UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0637390508

CHEMISTRY **5070/22**

Paper 2 Theory **October/November 2010**

1 hour 30 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 soft 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.

Section A
Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.

Section B
Answer any **three** questions.
Write your answers in the spaces provided in the Question Paper.

A copy of the Periodic Table is printed on page 20.
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	
Section A	
B6	
B7	
B8	
B9	
Total	

This document consists of **17** printed pages and **3** blank pages.

UNIVERSITY of CAMBRIDGE International Examinations

Section A

For Examiner's Use

Answer **all** the questions in this section in the spaces provided.

The total mark for this section is 45.

A1 **(a)** Choose from the following list of metals to answer the questions below.

aluminium
iron
lead
magnesium
potassium
silver
vanadium

Each metal can be used once, more than once or not at all.

Which metal

(i) reacts with cold water to form an alkaline solution,

.....[1]

(ii) forms a protective oxide layer on its surface,

.....[1]

(iii) is the catalyst used in the industrial manufacture of ammonia,

.....[1]

(iv) is a sacrificial metal used to prevent iron pipes from rusting,

.....[1]

(v) is in Period 5 of the Periodic Table?

.....[1]

(b) Draw a labelled diagram to show the structure of a typical metal.

[2]

[Total: 7]

A2 Ethanol can be made both by fermentation and by the addition of steam to ethene.

For Examiner's Use

(a) (i) Name the organic compound required for fermentation.

.....[1]

(ii) State the conditions under which fermentation most readily takes place.

.....

.....[2]

(b) Write an equation for the reaction between steam and ethene.

[1]

(c) Ethanol, C_2H_5OH, reacts with ethanoic acid, CH_3COOH.

$$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$$

(i) Name the compound $CH_3COOC_2H_5$.

.....[1]

(ii) What name is given to this type of chemical reaction?

.....[1]

(d) (i) Name the third member of the alcohol homologous series.

.....[1]

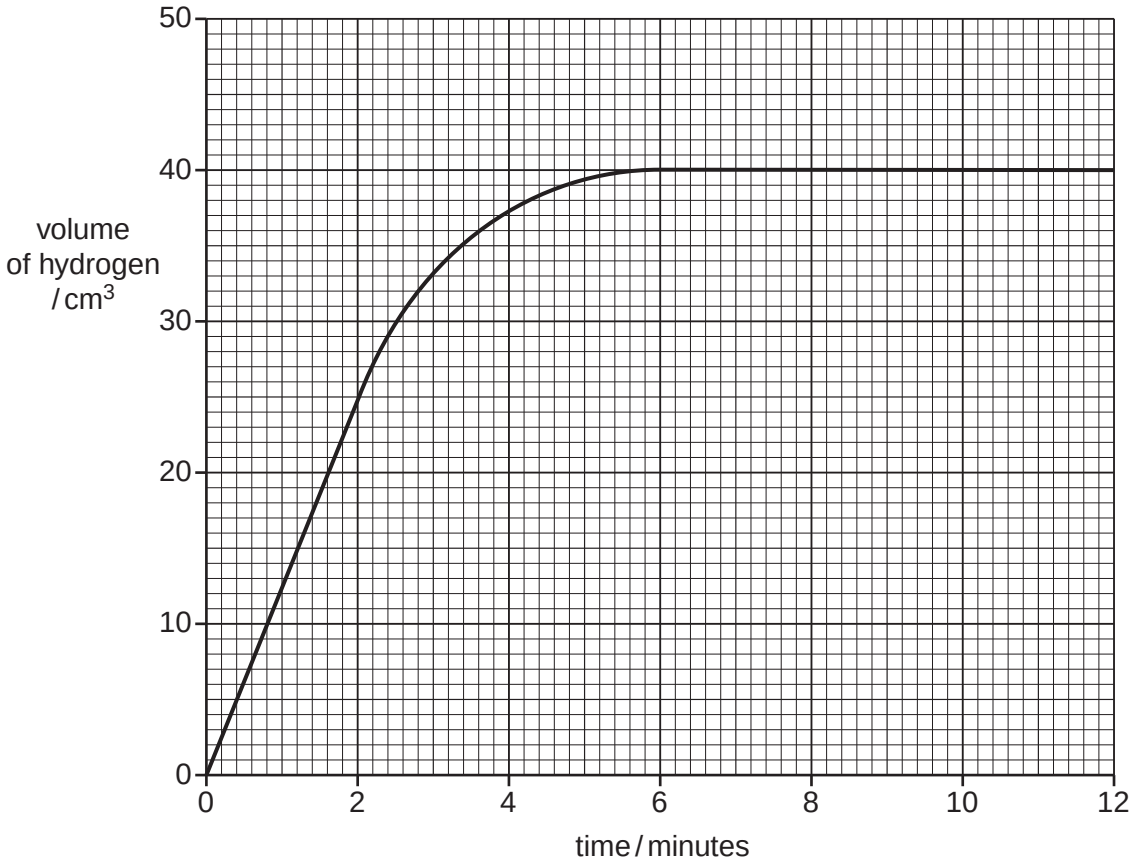
(ii) Draw the structural formula of this compound, showing all atoms and bonds.

