



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

CENTRE  
NUMBER

|  |  |  |  |  |
|--|--|--|--|--|
|  |  |  |  |  |
|--|--|--|--|--|

CANDIDATE  
NUMBER

|  |  |  |  |
|--|--|--|--|
|  |  |  |  |
|--|--|--|--|



**CHEMISTRY**

**0620/31**

Paper 3 (Extended)

**May/June 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            |  |
| 8            |  |
| <b>Total</b> |  |

This document consists of **13** printed pages and **3** blank pages.



1 Choose an element which fits each of the following descriptions.

(i) It is a yellow solid which burns to form an acidic oxide.

..... [1]

(ii) This element is a black solid which, when heated, forms a purple vapour.

..... [1]

(iii) Most of its soluble salts are blue.

..... [1]

(iv) It has a basic oxide of the type MO which is used to treat acidic soils.

..... [1]

(v) It is an unreactive gas used to fill balloons.

..... [1]

[Total: 5]

2 Ozone is a form of oxygen. Ozone is present in the upper atmosphere and it prevents dangerous solar radiation from reaching the Earth's surface. Some of the chemicals that diffuse into the upper atmosphere decompose ozone. Chemicals that have this effect are methane ( $\text{CH}_4$ ), chloromethane ( $\text{CH}_3\text{Cl}$ ) and an oxide of nitrogen ( $\text{NO}_2$ ).

(i) Which of these three chemicals diffuses the most slowly? Give a reason for your choice.

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

(ii) Chloromethane is formed when seaweed decomposes. Name the compounds in the environment from which seaweed might have obtained the following elements:

carbon; .....

hydrogen; .....

chlorine. .... [3]

(iii) How can chloromethane be made from methane?

reagent .....

condition ..... [2]

(iv) The oxides of nitrogen are atmospheric pollutants. Describe how they are formed.

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

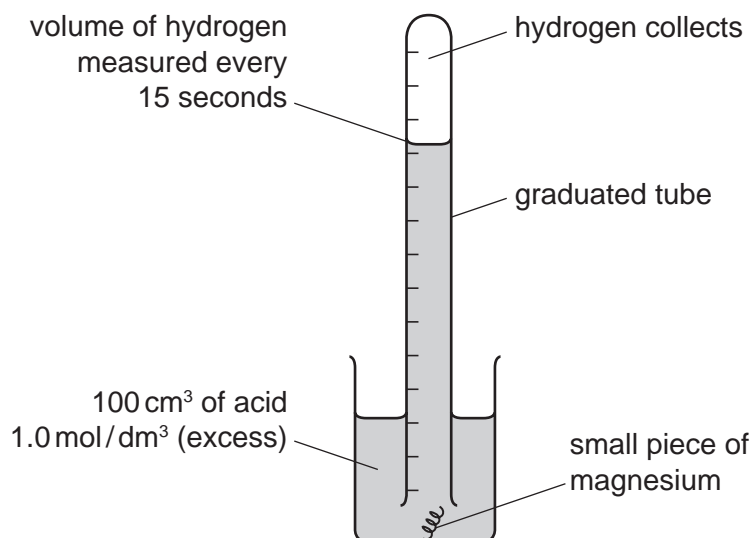
(v) Complete the equation for the decomposition of ozone.



[2]

[Total: 11]

- 3 A diagram of the apparatus which could be used to investigate the rate of reaction between magnesium and an excess of an acid is drawn below.



- (a) The magnesium kept rising to the surface. In one experiment, this was prevented by twisting the magnesium around a piece of copper. In a second experiment, the magnesium was held down by a plastic net fastened to the beaker.

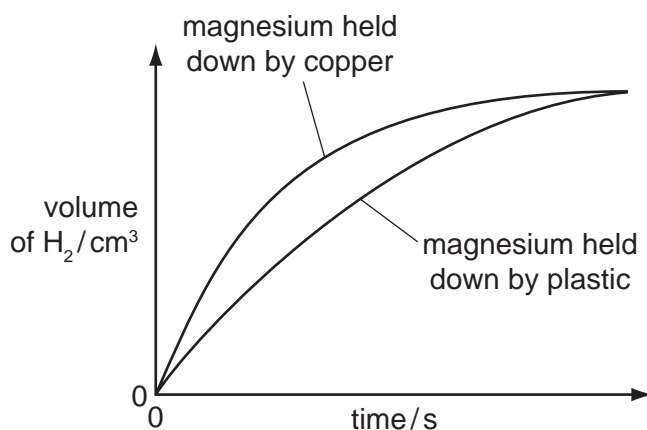
- (i) Suggest a reason why magnesium, which is denser than water, floated to the surface.

