UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **5070/02**

Paper 2 Theory **October/November 2008**

1 hour 30 minutes

Candidates answer on the Question Paper.

Additional Materials: Answer Booklet/Paper

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 on any lined pages and/or separate answer 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	
B7	
B8	
B9	
B10	
Total	

This document consists of **20** printed 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 The diagram shows part of the Periodic Table.

											He
						B	**C**	**N**	**O**	**F**	**Ne**
						Al	**Si**	**P**	**S**	**Cl**	**Ar**
	Fe	**Co**	**Ni**	**Cu**	**Zn**	**Ga**	**Ge**	**As**	**Se**	**Br**	**Kr**
										I	**Xe**

Answer these questions using **only** the elements shown in the diagram.

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

Write the symbol for

(i) an element which is in Group 5 and Period 3, [1]

(ii) an element which is used as a gas in balloons, [1]

(iii) an element which forms ions in aqueous solution which give a white precipitate on reaction with aqueous silver nitrate, [1]

(iv) an element which forms an ion of type X^{3-}, [1]

(v) an element which is a catalyst for the hydrogenation of alkenes, [1]

(vi) two elements which combine to form a compound which causes acid rain. and [1]

[Total: 6]

A2 Several small pieces of magnesium are placed on a block of solid carbon dioxide. The solid carbon dioxide is at a temperature of -60 °C. The magnesium is ignited and another block of solid carbon dioxide is immediately placed on top.

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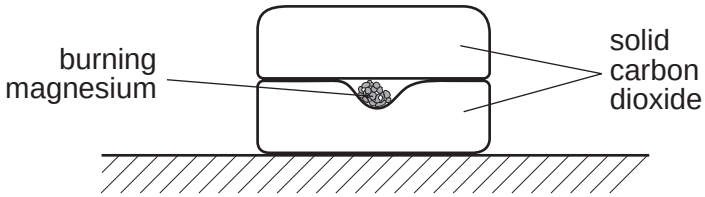

A vigorous reaction is observed.

$$2Mg + CO_2 \longrightarrow 2MgO + C$$

(a) Suggest what could be seen as the reaction proceeds to completion.

.....

..... [2]

(b) Why is another block of solid carbon dioxide placed above the burning magnesium?

..... [1]

(c) State **one** factor in the experiment which slows down the reaction.

..... [1]

(d) When 2 moles of magnesium react with one mole of carbon dioxide, 810 kJ of energy are released.
Calculate the energy released when 2.0 g of magnesium reacts completely with carbon dioxide.

[2]

[Turn over

(e) In a second experiment 6.0 g of magnesium and 4.4 g of carbon dioxide are used. Which solid, magnesium or carbon dioxide is in excess?
Show your working.

For Examiner's Use

[2]

(f) Explain, in terms of the energy changes taking place in both bond-making and bond-breaking, why the reaction is exothermic.

.....

.....

..... [2]

[Total: 10]

A3 Household waste can be disposed of by being dumped into landfill sites, recycled or burnt. In a landfill site, bacteria break down vegetable waste to produce a mixture of gases.

For Examiner's Use

(a) Name **two** gases which are likely to be formed by this bacterial action.

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

(b) A small amount of butanoic acid is also formed by bacterial action in landfill sites. Draw the structure of butanoic acid.

[1]

(c) A type of 'oil' can be made from the cellulose in waste paper. The waste paper is heated at 350 °C under high pressure and in the presence of a nickel catalyst. The equation for this reaction is shown.

$$6C_6H_{10}O_5 \longrightarrow \underset{\text{'oil'}}{C_{22}H_{22}O_2} + 19H_2O + CO_2 + 7CO + 6C$$

(i) State the function of a catalyst.

.....[1]

(ii) The 'oil', $C_{22}H_{22}O_2$, can be used for heating. Write an equation for the complete combustion of this 'oil'.

[2]

[Total: 6]

A4 The head of a safety match contains potassium chlorate and antimony sulphide. The side of the matchbox contains red phosphorus.
When a match is struck on the side of the box, the friction produces enough heat to light the match.

For Examiner's Use

(a) The equation for this reaction is shown.

$$\underset{\text{potassium chlorate}}{5KClO_3} + 6P \rightarrow 5KCl + \underset{\text{phosphorus(V) oxide}}{3P_2O_5}$$

Which is the oxidant and which is the reductant in this reaction?
Explain your answer.

oxidant .....

reductant .....

explanation .....

..... [2]

(b) Phosphorus(V) oxide, P_2O_5, absorbs water from the air to form meta-phosphoric acid, HPO_3.

(i) Write an equation for this reaction.

[1]

(ii) On addition of more water, phosphoric acid is formed. Phosphoric acid has typical acidic properties. What would you observe when aqueous phosphoric acid is added to

aqueous sodium carbonate, ...

blue litmus paper? .....
[2]

(c) Part of the chain structure of antimony sulphide is shown below.

