



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

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**CHEMISTRY**

**0620/32**

Paper 3 (Extended)

**October/November 2012**

**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 a pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

**DO NOT WRITE IN ANY BARCODES.**

Answer **all** questions.

A copy of the Periodic Table is printed on page 16.

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.

**For Examiner's Use**

1	
2	
3	
4	
5	
6	
7	
<b>Total</b>	

This document consists of **13** printed pages and **3** blank pages.



1 This question is concerned with the elements in Period 5, Rb to Xe.

(a) The electron distributions of some of these elements are given in the following list.

element **A**     $2 + 8 + 18 + 8 + 2$

element **B**     $2 + 8 + 18 + 18 + 8$

element **C**     $2 + 8 + 18 + 18 + 5$

element **D**     $2 + 8 + 18 + 18 + 6$

element **E**     $2 + 8 + 18 + 18 + 4$

element **F**     $2 + 8 + 18 + 18 + 7$

(i) Identify element **C**. ..... [1]

(ii) Which element in the list does not form any compounds?

..... [1]

(iii) Which element in the list forms a chloride of the type  $XC l_2$ ?

..... [1]

(iv) Which **two** elements would react together to form a compound of the type  $XY_4$ ?

..... [1]

(v) Which element in the list would react with cold water to form an alkaline solution and hydrogen?

..... [1]

(b) Predict **two** differences in physical properties and **two** differences in chemical properties between rubidium and the transition metal niobium.

physical .....

.....

.....

chemical .....

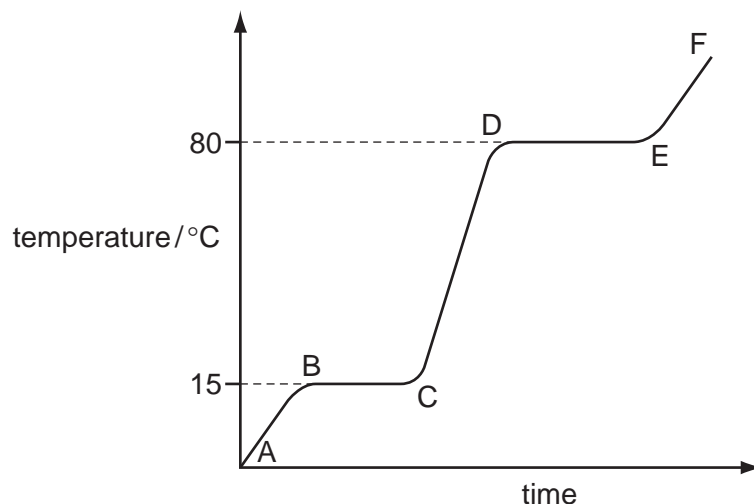
.....

..... [4]

[Total: 9]

- 2 The diagram shows a heating curve for a sample of compound X.

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- (a) Is X a solid, a liquid or a gas at room temperature, 20 °C?

..... [1]

- (b) Write an equation for the equilibrium which exists in region BC.

..... [2]

- (c) Name the change of state which occurs in region DE.

..... [1]

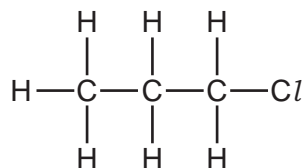
- (d) Explain how the curve shows that a pure sample of compound X was used.

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

[Total: 6]

3 Many organic compounds which contain a halogen have chloro, bromo or iodo in their name.

(a) The following diagram shows the structure of 1-chloropropane.



(i) Draw the structure of an isomer of this compound.

[1]

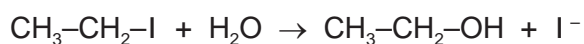
(ii) Describe how 1-chloropropane could be made from propane.

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

(iii) Suggest an explanation why the method you have described in (ii) does not produce a pure sample of 1-chloropropane.

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

(b) Organic halides react with water to form an alcohol and a halide ion.



(i) Describe how you could show that the reaction mixture contained an iodide ion.

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

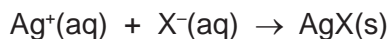
(ii) Name the alcohol formed when 1-chloropropane reacts with water.

..... [1]

- (c) The speed (rate) of reaction between an organic halide and water can be measured by the following method.

A mixture of 10 cm<sup>3</sup> of aqueous silver nitrate and 10 cm<sup>3</sup> of ethanol is warmed to 60 °C. Drops of the organic halide are added and the time taken for a precipitate to form is measured.

Silver ions react with the halide ions to form a precipitate of the silver halide.



