



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE
NAME

CENTRE
NUMBER

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CANDIDATE
NUMBER

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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.



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.

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?

- (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]

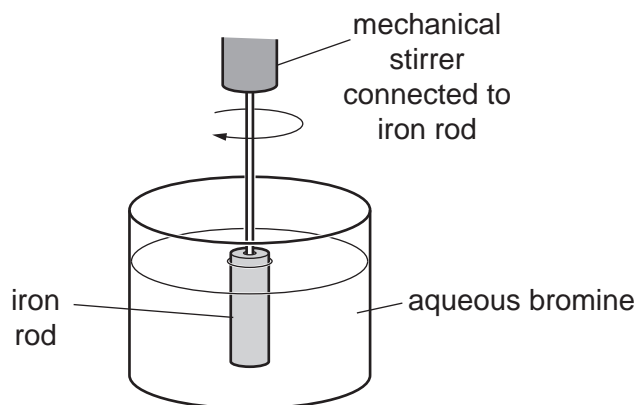
- (iii)** Only one naturally-occurring isotope of aluminium is known.
State the number of protons and neutrons in this isotope of aluminium.

number of protons

number of neutrons[1]

[Total: 6]

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



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.

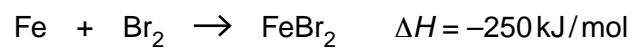
.....

 [2]

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

.....
 [1]

(b) The equation for the reaction is



(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]

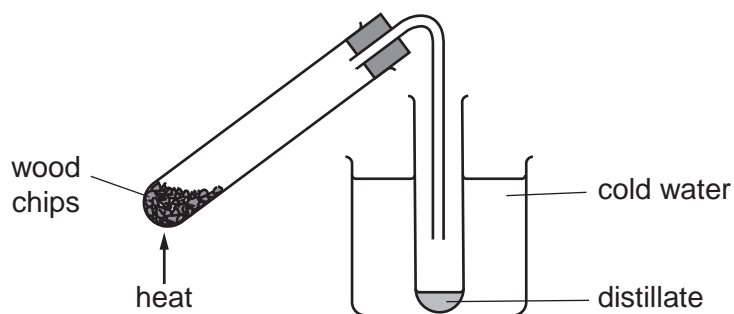
A4 Wood is made up of many different carbon compounds.

(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?

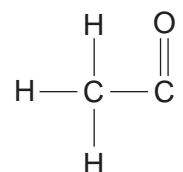
..... [1]

- (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.



[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 $\text{Ni}(\text{CO})_x$.

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.

.....

.....

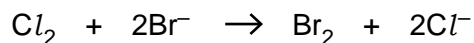
..... [3]

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.



- (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**.

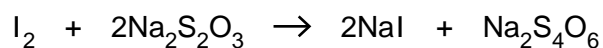
bromide	boiling point / °C	electrical conductivity when molten
A	1435	conducts
B	916	conducts
C	154	does not conduct
D	173	does not conduct

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.

- (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, $\text{Na}_2\text{S}_2\text{O}_3$.



A solution of sodium thiosulfate contains 12.4 g of sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$, 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.

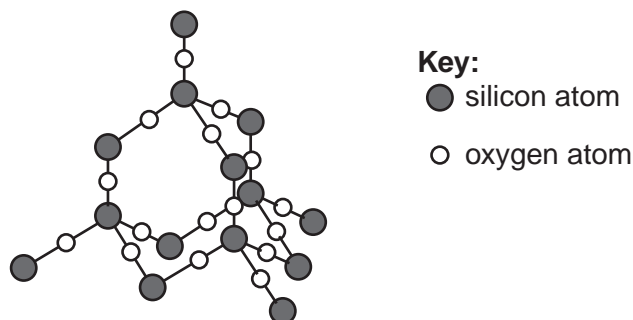
Calculate the concentration, in mol/dm^3 , of the aqueous iodine.

[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.



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

.....

 [2]

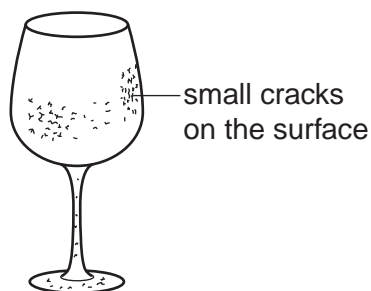
(ii) Explain why silicon(IV) oxide has a high melting point.

..... [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]

(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, $(\text{NH}_4)_2\text{SO}_4$, 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 $\text{Ca}_3(\text{PO}_4)_2$.
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.

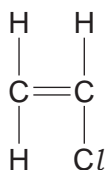
- (a) (i) Chlorine can be used to bleach wood pulp.
Name another chemical that can be used to bleach wood pulp.

