UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER							CANDIDATE NUMBER				

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.

UNIVERSITY of CAMBRIDGE
International Examinations

[Turn over

Section A

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.

<div align="center">

calcium carbonate

carbon dioxide

carbon monoxide

ethane

glucose

methane

propane

sodium oxide

sucrose

water

zinc oxide

</div>

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]

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

[2]

[Total: 9]

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

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.
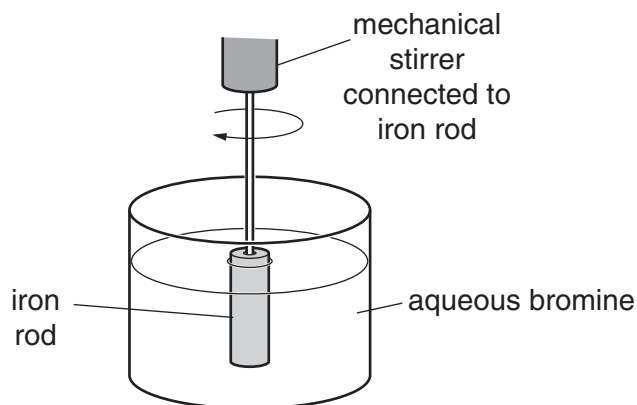State the number of protons and neutrons in this isotope of aluminium.

number of protons ....

number of neutrons ....[1]

[Total: 6]

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

mechanical stirrer connected to iron rod

iron rod

aqueous bromine

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

$$Fe \; + \; Br_2 \; \longrightarrow \; FeBr_2 \qquad \Delta H = -250 \, kJ/mol$$
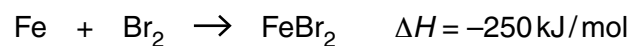
(i) Construct two half-equations for this reaction to show electron loss and gain.

[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]

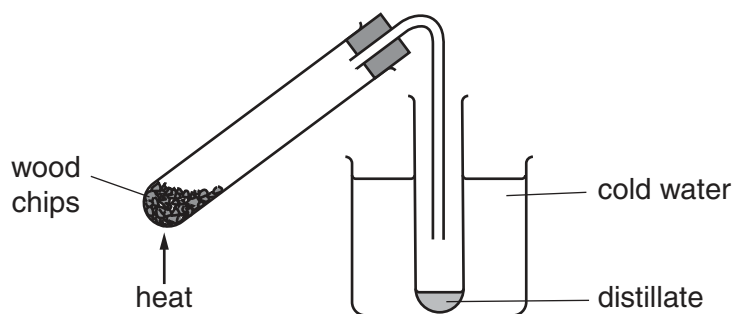**A4** Wood is made up of many different carbon compounds.

(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?
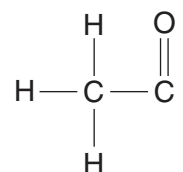
....[1]

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

[2]

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

(i) Complete the following formula for ethyl ethanoate.

$$
\begin{array}{ccc}
 & H & O \\
 & | & \parallel \\
H - & C - & C \\
 & | & \\
 & H & \\
\end{array}
$$

[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.

(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.
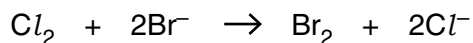State three physical properties shown by **all** metals.

....

....

....[3]

[Total: 11]

Section B

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.

$$Cl_2 \; + \; 2Br^- \; \longrightarrow \; Br_2 \; + \; 2Cl^-$$

(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]

(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, $Na_2S_2O_3$.

$$I_2 \ + \ 2Na_2S_2O_3 \ \rightarrow \ 2NaI \ + \ Na_2S_4O_6$$
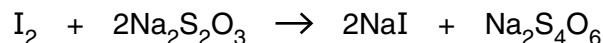
A solution of sodium thiosulfate contains 12.4 g of sodium thiosulfate, $Na_2S_2O_3.5H_2O$, in $1.00 \, dm^3$ of solution.

(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.
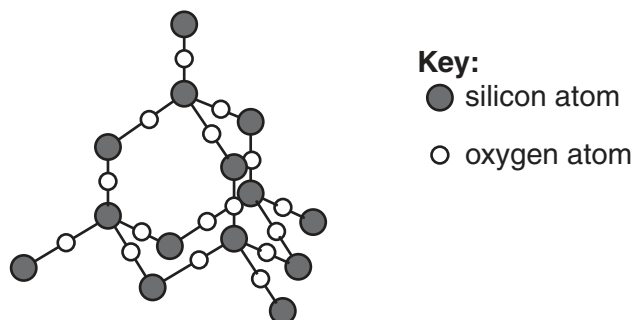Calculate the concentration, in mol/dm^3, of the aqueous iodine.

[3]

[Total: 10]

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

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

Key:
● silicon atom

○ oxygen atom

(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.

