UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

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	
Total	

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

For Examiner's Use

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 XCl_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 .....

.....

.....

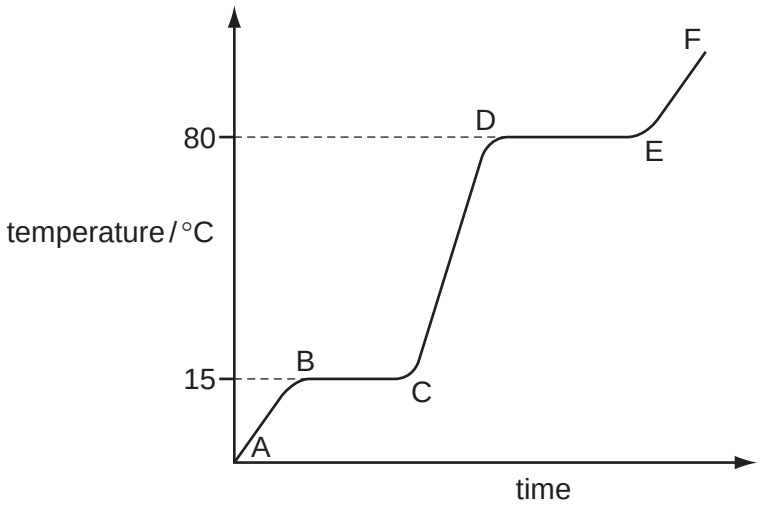
chemical .....

.....

..... [4]

[Total: 9]

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



(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.

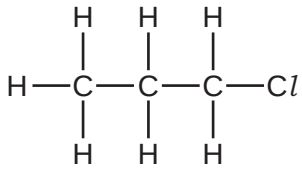
.....

..... [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.

$$CH_3–CH_2–I + H_2O \rightarrow CH_3–CH_2–OH + I^-$$

(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^3 of aqueous silver nitrate and 10 cm^3 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.

$$Ag^+(aq) + X^-(aq) \rightarrow AgX(s)$$

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

experiment	organic halide	number of drops	time / min
A	bromobutane	4	6
B	bromobutane	8	3
C	chlorobutane	4	80
D	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.

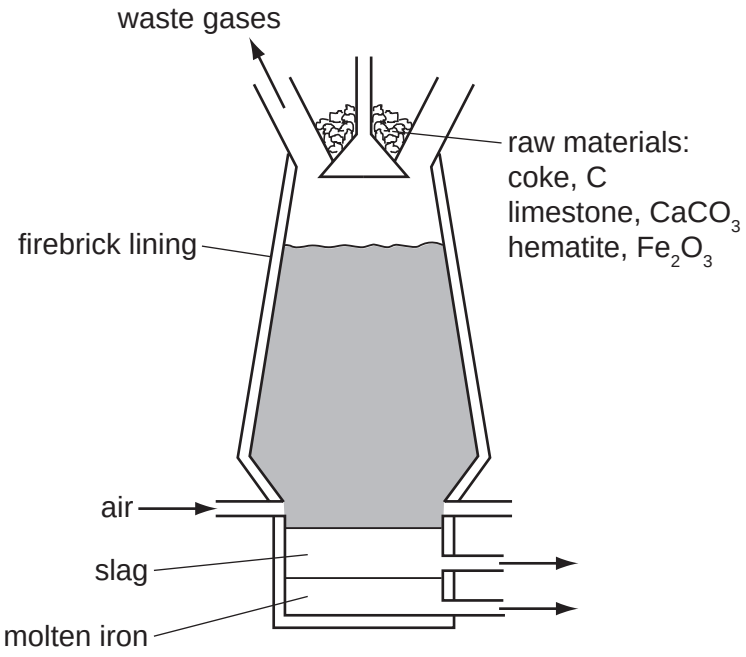
.....

.....

