



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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CANDIDATE
NUMBER

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CHEMISTRY

0620/31

Paper 3 (Extended)

May/June 2011

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 12.

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	
8	
Total	

This document consists of 11 printed pages and 1 blank page.

1 The following techniques are used to separate mixtures.

- A simple distillation B fractional distillation C evaporation
D chromatography E filtration F diffusion

From this list, choose the most suitable technique to separate the following.

- (a) methane from a mixture of the gases, methane and ethane [1]
(b) water from aqueous magnesium sulfate [1]
(c) glycine from a mixture of the amino acids, glycine and lysine [1]
(d) iron filings from a mixture of iron filings and water [1]
(e) zinc sulfate crystals from aqueous zinc sulfate [1]
(f) hexane from a mixture of the liquids, hexane and octane [1]

[Total: 6]

2 Selenium and sulfur are in Group VI. They have similar properties.

(a) One of the main uses of selenium is in photoelectric cells. These cells can change light into electrical energy.

(i) Name a process which can change light into chemical energy.

.....

(ii) Name a device which can change chemical energy into electrical energy.

..... [2]

(b) The electron distribution of a selenium atom is 2 + 8 + 18 + 6.

(i) Selenium forms an ionic compound with potassium. Draw a diagram which shows the formula of this ionic compound, the charges on the ions and the arrangement of the **valency** electrons around the negative ion.

Use o to represent an electron from an atom of potassium.

Use x to represent an electron from an atom of selenium.

[3]

- (ii) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound selenium chloride.
Use x to represent an electron from an atom of selenium.
Use o to represent an electron from an atom of chlorine.

[3]

- (iii) Predict **two** differences in the physical properties of these two compounds.

.....
 [2]

- (c) The selenide ion reacts with water.



What type of reagent is the selenide ion in this reaction? Give a reason for your choice.

.....
 [3]

[Total: 13]

- 3 Iron from the blast furnace is impure. It contains about 4 % carbon and 0.5 % silicon. Most of this impure iron is used to make mild steel, an alloy of iron containing less than 0.25 % carbon.

- (a) A jet of oxygen is blown through the molten iron in the presence of a base, usually calcium oxide. Explain how the percentage of carbon is reduced and how the silicon is removed.

.....

 [4]

(b) (i) Why are steel alloys used in preference to iron?

.....

(ii) State a use of the following alloys.

mild steel

stainless steel [2]

(c) Both iron and steel have typical metallic structures - a lattice of positive ions and a sea of electrons.

(i) Suggest an explanation for why they have high melting points.

.....

.....

..... [2]

(ii) Explain why, when a force is applied to a piece of steel, it does not break but just changes its shape.

.....

..... [2]

[Total: 11]

4 A major ore of zinc is zinc blende, ZnS. A by-product of the extraction of zinc from this ore is sulfur dioxide which is used to make sulfuric acid.

(a) (i) Zinc blende is heated in air. Zinc oxide and sulfur dioxide are formed. Write the balanced equation for this reaction.

..... [2]

(ii) Zinc oxide is reduced to zinc by heating with carbon. Name **two** other reagents which could reduce zinc oxide.

..... [2]

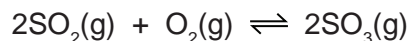
(iii) The zinc obtained is impure. It is a mixture of metals. Explain **how** fractional distillation could separate this mixture.

zinc bp = 908 °C, cadmium bp = 765 °C, lead bp = 1751 °C

.....

..... [2]

- (b) Sulfur dioxide is used to make sulfur trioxide in the Contact Process.



The forward reaction is exothermic. The conditions used are:

temperature: 450 °C
 pressure: 2 atmospheres
 catalyst: vanadium(V) oxide

Explain, mentioning both position of equilibrium and rate, why these conditions give the most economic yield.

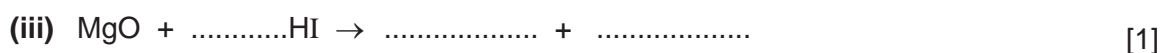
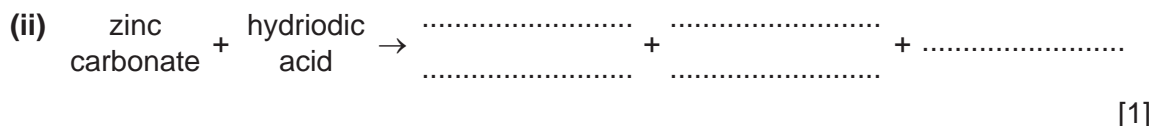
.....