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

- (ii) Iron, zinc and copper have similar densities. Why was copper a better choice than iron or zinc to weigh down the magnesium?

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

- (b) The only difference in the two experiments was the method used to hold down the magnesium. The results are shown below.



(i) In which experiment did the magnesium react faster?  
..... [1]

(ii) Suggest a reason why the experiment chosen in (i) had the faster rate.  
..... [1]

(c) The experiment was repeated using 1.0 mol/dm<sup>3</sup> propanoic acid instead of 1.0 mol/dm<sup>3</sup> hydrochloric acid. Propanoic acid is a weak acid.

(i) How would the graph for propanoic acid **differ** from the graph for hydrochloric acid?  
..... [1]

(ii) How would the graph for propanoic acid be the **same** as the graph for hydrochloric acid?  
..... [1]

(d) Give **two** factors which would alter the rate of this reaction.  
For each factor explain why it alters the rate.

factor .....

explanation .....

.....

factor .....

explanation .....

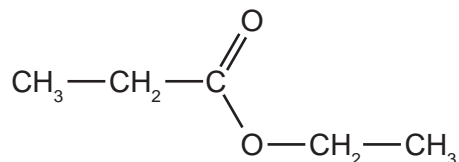
..... [4]

[Total: 10]

4 Hydrolysis is used in chemistry to break down complex molecules into simpler ones.

(a) Compounds containing the group  $\begin{array}{c} \text{O} \\ \parallel \\ \text{—C—} \\ \diagdown \\ \text{O—} \end{array}$  or  $\text{—COO—}$  are esters.

(i) Give the names and formulae of the two compounds formed when the ester ethyl propanoate is hydrolysed.

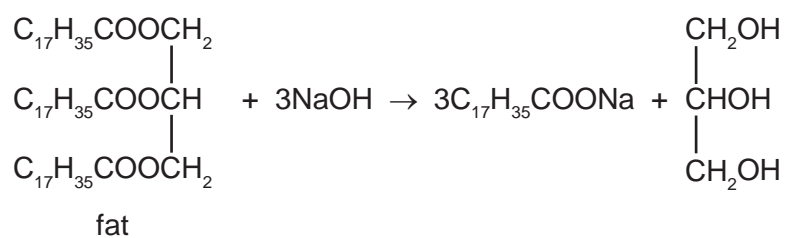


name ..... name .....

formula ..... formula .....

[4]

(ii) Fats are naturally occurring esters. They can be hydrolysed by boiling with aqueous sodium hydroxide.



What type of compound has the formula  $\text{C}_{17}\text{H}_{35}\text{COONa}$  and what is its main use?

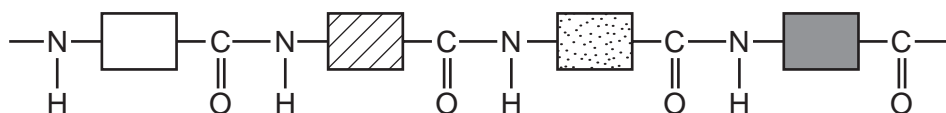
type of compound ..... [1]

use ..... [1]

(iii) Name a synthetic polyester.

..... [1]

(b) The structure of a typical protein is drawn below.



(i) What is the name of the polymer linkage?

..... [1]

(ii) Draw the structural formula of a man-made polymer with the same linkage.

[3]

(iii) A protein can be hydrolysed to a mixture of amino acids which are colourless. Individual amino acids can be identified by chromatography. The  $R_f$  value of the amino acid glycine is 0.5. Describe how you could show that glycine was present on a chromatogram.

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

[Total: 14]

5 Carbon and silicon are elements in Group IV. Both elements have macromolecular structures.

(a) Diamond and graphite are two forms of the element carbon.

(i) Explain why diamond is a very hard substance.