[1]

[Total: 8]

A3 A student measured the volume of hydrogen produced over time when small pieces of zinc reacted with excess sulfuric acid.
The results are shown in the graph below.

For Examiner's Use



(a) Use the information from the graph to calculate the average speed of reaction in the first two minutes.

[1]

(b) Explain why the reaction stopped after 6 minutes.

.....[1]

(c) Copper catalyses this reaction.

(i) On the axes above, sketch a line to show the expected results for the catalysed reaction. [1]

(ii) Explain how a catalyst changes the speed of reaction.

.....[1]

(d) Explain, using ideas about colliding particles, what happens to the speed of this reaction when larger particles of zinc are used.

For Examiner's Use

.....

.....

.....[2]

(e) Explain, using ideas about colliding particles, what happens to the speed of this reaction when the temperature of the reaction mixture is increased.

.....

.....

.....[2]

[Total: 8]

A4 Chlorine, bromine and iodine are non-metals in Group VII of the Periodic Table. Their molecules are diatomic.

For Examiner's Use

(a) What do you understand by the term *diatomic*?

.....[1]

(b) **(i)** Describe the trend in colour of the Group VII elements down the Group.

.....[1]

(ii) In what physical state do the following elements exist at room temperature and pressure?

bromine .....

iodine .....[2]

(c) Aqueous bromine reacts with aqueous potassium iodide.

$$Br_2(aq) + 2KI(aq) \longrightarrow 2KBr(aq) + I_2(aq)$$

(i) Write an ionic equation for this reaction.

[1]

(ii) Describe a positive test for iodide ions.

test .....

observation .....[2]

(iii) Explain why aqueous bromine does not react with aqueous potassium chloride.

.....

.....[1]

(d) Hydrochloric acid can be made by burning hydrogen in chlorine, then dissolving the product in water.
Give the formulae for the ions present in hydrochloric acid.

.....[1]

(e) An aqueous solution of calcium hydroxide was titrated with 0.0150 mol / dm^3 hydrochloric acid.

For Examiner's Use

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

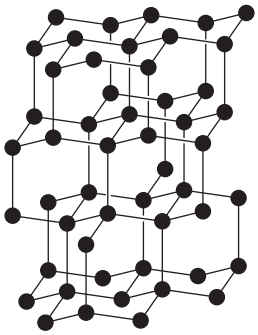
It required 6.00 cm^3 of this aqueous hydrochloric acid to neutralise 20.0 cm^3 of the calcium hydroxide solution.
Calculate the concentration, in mol / dm^3, of the calcium hydroxide solution.

[3]

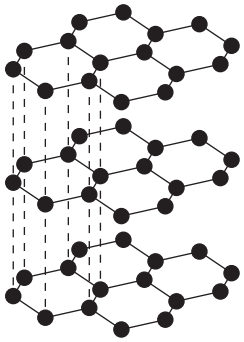
[Total: 12]

A5 Carbon and graphite are two forms of carbon.

