UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

CHEMISTRY **5070/22**

Paper 2 Theory **May/June 2013**

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.

Electronic calculators may be used.

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.

This document consists of **19** printed pages and **1** blank page.

Section A

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

The total mark for this section is 45.

A1 Choose from the following elements to answer the questions below.

barium

calcium

carbon

copper

helium

hydrogen

iron

lead

lithium

sulfur

zinc

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

Name an element which

(a) forms two acidic oxides,

..... [1]

(b) has an ion which, in aqueous solution, reacts with aqueous sodium hydroxide to give a green precipitate,

..... [1]

(c) has an atom with an electronic configuration with only four occupied shells,

..... [1]

(d) has two giant molecular structures,

..... [1]

(e) has an ion which, in aqueous solution, is used to test for sulfate ions,

..... [1]

(f) reacts with water to form an alkaline solution.

..... [1]

[Total: 6]

A2 Both respiration and combustion add carbon dioxide to the atmosphere.

(a) Give one reason why scientists are concerned about the increasing use of fossil fuels.

.....

..... [1]

(b) Respiration is a process that occurs in living organisms where glucose, $C_6H_{12}O_6$, reacts with oxygen.

Write the overall equation that represents respiration.

..... [1]

(c) Respiration is an exothermic reaction.

(i) Explain, in terms of the energy changes that occur during bond breaking and bond making, why respiration is an exothermic reaction.

.....

.....

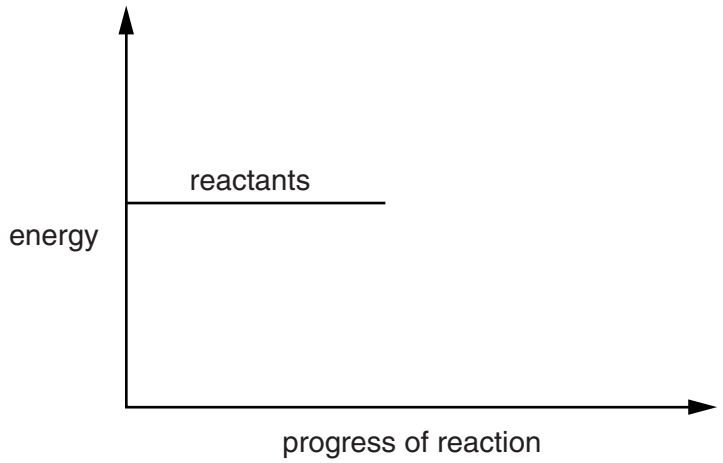
.....

..... [2]

(ii) Complete the energy profile diagram for respiration.

On your diagram label the

- products,
- enthalpy change for the reaction, ΔH,
- activation energy, E_a.



[3]

[Total: 7]

A3 Aluminium is a metal and both iodine and bromine are non-metals.

(a) How does the number of valency electrons help to explain why aluminium is a metal and iodine and bromine are non-metals?

.....

.....

.....

..... [2]

(b) At room temperature iodine is a solid and bromine is a liquid.

Describe the difference between both the arrangement and the motion of particles in a solid and a liquid.

.....

.....

..... [2]

(c) Iodine and bromine form the compound iodine bromide, IBr.

Draw the 'dot-and-cross' diagram for IBr.

Only draw the outer shell electrons.

[1]

(d) Describe how bromine is used to test for unsaturation in organic compounds.

.....

..... [1]

(e) Aluminium is used to make alloys for the aircraft industry. One reason for this is that aluminium does not corrode very easily.

(i) State one other reason why aluminium is used in the manufacture of aircraft.

..... [1]

(ii) Explain why aluminium does not corrode very easily.

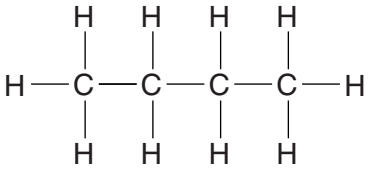
.....

.....