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

(ii) Give **one** use of diamond.

..... [1]

(iii) Explain why graphite is a soft material.

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

(iv) Give **one** use of graphite.

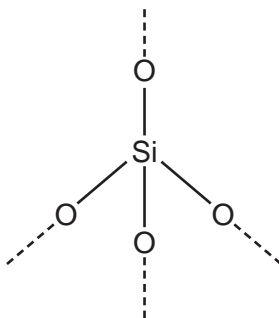
..... [1]

(b) Two of the oxides of these elements are carbon dioxide,  $\text{CO}_2$ , and silicon(IV) oxide,  $\text{SiO}_2$ .

(i) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound carbon dioxide.  
 Use x to represent an electron from a carbon atom.  
 Use o to represent an electron from an oxygen atom.

[3]

(ii) A section of the macromolecular structure of silicon(IV) oxide is given below.



Use this diagram to explain why the formula is  $\text{SiO}_2$  not  $\text{SiO}_4$ .

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

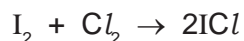
(iii) Predict **two** differences in the physical properties of these two oxides.

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

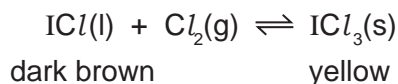
[Total: 13]



- 6 Iodine reacts with chlorine to form dark brown iodine monochloride.



This reacts with more chlorine to give yellow iodine trichloride.  
There is an equilibrium between these iodine chlorides.



- (a) Explain what is meant by *equilibrium*.

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

- (b) When the equilibrium mixture is heated it becomes a darker brown colour.  
Is the reverse reaction endothermic or exothermic? Give a reason for your choice.

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

- (c) The pressure on the equilibrium mixture is decreased.

- (i) How would this affect the position of equilibrium and why?

It would move to the ..... [1]

reason .....

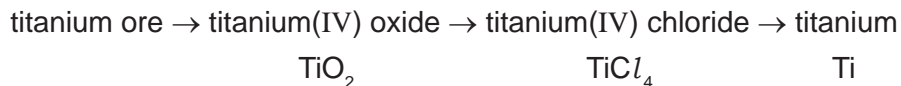
..... [1]

- (ii) Describe what you would observe.

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

[Total: 7]

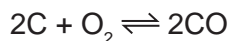
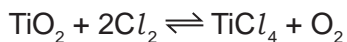
7 Titanium is a transition element. It is isolated by the following reactions.



(a) Why is it usually necessary to include a number in the name of the compounds of transition elements?

..... [1]

(b) Titanium(IV) chloride is made by heating the oxide with coke and chlorine.



Explain why the presence of coke ensures the maximum yield of the metal chloride.

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

(c) Explain why the change, titanium(IV) chloride to titanium, is reduction.

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

(d) Complete the table which shows some of the properties of titanium and its uses. The first line has been completed as an example.

| property  | related use                        |
|---|------------------------------------|
| soluble in molten steel                         | making steel titanium alloys       |
| .....   | making aircraft and space vehicles |
| resistant to corrosion, especially in sea water | .....                              |

[2]

(e) The titanium ore contains 36.8% iron, 31.6% titanium and the remainder is oxygen.

(i) Determine the percentage of oxygen in this titanium compound.

percentage of oxygen = ..... % [1]

(ii) Calculate the number of moles of atoms for each element.

The number of moles of Fe is shown as an example.

number of moles of Fe =  $36.8/56 = 0.66$

number of moles of Ti = .....

number of moles of O = ..... [1]

(iii) What is the simplest ratio for the moles of atoms?

|       |   |       |   |       |
|-------|---|-------|---|-------|
| Fe    | : | Ti    | : | O     |
| ..... |   | ..... |   | ..... |

[1]

(iv) What is the formula of this titanium compound?

..... [1]

[Total: 10]

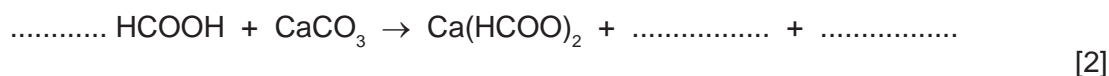
8 Methanoic acid is the first member of the homologous series of carboxylic acids.

(a) Give **two** general characteristics of a homologous series.

