UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9383590208

CHEMISTRY **5070/22**

Paper 2 Theory **October/November 2012**

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.

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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)** Define the term *compound*.

.....[1]

(b) Choose from the following compounds to answer the questions below.

calcium carbonate
carbon dioxide
carbon monoxide
ethane
glucose
methane
propane
sodium oxide
sucrose
water
zinc oxide

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

Which compound

(i) is a product of fermentation,

.....[1]

(ii) reacts with both hydrochloric acid and aqueous sodium hydroxide,

.....[1]

(iii) reacts with hydrochloric acid to form a gas which turns limewater milky,

.....[1]

(iv) is formed by the thermal decomposition of limestone,

.....[1]

(v) is a hydrocarbon formed by the bacterial decay of vegetable matter,

.....[1]

(vi) is a product of the incomplete combustion of a hydrocarbon?

.....[1]

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(c) Draw a 'dot-and-cross' diagram for a molecule of water.
Show only the outer shell electrons.

For Examiner's Use

[2]

[Total: 9]

A2 A student heated different mixtures of metals and metal oxides.
The table shows his results.

For Examiner's Use

mixture	reacts or no reaction
iron(III) oxide + zinc	reacts
lead(II) oxide + iron	reacts
lead(II) oxide + zinc	reacts
magnesium oxide + zinc	no reaction

(a) (i) Predict the order of reactivity of the metals iron, lead, magnesium and zinc.

least reactive ⟵⟶ most reactive

.....[1]

(ii) Construct the equation for the reaction of iron(III) oxide, Fe_2O_3, with zinc. The products are zinc oxide, ZnO, and iron.

[1]

(b) Aluminium is high in the reactivity series but does not appear to react with either water or acids.

(i) Explain why aluminium appears to be unreactive.

.....

.....[2]

(ii) Explain why aluminium is used in the manufacture of aircraft.

.....[1]

(iii) Only one naturally-occurring isotope of aluminium is known.
State the number of protons and neutrons in this isotope of aluminium.

number of protons .....

number of neutrons .....[1]

[Total: 6]

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A3 The rate of reaction of iron with aqueous bromine is determined using the apparatus shown below.

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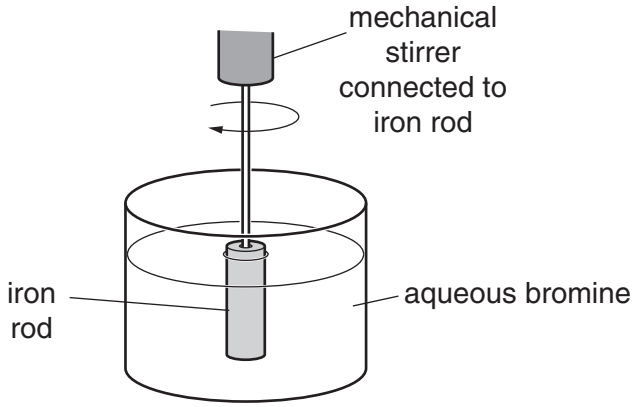

The iron is removed at regular intervals. It is washed, dried and then weighed. The iron is then replaced in the solution.
The experiment is repeated twice, each time with a different concentration of aqueous bromine.
The results are shown in the table below.

concentration of aqueous bromine mol/dm^3	speed of reaction mg iron reacted/min
0.050	9.2
0.10	18.1
0.15	27.2

(a) (i) Describe how and explain why the speed of this reaction changes with the concentration of bromine.

.....

.....

.....[2]

(ii) Describe and explain the effect of temperature on the speed of this reaction.

.....

.....

.....[2]

(iii) Suggest another method of measuring the speed of this reaction.

.....

.....[1]

(b) The equation for the reaction is

$$Fe + Br_2 \rightarrow FeBr_2 \qquad \Delta H = -250\,kJ/mol$$

For Examiner's Use

(i) Construct two half-equations for this reaction to show electron loss and gain.

[2]

(ii) Draw a labelled enthalpy profile diagram for the overall reaction.
On your diagram include

- the enthalpy change of reaction,
- the activation energy,
- reactants,
- products.

[3]

[Total: 10]

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A4 Wood is made up of many different carbon compounds.

