



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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CANDIDATE
NUMBER

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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	
Total	

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 (CH_4), chloromethane (CH_3Cl) and an oxide of nitrogen (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?

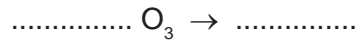
reagent

condition [2]

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

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

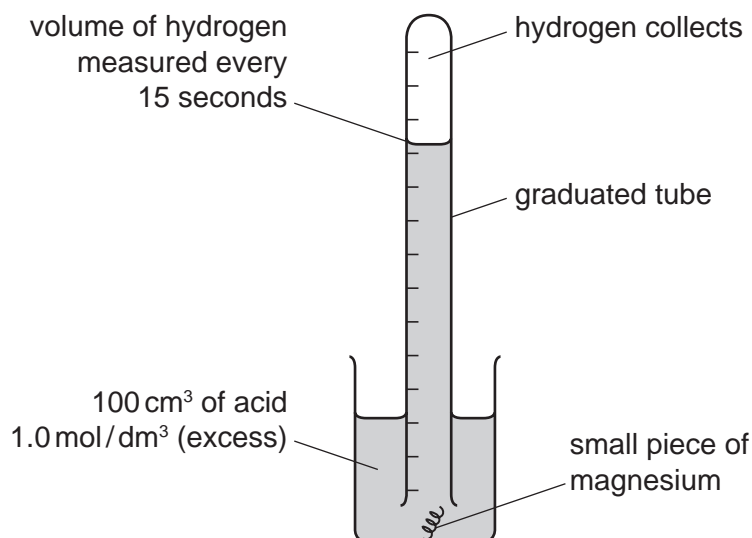
- (v) Complete the equation for the decomposition of ozone.



[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.

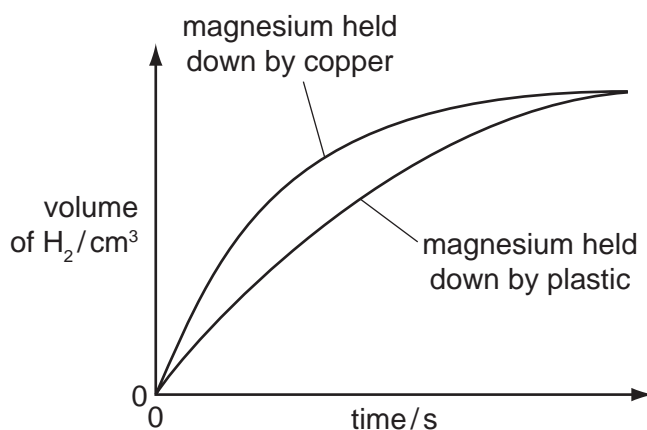
- (i) Suggest a reason why magnesium, which is denser than water, floated to the surface.

.....
 [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/dm³ propanoic acid instead of 1.0 mol/dm³ 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

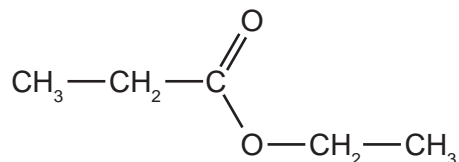
..... [4]

[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 —COO— are esters.

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

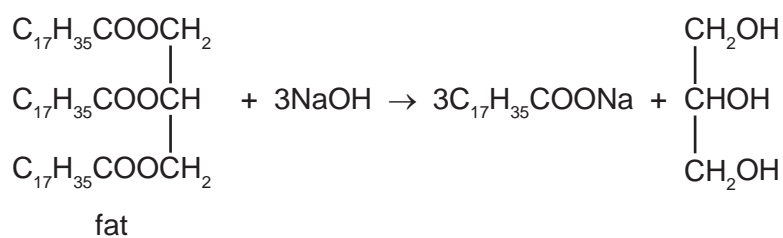


name name

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?

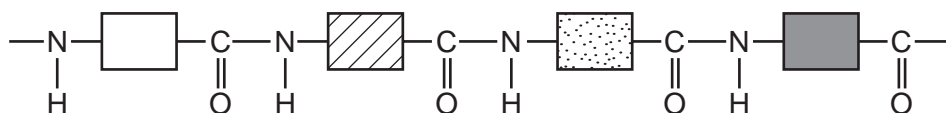
type of compound [1]

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.

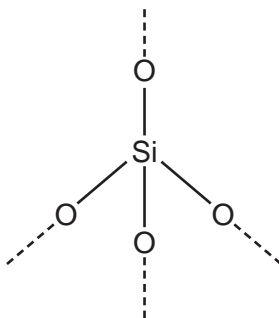
..... [1]

(b) Two of the oxides of these elements are carbon dioxide, CO_2 , and silicon(IV) oxide, 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 SiO_2 not SiO_4 .

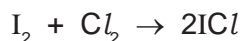
.....
 [2]

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

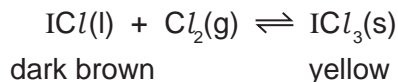
.....
 [2]

[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]

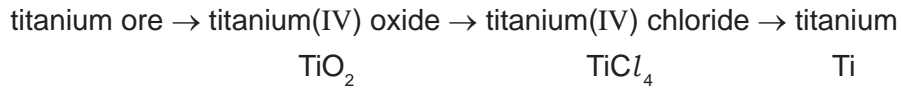
(ii) Describe what you would observe.

.....

..... [1]

[Total: 7]

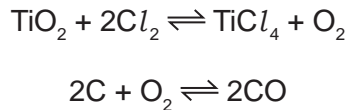
7 Titanium is a transition element. It is isolated by the following reactions.



(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.

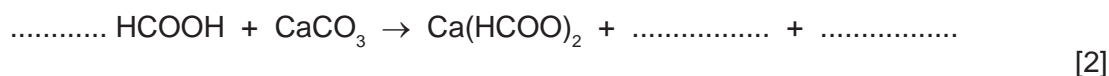
(a) Give **two** general characteristics of a homologous series.

.....

 [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

I		Group										VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII																																													
		II	III	IV	V	VI	VII	0																																																												
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1	11 B Boron 5	12 C Carbon 6	13 Al Aluminium 13	14 N Nitrogen 7	15 O Oxygen 8	16 F Fluorine 9	17 Ne Neon 10	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	†
133 Cs Caesium 55	137 Ba Barium 56	226 Ra Radium 88	227 Ac Actinium 89	†	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	152 Eu Europium 63	150 Sm Samarium 62	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	238 U Uranium 92	238 Pa Protactinium 91	238 U Uranium 92	93 Np Neptunium 93	94 Pu Plutonium 94	95 Am Americium 95	96 Cm Curium 96	97 Bk Berkelium 97	98 Cf Californium 98	99 Es Einsteinium 99	100 Fm Fermium 100	101 Md Mendelevium 101	102 No Nobelium 102	103 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 dm³ at room temperature and pressure (r.t.p.).

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