Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

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.

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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]

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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]

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.)

.....

.....

.....

.....

..... [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.

.....

.....

.....

..... [3]

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

..... [2]

[Total: 12]

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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]

(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**?

.....

.....

..... [2]

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

.....

.....

..... [3]

[Total: 18]

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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.

.....

.....

..... [2]

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

.....

..... [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.

.....

.....

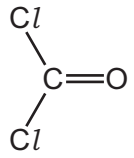
.....

.....

.....

..... [5]

(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?

.....

.....

.....

..... [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.

.....

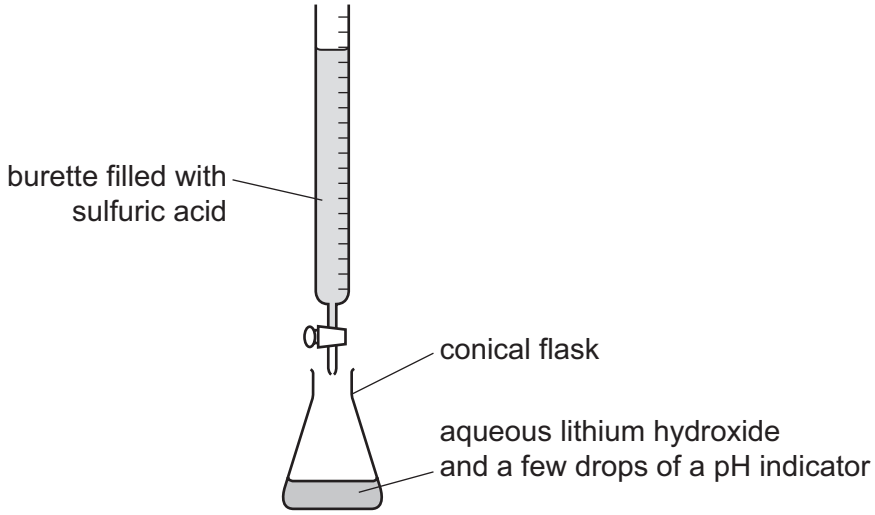
.....

.....

..... [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.

.....

.....

.....

.....

.....

..... [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]

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(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	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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	**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 †															

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
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

*58-71 Lanthanoid series
†90-103 Actinoid series

Key

a
X
b

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

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

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