For Examiner's Use

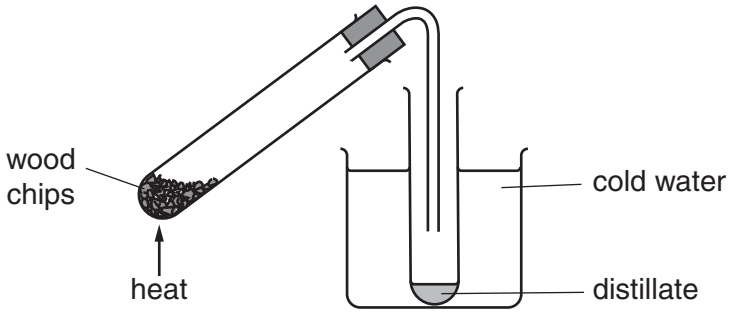
(a) Describe how carbon compounds are made in plants by photosynthesis.

.....

.....

.....[3]

(b) When wood is heated in the absence of air, the carbon compounds in the wood decompose.



The distillate contains a number of organic compounds, including

ethanoic acid

ethanal

ethanol

methanol

(i) When calcium hydroxide is added to the distillate, it neutralises the ethanoic acid. Name the salt formed in this neutralisation.

.....[1]

(ii) Ethanal can be removed from the distillate by a second distillation. On what physical property of ethanal does this distillation depend?

.....[1]

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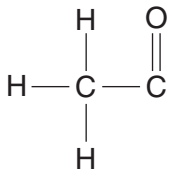
(iii) The composition by mass of ethanal is C 54.5%, H 9.1%, O 36.4%. Calculate the empirical formula of ethanal.

For Examiner's Use

[2]

(c) Ethanol reacts with ethanoic acid to form the ester ethyl ethanoate.

(i) Complete the following formula for ethyl ethanoate.



[1]

(ii) State a commercial use for esters.

.....[1]

[Total: 9]

A5 Nickel can be refined by reacting the impure metal with carbon monoxide. The impurities do not react with carbon monoxide.
A volatile compound called nickel carbonyl is formed.
This is decomposed to give pure nickel and carbon monoxide.

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(a) (i) Explain the meaning of the term *volatile*.

.....[1]

(ii) Suggest how nickel carbonyl might be decomposed.

.....[1]

(iii) Explain how this method separates nickel from its impurities.

.....[1]

(b) Nickel carbonyl has the formula $Ni(CO)_x$.
The relative molecular mass of nickel carbonyl is 171.
Calculate the value of x.

value of x = ...[1]

(c) Nickel is refined by electrolysis in a similar way to copper.
Draw a labelled diagram of the apparatus you would use to purify nickel by electrolysis in the laboratory.

[4]

(d) Nickel is a metal.
State three physical properties shown by **all** metals.

.....

.....

.....[3]

[Total: 11]

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 Seawater contains chloride, bromide and iodide ions.
Bromine can be manufactured by bubbling chlorine through seawater.

$$Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$$

(a) (i) Explain why the reaction of chlorine with bromide ions involves both oxidation and reduction.

.....

.....[2]

(ii) Describe how you could determine the pH of the resulting solution.

.....

.....[1]

(iii) Explain why iodine will not displace bromine from seawater.

.....[1]

(b) Bromine reacts with many elements to form bromides.
The table shows the boiling points and electrical conductivity for the bromides **A**, **B**, **C** and **D**.

bromide	boiling point / °C	electrical conductivity when molten
A	1435	conducts
B	916	conducts
C	154	does not conduct
D	173	does not conduct

Which two bromides are bonded covalently? Give a reason for your answer.

.....[1]

(c) Chlorine reacts with cold dilute sodium hydroxide to form sodium chlorate(I), $NaClO$, sodium chloride and water.
Construct an equation for this reaction.

[1]

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(d) The concentration of sodium chlorate(I) in a solution can be found by reacting sodium chlorate(I) with excess acidified potassium iodide and then titrating the iodine liberated with aqueous sodium thiosulfate, $Na_2S_2O_3$.

$$I_2 + 2Na_2S_2O_3 \rightarrow 2NaI + Na_2S_4O_6$$

A solution of sodium thiosulfate contains 12.4 g of sodium thiosulfate, $Na_2S_2O_3.5H_2O$, in 1.00 dm^3 of solution.

(i) Calculate the concentration of the sodium thiosulfate solution in mol/dm^3.

concentration = ... mol/dm^3 [1]

(ii) 23.6 cm^3 of this sodium thiosulfate solution reacts with exactly 12.5 cm^3 of aqueous iodine.
Calculate the concentration, in mol/dm^3, of the aqueous iodine.

