



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE
NAME

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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.



- 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]

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]

4 Propanoic acid is a carboxylic acid. Its formula is $\text{CH}_3\text{-CH}_2\text{-COOH}$.

(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.

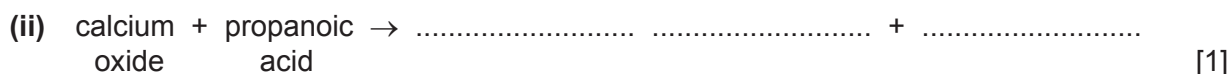
(i) Draw the structural formula of the alcohol which can be oxidised to propanoic acid.
Show all atoms and bonds.

[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.



- (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 / $^\circ\text{C}$	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]

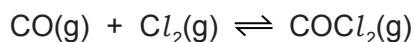
- (iii) Why is the rate in experiment **D** faster than the rate in experiment **A**?

.....

 [3]

[Total: 18]

- 5 Carbonyl chloride is made from carbon monoxide and chlorine.

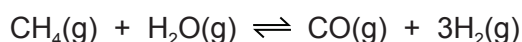


- (a) Two methods of preparing carbon monoxide are from methane and oxygen, and from methane and steam.

- (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.



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)?

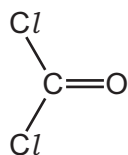
.....
 [2]

- (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 o to represent an electron from an oxygen atom.

Use x 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 x to represent an electron from a fluorine atom.

Use o 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.

.....

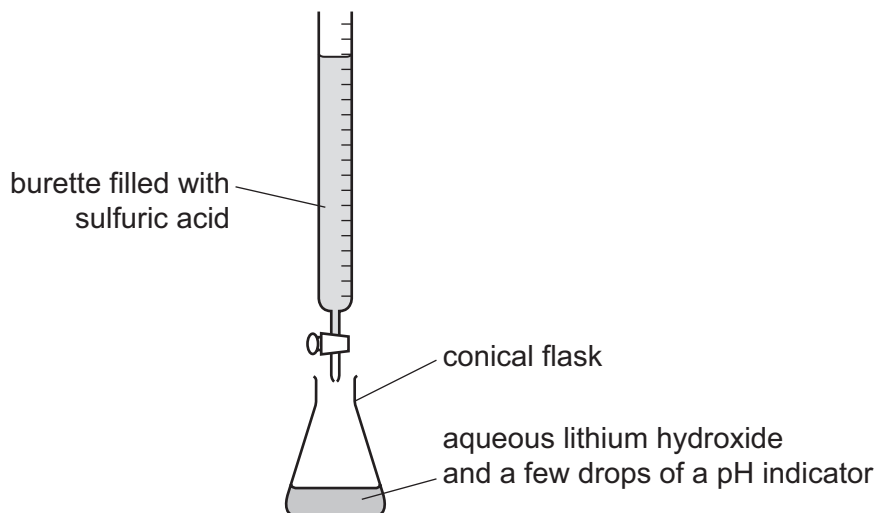
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.....

..... [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.

.....

.....

.....

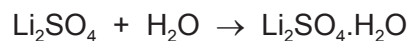
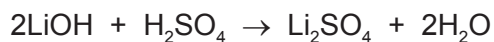
.....

.....

.....

..... [5]

- (b) Using 25.0 cm³ of aqueous lithium hydroxide, concentration 2.48 mol/dm³, 2.20 g of hydrated lithium sulfate was obtained. Calculate the percentage yield, giving your answer to **one** decimal place.



Number of moles of LiOH used =

Number of moles of Li₂SO₄·H₂O which could be formed =

Mass of one mole of Li₂SO₄·H₂O = 128 g

Maximum yield of Li₂SO₄·H₂O = g

Percentage yield =%

[4]

(c) An experiment was carried out to show that the formula of the hydrated salt is $\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$. 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																																																													
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1	11 B Boron 5	12 C Carbon 6	13 Al Aluminium 13	14 N Nitrogen 7	15 O Oxygen 8	16 F Fluorine 9	17 Ne Neon 10	18 Ar Argon 18	19 K Potassium 19	20 Ca Calcium 20	21 Sc Scandium 21	22 Ti Titanium 22	23 V Vanadium 23	24 Cr Chromium 24	25 Mn Manganese 25	26 Fe Iron 26	27 Co Cobalt 27	28 Ni Nickel 28	29 Cu Copper 29	30 Zn Zinc 30	31 Ga Gallium 31	32 Ge Germanium 32	33 As Arsenic 33	34 Se Selenium 34	35 Br Bromine 35	36 Kr Krypton 36	37 Rb Rubidium 37	38 Sr Strontium 38	39 Y Yttrium 39	40 Zr Zirconium 40	41 Nb Niobium 41	42 Mo Molybdenum 42	43 Tc Technetium 43	44 Ru Ruthenium 44	45 Rh Rhodium 45	46 Pd Palladium 46	47 Ag Silver 47	48 Cd Cadmium 48	49 In Indium 49	50 Sn Tin 50	51 Sb Antimony 51	52 Te Tellurium 52	53 I Iodine 53	54 Xe Xenon 54	55 Cs Caesium 55	56 Ba Barium 56	57 La Lanthanum 57	72 Hf Hafnium 72	73 Ta Tantalum 73	74 W Tungsten 74	75 Re Rhenium 75	76 Os Osmium 76	77 Ir Iridium 77	78 Pt Platinum 78	79 Au Gold 79	80 Hg Mercury 80	81 Tl Thallium 81	82 Pb Lead 82	83 Bi Bismuth 83	84 Po Polonium 84	85 At Astatine 85	86 Rn Radon 86	87 Fr Francium 87	88 Ra Radium 88	89 Ac Actinium 89	†
												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	212 Po Polonium 84	210 At Astatine 85	210 Rn Radon 86	226 Fr Francium 87	227 Ra Radium 88	227 Ac Actinium 89	†																																			
												140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	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	238 U Uranium 92	91 Pa Protactinium 91	92 U Uranium 92	93 Np Neptunium 93	94 Pu Plutonium 94	95 Am Americium 95	96 Cm Curium 96	97 Bk Berkelium 97	98 Cf Californium 98	99 Es Einsteinium 99	100 Fm Fermium 100	101 Md Mendelevium 101	102 No Nobelium 102	103 Lr Lawrencium 103																													

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

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

Key

a	X
b	

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

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