



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

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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.

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 ₃ H ₈

Identify, by letter:

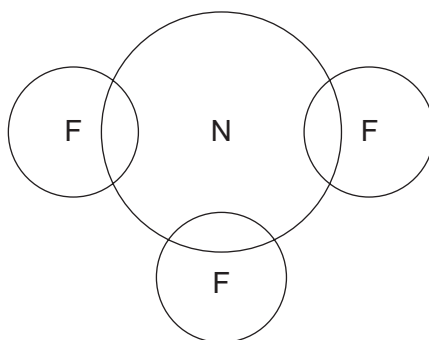
- (i) a gas which combines with water to form acid rain [1]
- (ii) **two** gases which exist as diatomic molecules [2]
- (iii) a gas which bleaches damp litmus paper [1]
- (iv) a gas which is used as an inert atmosphere in lamps [1]
- (v) **two** gases which are found in clean dry air [2]
- (vi) **two** gases which are found in refinery gas. [2]

(b) NF₃ 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 NF₃.
 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?

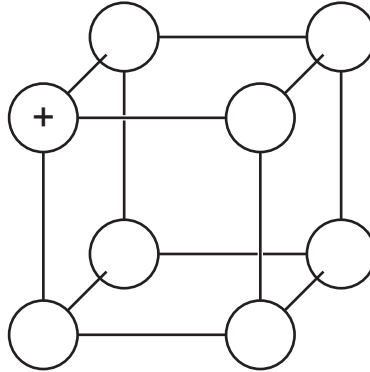
..... [1]

[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

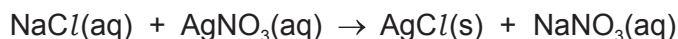
3

[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.



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 cm³ of 0.20 mol/dm³ NaCl(aq).

- Determine the amount of NaCl(aq) used.

amount of NaCl(aq) used = mol

The yield of NaNO₃ crystals was 90%.

- Calculate the mass of NaNO₃ crystals made.

mass of NaNO₃ crystals = g
 [4]

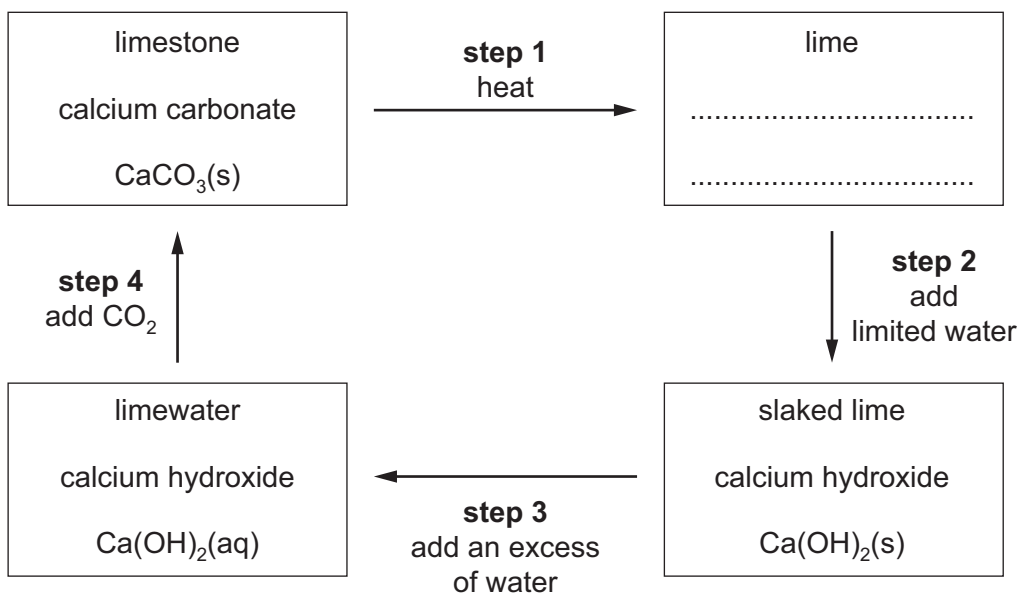
- (v) Write a chemical equation for the action of heat on sodium nitrate crystals.

..... [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, 2.73g; Si, 1.58g; O, 3.60g.

Calculate the empirical formula of forsterite.

empirical formula = [2]

[Total: 12]

4 Ammonia is an important chemical.

(a) Ammonia is a base.

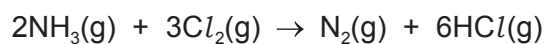
(i) In chemistry, what is meant by the term *base*?

.....
..... [1]

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

.....
..... [2]

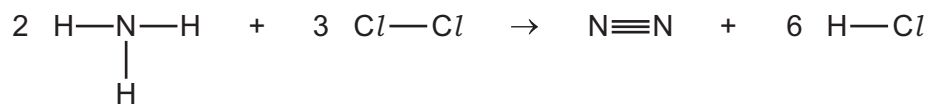
(b) Ammonia reacts with chlorine. The chemical equation is shown.



(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 = cm³ [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
Cl-Cl	240
N≡N	945
H-Cl	430

- energy needed to break bonds

..... kJ

- energy released when bonds are formed

..... kJ

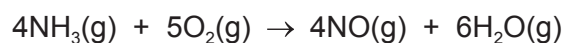
- energy change, ΔH , for the reaction between ammonia and chlorine

..... 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.



- (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																				
		Key										1 H hydrogen 1								2 He helium 4																	
		atomic number atomic symbol name relative atomic mass										5 B boron 11		6 C carbon 12		7 N nitrogen 14		8 O oxygen 16		9 F fluorine 19		10 Ne neon 20															
		3 Li lithium 7		4 Be beryllium 9												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											
		11 Na sodium 23		12 Mg magnesium 24		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 dm³ at room temperature and pressure (r.t.p.).