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

(b) In some areas when water is boiled, the inside of kettles become coated with a layer of calcium carbonate. This can be removed by adding methanoic acid.

(i) Complete the equation.



(ii) Methanoic acid reacts with most metals above hydrogen in the reactivity series. Complete the word equation.

zinc + methanoic acid  $\rightarrow$  ..... + ..... [2]

(iii) Aluminium is also above hydrogen in the reactivity series. Why does methanoic acid not react with an aluminium kettle?

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

(c) Give the name, molecular formula and empirical formula of the fourth acid in this series.

name ..... [1]

molecular formula ..... [1]

empirical formula ..... [1]

[Total: 10]







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

| Group                             |                                    | I                              | II | III | IV                                  | V                                      | VI                                     | VII                                   | 0                                    |                                     |                                    |                                      |                                       |                                       |                                    |  |                                     |                                       |                                    |
|-----------------------------------|------------------------------------|--------------------------------|----|-----|-------------------------------------|--|--|---------------------------------------|--------------------------------------|-------------------------------------|------------------------------------|--------------------------------------|---------------------------------------|---------------------------------------|------------------------------------|--|-------------------------------------|---------------------------------------|------------------------------------|
|                                   |                                    | 1<br><b>H</b><br>Hydrogen<br>1 |    |     |                                     |  |  |                                       | 4<br><b>He</b><br>Helium<br>2        |                                     |                                    |                                      |                                       |                                       |                                    |  |                                     |                                       |                                    |
| 7<br><b>Li</b><br>Lithium<br>3    | 9<br><b>Be</b><br>Beryllium<br>4   |                                |    |     | 11<br><b>B</b><br>Boron<br>5        | 12<br><b>C</b><br>Carbon<br>6          | 13<br><b>Al</b><br>Aluminium<br>13     | 14<br><b>Si</b><br>Silicon<br>14      | 15<br><b>P</b><br>Phosphorus<br>15   | 16<br><b>S</b><br>Sulfur<br>16      | 17<br><b>Cl</b><br>Chlorine<br>17  | 18<br><b>Ar</b><br>Argon<br>18       | 19<br><b>F</b><br>Fluorine<br>9       | 20<br><b>Ne</b><br>Neon<br>10         |                                    |  |                                     |                                       |                                    |
| 23<br><b>Na</b><br>Sodium<br>11   | 24<br><b>Mg</b><br>Magnesium<br>12 |                                |    |     | 27<br><b>Fe</b><br>Iron<br>26       | 28<br><b>Mn</b><br>Manganese<br>25     | 29<br><b>Co</b><br>Cobalt<br>27        | 30<br><b>Ni</b><br>Nickel<br>28       | 31<br><b>Cu</b><br>Copper<br>29      | 32<br><b>Zn</b><br>Zinc<br>30       | 33<br><b>Ga</b><br>Gallium<br>31   | 34<br><b>Ge</b><br>Germanium<br>32   | 35<br><b>As</b><br>Arsenic<br>33      | 36<br><b>Se</b><br>Selenium<br>34     | 37<br><b>Br</b><br>Bromine<br>35   | 38<br><b>Kr</b><br>Krypton<br>36       |                                     |                                       |                                    |