[3]

[Total: 10]

B7 Glass contains silicon(IV) oxide and a number of metal oxides.

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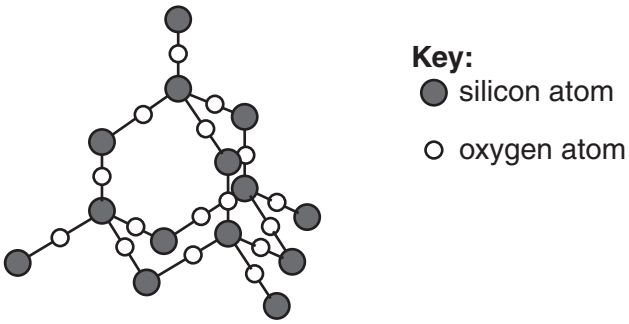
(a) The structure of silicon(IV) oxide is shown below.



(i) Describe **two** similarities in the structure of silicon(IV) oxide and diamond.

.....

.....

.....[2]

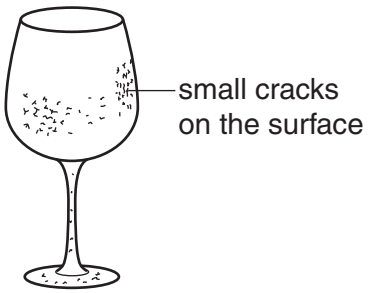
(ii) Explain why silicon(IV) oxide has a high melting point.

.....[2]

(iii) Explain why silicon(IV) oxide does not conduct electricity.

.....[1]

(b) Old wine glasses often appear cloudy because they have many small cracks on their surface.



The cracks are caused by differences in the rate of diffusion of sodium ions and hydrogen ions in the glass.

(i) Explain the meaning of the term *diffusion*.

.....

.....[1]

(ii) Suggest why sodium and hydrogen ions do not diffuse at the same rate.

.....[1]

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(c) Sodium oxide is an ionic compound.
Draw a 'dot-and-cross' diagram to show

- the arrangement of the outer shell electrons,
- the charges on the ions and
- the formula of sodium oxide.

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[3]

[Total: 10]

B8 Many fertilisers contain phosphate ions and nitrate ions.

For Examiner's Use

(a) Explain why farmers put fertilisers on the soil.

.....[1]

(b) Why should the chemicals in fertilisers be soluble in water?

.....[1]

(c) Ammonium nitrate, NH_4NO_3, and ammonium sulfate, $(NH_4)_2SO_4$, are commonly used in fertilisers.

(i) Calculate the percentage of nitrogen by mass in ammonium nitrate.

[3]

(ii) Describe how crystals of ammonium sulfate can be prepared from aqueous ammonia.

.....

.....

.....

.....

.....[4]

(d) The formula of calcium phosphate is $Ca_3(PO_4)_2$.
Use this formula to deduce the charge on the phosphate ion.

.....[1]

[Total: 10]

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B9 Chlorine and sodium hydroxide are manufactured by the electrolysis of concentrated aqueous sodium chloride.

For Examiner's Use

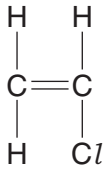
(a) (i) Chlorine can be used to bleach wood pulp.
Name another chemical that can be used to bleach wood pulp.

.....[1]

(ii) Explain the purpose of chlorine in water purification.

.....[1]

(b) Chlorine is used to make chloroethene.
The structure of chloroethene is shown below.



(i) Draw the structure of the polymer poly(chloroethene).

[2]

(ii) Chloroethene is an unsaturated compound.
Describe a positive test for an unsaturated compound.

test .....

result .....[2]

(c) Sodium hydroxide is a typical alkali.
It reacts with ethanoic acid to form water and the ionic salt, sodium ethanoate.

For Examiner's Use

(i) Write the formula for the ethanoate ion showing all atoms and bonds.

[1]

(ii) Construct the ionic equation for the reaction of ethanoic acid with sodium hydroxide.

[1]

(d) Compounds containing hydroxide ions can be added to the soil to reduce its acidity.

(i) Explain why adding hydroxide ions to the soil can cause the loss of nitrogen from fertilisers containing ammonium salts.

.....[1]

(ii) Construct an ionic 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 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.).