



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 2010

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 **14** printed pages and **2** blank pages.



- 1 The diagrams below show the electron arrangement in two compounds.



- (a) In a water molecule, each hydrogen atom is bonded to the oxygen atom by sharing a pair of electrons.

Why does an oxygen atom share two pairs of electrons rather than just one pair?

.....
 [1]

- (b) Describe how a potassium atom becomes a potassium ion.

..... [1]

- (c) Why is there a bond between the ions in potassium chloride?

.....
 [1]

- (d) Solid potassium chloride is a poor conductor of electricity. When dissolved in water it is a good conductor. Explain.

.....
 [2]

[Total: 5]

2 Vanadium is a transition element.

(a) An atom of the most common isotope of vanadium can be represented as ${}_{23}^{51}\text{V}$.

Complete the following table to show the number of protons, electrons and neutrons in each particle.

particle	number of protons	number of electrons	number of neutrons
${}_{23}^{51}\text{V}$			
${}_{23}^{51}\text{V}^{3+}$			
${}_{23}^{50}\text{V}$			

[3]

(b) The major use of vanadium is to make vanadium steel alloys.

(i) Explain the phrase *steel alloys*.

.....
 [2]

(ii) State the name and use of another steel alloy.

name

use [2]

(c) Two of the oxidation states of vanadium are +3 and +4.

(i) Write the formula of vanadium(III) oxide and of vanadium(IV) oxide.

vanadium(III) oxide

vanadium(IV) oxide [2]

(ii) Vanadium(III) oxide is basic and vanadium(IV) oxide is amphoteric.
 Describe how you would obtain a sample of vanadium(III) oxide from a mixture of these two oxides.

.....

 [3]

[Total: 12]

3 The reactions of a metal and the thermal stability of some of its compounds are determined by the position of the metal in the reactivity series.

(a) To find the order of reactivity of the metals, cobalt, magnesium, silver and tin, the following experiments were carried out.

experiment	result
tin plus silver(I) nitrate solution	silvery layer on tin
magnesium plus tin(II) nitrate solution	grey deposit on magnesium
tin plus cobalt nitrate solution	no reaction

(i) Give as far as possible the order of reactivity of these metals.
Write the least reactive first.

..... [2]

(ii) What additional experiment needs to be done to put all four metals in order of reactivity?

..... [1]

(iii) Write an ionic equation for the reaction between tin atoms and silver(I) ions. Indicate on the equation the change which is oxidation.

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

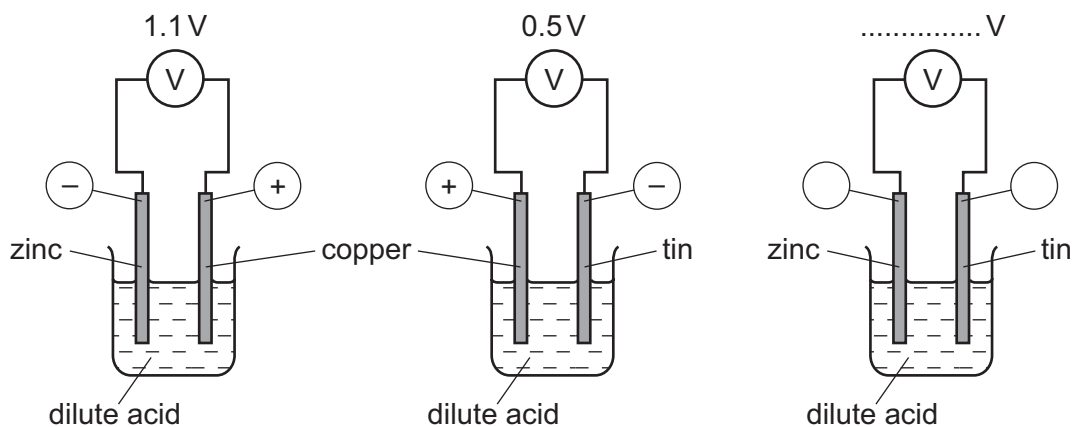
(b) Sodium is a more reactive metal than magnesium. Sodium compounds are more stable than magnesium compounds.