 [4]

[Total: 10]

- 5 Hydriodic acid, HI(aq), is a strong acid. Its salts are iodides.

- (a) It has the reactions of a typical strong acid. Complete the following equations.



- (b) Two of the reactions in (a) are acid/base and one is redox. Which one is redox? Explain your choice.

.....

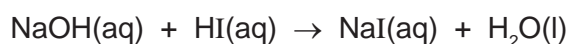
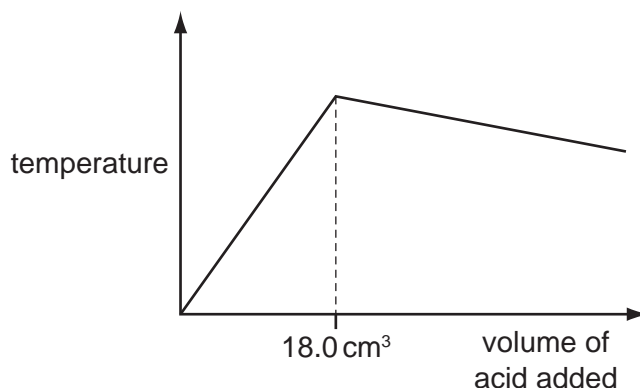
 [2]

- (c) Describe how you could distinguish between hydriodic, HI(aq), and hydrobromic, HBr(aq) acids, by bubbling chlorine through these two acids.

result with hydriodic acid

result with hydrobromic acid [2]

- (d) 20.0 cm³ of aqueous sodium hydroxide, 2.00 mol/dm³, was placed in a beaker. The temperature of the alkali was measured and 1.0 cm³ portions of hydriodic acid were added. After each addition, the temperature of the mixture was measured. Typical results are shown on the graph.



- (i) Explain why the temperature increases rapidly at first then stops increasing.

.....
 [2]

- (ii) Suggest why the temperature drops after the addition of 18.0 cm³ of acid.

..... [1]

- (iii) In another experiment, it was shown that 15.0 cm³ of the acid neutralised 20.0 cm³ of aqueous sodium hydroxide, 1.00 mol/dm³. Calculate the concentration of the acid.

.....
 [2]

[Total: 12]

- 6 The structural formula of a butanol is given below.



- (a) Butanol can be made from petroleum and also by fermentation.

- (i) Describe the chemistry of making butanol from petroleum by the following route.



.....

 [3]

(ii) Explain, in general terms, what is meant by *fermentation*.

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

(b) Butanol can be oxidised to a carboxylic acid by heating with acidified potassium manganate(VII). Give the name and structural formula of the carboxylic acid.

name [1]

structural formula

[1]

(c) Butanol reacts with ethanoic acid to form a liquid, **X**, which has the sweet smell of bananas. Its empirical formula is C_3H_6O and its M_r is 116.

(i) What type of compound is liquid **X**?

..... [1]

(ii) Give the molecular formula of liquid **X**.

..... [1]

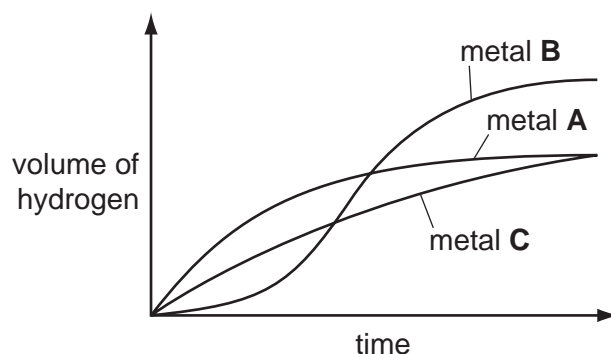
(iii) Draw the structural formula of **X**. Show all the individual bonds.

[2]

[Total: 12]

- 7 Excess hydrochloric acid was added to powdered zinc. The hydrogen evolved was collected and its volume measured every 20 seconds.

The experiments were repeated at the same temperature using the same number of moles of powdered magnesium and aluminium.



- (a) Identify metals **A**, **B** and **C** by choosing from zinc, magnesium and aluminium. Give a reason for each choice.

metal **A**

.....

metal **B**

.....

metal **C**

..... [5]

- (b) Using 'moles', explain why two of the metals form the same volume of hydrogen but the third metal forms a larger volume.

.....

.....