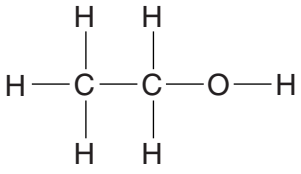
..... [2]

[Total: 9]

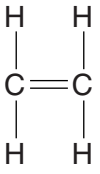
A4 The structures of some of the compounds that can be manufactured from crude oil are



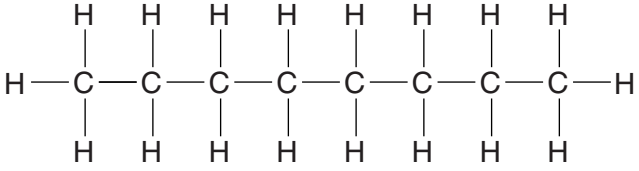
butane



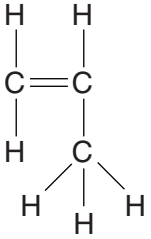
ethanol



ethene



octane



propene

(a) Octane is found in the petrol fraction separated from crude oil.

Name the process by which petrol is separated from crude oil and state the physical property which allows this process to be carried out.

.....

.....

..... [2]

(b) Hexadecane, $C_{16}H_{34}$, can be cracked to produce a mixture of alkanes and alkenes.

Construct an equation to show the cracking of hexadecane to produce octane.

..... [2]

(c) Propene can be polymerised to make poly(propene).

Draw a section of the structure of poly(propene).

[2]

(d) Ethanol is manufactured by a hydration reaction.

State both the reagents and conditions for this reaction.

.....

..... [2]

[Total: 8]

A5 Analysis of compound **X** shows it has the following composition.

element	percentage by mass
hydrogen	3.40
nitrogen	12.0
oxygen	41.0
vanadium	43.6

(a) Show that **X** has the formula H_4NO_3V.

[2]

(b) Suggest one property of aqueous **X** caused by the presence of vanadium.

..... [1]

(c) Aqueous sodium hydroxide is added to solid **X** and the mixture is warmed.

A colourless gas that turns moist red litmus blue is evolved.

Deduce the formula of each of the two ions present in **X**.

.....

..... [2]

(d) An acidified aqueous solution of **X** reacts with aqueous potassium iodide to form iodine.

State and explain what you can deduce about the chemical nature of **X**.

.....

..... [2]

(e) When solid **X** is heated only V_2O_5, water and gas **Z** are formed.

Name gas **Z**.

..... [1]

[Total: 8]

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A6 A 0.250 g sample of iron filings is added to 25.0 cm^3 of 0.100 mol/dm^3 aqueous copper(II) sulfate.

$$Cu^{2+}(aq) + Fe(s) \longrightarrow Fe^{2+}(aq) + Cu(s)$$

(a) Explain, using electron transfer, why iron is oxidised in this reaction.

.....

..... [1]

(b) Show, by calculation, which reactant is in excess.

[3]

(c) What would you observe in this reaction?

.....

.....

..... [2]

(d) Copper powder is added to aqueous silver nitrate.

Predict whether or not a reaction will take place. Explain your answer.

.....

..... [1]

[Total: 7]

