



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

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CENTRE  
NUMBER

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**CHEMISTRY**

**0620/33**

Paper 3 (Extended)

**October/November 2013**

**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.

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.

This document consists of **12** printed pages.



1 Zirconium (Zr) is a metal in Period 5. Its main oxidation state is +4.

(a) The following are all zirconium atoms:  ${}_{40}^{90}\text{Zr}$ ,  ${}_{40}^{91}\text{Zr}$  and  ${}_{40}^{92}\text{Zr}$ .

In terms of numbers of electrons, neutrons and protons, how are these three atoms the same and how are they different?

They are the same because .....

.....

They are different because .....

..... [3]

(b) Containers for fuel rods in nuclear reactors are made of zirconium.  
Nuclear reactors are used to produce energy and to make radioactive isotopes.

(i) Which isotope of a different element is used as a fuel in nuclear reactors?

..... [1]

(ii) State one medical and one industrial use of radioactive isotopes.

.....

..... [2]

(iii) Above 900 °C, zirconium reacts with water to form zirconium(IV) oxide,  $\text{ZrO}_2$ , and hydrogen. Write an equation for this reaction.

..... [2]

(iv) In a nuclear accident, water may come in contact with very hot zirconium.  
Explain why the presence of hydrogen inside the reactor greatly increases the danger of the accident.

..... [1]

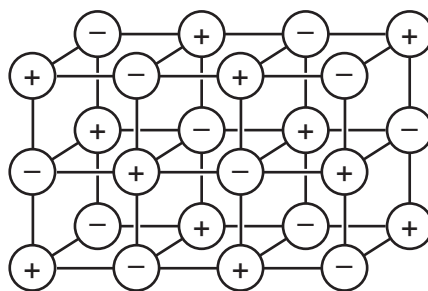
(c) It is possible to determine whether zirconium(IV) oxide is acidic, neutral, basic or amphoteric using an acid and an alkali. Complete the table of possible results. If the oxide is predicted to react write 'R', if it is predicted not to react write 'NR'.

if the oxide is	predicted result with hydrochloric acid	predicted result with aqueous sodium hydroxide
acidic		
neutral		
basic		
amphoteric		

[4]

[Total: 13]

- 2 (a) The diagram shows the lattice of a typical ionic compound.



- (i) Explain the term *ionic lattice*.

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

- (ii) In this lattice, the ratio of positive ions to negative ions is 1:1.  
 In the lattice of a different ionic compound, the ratio of positive ions to negative ions is 1:2.  
 Suggest why this ratio varies in different ionic compounds.

..... [1]

- (iii) Give **three** physical properties of ionic compounds.

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

- (b) Strontium oxide is an ionic compound. Draw a diagram which shows its formula, the charges on the ions and the arrangement of the **valency** electrons around the negative ion.

The electron distribution of a strontium atom is 2 + 8 + 18 + 8 + 2.

Use o to represent an electron from a strontium atom.

Use x to represent an electron from an oxygen atom.

[3]

[Total: 9]

3 The main uses of zinc are preventing steel from rusting and making alloys.

(a) The main ore of zinc is zinc blende. Zinc blende consists mainly of zinc sulfide, ZnS. There are two major methods of extracting zinc from its ore. They are the direct reduction of zinc oxide to zinc and by electrolysis. In both methods, zinc oxide is made from the zinc sulfide in the ore.

(i) How is zinc oxide made from zinc sulfide?

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

(ii) Write an equation for the reaction used to reduce zinc oxide to zinc.

..... [1]

(b) In the electrolytic method, zinc oxide reacts with sulfuric acid to form impure aqueous zinc sulfate. This solution contains Ni<sup>2+</sup>, Co<sup>2+</sup> and Cu<sup>2+</sup> ions as impurities.

(i) Write the equation for the reaction between zinc oxide and sulfuric acid.

..... [1]

(ii) Nickel, cobalt and copper are all less reactive than zinc. Explain why the addition of zinc powder removes these ions from the solution.

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

(c) The solution of zinc sulfate is electrolysed using inert electrodes. This electrolysis is similar to that of copper(II) sulfate with inert electrodes.

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

..... [1]

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



(iii) The electrolyte changes from zinc sulfate to

..... [1]

(d) (i) Brass is an alloy of copper and zinc. Suggest **two** reasons why brass is often used in preference to copper.

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

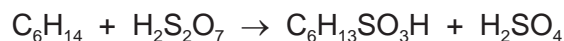
(ii) Sacrificial protection is a method of rust prevention. Explain in terms of electron transfer why steel, which is in electrical contact with zinc, does not rust.