In an experiment, their hydroxides were heated. If the hydroxide did not decompose write 'no reaction' otherwise complete the equation.

$\text{NaOH} \rightarrow$

$\text{Mg(OH)}_2 \rightarrow$ [2]

- (c) A cell consists of two different metal electrodes in an electrolyte. Three possible cells are shown below.



- (i) Why is the more reactive metal the negative electrode?

.....
 [2]

- (ii) How can you deduce that zinc is more reactive than tin?

..... [1]

- (iii) How could you change the zinc/copper cell to have a voltage greater than 1.1 V?

..... [1]

- (iv) Complete the labelling of the zinc/tin cell.

[2]

[Total: 14]

4 The electrolysis of concentrated aqueous sodium chloride, between inert electrodes, is used to make four important chemicals.

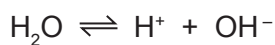
- hydrogen
- chlorine
- sodium hydroxide
- sodium chlorate(I)

(a) The ions present in the electrolyte are Na⁺, H⁺, Cl⁻ and OH⁻.

(i) Hydrogen ions are discharged at the negative electrode (cathode).
Write an equation for this reaction.

..... [2]

(ii) The hydrogen ions are from the water.



Suggest an explanation why the concentration of hydroxide ions increases.

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

(iii) When a dilute solution of sodium chloride is used, chlorine is not formed at the positive electrode (anode), a different gas is produced. Name this gas.

..... [1]

(iv) State an example of an inert electrode.

..... [1]

(b) (i) State a use of hydrogen.

..... [1]

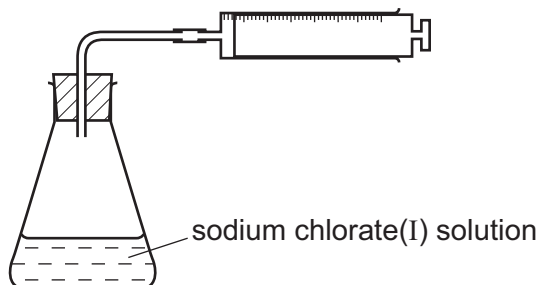
(ii) Why is chlorine used to treat the water supply?

..... [1]

- (c) Sodium chlorate(I) is made by the reaction between chlorine and sodium hydroxide. It is used as bleach but over time it decomposes.



The rate of decomposition can be studied using the apparatus shown below.



- (i) How could you measure the rate of decomposition of sodium chlorate(I)?

..... [1]

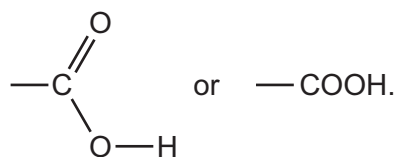
- (ii) Describe how you could show that the rate of decomposition of sodium chlorate(I) is a photochemical reaction.

.....

..... [2]

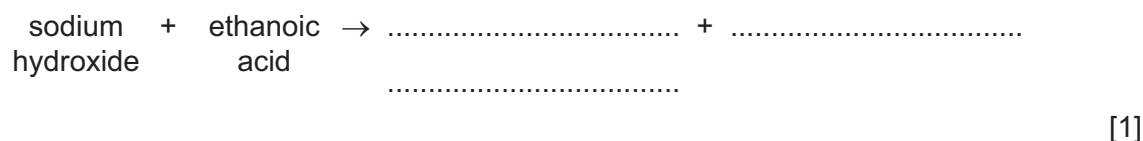
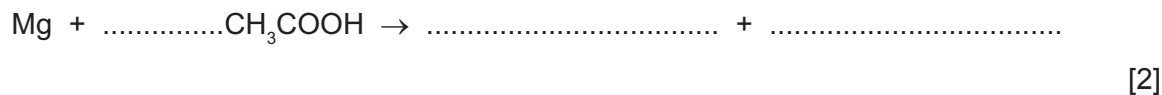
[Total: 11]

5 Carboxylic acids contain the group



(a) Ethanoic acid is a typical carboxylic acid. It forms ethanoates.