| 39<br><b>K</b><br>Potassium<br>19 | 40<br><b>Ca</b><br>Calcium<br>20   |                                |    |     | 41<br><b>Nb</b><br>Niobium<br>41    | 42<br><b>Mo</b><br>Molybdenum<br>42    | 43<br><b>Tc</b><br>Technetium<br>43    | 44<br><b>Ru</b><br>Ruthenium<br>44    | 45<br><b>Rh</b><br>Rhodium<br>45     | 46<br><b>Pd</b><br>Palladium<br>46  | 47<br><b>Ag</b><br>Silver<br>47    | 48<br><b>Cd</b><br>Cadmium<br>48     | 49<br><b>In</b><br>Indium<br>49       | 50<br><b>Sn</b><br>Tin<br>50          | 51<br><b>Sb</b><br>Antimony<br>51  | 52<br><b>Te</b><br>Tellurium<br>52     | 53<br><b>I</b><br>Iodine<br>53      | 54<br><b>Xe</b><br>Xenon<br>54        |                                    |
| 55<br><b>Rb</b><br>Rubidium<br>37 | 56<br><b>Sr</b><br>Strontium<br>38 |                                |    |     | 57<br><b>Ba</b><br>Barium<br>56     | 58<br><b>La</b><br>Lanthanum<br>57     | 59<br><b>Ce</b><br>Cerium<br>58        | 60<br><b>Pr</b><br>Praseodymium<br>59 | 61<br><b>Nd</b><br>Neodymium<br>60   | 62<br><b>Pm</b><br>Promethium<br>61 | 63<br><b>Sm</b><br>Samarium<br>62  | 64<br><b>Eu</b><br>Europium<br>63    | 65<br><b>Gd</b><br>Gadolinium<br>64   | 66<br><b>Dy</b><br>Dysprosium<br>66   | 67<br><b>Ho</b><br>Holmium<br>67   | 68<br><b>Er</b><br>Erbium<br>68        | 69<br><b>Tm</b><br>Thulium<br>69    | 70<br><b>Yb</b><br>Ytterbium<br>70    | 71<br><b>Lu</b><br>Lutetium<br>71  |
| 87<br><b>Fr</b><br>Francium       | 88<br><b>Ra</b><br>Radium          |                                |    |     | 89<br><b>Ac</b><br>Actinium         | 90<br><b>Th</b><br>Thorium             | 91<br><b>Pa</b><br>Protactinium        | 92<br><b>U</b><br>Uranium             | 93<br><b>Np</b><br>Neptunium         | 94<br><b>Pu</b><br>Plutonium        | 95<br><b>Am</b><br>Americium       | 96<br><b>Cm</b><br>Curium            | 97<br><b>Bk</b><br>Berkelium          | 98<br><b>Cf</b><br>Californium        | 99<br><b>Es</b><br>Einsteinium     | 100<br><b>Fm</b><br>Fermium            | 101<br><b>Md</b><br>Mendelevium     | 102<br><b>No</b><br>Nobelium          | 103<br><b>Lr</b><br>Lawrencium     |
| 133<br><b>Cs</b><br>Caesium<br>55 | 137<br><b>Ba</b><br>Barium<br>56   |                                |    |     | 139<br><b>La</b><br>Lanthanum<br>57 | 140<br><b>Ce</b><br>Cerium<br>58       | 141<br><b>Pr</b><br>Praseodymium<br>59 | 142<br><b>Nd</b><br>Neodymium<br>60   | 143<br><b>Pm</b><br>Promethium<br>61 | 144<br><b>Sm</b><br>Samarium<br>62  | 145<br><b>Eu</b><br>Europium<br>63 | 146<br><b>Gd</b><br>Gadolinium<br>64 | 147<br><b>Tb</b><br>Terbium<br>65     | 148<br><b>Dy</b><br>Dysprosium<br>66  | 149<br><b>Ho</b><br>Holmium<br>67  | 150<br><b>Er</b><br>Erbium<br>68       | 151<br><b>Tm</b><br>Thulium<br>69   | 152<br><b>Yb</b><br>Ytterbium<br>70   | 153<br><b>Lu</b><br>Lutetium<br>71 |
| 226<br><b>Ra</b><br>Radium<br>88  | 227<br><b>Ac</b><br>Actinium<br>89 |                                |    |     | 228<br><b>Th</b><br>Thorium<br>90   | 229<br><b>Pa</b><br>Protactinium<br>91 | 230<br><b>U</b><br>Uranium<br>92       | 231<br><b>Np</b><br>Neptunium<br>93   | 232<br><b>Pu</b><br>Plutonium<br>94  | 233<br><b>Am</b><br>Americium<br>95 | 234<br><b>Cm</b><br>Curium<br>96   | 235<br><b>Bk</b><br>Berkelium<br>97  | 236<br><b>Cf</b><br>Californium<br>98 | 237<br><b>Es</b><br>Einsteinium<br>99 | 238<br><b>Fm</b><br>Fermium<br>100 | 239<br><b>Md</b><br>Mendelevium<br>101 | 240<br><b>No</b><br>Nobelium<br>102 | 241<br><b>Lr</b><br>Lawrencium<br>103 |                                    |

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

Key

|   |          |
|---|----------|
| a | <b>X</b> |
| b |          |

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

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.