.....  
.....  
.....  
..... [4]

[Total: 15]

- 4 Sulfuric acid is a strong acid. Hexanesulfonic acid is also a strong acid. It has similar properties to sulfuric acid.

(a) Sulfonic acids are made from alkanes and oleum,  $\text{H}_2\text{S}_2\text{O}_7$ .



- (i) Describe how oleum is made from sulfur by the Contact process. Give equations and reaction conditions.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

- (ii) How is concentrated sulfuric acid made from oleum?

..... [1]

(b) The formula of the hexanesulfonate ion is  $\text{C}_6\text{H}_{13}\text{SO}_3^-$ .

The formula of the barium ion is  $\text{Ba}^{2+}$ . What is the formula of barium hexanesulfonate?

..... [1]

(c) Complete the following equations.

(i) magnesium + hexanesulfonic acid  $\rightarrow$  ..... + .....  
acid  
..... [1]

(ii) calcium + hexanesulfonic oxide acid  $\rightarrow$  ..... + .....  
..... [1]

(iii) ..... $\text{C}_6\text{H}_{13}\text{SO}_3\text{H} + \text{Na}_2\text{CO}_3 \rightarrow$  ..... + ..... + ..... [2]

- (d) (i) Sulfuric acid is a strong acid.  
You are given aqueous sulfuric acid, concentration  $0.1 \text{ mol/dm}^3$ , and aqueous hexanesulfonic acid, concentration  $0.2 \text{ mol/dm}^3$ . Describe how you could show that hexanesulfonic acid is also a strong acid.

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

- (ii) Deduce why, for a fair comparison, the two acid solutions must have different concentrations.

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

- (iii) Explain the terms *strong acid* and *weak acid*.

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

[Total: 17]

- 5 Domestic rubbish is disposed of in landfill sites. Rubbish could include the following items.

item of rubbish	approximate time for item to break down
newspaper	one month
cotton rag	six months
woollen glove	one year
aluminium container	up to 500 years
styrofoam cup	1000 years

- (a) Explain why aluminium, a reactive metal, takes so long to corrode.

..... [1]

- (b) Both paper and cotton are complex carbohydrates. They can be hydrolysed to simple sugars such as glucose.

The formula of glucose can be represented as:



Draw the structural formula of a complex carbohydrate, such as cotton.  
Include at least **two** glucose units.

[2]



(c) Wool is a protein. It can be hydrolysed to a mixture of monomers by enzymes.

(i) What are enzymes?

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

(ii) Name another substance which can hydrolyse proteins.

..... [1]

(iii) What type of compound are the monomers formed by the hydrolysis of proteins?

..... [1]

(iv) Which technique could be used to identify the individual monomers in the mixture?

..... [1]

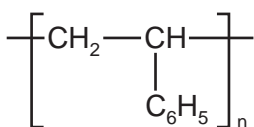
(v) Proteins contain the amide linkage. Name a synthetic macromolecule which contains the same linkage.

..... [1]

(d) (i) What is the scientific term used to describe polymers which do not break down in landfill sites?

..... [1]

(ii) Styrofoam is poly(phenylethene). It is an addition polymer. Its structural formula is given below. Deduce the structural formula of the monomer, phenylethene.



[1]

[Total: 11]

- 6 The alcohols form a homologous series. The first five members are given in the table below.

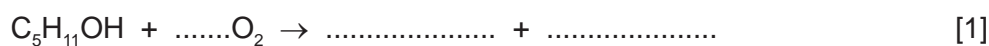
For  
Examiner's  
Use

(a)

alcohol	formula	heat of combustion in kJ/mol
methanol	CH <sub>3</sub> OH	730
ethanol	CH <sub>3</sub> -CH <sub>2</sub> -OH	1380
propan-1-ol		
butan-1-ol	CH <sub>3</sub> -CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> -OH	2680
pentan-1-ol	CH <sub>3</sub> -CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> -OH	3350

(i) Complete the table. [2]

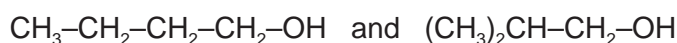
(ii) Complete the equation for the combustion of pentan-1-ol in excess oxygen.



(b) State **three** characteristics of a homologous series other than the variation of physical properties down the series.

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

(c) The following alcohols are isomers.



(i) Explain why they are isomers.

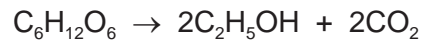
.....  
 .....  
 ..... [2]

(ii) Draw the structural formula of another isomer of the above alcohols.

[1]

(d) Alcohols can be made by fermentation and from petroleum.

(i) Ethanol is made from sugars by fermentation.



The mass of one mole of glucose,  $\text{C}_6\text{H}_{12}\text{O}_6$ , is 180 g.