..... [3]

[Total: 8]

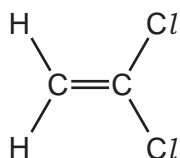
8 There are two types of polymerisation - addition and condensation.

(a) Explain the difference between them.

.....

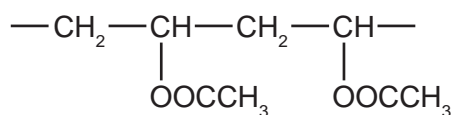
 [2]

(b) Poly(dichloroethene) is used to package food. Draw its structure. The structural formula of dichloroethene is shown below.



[2]

(c) The polymer known as PVA is used in paints and adhesives. Its structural formula is shown below.

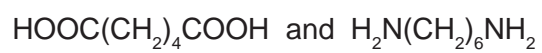


Deduce the structural formula of its monomer.

[1]

10

(d) A condensation polymer can be made from the following monomers.



Draw the structural formula of this polymer.

[3]

[Total: 8]

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		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		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		204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86						
87 Fr Francium	226 Ra Radium		65 Zn Zinc 30	64 Cu Copper 29	59 Ni Nickel 28	59 Co Cobalt 27	56 Fe Iron 26	55 Mn Manganese 25	52 Cr Chromium 24	51 V Vanadium 23	48 Ti Titanium 22	45 Sc Scandium 21		
			112 Cd Cadmium 48	108 Ag Silver 47	106 Pd Palladium 46	103 Rh Rhodium 45	101 Ru Ruthenium 44	96 Mo Molybdenum 42	93 Nb Niobium 41	91 Zr Zirconium 40	89 Y Yttrium 39	88 Sr Strontium 38	85 Rb Rubidium 37	
			201 Hg Mercury 80	197 Au Gold 79	195 Pt Platinum 78	192 Ir Iridium 77	190 Os Osmium 76	186 Re Rhenium 75	184 W Tungsten 74	181 Ta Tantalum 73	178 Hf Hafnium 72	173 U Uranium 92	171 Lu Lutetium 71	
			162 Dy Dysprosium 66	157 Gd Gadolinium 64	152 Eu Europium 63	150 Sm Samarium 62	144 Nd Neodymium 60	141 Pr Praseodymium 59	140 Ce Cerium 58	139 La Lanthanum 57	137 Ba Barium 56	133 Cs Caesium 55	127 Ac Actinium 89	
			167 Er Erbium 68	165 Ho Holmium 67	162 Dy Dysprosium 66	159 Tb Terbium 65	157 Gd Gadolinium 64	152 Eu Europium 63	144 Nd Neodymium 60	141 Pr Praseodymium 59	139 La Lanthanum 57	137 Ba Barium 56	133 Cs Caesium 55	
			169 Tm Thulium 69	167 Er Erbium 68	165 Ho Holmium 67	162 Dy Dysprosium 66	159 Tb Terbium 65	157 Gd Gadolinium 64	152 Eu Europium 63	144 Nd Neodymium 60	141 Pr Praseodymium 59	139 La Lanthanum 57	137 Ba Barium 56	
			100 Fm Fermium 100	99 Es Einsteinium 99	98 Cf Californium 98	97 Bk Berkelium 97	96 Cm Curium 96	95 Am Americium 95	94 Pu Plutonium 94	93 Np Neptunium 93	92 U Uranium 92	91 Pa Protactinium 91	90 Th Thorium 90	
			101 Md Mendelevium 101	100 Fm Fermium 100	99 Es Einsteinium 99	97 Bk Berkelium 97	96 Cm Curium 96	95 Am Americium 95	94 Pu Plutonium 94	93 Np Neptunium 93	92 U Uranium 92	91 Pa Protactinium 91	90 Th Thorium 90	
			102 No Nobelium 102	101 Md Mendelevium 101	100 Fm Fermium 100	99 Es Einsteinium 99	97 Bk Berkelium 97	96 Cm Curium 96	94 Pu Plutonium 94	93 Np Neptunium 93	92 U Uranium 92	91 Pa Protactinium 91	90 Th Thorium 90	
			103 Lr Lawrencium 103	102 No Nobelium 102	101 Md Mendelevium 101	100 Fm Fermium 100	99 Es Einsteinium 99	97 Bk Berkelium 97	96 Cm Curium 96	94 Pu Plutonium 94	93 Np Neptunium 93	92 U Uranium 92	91 Pa Protactinium 91	90 Th Thorium 90

*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 dm³ at room temperature and pressure (r.t.p.).