For Examiner's Use



diamond



graphite

(a) **(i)** Describe **two** differences in the structure of diamond and graphite.

.....

.....

.....

.....[2]

(ii) Explain, in terms of their structure, why graphite is soft but diamond is hard.

.....

.....

.....[2]

(b) Tin is extracted by heating tin(IV) oxide, SnO_2, with carbon in a furnace.

$$SnO_2 + 2C \longrightarrow Sn + 2CO$$

(i) How does this equation show that tin(IV) oxide gets reduced?

.....

.....[1]

(ii) Explain why carbon monoxide must not be allowed to escape from the furnace.

.....[1]

(c) Carbon monoxide can be formed by the reduction of carbon dioxide with red-hot carbon.

(i) Write an equation for this reaction.

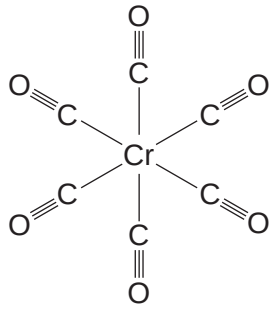
[1]

(ii) Carbon monoxide has a triple covalent bond.
Draw the electronic structure of carbon monoxide. Show only the outer electrons.

For Examiner's Use

[2]

(iii) Carbon monoxide reacts with chromium to form chromium carbonyl.
The structure of chromium carbonyl is shown below.



Write the empirical formula for chromium carbonyl.

.....[1]

[Total: 10]

Section B

For Examiner's Use

Answer **three** questions from this section in the spaces provided.

The total mark for this section is 30.

B6 The carbon cycle regulates the amount of carbon dioxide in the atmosphere.

(a) Explain how the processes of photosynthesis and respiration help to regulate the amount of carbon dioxide in the atmosphere.

.....

.....

.....

.....

..... [3]

(b) Methane is an atmospheric pollutant which contributes to global warming.

(i) Suggest **two** possible consequences of an increase in global warming.

.....

..... [2]

(ii) Write an equation for the complete combustion of methane.

[1]

(iii) Methane is generally unreactive. Apart from combustion, state one other chemical reaction of methane.

..... [1]

(c) Methane is a member of the alkane homologous series.

For Examiner's Use

(i) Describe how the boiling points of unbranched alkanes vary with the size of their molecules.

.....

..... [1]

(ii) Alkanes can be cracked to form alkenes.
State the conditions required for cracking alkanes.

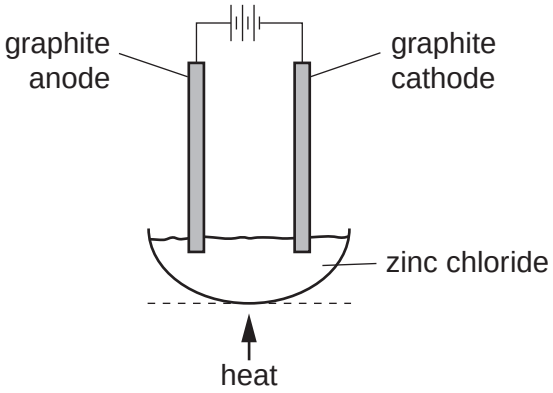
.....

..... [2]

[Total: 10]

B7 Zinc chloride is an ionic solid. It can be electrolysed using the apparatus shown below.

For Examiner's Use



(a) Explain why zinc chloride conducts electricity when molten, but not when solid.

.....

..... [2]

(b) Predict the products of this electrolysis at

the anode, ...

the cathode. ..... [1]

(c) When a dilute aqueous solution of zinc chloride is electrolysed, hydroxide ions are converted to oxygen at the anode.
Write the ionic equation for this reaction.

[2]

(d) Describe a positive test for zinc ions.

test .....

observations .....

..... [3]

(e) Solid zinc chloride absorbs ammonia to form tetrammine zinc chloride, $Zn(NH_3)_4Cl_2$.

For Examiner's Use

$$ZnCl_2 + 4NH_3 \longrightarrow Zn(NH_3)_4Cl_2$$

Calculate the maximum yield, in grams, of tetrammine zinc chloride formed when 3.4 g of zinc chloride reacts with excess ammonia.

