



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

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, 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'.

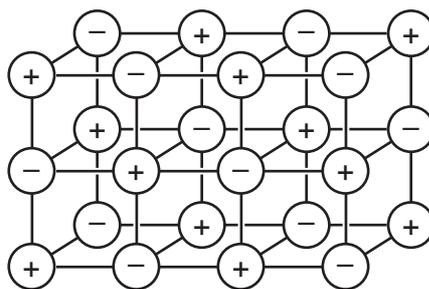
if the oxide is	predicted result with hydrochloric acid	predicted result with aqueous sodium hydroxide
acidic		
neutral		
basic		
amphoteric		

[4]

[Total: 13]

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

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Use



- (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^{2+} , Co^{2+} and Cu^{2+} 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]

(d) (i) Sulfuric acid is a strong acid.
You are given aqueous sulfuric acid, concentration 0.1 mol/dm^3 , and aqueous hexanesulfonic acid, concentration 0.2 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.

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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]

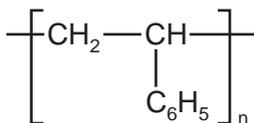
(v) Proteins contain the amide linkage. Name a synthetic macromolecule which contains the same linkage.

..... [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]

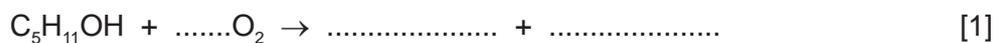
- 6 The alcohols form a homologous series. The first five members are given in the table below.

(a)

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

(i) Complete the table. [2]

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

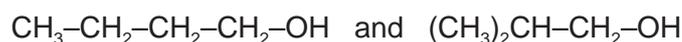


(b) State **three** characteristics of a homologous series other than the variation of physical properties down the series.

.....

 [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.

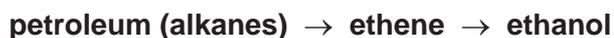
(i) Ethanol is made from sugars by fermentation.



The mass of one mole of glucose, $C_6H_{12}O_6$, 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.



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

[Total: 15]

DATA SHEET
The Periodic Table of the Elements

		Group																										
I	II	III	IV	V	VI	VII	0																					
1 H Hydrogen 1											2 He Helium 2																	
3 Li Lithium 3	4 Be Beryllium 4	5 B Boron 5	6 C Carbon 6	7 N Nitrogen 7	8 O Oxygen 8	9 F Fluorine 9	10 Ne Neon 10	11 B Boron 11	12 C Carbon 12	13 Al Aluminium 13	14 Si Silicon 14	15 P Phosphorus 15	16 S Sulfur 16	17 Cl Chlorine 17	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																										
*58-71 Lanthanoid series																												
†90-103 Actinoid series																												
<table border="1"> <tr> <td>a</td> <td>X</td> </tr> <tr> <td>b</td> <td></td> </tr> </table> <p>Key a = relative atomic mass X = atomic symbol b = proton (atomic) number</p>																	a	X	b									
a	X																											
b																												
89 La Lanthanum 89	90 Ce Cerium 90	91 Pr Praseodymium 91	92 Nd Neodymium 92	93 Pm Promethium 93	94 Sm Samarium 94	95 Eu Europium 95	96 Gd Gadolinium 96	97 Tb Terbium 97	98 Dy Dysprosium 98	99 Ho Holmium 99	100 Er Erbium 100	101 Tm Thulium 101	102 Yb Ytterbium 102	103 Lu Lutetium 103	104 Th Thorium 104	105 Pa Protactinium 105	106 U Uranium 106	107 Np Neptunium 107	108 Pu Plutonium 108	109 Am Americium 109	110 Cm Curium 110	111 Bk Berkelium 111	112 Cf Californium 112	113 Es Einsteinium 113	114 Fm Fermium 114	115 Md Mendelevium 115	116 No Nobelium 116	117 Lr Lawrencium 117

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

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