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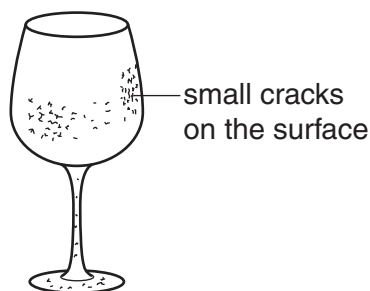
The cracks are caused by differences in the rate of diffusion of sodium ions and hydrogen ions in the glass.

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

....

....[1]

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

....[1]

(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.

[3]

[Total: 10]

B8 Many fertilisers contain phosphate ions and nitrate ions.

(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]

B9 Chlorine and sodium hydroxide are manufactured by the electrolysis of concentrated aqueous sodium chloride.
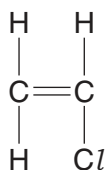
(a) (i) Chlorine can be used to bleach wood pulp.
Name another chemical that can be used to bleach wood pulp.

....[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.

$$\begin{array}{ccc} \text{H} & & \text{H} \\ | & & | \\ \text{C} & = & \text{C} \\ | & & | \\ \text{H} & & \text{C}l \end{array}$$

(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.

(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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19

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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	9		11	12	14	16	19	20
Li	**Be**		**B**	**C**	**N**	**O**	**F**	**Ne**
Lithium	Beryllium		Boron	Carbon	Nitrogen	Oxygen	Fluorine	Neon
3	4		5	6	7	8	9	10

23	24		27	28	31	32	35.5	40
Na	**Mg**		**A*l***	**Si**	**P**	**S**	**C*l***	**Ar**
Sodium	Magnesium		Aluminium	Silicon	Phosphorus	Sulfur	Chlorine	Argon
11	12		13	14	15	16	17	18

39	40	45	48	51	52	55	56	59	59	64	65	70	73	75	79	80	84
K	**Ca**	**Sc**	**Ti**	**V**	**Cr**	**Mn**	**Fe**	**Co**	**Ni**	**Cu**	**Zn**	**Ga**	**Ge**	**As**	**Se**	**Br**	**Kr**
Potassium	Calcium	Scandium	Titanium	Vanadium	Chromium	Manganese	Iron	Cobalt	Nickel	Copper	Zinc	Gallium	Germanium	Arsenic	Selenium	Bromine	Krypton
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36

85	88	89	91	93	96		101	103	106	108	112	115	119	122	128	127	131
Rb	**Sr**	**Y**	**Zr**	**Nb**	**Mo**	**Tc**	**Ru**	**Rh**	**Pd**	**Ag**	**Cd**	**In**	**Sn**	**Sb**	**Te**	**I**	**Xe**
Rubidium	Strontium	Yttrium	Zirconium	Niobium	Molybdenum	Technetium	Ruthenium	Rhodium	Palladium	Silver	Cadmium	Indium	Tin	Antimony	Tellurium	Iodine	Xenon
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54

133	137	139	178	181	184	186	190	192	195	197	201	204	207	209	209	210	222
Cs	**Ba**	**La** *	**Hf**	**Ta**	**W**	**Re**	**Os**	**Ir**	**Pt**	**Au**	**Hg**	**T*l***	**Pb**	**Bi**	**Po**	**At**	**Rn**
Caesium	Barium	Lanthanum	Hafnium	Tantalum	Tungsten	Rhenium	Osmium	Iridium	Platinum	Gold	Mercury	Thallium	Lead	Bismuth	Polonium	Astatine	Radon
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86

223	226	227
Fr	**Ra**	**Ac** †
Francium	Radium	Actinium
87	88	89

140	141	144	147	150	152	157	159	162	165	167	169	173	175
Ce	**Pr**	**Nd**	**Pm**	**Sm**	**Eu**	**Gd**	**Tb**	**Dy**	**Ho**	**Er**	**Tm**	**Yb**	**Lu**
Cerium	Praseodymium	Neodymium	Promethium	Samarium	Europium	Gadolinium	Terbium	Dysprosium	Holmium	Erbium	Thulium	Ytterbium	Lutetium
58	59	60	61	62	63	64	65	66	67	68	69	70	71

232	231	238	237	244	243	247	247	251	252	257	258	259	260
Th	**Pa**	**U**	**Np**	**Pu**	**Am**	**Cm**	**Bk**	**Cf**	**Es**	**Fm**	**Md**	**No**	**Lr**
Thorium	Protactinium	Uranium	Neptunium	Plutonium	Americium	Curium	Berkelium	Californium	Einsteinium	Fermium	Mendelevium	Nobelium	Lawrencium
90	91	92	93	94	95	96	97	98	99	100	101	102	103

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

Key

a
X
b

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

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).