Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

5748052947

CHEMISTRY **5070/22**

Paper 2 Theory **October/November 2015**

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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, 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.
You may lose marks if you do not show your working or if you do not use appropriate units.
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 **20** printed pages.

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CAMBRIDGE International Examinations

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.

aluminium
argon
carbon
copper
iodine
iron
lead
magnesium
nitrogen
oxygen
sulfur

Each of these elements can be used once, more than once or not at all.

Which element

(a) has an ion which, in aqueous solution, reacts with aqueous sodium hydroxide to give a red-brown precipitate,

.....[1]

(b) has an atom with an electronic configuration with only five occupied electron shells,

.....[1]

(c) has an oxide which decolourises acidified potassium manganate(VII),

.....[1]

(d) has a sulfate which is insoluble in water,

.....[1]

(e) provides an inert atmosphere for the extraction of reactive metals,

.....[1]

(f) produces ammonia when it is warmed with an aqueous mixture of sodium nitrate and sodium hydroxide?

.....[1]

[Total: 6]

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A2 Plants contain many different types of carbon compounds.

(a) Carbon compounds are made in plants by photosynthesis.

Write the overall equation for photosynthesis and state the conditions required for this process.

.....

.....

.....[3]

(b) Starch is a polymer found in plants.
Starch can be hydrolysed.

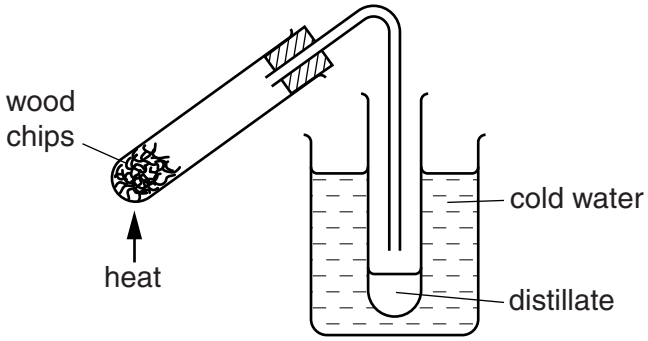
(i) Give the name of the product formed when starch is hydrolysed.

.....[1]

(ii) Give the reagent and conditions needed to hydrolyse starch.

.....[2]

(c) When wood chips are heated in the absence of air, a colourless distillate is formed.



The distillate contains ethanoic acid, esters and other organic compounds.

(i) Ethanoic acid reacts with calcium hydroxide to form a salt and water.

Give the name and formula of the salt formed.

name .....

formula .....[2]

(ii) One of the esters in the distillate has the molecular formula, $C_4H_8O_2$.

Draw the structure of an ester with this formula, showing all the atoms and all the bonds.

[1]

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(iii) The distillate also contains a compound with the following composition.

element	percentage by mass
carbon	37.5
hydrogen	12.5
oxygen	50.0

Deduce the empirical formula of this compound.

empirical formula .....[2]

[Total: 11]

A3 Water for use in the home is treated using carbon and chlorine.

(a) Explain the purpose of using carbon and chlorine in water treatment.

carbon.....

chlorine .....[2]

(b) In some parts of the world, drinking water is purified by desalination.

What is meant by the term *desalination*?

.....[1]

(c) River water may contain pollutants from agricultural sources.
These pollutants may cause eutrophication.

Give the names of two anions present in fertilisers which contribute to eutrophication.

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

(d) An aqueous solution of barium chloride is added to a sample of water which contains sulfate ions. A white precipitate forms.

Construct an ionic equation, including state symbols, for this reaction.

.....[2]

[Total: 6]

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A4 Iron is extracted in a blast furnace. The raw materials required are

- iron ore, which contains iron(III) oxide, Fe_2O_3,
- limestone,
- coke (carbon),
- air.

(a) The coke first burns in air to form carbon dioxide.
The carbon dioxide is then reduced by coke to produce carbon monoxide.
The carbon monoxide reduces the iron(III) oxide to iron.

Write equations for

(i) the reduction of carbon dioxide by coke,

.....[1]

(ii) the reduction of iron(III) oxide to iron by carbon monoxide.