Calculate the maximum mass of ethanol which could be obtained from 72 g of glucose.

.....

.....

.....

..... [3]

(ii) Describe how ethanol is made from petroleum.

**petroleum (alkanes) → ethene → ethanol**

.....

.....

.....

..... [3]

[Total: 15]

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

Group		I	II	III	IV	V	VI	VII	0							
		1 <b>H</b> Hydrogen 1							2 <b>He</b> Helium 2							
3	4	7 <b>Li</b> Lithium	9 <b>Be</b> Beryllium		11 <b>B</b> Boron	12 <b>C</b> Carbon	13 <b>Al</b> Aluminium	14 <b>Si</b> Silicon	15 <b>P</b> Phosphorus	16 <b>S</b> Sulfur	17 <b>Cl</b> Chlorine	18 <b>Ar</b> Argon				
11	12	23 <b>Na</b> Sodium	24 <b>Mg</b> Magnesium		27 <b>Fe</b> Iron	28 <b>Ni</b> Nickel	29 <b>Cu</b> Copper	30 <b>Zn</b> Zinc	31 <b>Ga</b> Gallium	32 <b>Ge</b> Germanium	33 <b>As</b> Arsenic	34 <b>Se</b> Selenium	35 <b>Br</b> Bromine	36 <b>Kr</b> Krypton		
19	20	39 <b>K</b> Potassium	40 <b>Ca</b> Calcium		44 <b>Ru</b> Ruthenium	45 <b>Rh</b> Rhodium	46 <b>Pd</b> Palladium	47 <b>Ag</b> Silver	48 <b>Cd</b> Cadmium	49 <b>In</b> Indium	50 <b>Sn</b> Tin	51 <b>Sb</b> Antimony	52 <b>Te</b> Tellurium	53 <b>I</b> Iodine	54 <b>Xe</b> Xenon	
37	38	85 <b>Rb</b> Rubidium	88 <b>Sr</b> Strontium		101 <b>Ru</b> Ruthenium	102 <b>Rh</b> Rhodium	103 <b>Pd</b> Palladium	104 <b>Ag</b> Silver	105 <b>Cd</b> Cadmium	106 <b>In</b> Indium	107 <b>Sn</b> Tin	108 <b>Sb</b> Antimony	109 <b>Te</b> Tellurium	110 <b>I</b> Iodine	111 <b>Xe</b> Xenon	
55	56	133 <b>Cs</b> Caesium	137 <b>Ba</b> Barium		186 <b>Re</b> Rhenium	187 <b>Rh</b> Rhodium	188 <b>Pt</b> Platinum	189 <b>Au</b> Gold	190 <b>Hg</b> Mercury	191 <b>Tl</b> Thallium	192 <b>Pb</b> Lead	193 <b>Bi</b> Bismuth	194 <b>Po</b> Polonium	195 <b>At</b> Astatine	196 <b>Rn</b> Radon	
87	88	226 <b>Fr</b> Francium	226 <b>Ra</b> Radium		227 <b>Ac</b> Actinium	227 <b>Ac</b> Actinium	227 <b>Ac</b> Actinium	227 <b>Ac</b> Actinium	227 <b>Ac</b> Actinium	227 <b>Ac</b> Actinium	227 <b>Ac</b> Actinium	227 <b>Ac</b> Actinium	227 <b>Ac</b> Actinium	227 <b>Ac</b> Actinium	227 <b>Ac</b> Actinium	227 <b>Ac</b> Actinium

140 <b>Ce</b> Cerium	141 <b>Pr</b> Praseodymium	144 <b>Nd</b> Neodymium	150 <b>Sm</b> Samarium	152 <b>Eu</b> Europium	157 <b>Gd</b> Gadolinium	162 <b>Dy</b> Dysprosium	165 <b>Ho</b> Holmium	167 <b>Er</b> Erbium	169 <b>Tm</b> Thulium	173 <b>Yb</b> Ytterbium	175 <b>Lu</b> Lutetium
58	59	60	62	63	64	66	67	68	69	70	71
90 <b>Th</b> Thorium	91 <b>Pa</b> Protactinium	92 <b>U</b> Uranium	94 <b>Pu</b> Plutonium	95 <b>Am</b> Americium	96 <b>Cm</b> Curium	98 <b>Cf</b> Californium	99 <b>Es</b> Einsteinium	100 <b>Fm</b> Fermium	101 <b>Md</b> Mendelevium	102 <b>No</b> Nobelium	103 <b>Lr</b> Lawrencium
90	91	92	94	95	96	98	99	100	101	102	103

a	<b>X</b>	b
Key	a = relative atomic mass	X = atomic symbol
	b = proton (atomic) number	

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

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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