Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

5879467154

CHEMISTRY **0620/32**

Paper 3 (Extended) **May/June 2014**

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 12.
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 **12** printed pages.

CAMBRIDGE International Examinations

[Turn over

1 The table below gives the electron distributions of atoms of different elements.

element	electron distribution
A	2 + 7
B	2 + 8 + 4
C	2 + 8 + 8 + 1
D	2 + 8 + 18 + 5
E	2 + 8 + 18 + 7
F	2 + 8 + 18 + 18 + 8

For each of the following, select an element or elements from the table that matches the description. Each element may be selected once, more than once or not at all.

(a) These **two** elements are in the same group.

..... [1]

(b) This element forms a fluoride with a formula of the type XF_3.

..... [1]

(c) This element reacts violently with cold water.

..... [1]

(d) This element has a macromolecular structure similar to that of diamond.

..... [1]

(e) The only oxidation state of this element is 0.

..... [1]

(f) This element is bromine.

..... [1]

(g) This element is a good conductor of electricity.

..... [1]

[Total: 7]

2 **(a)** Natural gas, which is mainly methane, is a fossil fuel.

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

.....

..... [1]

(ii) Name **two** other fossil fuels.

..... [2]

(iii) Name a **solid** fuel which is not a fossil fuel.

..... [1]

(b) Fossil fuels are formed by the anaerobic decomposition of organic matter. Anaerobic means in the absence of oxygen.

(i) The organic matter contains hydrogen and carbon. Suggest the products that would be formed if the decomposition occurred in the presence of oxygen.

..... [2]

(ii) What are the **two** main disadvantages in the widespread use of fossil fuels?

.....

.....

..... [2]

[Total: 8]

[Turn over

3 Plant growth is improved by the availability of essential elements, such as nitrogen, and by the soil having a suitable pH.

(a) Nitrogen-based fertilisers are made from ammonia. Ammonia is manufactured by the Haber process.

(i) Describe the Haber process giving reaction conditions and a balanced equation.
(Do not discuss reaction rate and yield.)

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..... [5]

(ii) Fertilisers contain nitrogen.
Name the other **two** elements essential for plant growth commonly found in fertilisers.

..... [2]

(b) Crops do not grow well if the soil is too acidic.

(i) One cause of acidity in soil is acid rain. Explain how acid rain is formed.

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.....

.....

..... [3]

(ii) Name **two** bases which are used to increase the pH of acidic soils.

..... [2]

[Total: 12]

4 Propanoic acid is a carboxylic acid. Its formula is $CH_3–CH_2–COOH$.

(a) Propanoic acid is the third member of the homologous series of carboxylic acids.

(i) Give the name and structural formula of the fourth member of this series.

name .....

formula ..... [2]

(ii) Members of a homologous series have very similar chemical properties.
State **three** other characteristics of a homologous series.

.....

.....

.....

..... [3]

(b) Carboxylic acids can be made by the oxidation of alcohols.

(i) Draw the structural formula of the alcohol which can be oxidised to propanoic acid.
Show all atoms and bonds.

[1]

(ii) Name a reagent, other than oxygen, which can oxidise alcohols to carboxylic acids.

..... [2]

[Turn over

(c) Complete the following equations for some of the reactions of propanoic acid.
The salts of this acid are called propanoates.

(i) zinc + propanoic acid → .... + hydrogen [1]

(ii) calcium oxide + propanoic acid → .... + ... [1]

(iii) $LiOH + CH_3CH_2COOH \rightarrow$ ..... + ... [1]

(d) A piece of magnesium was added to 100 cm^3 of an aqueous acid. The time taken for the metal to react completely was measured. This experiment was repeated using different aqueous acids. The same volume of acid was used in each experiment and the pieces of magnesium used were identical. In one experiment the reaction was carried out at a different temperature.

experiment	acid	concentration in mol / dm^3	temperature / °C	time / minutes
A	propanoic	1.0	20	5
B	propanoic	1.0	30	3
C	propanoic	0.5	20	8
D	hydrochloric	1.0	20	1

Explain the following in terms of collision rate between reacting particles.

(i) Why is the rate in experiment **C** slower than the rate in experiment **A**?

.....

.....

..... [2]

(ii) Why is the rate in experiment **B** faster than the rate in experiment **A**?

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..... [2]

(iii) Why is the rate in experiment **D** faster than the rate in experiment **A**?

.....

.....

..... [3]

[Total: 18]

5 Carbonyl chloride is made from carbon monoxide and chlorine.

$$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$$

(a) Two methods of preparing carbon monoxide are from methane and oxygen, and from methane and steam.

(i) The reaction between methane and oxygen can also form carbon dioxide. How can carbon monoxide be made instead of carbon dioxide?

..... [1]

(ii) The following reaction is used to make carbon monoxide and hydrogen.
The reaction is carried out at 1100 °C and normal pressure.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

The reaction is reversible and comes to equilibrium. Suggest why a high temperature is used.

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..... [2]

(iii) What is the disadvantage of using a high pressure for the reaction given in **(a)(ii)**?

