is the name given to any 'family' of organic molecules which have the same general formula and similar chemical properties?

..... [1]

**(b)** Give the general formula of alcohols.

..... [1]

**(c)** Propan-1-ol can be made from propene.

**(i)** Name the reagent and give the conditions needed to convert propene into propan-1-ol.

reagent .....

conditions .....
[2]

**(ii)** Write a chemical equation for the complete combustion of propan-1-ol.

..... [2]

**(d)** A simple sugar can be represented as shown.




Simple sugars can be polymerised to make more complex carbohydrates.

**(i)** Complete the diagram to show part of a carbohydrate **polymer** made from the simple sugar shown.



[2]

**(ii)** Name the chemical process which occurs when a carbohydrate polymer is broken down into simple sugars.

..... [1]

**(iii)** What conditions are needed for this process to occur?

..... [1]

**(e)** Chromatography can be used to identify simple sugars in a mixture.

A student analysed a mixture of simple sugars by chromatography. All the simple sugars in the mixture were colourless.

**(i)** What is the name given to the type of substance used to identify the positions of the simple sugars on the chromatogram?

..... [1]

**(ii)** The student calculated the $R_f$ value of a spot on the chromatogram.

Complete the expression for the $R_f$ value of the spot.

$R_f$ =

[1]

**(iii)** How could a student identify a simple sugar from its $R_f$ value?

.....

..... [1]

**(iv)** Sometimes not all the substances in a mixture can be identified from the chromatogram produced.

Explain why this may happen.

..... [1]

[Total: 14]

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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.).