UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

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.

For Examiner's Use

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 $^{51}_{23}V$.

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
$^{51}_{23}V$			
$^{51}_{23}V^{3+}$			
$^{50}_{23}V$			

[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 vandium(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.

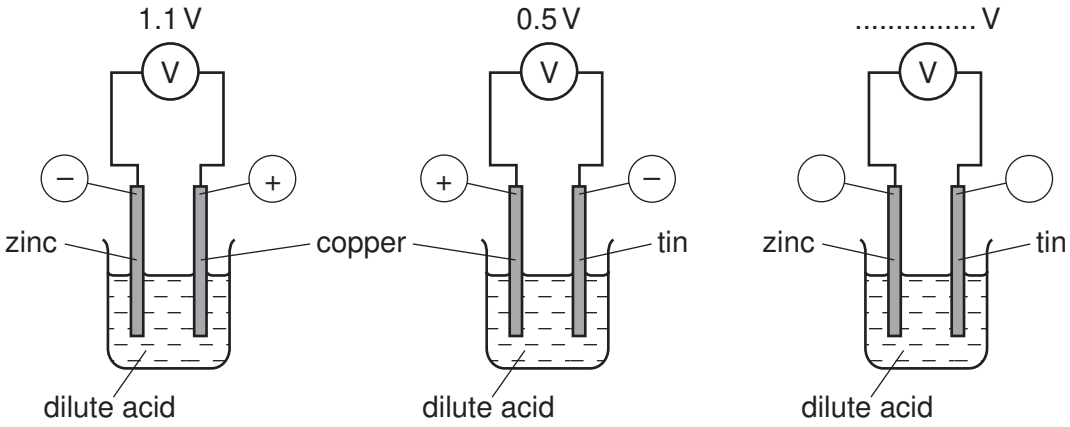
In an experiment, their hydroxides were heated. If the hydroxide did not decompose write 'no reaction' otherwise complete the equation.

$NaOH \rightarrow$ .....

$Mg(OH)_2 \rightarrow$ ..... [2]

For Examiner's Use

(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.

$$H_2O \rightleftharpoons H^+ + OH^-$$

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]

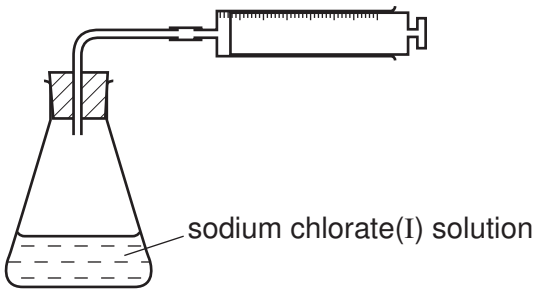
(ii) Why is chlorine used to treat the water supply?

..... [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.

$$2NaClO(aq) \rightarrow 2NaCl(aq) + O_2(g)$$

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]

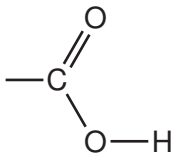
(ii) Describe how you could show that the rate of decomposition of sodium chlorate(I) is a photochemical reaction.

.....

..... [2]

[Total: 11]

5 Carboxylic acids contain the group



or —COOH.

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

(i) Complete the following equations.

Mg + ...CH_3COOH → ..... + ...

[2]

sodium hydroxide + ethanoic acid → ..... + ...
.....

[1]

(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]

[Turn over

For Examiner's Use

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 × 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]

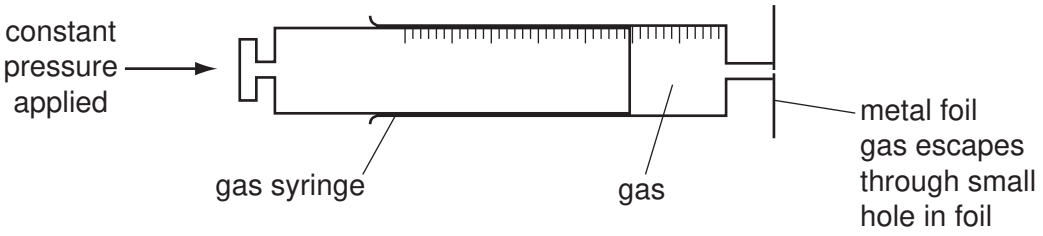
(b) Use the ideas of the Kinetic Theory to explain the following.

(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]

For Examiner's Use

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.

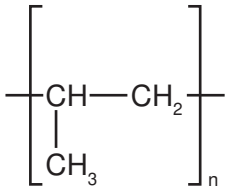
.....

.....

..... [3]

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

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



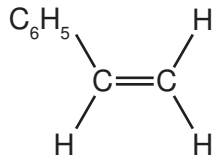
Give the name and structural formula of the monomer.

name of monomer ..... [1]

structural formula of monomer

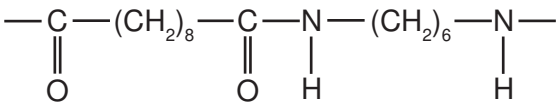
[1]

(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]

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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.).