Typical results for four experiments, **A**, **B**, **C** and **D**, are given in the table.

experiment	organic halide	number of drops	time / min
<b>A</b>	bromobutane	4	6
<b>B</b>	bromobutane	8	3
<b>C</b>	chlorobutane	4	80
<b>D</b>	iodobutane	4	0.1

- (i) Explain why it takes longer to produce a precipitate in experiment **A** than in **B**.

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

- (ii) How does the order of reactivity of the organic halides compare with the order of reactivity of the halogens?

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

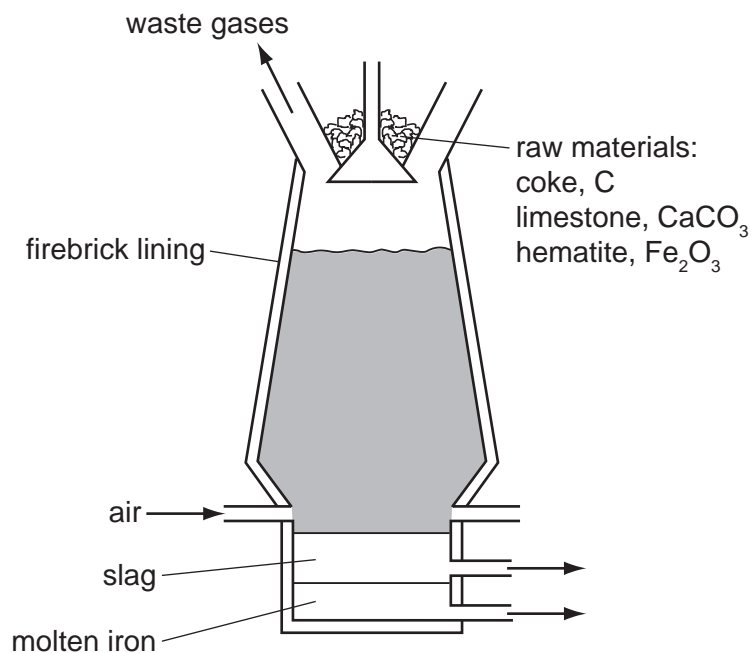
- (iii) Explain why the time taken to produce a precipitate would increase if the experiments were repeated at 50 °C.

.....  
 .....  
 ..... [3]

[Total: 15]

- 4 Iron is extracted from its ore, hematite, in the blast furnace.

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- (a) The temperature inside the blast furnace can rise to 2000 °C.  
Write an equation for the exothermic reaction which causes this high temperature.
- ..... [1]
- (b) Carbon monoxide is formed in the blast furnace. This reduces the ore hematite, Fe<sub>2</sub>O<sub>3</sub>, to iron.
- (i) Explain how carbon monoxide is formed in the blast furnace.
- .....
- ..... [2]
- (ii) Write an equation for the reduction of hematite by carbon monoxide.
- ..... [2]
- (c) Explain why it is necessary to add limestone, calcium carbonate, to the blast furnace.  
Include an equation in your explanation.
- .....
- .....
- ..... [3]

**(d)** Most of the iron from the blast furnace is converted into mild steel. A method of preventing the steel from rusting is coating it with zinc.

**(i)** What is the name of this method of rust prevention?

..... [1]

**(ii)** Explain, using the idea of electron transfer, why zinc-coated steel does not rust even when the coating is scratched and the steel is in contact with oxygen and water.

.....  
.....  
.....  
..... [3]

[Total: 12]

5 The food additive E220 is sulfur dioxide. It is a preservative for a variety of foods and drinks.

(a) State **two** other uses of sulfur dioxide.

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

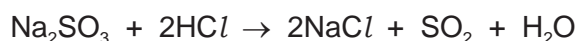
(b) How is sulfur dioxide manufactured?

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

(c) Sulfur dioxide is a reductant (reducing agent). Describe what you would see when aqueous sulfur dioxide is added to acidified potassium manganate(VII).

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

(d) Sulfur dioxide can also be made by the reaction between a sulfite and an acid.



Excess hydrochloric acid was added to 3.15 g of sodium sulfite. Calculate the maximum volume, measured at r.t.p., of sulfur dioxide which could be formed.

The mass of one mole of  $\text{Na}_2\text{SO}_3$  is 126 g.