(i) Complete the following equations.



(ii) Ethanoic acid reacts with ethanol to form an ester. Give the name of the ester and draw its structural formula. Show all of the bonds.

name

structural formula

[2]

(b) Maleic acid is an unsaturated acid. 5.8 g of this acid contained 2.4 g of carbon, 0.2 g of hydrogen and 3.2 g of oxygen.

(i) How do you know that the acid contained only carbon, hydrogen and oxygen?

.....

..... [1]

(ii) Calculate the empirical formula of maleic acid.

Number of moles of carbon atoms =

Number of moles of hydrogen atoms =

Number of moles of oxygen atoms =

The empirical formula is [3]

(iii) The mass of one mole of maleic acid is 116 g. What is its molecular formula?

..... [2]

(iv) Maleic acid is dibasic. One mole of acid produces two moles of H^+ . Deduce its structural formula.

[2]

[Total: 13]

6 The Kinetic Theory explains the properties of matter in terms of the arrangement and movement of particles.

(a) Nitrogen is a gas at room temperature. Nitrogen molecules, N_2 , which are spread far apart move in a random manner at high speed.

(i) Draw a diagram showing the arrangement of the valency electrons in a nitrogen molecule.

Use \times to represent an electron from a nitrogen atom.

[2]

(ii) How does the movement and arrangement of the molecules in a crystal of nitrogen differ from those in gaseous nitrogen?

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

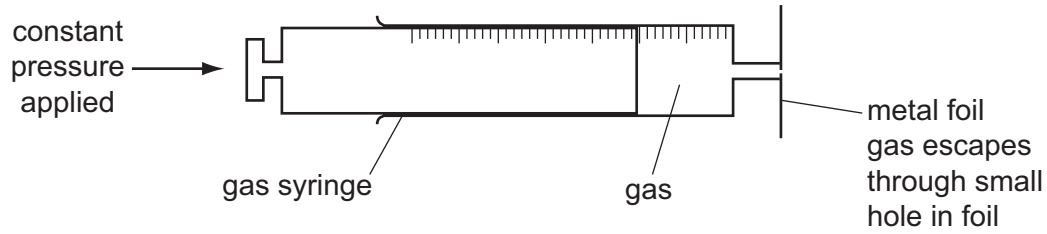
(b) Use the ideas of the Kinetic Theory to explain the following.

(i) A sealed container contains nitrogen gas. The pressure of a gas is due to the molecules of the gas hitting the walls of the container.

Explain why the pressure inside the container increases when the temperature is increased.

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

(ii) The following apparatus can be used to measure the rate of diffusion of a gas.



The following results were obtained.

gas	temperature / °C	rate of diffusion in cm ³ /min
nitrogen	25	1.00
chlorine	25	0.63
nitrogen	50	1.05

Explain why nitrogen diffuses faster than chlorine.

.....
 [2]

Explain why the nitrogen diffuses faster at the higher temperature.

..... [1]

[Total: 10]

7 Synthetic polymers are widely used in the modern world.

(a) Their use has brought considerable advantages to modern life as well as some disadvantages.

(i) Suggest **two** advantages of a plastic bucket compared to a steel bucket.

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

(ii) Name **two** uses of man-made fibres, such as nylon and Terylene.

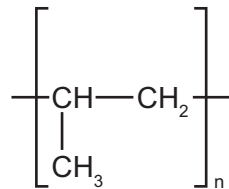
.....
..... [2]

(iii) Describe the pollution caused by synthetic polymers.