.....[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.



- (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]

DATA SHEET
The Periodic Table of the Elements

Group		Group																																																															
		I	II	III	IV	V	VI	VII	0																																																								
7	Li Lithium 4	9	Be Beryllium	1	H Hydrogen 1	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 12	24	Mg Magnesium	25	Mn Manganese	26	Fe Iron	27	Co Cobalt	28	Ni Nickel	29	Cu Copper	30	Zn Zinc	31	Ga Gallium	32	Ge Germanium	33	As Arsenic	34	Se Selenium	35	Br Bromine	36	Kr Krypton																																						
39	K Potassium 20	40	Ca Calcium	41	Sc Scandium	42	Ti Titanium	43	V Vanadium	44	Cr Chromium	45	Mn Manganese	46	Fe Iron	47	Co Cobalt	48	Ni Nickel	49	Cu Copper	50	Zn Zinc	51	Ga Gallium	52	Ge Germanium	53	As Arsenic	54	Se Selenium																																		
85	Rb Rubidium 38	86	Sr Strontium	87	Y Yttrium	88	Zr Zirconium	89	Nb Niobium	90	Mo Molybdenum	91	Tc Technetium	92	Ru Ruthenium	93	Rh Rhodium	94	Pd Palladium	95	Ag Silver	96	Cd Cadmium	97	In Indium	98	Sn Tin	99	Sb Antimony	100	Te Tellurium	101	I Iodine	102	Xe Xenon																														
133	Cs Caesium 56	137	Ba Barium	138	La Lanthanum	139	Hf Hafnium	140	Ta Tantalum	141	W Tungsten	142	Re Rhenium	143	Os Osmium	144	Ir Iridium	145	Pt Platinum	146	Au Gold	147	Hg Mercury	148	Tl Thallium	149	Pb Lead	150	Bi Bismuth	151	Po Polonium	152	At Astatine	153	Rn Radon																														
223	Fr Francium 88	226	Ra Radium	227	Ac Actinium	228	Th Thorium	229	Pa Protactinium	230	U Uranium	231	Np Neptunium	232	Pu Plutonium	233	Am Americium	234	Cm Curium	235	Bk Berkelium	236	Cf Californium	237	Es Einsteinium	238	Fm Fermium	239	Md Mendelevium	240	No Nobelium	241	Lr Lawrencium	242	Rf Rutherfordium																														
108	Hg Mercury 80	109	Tl Thallium	110	Pb Lead	111	Bi Bismuth	112	Po Polonium	113	At Astatine	114	Rn Radon	115	Fr Francium	116	Ra Radium	117	Ac Actinium	118	Th Thorium	119	Pa Protactinium	120	U Uranium	121	Np Neptunium	122	Pu Plutonium	123	Am Americium	124	Cm Curium	125	Bk Berkelium	126	Cf Californium	127	Es Einsteinium	128	Fm Fermium	129	Md Mendelevium	130	No Nobelium	131	Lr Lawrencium																		
175	Lu Lutetium 71	176	Hf Hafnium	177	Ta Tantalum	178	W Tungsten	179	Re Rhenium	180	Os Osmium	181	Ir Iridium	182	Pt Platinum	183	Au Gold	184	Hg Mercury	185	Tl Thallium	186	Pb Lead	187	Bi Bismuth	188	Po Polonium	189	At Astatine	190	Rn Radon	191	Fr Francium	192	Ra Radium	193	Ac Actinium	194	Th Thorium	195	Pa Protactinium	196	U Uranium	197	Np Neptunium	198	Pu Plutonium	199	Am Americium	200	Cm Curium	201	Bk Berkelium	202	Cf Californium	203	Es Einsteinium	204	Fm Fermium	205	Md Mendelevium	206	No Nobelium	207	Lr Lawrencium
222	Rn Radon 86	223	Fr Francium	224	Ra Radium	225	Ac Actinium	226	Th Thorium	227	Pa Protactinium	228	U Uranium	229	Np Neptunium	230	Pu Plutonium	231	Am Americium	232	Cm Curium	233	Bk Berkelium	234	Cf Californium	235	Es Einsteinium	236	Fm Fermium	237	Md Mendelevium	238	No Nobelium	239	Lr Lawrencium	240	Rf Rutherfordium	241	Db Dubnium	242	Sg Seaborgium	243	Bh Bohrium	244	Hs Hassium	245	Mt Meitnerium	246	Ds Darmstadtium	247	Rg Roentgenium	248	Cn Copernicium	249	Nh Nihonium	250	Fl Flerovium	251	Mc Moscovium	252	Lv Livermorium	253	Ts Tennessine	254	Og Oganesson

8–71 Lanthanoid series
90–103 Actinoid series

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

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