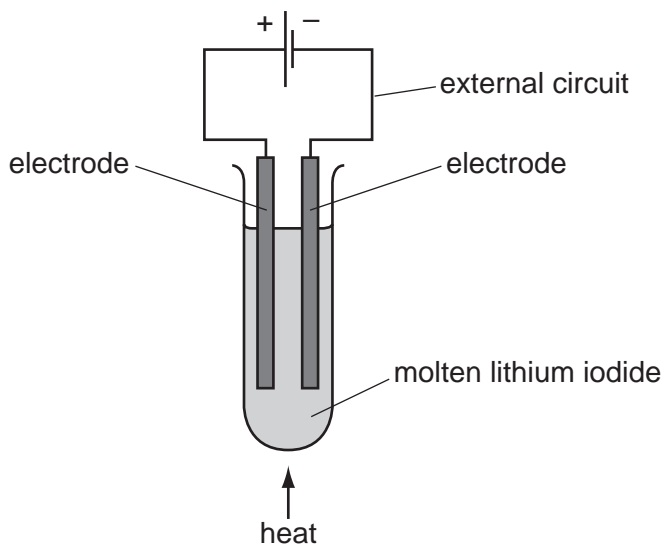
.....  
.....  
..... [3]

[Total: 9]



6 During electrolysis, ions move in the electrolyte and electrons move in the external circuit. Reactions occur at the electrodes.

(a) The diagram shows the electrolysis of molten lithium iodide.



(i) Draw an arrow on the diagram to show the direction of the electron flow in the external circuit. [1]

(ii) Electrons are supplied to the external circuit. How and where is this done?

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

(iii) Explain why solid lithium iodide does not conduct electricity but when molten it is a good conductor.

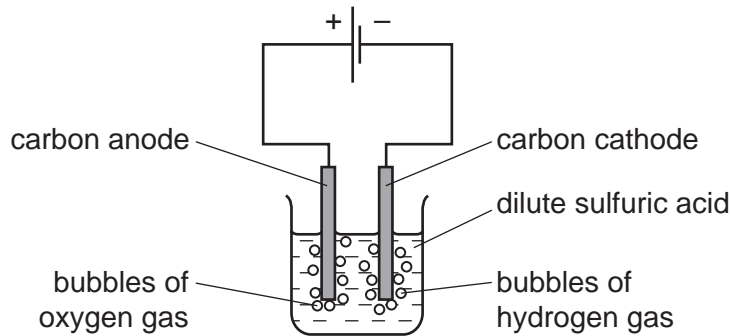
.....  
..... [1]

(b) The results of experiments on electrolysis are shown in the following table. Complete the table. The first line has been done as an example.

electrolyte	electrodes	product at cathode	product at anode	change to electrolyte
molten lithium iodide	carbon	lithium	iodine	used up
aqueous copper(II) sulfate	platinum		oxygen	
concentrated aqueous potassium chloride	carbon		chlorine	

[4]

- (c) The diagram below shows the electrolysis of dilute sulfuric acid. Hydrogen is formed at the negative electrode (cathode) and oxygen at the positive electrode (anode) and the concentration of sulfuric acid increases.



The ions present in the dilute acid are  $\text{H}^+(\text{aq})$ ,  $\text{OH}^-(\text{aq})$  and  $\text{SO}_4^{2-}(\text{aq})$ .

- (i) Write an equation for the reaction at the negative electrode (cathode).

..... [2]

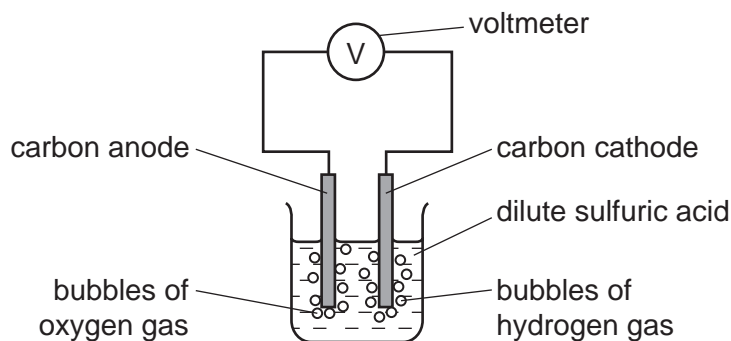
- (ii) Complete the equation for the reaction at the positive electrode (anode).



- (iii) Suggest an explanation of why the concentration of the sulfuric acid increases.

..... [1]

- (d) In the apparatus used in (c), the power supply is removed and immediately replaced by a voltmeter.



A reading on the voltmeter shows that electrical energy is being produced. Suggest an explanation for how this energy is produced.

.....  
 .....  
 ..... [3]

[Total: 15]

7 The alcohols form a homologous series. The first member of this series is methanol, CH<sub>3</sub>OH.

(a) (i) Give the general formula of the alcohols.

..... [1]

(ii) The mass of one mole of an alcohol is 116 g. What is its formula?  
Show your reasoning.

.....

..... [2]

(iii) Draw a diagram showing the arrangement of the outer (valency) electrons in one molecule of methanol.

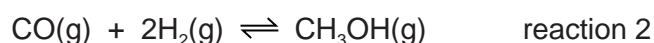
Use x to represent an electron from a carbon atom.

Use o to represent an electron from a hydrogen atom.