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

(b) One type of polymer is formed by addition polymerisation.

(i) The structural formula of an addition polymer is given below.



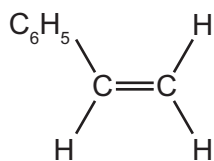
Give the name and structural formula of the monomer.

name of monomer [1]

structural formula of monomer

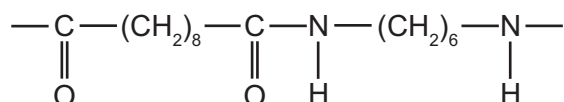
[1]

- (ii) Draw the structural formula of the addition polymer formed by the polymerisation of phenylethene. The structural formula of phenylethene is given below.



[2]

- (c) Nylon is made by condensation polymerisation. It has the structural formula shown below.



- (i) Name the linkage in this polymer.

..... [1]

- (ii) Name the natural macromolecules which have the same linkage.

..... [1]

- (iii) Deduce the formulae of the two monomers which reacted to form the nylon and water.

monomer

monomer

[2]

[Total: 15]

DATA SHEET
The Periodic Table of the Elements

Group		I	II	III	IV	V	VI	VII	0																																																																																																																																																																																																																																																																		
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		1 H Hydrogen 1								4 He Helium 2																																																																																																																																																																																																																																																																	
		7 Li Lithium 3	9 Be Beryllium 4	11 B Boron 5	12 C Carbon 6	13 Al Aluminium 13	14 Si Silicon 14	15 P Phosphorus 15	16 S Sulfur 16	17 Cl Chlorine 17	18 Ar Argon 18																																																																																																																																																																																																																																																																
		23 Na Sodium 11	24 Mg Magnesium 12	27 Fe Iron 26	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																																																																																																																																																																																																																																																														
		39 K Potassium 19	40 Ca Calcium 20	44 Ru Ruthenium 44	45 Sc Scandium 21	46 Ti Titanium 22	47 V Vanadium 23	48 Cr Chromium 24	49 Mn Manganese 25	50 Fe Iron 26	51 Co Cobalt 27	52 Ni Nickel 28	53 Cu Copper 29	54 Zn Zinc 30	55 Ga Gallium 31	56 Ge Germanium 32	57 As Arsenic 33	58 Se Selenium 34	59 Br Bromine 35	60 Kr Krypton 36																																																																																																																																																																																																																																																							
		87 Fr Francium 87	88 Ra Radium 88	133 Cs Caesium 55	137 Ba Barium 56	138 La Lanthanum 57	139 Ce Cerium 58	140 Pr Praseodymium 59	141 Nd Neodymium 60	142 Pm Promethium 61	143 Sm Samarium 62	144 Eu Europium 63	145 Gd Gadolinium 64	146 Tb Terbium 65	147 Dy Dysprosium 66	148 Ho Holmium 67	149 Er Erbium 68	150 Tm Thulium 69	151 Yb Ytterbium 70	152 Lu Lutetium 71	153 Lr Lawrencium 103																																																																																																																																																																																																																																																						
		101 Fr Francium 87	102 Ra Radium 88	201 Hg Mercury 80	204 Pb Lead 82	207 Bi Bismuth 83	208 Po Polonium 84	209 At Astatine 85	210 Rn Radon 86	211 Ac Actinium 89	212 Th Thorium 90	213 Pa Protactinium 91	214 U Uranium 92	215 Np Neptunium 93	216 Pu Plutonium 94	217 Am Americium 95	218 Cm Curium 96	219 Bk Berkelium 97	220 Cf Californium 98	221 Es Einsteinium 99	222 Fm Fermium 100	223 Md Mendelevium 101	224 No Nobelium 102	225 Lr Lawrencium 103																																																																																																																																																																																																																																																			
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The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

Key

a	X
b	

 a = relative atomic mass
 X = atomic symbol
 b = proton (atomic) number

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

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