



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	
<b>Section A</b>	
<b>B6</b>	
<b>B7</b>	
<b>B8</b>	
<b>B9</b>	
<b>Total</b>	

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.

For  
Examiner's  
Use

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]

- (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,  $\text{Fe}_2\text{O}_3$ , with zinc. The products are zinc oxide,  $\text{ZnO}$ , 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.

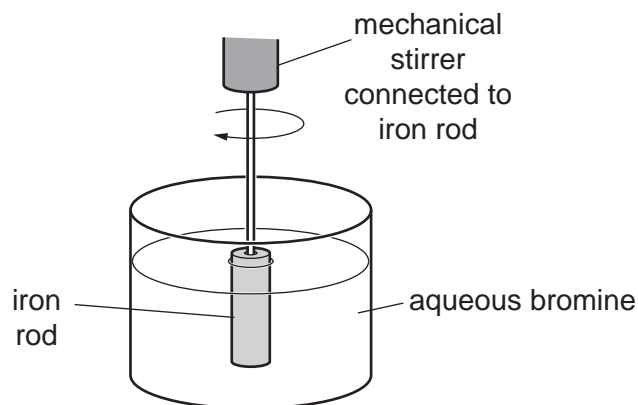
number of protons .....

number of neutrons ..... [1]

[Total: 6]

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

For  
Examiner's  
Use



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 <sup>3</sup>	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]

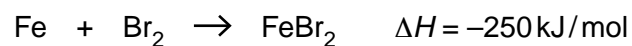
**(ii)** Describe and explain the effect of temperature on the speed of this reaction.

.....  
 .....  
 ..... [2]

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

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

(b) The equation for the reaction is



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]

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

For  
Examiner's  
Use

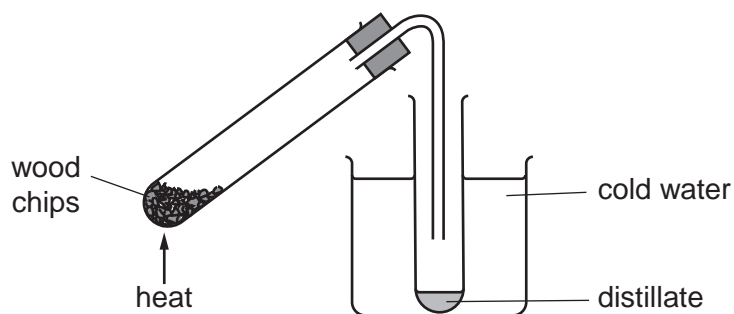
(a) Describe how carbon compounds are made in plants by photosynthesis.

.....

.....

.....[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]

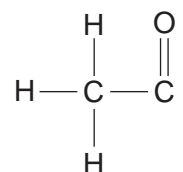
- (iii) The composition by mass of ethanal is C 54.5%, H 9.1%, O 36.4%.  
Calculate the empirical formula of ethanal.

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.

For  
Examiner's  
Use

**(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]

[Total: 11]

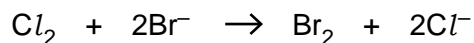
## Section B

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

The total mark for this section is 30.

For  
Examiner's  
Use

- 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.

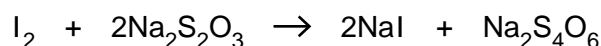
..... [1]

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

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

For  
Examiner's  
Use



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  $1.00 \text{ dm}^3$  of solution.

- (i) Calculate the concentration of the sodium thiosulfate solution in  $\text{mol/dm}^3$ .

concentration = .....  $\text{mol/dm}^3$  [1]

- (ii)  $23.6 \text{ cm}^3$  of this sodium thiosulfate solution reacts with exactly  $12.5 \text{ cm}^3$  of aqueous iodine.

Calculate the concentration, in  $\text{mol/dm}^3$ , of the aqueous iodine.

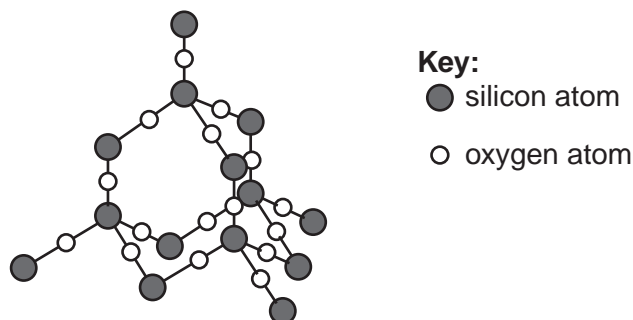
[3]

[Total: 10]

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

For  
Examiner's  
Use

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



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

.....  
 .....  
 ..... [2]

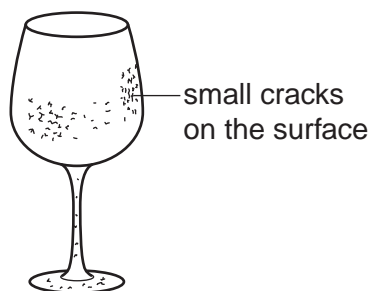
(ii) Explain why silicon(IV) oxide has a high melting point.