Use • to represent an electron from an oxygen atom.

[3]

(b) Methanol is manufactured using the following method.



The conditions for reaction 2 are:

pressure      100 atmospheres

catalyst      a mixture of copper, zinc oxide and aluminium oxide

temperature   250 °C

The forward reaction is exothermic.

(i) Why is high pressure used in reaction 2?

.....

..... [2]

- (ii) Explain why using a catalyst at 250 °C is preferred to using a higher temperature of 350 °C and no catalyst.

.....  
.....  
..... [3]

- (c) Methanol is oxidised by atmospheric oxygen. This reaction is catalysed by platinum.

- (i) The products of this reaction include a carboxylic acid. Give its name and structural formula.

name .....

structural formula showing all bonds

[2]

- (ii) Deduce the name of the ester formed by the reaction of methanol with the carboxylic acid named in (i).

..... [1]

[Total: 14]







**DATA SHEET**  
**The Periodic Table of the Elements**

		Group																
I	II	III	IV	V	VI	VII	0											
		1 <b>H</b> Hydrogen 1					4 <b>He</b> Helium 2											
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4		11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	14 <b>N</b> Nitrogen 7	16 <b>O</b> Oxygen 8	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10										
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12		27 <b>Al</b> Aluminium 13	28 <b>Si</b> Silicon 14	31 <b>P</b> Phosphorus 15	32 <b>S</b> Sulfur 16	35.5 <b>Cl</b> Chlorine 17	40 <b>Ar</b> Argon 18										
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20		48 <b>Ti</b> Titanium 22	45 <b>Sc</b> Scandium 21	59 <b>Co</b> Cobalt 27	59 <b>Ni</b> Nickel 28	64 <b>Cu</b> Copper 29	65 <b>Zn</b> Zinc 30	70 <b>Ga</b> Gallium 31	73 <b>Ge</b> Germanium 32	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	80 <b>Br</b> Bromine 35	84 <b>Kr</b> Krypton 36				
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38		91 <b>Zr</b> Zirconium 40	89 <b>Y</b> Yttrium 39	101 <b>Ru</b> Ruthenium 44	106 <b>Pd</b> Palladium 46	108 <b>Ag</b> Silver 47	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49	119 <b>Sn</b> Tin 50	122 <b>Sb</b> Antimony 51	128 <b>Te</b> Tellurium 52	127 <b>I</b> Iodine 53	131 <b>Xe</b> Xenon 54				
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56		178 <b>Hf</b> Hafnium 72	139 <b>La</b> Lanthanum 57	190 <b>Os</b> Osmium 76	195 <b>Pt</b> Platinum 78	197 <b>Au</b> Gold 79	201 <b>Hg</b> Mercury 80	204 <b>Tl</b> Thallium 81	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	210 <b>Po</b> Polonium 84	210 <b>At</b> Astatine 85	222 <b>Rn</b> Radon 86				
87 <b>Fr</b> Francium	226 <b>Ra</b> Radium			227 <b>Ac</b> Actinium														
<p style="text-align: center;">*58-71 Lanthanoid series †90-103 Actinoid series</p>																		
<p style="text-align: center;">Key</p> <table style="margin-left: auto; margin-right: auto;"> <tr> <td style="border: 1px solid black; padding: 2px;">a</td> <td style="border: 1px solid black; padding: 2px;"><b>X</b></td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">b</td> <td style="border: 1px solid black; padding: 2px;"></td> </tr> </table> <p style="text-align: center;">a = relative atomic mass X = atomic symbol b = proton (atomic) number</p>															a	<b>X</b>	b	
a	<b>X</b>																	
b																		
140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	159 <b>Tb</b> Terbium 65	162 <b>Dy</b> Dysprosium 66	165 <b>Ho</b> Holmium 67	167 <b>Er</b> Erbium 68	169 <b>Tm</b> Thulium 69	173 <b>Yb</b> Ytterbium 70	175 <b>Lu</b> Lutetium 71	232 <b>Th</b> Thorium 90	238 <b>U</b> Uranium 92	238 <b>Np</b> Neptunium 93				
	232 <b>Pa</b> Protactinium 91	238 <b>U</b> Uranium 92	238 <b>Np</b> Neptunium 93	238 <b>Pu</b> Plutonium 94	238 <b>Am</b> Americium 95	238 <b>Cm</b> Curium 96	238 <b>Bk</b> Berkelium 97	238 <b>Cf</b> Californium 98	238 <b>Es</b> Einsteinium 99	238 <b>Fm</b> Fermium 100	238 <b>Md</b> Mendelevium 101	238 <b>No</b> Nobelium 102	238 <b>Lr</b> Lawrencium 103					

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

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