.....[1]

(b) Why is limestone added to the blast furnace?

.....[1]

(c) Another ore of iron contains an oxide with the formula Fe_3O_4.

Calculate the percentage by mass of iron in Fe_3O_4.

[2]

(d) Iron can be obtained by the electrolysis of an aqueous acidified solution of iron(II) sulfate. The reactions at the electrodes are given.

at the anode (positive electrode): $4OH^- \longrightarrow O_2 + 2H_2O + 4e^-$

at the cathode (negative electrode): $Fe^{2+} + 2e^- \longrightarrow Fe$

Which reaction is oxidation and which is reduction? Explain your answer.

.....

.....

.....[2]

(e) Attaching magnesium strips to the iron hulls of ships can lower their rate of rusting.

Explain how the magnesium stops the iron from rusting.

.....

.....

.....

.....[2]

(f) Aqueous iron(II) chloride is one of the products formed when iron reacts with hydrochloric acid.

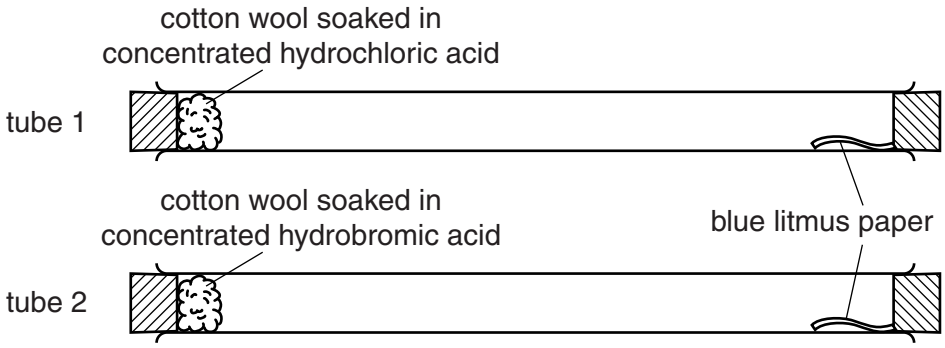
Construct an equation for this reaction.

.....[1]

[Total: 10]

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A5 (a) Two students set up tubes as shown.



Concentrated hydrochloric acid produces fumes of hydrogen chloride.
Concentrated hydrobromic acid produces fumes of hydrogen bromide.

Four minutes after setting up the experiment, the litmus paper in tube 1 turns red.
Seven minutes after setting up the experiment, the litmus paper in tube 2 turns red.

Use the kinetic particle theory to explain

(i) how the gases move through the tubes,

.....

.....

.....

.....[2]

(ii) why the gases take different times to reach the litmus paper.

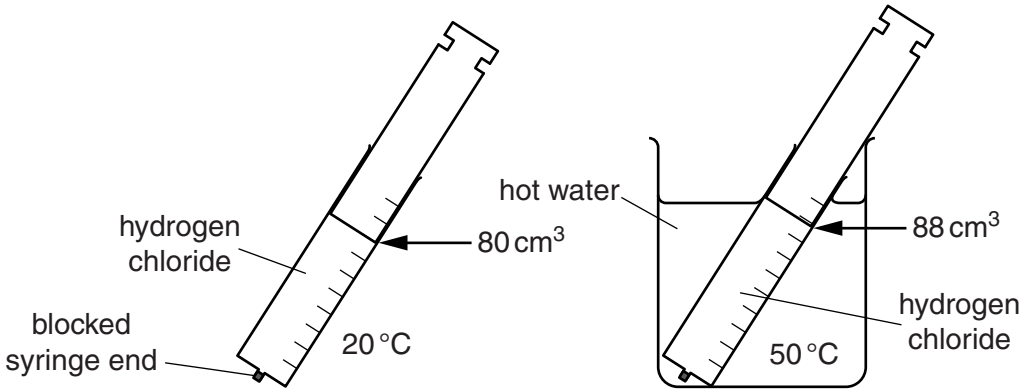
.....