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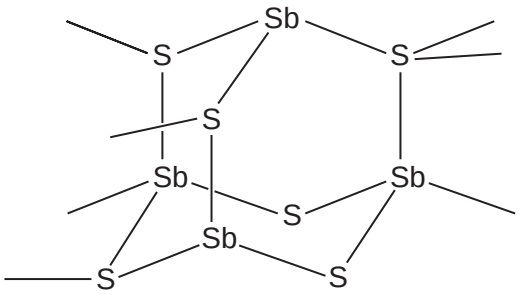


Deduce the empirical formula of antimony sulphide.

.....[1]

[Total: 6]

A5 Cement is made by heating clay with crushed calcium carbonate. During this process, the calcium carbonate is first converted to calcium oxide.

For Examiner's Use

$$CaCO_3 \longrightarrow CaO + CO_2$$

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

.....[1]

(ii) Suggest why calcium oxide is used to neutralise acidic soils.

.....[1]

(b) Concrete is made from cement, sand and water. When set, concrete is slightly porous. When rain water soaks through concrete, some of the uncombined calcium oxide dissolves to form calcium hydroxide.

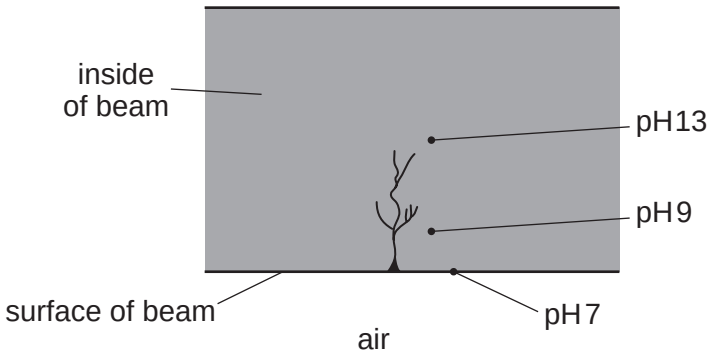
(i) Write an equation for this reaction.

[1]

(ii) The aqueous calcium hydroxide in wet concrete reacts with carbon dioxide in the air.

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$$

The diagram shows the pH at various points inside a cracked concrete beam.



Describe and explain the change in pH from the surface to the centre of the beam.

.....

.....

.....[3]

(iii) 25.0 cm^3 of an aqueous solution of calcium hydroxide is exactly neutralised by 18.0 cm^3 of 0.040 mol/dm^3 hydrochloric acid.

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

Calculate the concentration, in mol/dm^3, of the aqueous calcium hydroxide.

concentration = ...mol/dm^3 [3]

[Total: 9]

[Turn over

A6 Electrolysis is used to produce many important chemicals such as chlorine, sodium hydroxide and aluminium.

For Examiner's Use

(a) Chlorine is used in both water treatment and as a bleach.

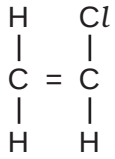
(i) Why is chlorine used in water treatment?

.....[1]

(ii) Name a substance, other than chlorine, that is used to bleach wood pulp.

.....[1]

(b) Chlorine is used to make chloroethene.



Chloroethene can be polymerised to form poly(chloroethene).
Draw a section of a poly(chloroethene) chain to show at least two repeating units.

[1]

(c) In the production of aluminium, sodium hydroxide is used to separate aluminium oxide from the impurities in the bauxite ore. The main impurity in the ore is iron(III) oxide. Aluminium oxide is an amphoteric oxide whilst iron(III) oxide is a basic oxide.
Suggest how these two oxides can be separated by the addition of aqueous sodium hydroxide.

.....

.....

.....[2]

(d) Aluminium is extracted by the electrolysis of a mixture of molten aluminium oxide and cryolite. What is the function of the cryolite?

.....[1]

For Examiner's Use

(e) Acidic foods can be safely packed in aluminium containers.
Explain why the acid in the food does not attack the aluminium, despite the fact that aluminium is a reactive metal.

.....

.....[2]

[Total: 8]

Section B

Answer **three** questions from this section.

The total mark for this section is 30.

B7 Ammonia is made by the Haber process using an iron catalyst.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \quad \Delta H = -92\,\text{kJ/mol}$$

(a) On the same axes draw energy profile diagrams to show both the catalysed and the uncatalysed reaction. Label the diagram to show

- the catalysed and uncatalysed reactions,
- the reactants and products,
- the enthalpy change for the reaction. [3]

(b) The raw materials for the Haber process can be obtained from the air and from hydrocarbons produced by the distillation of petroleum.

(i) Describe how pure nitrogen can be separated from other gases in the air. [1]

(ii) Describe how hydrogen can be made from hydrocarbons. [2]

(c) Explain how the position of equilibrium in the Haber process is altered by

(i) an increase in pressure, [2]

(ii) an increase in temperature. [2]

[Total: 10]

B8 Sorrel is a small green plant.