[2]

[Total:10]

B8 Magnesium is a reactive metal.

For Examiner's Use

(a) **(i)** Name the products formed when magnesium reacts with steam.

.....[1]

(ii) Write the equation for the reaction of magnesium with ethanoic acid, CH_3COOH.

[2]

(b) Magnesium chloride is a soluble salt.
Describe how you can make pure dry crystals of magnesium chloride from magnesium carbonate.

.....

.....

.....

.....

.....[3]

(c) The equation shows the reaction which occurs when magnesium carbonate is heated.

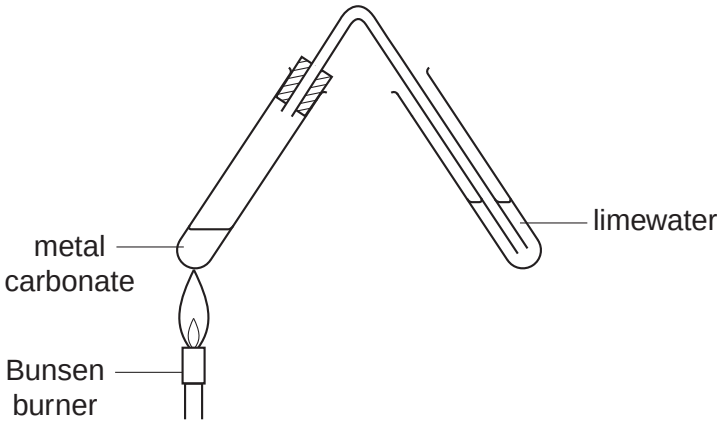
$$MgCO_3 \longrightarrow MgO + CO_2$$

State the name given to this type of chemical reaction.

.....[1]

(d) A student compared the action of heat on three solid metal carbonates.
She heated each carbonate using the apparatus shown below. In each case, she recorded the length of time taken for the limewater to turn milky.

For Examiner's Use



(i) State one factor that must be kept constant if the speeds of reaction are to be compared in a fair way.

.....[1]

(ii) The time taken for the limewater to turn milky for each metal carbonate is shown in the table.

metal carbonate	time taken for the limewater to turn milky / s
copper carbonate	10
magnesium carbonate	40
zinc carbonate	24

Describe and explain these results in terms of the reactivity of the metals.

.....

.....

.....[2]

[Total: 10]

B9 Sulfur dioxide is a gas which contributes to acid rain.

For Examiner's Use

(a) **(i)** State one source of sulfur dioxide in the atmosphere.

.....[1]

(ii) Acid rain can cause lakes to become acidic. This may cause fish and plants in the water to die.
Describe one **other** environmental problem caused by acid rain.

.....[1]

(b) Acid rain is a solution of dilute sulfuric acid.
The acidity in lakes can be neutralised by adding powdered calcium carbonate.

(i) Write an equation, including state symbols, for the reaction of calcium carbonate with sulfuric acid.

[2]

(ii) State one industrial use of sulfuric acid.

.....[1]

(iii) Sulfuric acid is a strong acid.
What do you understand by the term *strong acid*?

.....

.....[1]

(c) Sulfuric acid is manufactured by the Contact process.
Name the raw materials used in the first stage of the Contact process.

.....[1]

(d) The equation shows the second stage of the Contact process.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3 \quad \Delta H = -197\,\text{kJ / mol}$$

(i) State the meaning of the symbol ΔH.

.....[1]

(ii) Predict and explain the effect of increasing the temperature on the position of equilibrium in this reaction.

.....

.....

.....[2]

[Total: 10]

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DATA SHEET
The Periodic Table of the Elements

Group I	Group II						Group III	Group IV	Group V	Group VI	Group VII	Group 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	209 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 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	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	244 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	247 Bk Berkelium 97	251 Cf Californium 98	252 Es Einsteinium 99	257 Fm Fermium 100	258 Md Mendelevium 101	259 No Nobelium 102	260 Lr Lawrencium 103

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

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

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