.....[1]

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[Turn over

(b) A gas syringe is filled with 80 cm^3 of hydrogen chloride gas at 20 °C.
The syringe is placed in some hot water at 50 °C.
The atmospheric pressure does not change but the volume of the gas in the syringe increases to 88 cm^3.



Use the kinetic particle theory to explain why the volume increases.

.....

.....

.....

.....[2]

[Total: 5]

A6 When one mole of sulfur burns, 247 kJ of energy is released.

$$S(s) + O_2(g) \rightarrow SO_2(g)$$

(a) Calculate the energy released when 9.60 g of sulfur is burnt.

[2]

(b) When sulfur dioxide is passed through aqueous sodium hydroxide, sodium hydrogensulfite is formed. Sodium hydrogensulfite contains the hydrogensulfite ion, HSO_3^-.

Construct the ionic equation for this reaction.

.....[1]

(c) The hydrogensulfite ion is a weaker acid than ethanoic acid.

Samples of 0.1 g of magnesium are added separately to 0.1 mol/dm^3 ethanoic acid and 0.1 mol/dm^3 hydrogensulfite ions.

Explain why the reaction is faster with ethanoic acid.

.....

.....

.....

.....[2]

(d) Calculate the volume of 0.10 mol/dm^3 sodium hydroxide which contains 3.2 g of sodium hydroxide.

volume of aqueous sodium hydroxide = ... cm^3 [2]

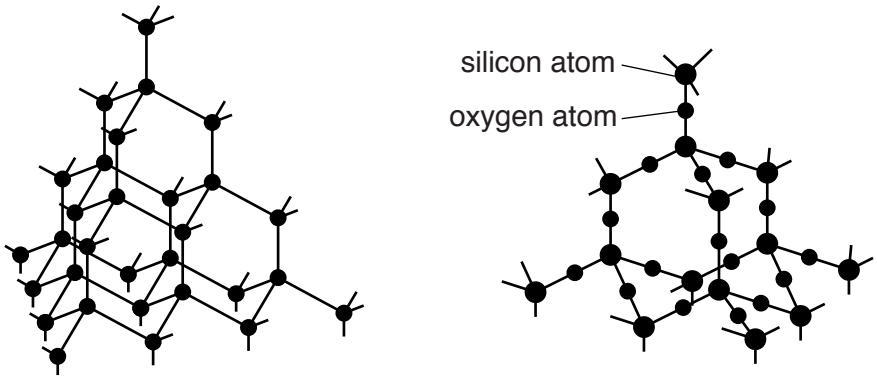
[Total: 7]

Section B

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

The total mark for this section is 30.

B7 The structures of diamond and silicon dioxide are shown.



diamond silicon dioxide

(a) Describe one similarity in the structures of diamond and silicon dioxide.

.....[1]

(b) Explain why silicon dioxide has a high melting point.

.....

.....[2]

(c) Silicon dioxide reacts with hot concentrated sodium hydroxide to form sodium silicate, Na_2SiO_3.

Deduce the formula of the silicate ion.

.....[1]

(d) Explain why diamond does not conduct electricity.

.....[1]

(e) Graphite is a form of carbon which conducts electricity.
Graphite is used as electrodes in electrolysis.

What is the meaning of the term *electrolysis*?

.....

.....[1]

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(f) Aluminium is extracted by the electrolysis of molten aluminium oxide dissolved in cryolite.

Construct the equation for the reaction at

(i) the anode (positive electrode),

.....[1]

(ii) the cathode (negative electrode).

.....[1]

(g) An isotope of silicon is represented by the symbol $^{29}_{14}Si$.

Deduce the number of protons and neutrons in this isotope.

number of protons .....

number of neutrons .....[1]

(h) Silicon has a relative atomic mass of 28.

Define the term *relative atomic mass*.

.....

.....[1]

[Total: 10]

B8 Chlorine reacts with sodium hydroxide.

$$Cl_2(g) + 2NaOH(aq) \longrightarrow NaCl(aq) + NaClO(aq) + H_2O(l)$$

(a) A volume of 144 cm^3 of chlorine gas, measured at room temperature and pressure, is passed into 38.0 cm^3 of 0.250 mol/dm^3 sodium hydroxide.