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..... [2]

(b) Chlorine is made by the electrolysis of concentrated aqueous sodium chloride.
Describe this electrolysis. Write ionic equations for the reactions at the electrodes and name the sodium compound formed.

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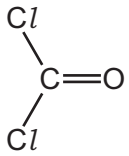
..... [5]

[Turn over

(c) The structural formula of carbonyl chloride is given below.



Draw a diagram showing the arrangement of the valency electrons around the atoms in one molecule of this covalent compound.

Use ○ to represent an electron from an oxygen atom.
Use × to represent an electron from a chlorine atom.
Use ● to represent an electron from a carbon atom.

[3]

[Total: 13]

6 Scandium, proton number 21, is not a typical transition element.

(a) Scandium is a low density metal which has only one oxidation state in its compounds. Scandium compounds are white solids which form colourless solutions. Titanium, the next metal in the period, is a far more typical transition element. How would the properties of titanium differ from those of scandium?

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..... [3]

(b) Scandium fluoride is an ionic compound. The valency of scandium in scandium fluoride is three.
Draw a diagram which shows the formula of this compound, the charges on the ions and the arrangement of the valency electrons around the negative ions.

Use × to represent an electron from a fluorine atom.
Use ○ to represent an electron from a scandium atom.

[3]

(c) Scandium oxide is insoluble in water. Describe how you could show that it is an amphoteric oxide.

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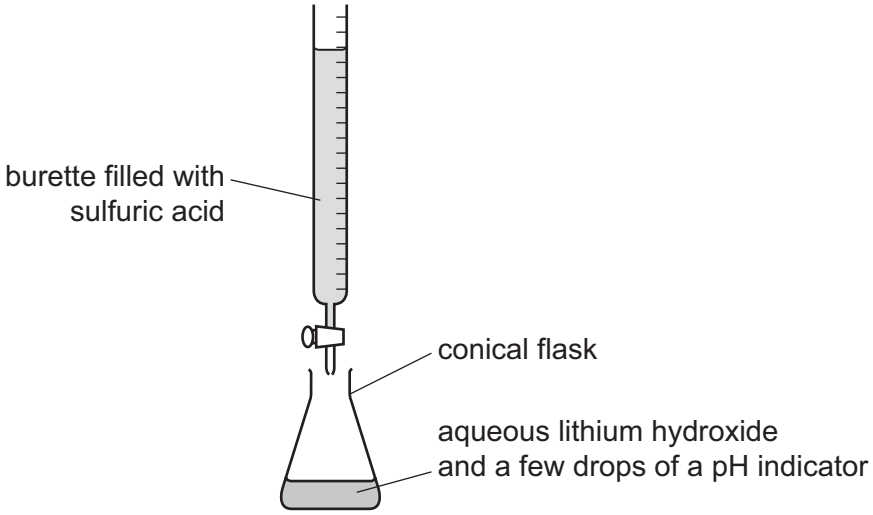
..... [3]

[Total: 9]

7 The soluble salt hydrated lithium sulfate is made by titration from the soluble base lithium hydroxide.



(a) The sulfuric acid is added slowly from the burette until the indicator just changes colour. The volume of sulfuric acid needed to just neutralise the lithium hydroxide is noted.
Describe how you would continue the experiment to obtain pure dry crystals of hydrated lithium sulfate.

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..... [5]

(b) Using 25.0 cm^3 of aqueous lithium hydroxide, concentration 2.48 mol / dm^3, 2.20 g of hydrated lithium sulfate was obtained.
Calculate the percentage yield, giving your answer to **one** decimal place.

$$2LiOH + H_2SO_4 \rightarrow Li_2SO_4 + 2H_2O$$

$$Li_2SO_4 + H_2O \rightarrow Li_2SO_4.H_2O$$

Number of moles of LiOH used = ...

Number of moles of $Li_2SO_4.H_2O$ which could be formed = ...

Mass of one mole of $Li_2SO_4.H_2O$ = 128 g

Maximum yield of $Li_2SO_4.H_2O$ = ... g

Percentage yield = ...% [4]

(c) An experiment was carried out to show that the formula of the hydrated salt is $Li_2SO_4.H_2O$. A sample of the hydrated salt was weighed and its mass recorded. It was then heated and the anhydrous salt was weighed. This procedure was repeated until two consecutive masses were the same. This procedure is called 'heating to constant mass'.

(i) What is the reason for heating to constant mass?

..... [1]

(ii) The mass of the hydrated salt is m_1 and the mass of the anhydrous salt is m_2. Explain how you could show that the hydrated salt has **one** mole of water of crystallisation per mole of the anhydrous salt.

.....

.....

..... [3]

[Total: 13]

DATA SHEET
The Periodic Table of the Elements

	Group																	
	I	II									III	IV	V	VI	VII	0
						1 H Hydrogen 1										4 He Helium 2
	7 Li Lithium 3	9 Be Beryllium 4									11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
	23 Na Sodium 11	24 Mg Magnesium 12									27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
	39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
	85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	98 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
	133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
	Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

*58-71 Lanthanoid series	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
†90-103 Actinoid series	232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

Key

a	a = relative atomic mass
X	X = atomic symbol
b	b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).