..... [3]

[Total: 15]

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



(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_2O_3, 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]

For Examiner's Use

(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]

[Turn over

For Examiner's Use

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.

$$Na_2SO_3 + 2HCl \rightarrow 2NaCl + SO_2 + H_2O$$

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 Na_2SO_3 is 126 g.

.....

.....

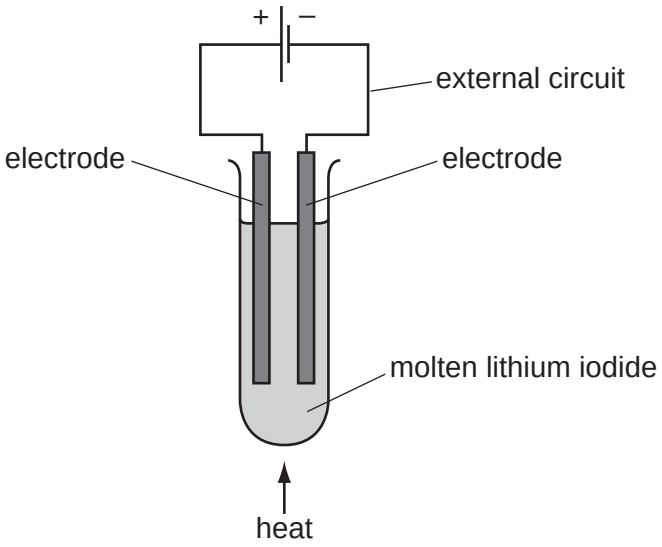
..... [3]

[Total: 9]

For Examiner's Use

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]

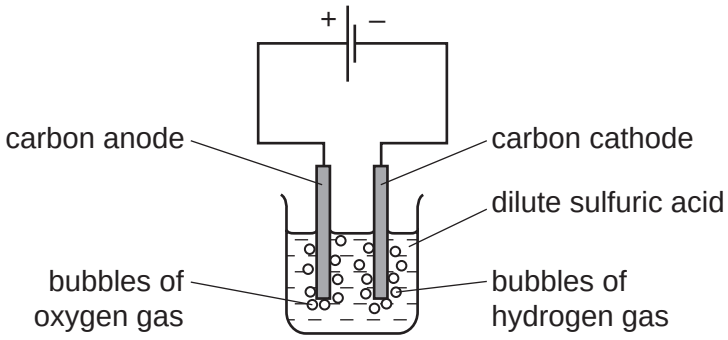
(b) The results of experiments on electrolysis are shown in the following table. Complete the table. The first line has been done as an example.

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]

For Examiner's Use

(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 $H^+(aq)$, $OH^-(aq)$ and $SO_4^{2-}(aq)$.

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

..... [2]

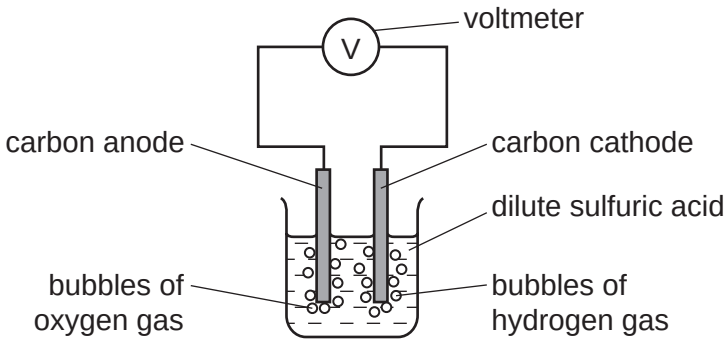
(ii) Complete the equation for the reaction at the positive electrode (anode).

$$4OH^-(aq) \rightarrow O_2(g) + ...H_2O(l) + ...$$ [1]

(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]

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7 The alcohols form a homologous series. The first member of this series is methanol, CH_3OH.

(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.

$$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g) \qquad \text{reaction 1}$$

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \qquad \text{reaction 2}$$

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]

[Turn over

(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]

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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	**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.).