Show by calculation which reactant is in excess.

[3]

(b) Chlorine displaces bromine from an aqueous solution of potassium bromide.

(i) Construct the equation for this reaction.

.....[2]

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

.....

.....[1]

(iii) Give the charge of a chloride ion and its electronic configuration.

charge .....

electronic configuration .....[2]

(c) Explain why sodium chloride does not conduct electricity when solid but does conduct electricity when molten.

.....

.....

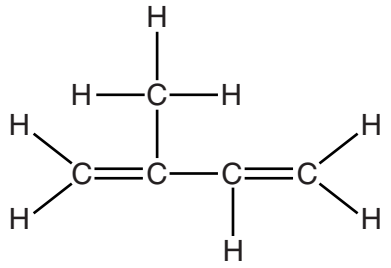
.....[2]

[Total: 10]

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Question B9 begins on page 16.

B9 When rubber is heated in the absence of air, a small amount of isoprene is formed. The structure of isoprene is shown.



(a) Isoprene is an unsaturated hydrocarbon.

Describe a test for an unsaturated hydrocarbon.

.....

.....[2]

(b) Isoprene is a liquid at 25 °C.

Describe the arrangement and motion of the particles in isoprene at 25 °C.

.....

.....[2]

(c) Isoprene reacts with sulfur dioxide to form methylsulfolene.

$$\underset{\text{isoprene}}{C_5H_8} + SO_2 \rightarrow \underset{\text{methylsulfolene}}{C_5H_8SO_2}$$

Calculate the maximum mass of methylsulfolene that can be formed from 100 g of isoprene.

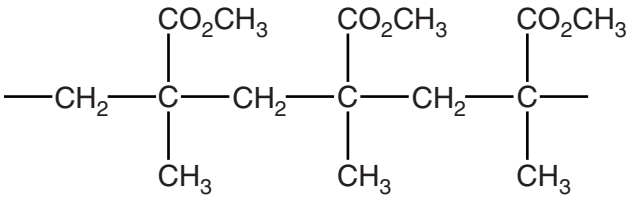
mass of methylsulfolene = ... g [3]

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(d) (i) What feature of the isoprene molecule is responsible for it forming an addition polymer?

.....[1]

(ii) *Perspex* is also an addition polymer.
The diagram shows part of the polymer chain of *Perspex*.



Deduce the formula of the monomer used to make *Perspex*.

[2]

[Total: 10]

B10 At 200 °C and 200 atmospheres pressure, phosphorus(V) chloride forms an equilibrium mixture with phosphorus(III) chloride and chlorine.

$$\underset{\substack{\text{phosphorus(V)}\\\text{chloride}}}{PCl_5(g)} \rightleftharpoons \underset{\substack{\text{phosphorus(III)}\\\text{chloride}}}{PCl_3(g)} + Cl_2(g)$$

(a) Predict and explain the effect of decreasing the pressure on the position of this equilibrium. The temperature remains constant.

.....

.....

.....[2]

(b) Predict and explain the effect of increasing the concentration of chlorine on the position of this equilibrium.

.....

.....

.....[2]

(c) The table shows the percentage of phosphorus(III) chloride in the equilibrium mixture at different temperatures. The pressure is the same in each case.

temperature / °C	% PCl_3 in the mixture
200	48
300	95
400	99

(i) Describe how the composition of this equilibrium mixture changes with temperature.

.....

.....[1]

(ii) Explain what this tells you about the energy change in this reaction.

.....

.....[1]

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(d) How is the position of equilibrium affected by the presence of a catalyst?

.....[1]

(e) The rate of this reaction increases with increase in temperature.
Explain why.

.....

.....

.....

.....[2]

(f) Phosphorus(V) chloride reacts with water. Phosphoric acid, H_3PO_4, and hydrogen chloride are formed.

Construct the equation for this reaction.

.....[1]

[Total: 10]

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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 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 Radius 88	227 Ac Actinium 89 †															

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

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	

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.).