Section B

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

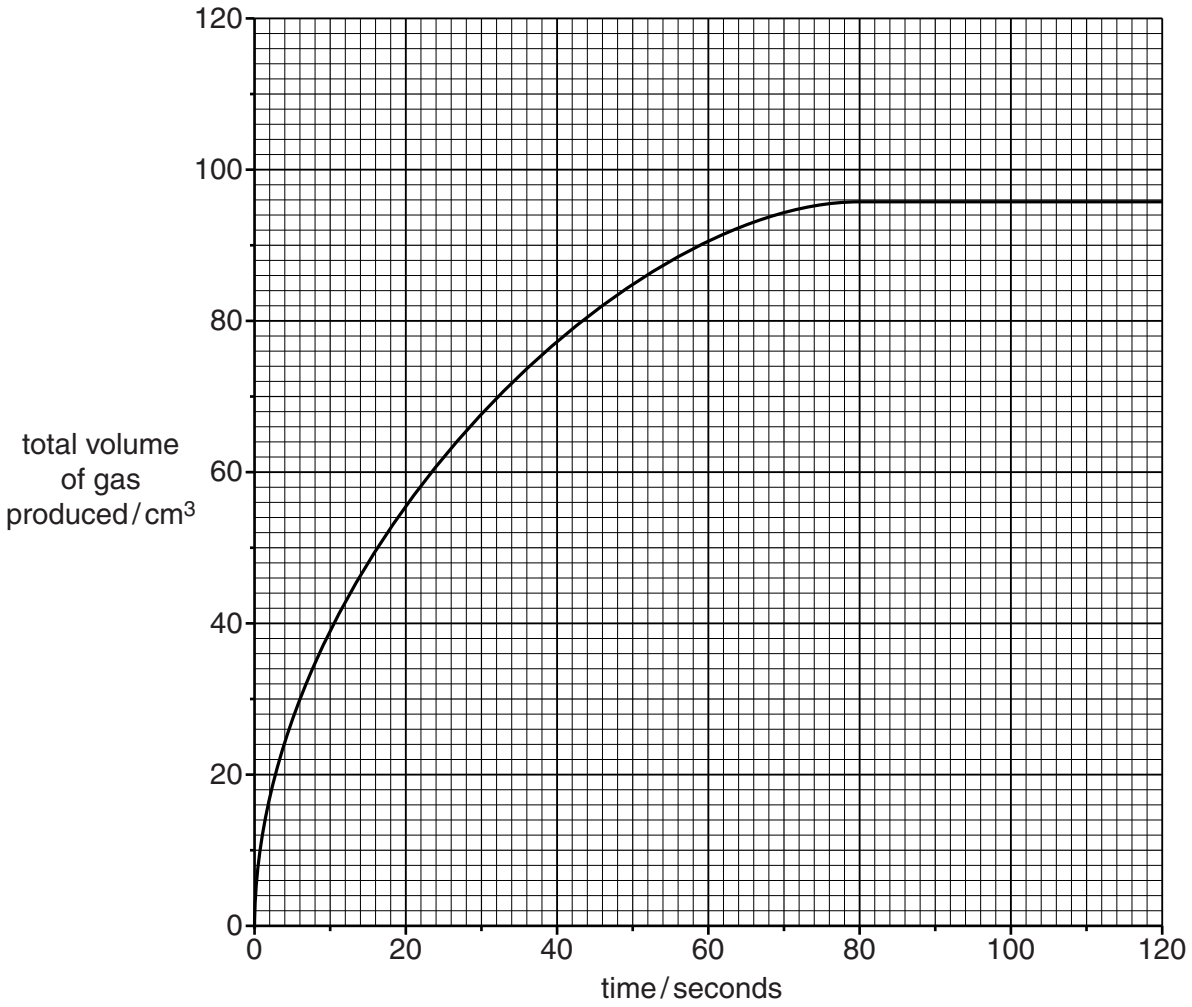
The total mark for this section is 30.

B7 An antacid tablet contains a mixture of magnesium hydroxide, $Mg(OH)_2$, and calcium carbonate, $CaCO_3$.

Stomach acid contains dilute hydrochloric acid.

A student adds a 0.500 g antacid tablet to 50.0 cm^3 of 1.00 mol/dm^3 hydrochloric acid, HC*l*. The acid is in excess.

The graph shows how the total volume of gas produced at r.t.p. changes with time.



(a) Describe, with the aid of a labelled diagram, the apparatus needed to collect this

[2]

(b) **(i)** Write equations for the reactions of HC*l* with $Mg(OH)_2$ and also with $CaCO_3$.

$Mg(OH)_2$

.....

$CaCO_3$

..... [2]

(ii) Calculate the amount, in moles, of carbon dioxide formed at r.t.p. once the reaction had stopped.

amount in moles = ... [2]

(iii) Calculate the mass of $CaCO_3$ in the tablet.

mass of $CaCO_3$ = ... g [2]

Question B7 continues on page 12.