(a) The pigments in the sorrel leaf can be separated by chromatography.

(i) Describe how chromatography can be used to separate different pigments. [2]

(ii) Explain what is meant by R_f value. [1]

(b) Sorrel plants contain a poisonous carboxylic acid **X**.
What can be deduced about **X** from each of the following three pieces of information?

(i) When **X** is warmed with acidified potassium manganate(VII), the solution changes from pink to colourless. [1]

(ii) Aqueous bromine is not decolourised when added to a solution of **X**. [1]

(iii) A 0.1 mol/dm^3 solution of **X** has a pH of 3 whereas a 0.1 mol/dm^3 solution of hydrochloric acid has a pH of 1. [1]

(c) Analysis of 10.0 g of carboxylic acid **X** shows that it contains 2.67 g carbon, 0.220 g hydrogen and 7.11 g oxygen.

(i) Deduce the empirical formula of **X**. [3]

(ii) The relative molecular mass of **X** is 90. Deduce the molecular formula of **X**. [1]

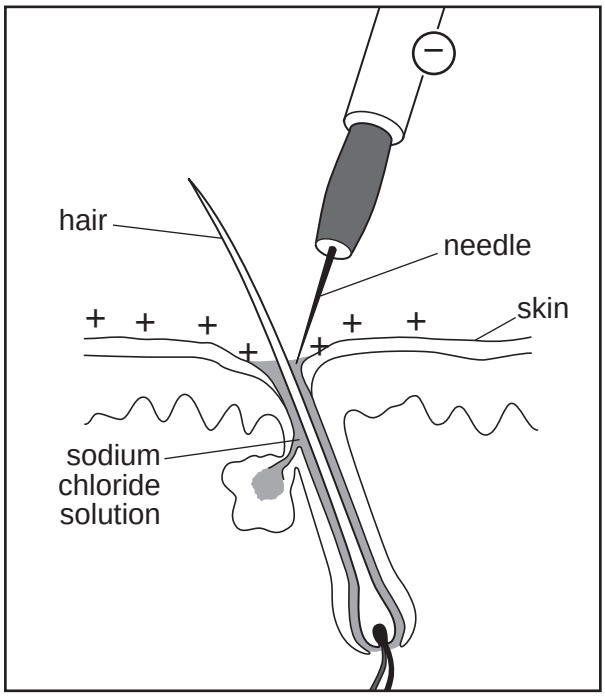
[Total: 10]

[Turn over

B9 Electrolysis can be used to remove unwanted hair. The customer holds a metal bar which acts as a positive electrode. A needle, which acts as the negative electrode, is held by the operator.

(a) What do you understand by the term *electrolysis*? [1]

(b) The solution around the tip of the needle is mainly a dilute aqueous solution of sodium chloride.



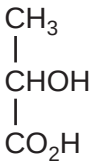
(i) Name all the ions present in the solution during this electrolysis. [1]

(ii) During electrolysis a small amount of chlorine is formed at the surface of the skin. Write an ionic equation for this reaction. [1]

(iii) During electrolysis, a gas forms at the tip of the needle and the solution changes from pH 7 to pH 10.
Explain both these changes. [2]

(c) Explain why aqueous sodium chloride solution conducts electricity but solid sodium chloride does not. [2]

(d) The sweat glands in the skin produce small amounts of lactic acid.



lactic acid

Lactic acid reacts with ethanol to form an ester.

(i) State the conditions needed to form an ester. [2]

(ii) Draw the structure of the ester produced by the reaction of lactic acid with ethanol. [1]

[Total: 10]

B10 Radioactive iodine is used to treat some cancerous tumours.

(a) Two radioactive isotopes of iodine are $^{125}_{53}\mathrm{I}$ and $^{131}_{53}\mathrm{I}$.

For each isotope state the type and number of subatomic particles present. [2]

(b) Name a reagent that reacts with iodide ions to form iodine molecules.
Describe the colour change that occurs in this reaction. [2]

(c) Zinc can reduce iodine to iodide ions.
Write an ionic equation for this reaction. [2]

(d) In cancer treatment, the radioactive iodine can be injected into the tumour with a titanium needle.

(i) Titanium is a transition element. State **three** characteristic properties of transition elements. [2]

(ii) An oxide of titanium is formed from Ti^{3+} ions and oxide ions.
Deduce the formula of this compound. [1]

(iii) Titanium(IV) chloride, $TiCl_4$, reacts with water to form titanium(IV) oxide, TiO_2, and hydrogen chloride. Write an equation for this reaction. [1]

[Total: 10]

If you use these lined pages to complete an answer to any question, the question number **must** be clearly shown.

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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 Sulphur 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	55 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.).