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]

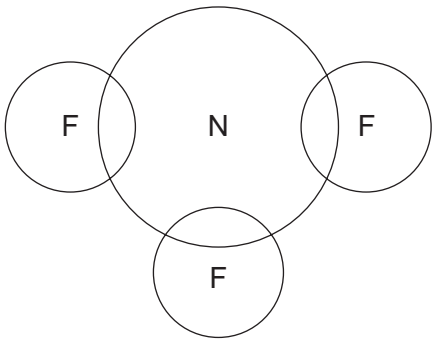
(b) NF_3 has covalent bonds.

(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]

(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?

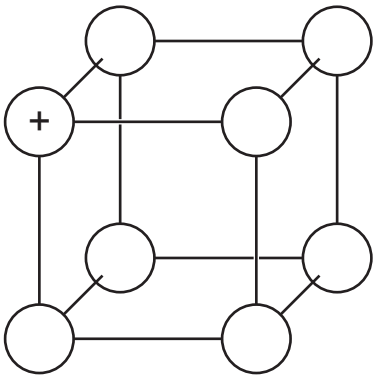
..... [1]

[Total: 20]

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]

(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]

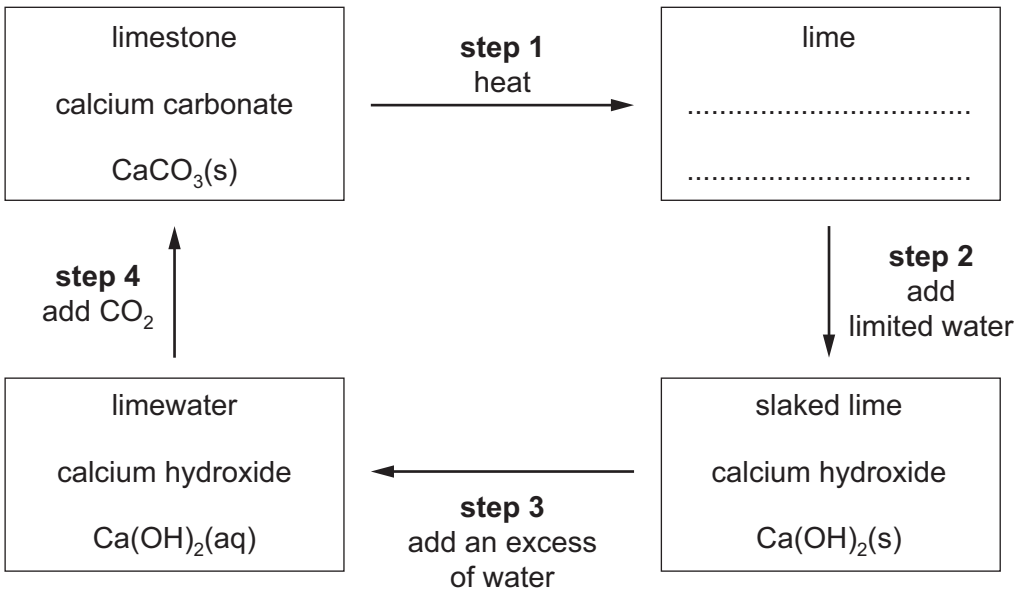
(v) Write a chemical equation for the action of heat on sodium nitrate crystals.

..... [2]

[Total: 21]

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]

(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]

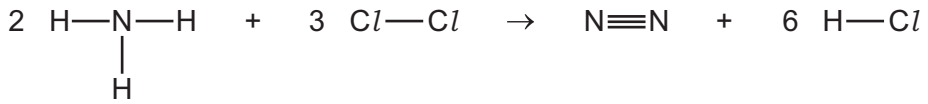
(b) Ammonia reacts with chlorine. The chemical equation is shown.

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

(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, ΔH, 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, ΔH, 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]

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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

Key

atomic number
atomic symbol
name
relative atomic mass

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 –		

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.).

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