(c) The student repeats the experiment. This time she uses a 0.500 g antacid tab... 50.0 cm^3 of **2.00 mol/dm^3** HC*l* instead of 50.0 cm^3 of 1.00 mol/dm^3 HC*l*.

Describe and explain what will happen to the rate of reaction.

.....

.....

.....

..... [2]

[Total: 10]

Question B8 starts on page 14.

B8 Alcohols are a homologous series of organic compounds.

The table shows information about some alcohols.

alcohol	molecular formula	melting point /°C	density /g/cm^3
methanol	CH_4O	–98	0.79
ethanol	C_2H_6O	–114	0.79
	C_3H_8O	–126	0.80
butanol	$C_4H_{10}O$		
decanol		7	0.83

(a) Which group of atoms (functional group) must be present in the homologous series of alcohols?

..... [1]

(b) Name the alcohol with the molecular formula C_3H_8O.

..... [1]

(c) **(i)** Deduce the general formula for an alcohol.

..... [1]

(ii) A molecule of decanol has ten carbon atoms.

What is the molecular formula for decanol?

..... [1]

(d) It is more difficult to estimate the melting point of butanol than to estimate its density. Use the data in the table to explain why.

.....

..... [1]

(e) When warmed in the presence of concentrated sulfuric acid, butanol reacts with ethanoic acid to form an ester.

Name and draw the structure, showing all the atoms and all the bonds, of this ester.

name .....

structure

[2]

(f) Ethanol reacts with oxygen in the air to form ethanoic acid.

Describe another method by which ethanol can be converted into ethanoic acid.

.....

.....

..... [2]

(g) Butanol can burn in a **limited** supply of air.

Name **two** products of this reaction.

..... [1]

[Total: 10]

B9 Methane reacts with water to produce hydrogen and carbon monoxide.

$$CH_4(g) + H_2O(g) \rightleftharpoons 3H_2(g) + CO(g) \qquad \Delta H = +210\,kJ/mol$$

This reaction is endothermic.

The reaction is normally carried out at a pressure of 30 atmospheres and a temperature of 850 °C.

(a) The reaction is carried out at 30 atmospheres pressure and at **600 °C** rather than 850 °C.

Predict and explain the effect of lowering the temperature on

(i) the rate of reaction,

.....

.....

..... [2]

(ii) the position of equilibrium.

.....

.....

..... [2]

(b) The reaction is carried out at **50 atmospheres** rather than 30 atmospheres, and at 850 °C.

Predict and explain the effect of raising the pressure on the position of equilibrium.

.....

.....

..... [2]

(c) The reaction uses a catalyst.

(i) What effect does a catalyst have on the position of equilibrium?

..... [1]

(ii) Explain how a catalyst causes the rate of reaction to increase.

.....

..... [1]

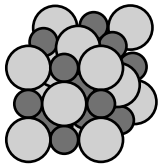
(d) Calculate the energy absorbed by the reaction when 560 g of CO is formed.

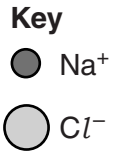
energy absorbed = ... kJ [2]

[Total: 10]

B10 Solid sodium chloride and magnesium oxide have the same structure and bonding.

This is the structure of sodium chloride.





The table shows the melting point of these two compounds.

compound	melting point / °C
magnesium oxide	2852
sodium chloride	801

(a) (i) What are the formulae for a magnesium ion and an oxide ion?

..... [1]

(ii) Suggest why magnesium oxide has a much higher melting point than sodium chloride.

.....

..... [1]

(b) (i) Explain why pure sodium chloride can be electrolysed at 1000 °C but not at 600 °C.

.....

.....

..... [2]

(ii) Construct an equation for the anode reaction in the electrolysis of pure sodium chloride at 1000 °C.

..... [1]

(c) Sodium chloride is dissolved in distilled water.

Excess aqueous silver nitrate is added to this solution and 0.232 g of a white precipitate is formed.

(i) Construct an ionic equation, including state symbols, for the formation of the white precipitate.

..... [2]

(ii) Calculate the mass of sodium chloride present in the solution.

mass of sodium chloride = ... g [3]

[Total: 10]

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	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.).