..... [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.

*For  
Examiner's  
Use*

[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,  $\text{NH}_4\text{NO}_3$ , 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.

For  
Examiner's  
Use

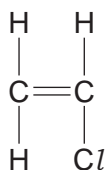
- (a) (i)** Chlorine can be used to bleach wood pulp.  
Name another chemical that can be used to bleach wood pulp.

.....[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.

(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 <b>H</b> Hydrogen 1										2 <b>He</b> Helium 2					
3 <b>Li</b> Lithium 3	4 <b>Be</b> Beryllium 4	5 <b>B</b> Boron 5	6 <b>C</b> Carbon 6	7 <b>N</b> Nitrogen 7	8 <b>O</b> Oxygen 8	9 <b>F</b> Fluorine 9	10 <b>Ne</b> Neon 10	11 <b>B</b> Boron 11	12 <b>C</b> Carbon 12	13 <b>Al</b> Aluminium 13	14 <b>Si</b> Silicon 14	15 <b>P</b> Phosphorus 15	16 <b>S</b> Sulfur 16	17 <b>Cl</b> Chlorine 17	18 <b>Ar</b> Argon 18		
19 <b>K</b> Potassium 19	20 <b>Ca</b> Calcium 20	21 <b>Sc</b> Scandium 21	22 <b>Ti</b> Titanium 22	23 <b>V</b> Vanadium 23	24 <b>Cr</b> Chromium 24	25 <b>Mn</b> Manganese 25	26 <b>Fe</b> Iron 26	27 <b>Co</b> Cobalt 27	28 <b>Ni</b> Nickel 28	29 <b>Cu</b> Copper 29	30 <b>Zn</b> Zinc 30	31 <b>Ga</b> Gallium 31	32 <b>Ge</b> Germanium 32	33 <b>As</b> Arsenic 33	34 <b>Se</b> Selenium 34	35 <b>Br</b> Bromine 35	36 <b>Kr</b> Krypton 36
37 <b>Rb</b> Rubidium 37	38 <b>Sr</b> Strontium 38	39 <b>Y</b> Yttrium 39	40 <b>Zr</b> Zirconium 40	41 <b>Nb</b> Niobium 41	42 <b>Mo</b> Molybdenum 42	43 <b>Tc</b> Technetium 43	44 <b>Ru</b> Ruthenium 44	45 <b>Rh</b> Rhodium 45	46 <b>Pd</b> Palladium 46	47 <b>Ag</b> Silver 47	48 <b>Cd</b> Cadmium 48	49 <b>In</b> Indium 49	50 <b>Sn</b> Tin 50	51 <b>Sb</b> Antimony 51	52 <b>Te</b> Tellurium 52	53 <b>I</b> Iodine 53	54 <b>Xe</b> Xenon 54
55 <b>Cs</b> Caesium 55	56 <b>Ba</b> Barium 56	57 <b>La</b> Lanthanum 57	72 <b>Hf</b> Hafnium 72	73 <b>Ta</b> Tantalum 73	74 <b>W</b> Tungsten 74	75 <b>Re</b> Rhenium 75	76 <b>Os</b> Osmium 76	77 <b>Ir</b> Iridium 77	78 <b>Pt</b> Platinum 78	79 <b>Au</b> Gold 79	80 <b>Hg</b> Mercury 80	81 <b>Tl</b> Thallium 81	82 <b>Pb</b> Lead 82	83 <b>Bi</b> Bismuth 83	84 <b>Po</b> Polonium 84	85 <b>At</b> Astatine 85	86 <b>Rn</b> Radon 86
87 <b>Fr</b> Francium 87	88 <b>Ra</b> Radium 88	89 <b>Ac</b> Actinium 89															

140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	142 <b>Nd</b> Neodymium 60	143 <b>Pm</b> Promethium 61	144 <b>Nd</b> Neodymium 60	145 <b>Sm</b> Samarium 62	146 <b>Eu</b> Europium 63	147 <b>Pm</b> Promethium 61	148 <b>Sm</b> Samarium 62	149 <b>Gd</b> Gadolinium 64	150 <b>Eu</b> Europium 63	151 <b>Gd</b> Gadolinium 64	152 <b>Tb</b> Terbium 65	153 <b>Dy</b> Dysprosium 66	154 <b>Ho</b> Holmium 67	155 <b>Er</b> Erbium 68	156 <b>Tm</b> Thulium 69	157 <b>Yb</b> Ytterbium 70	158 <b>Lu</b> Lutetium 71
232 <b>Th</b> Thorium 90	231 <b>Pa</b> Protactinium 91	238 <b>U</b> Uranium 92	237 <b>Np</b> Neptunium 93	244 <b>Pu</b> Plutonium 94	243 <b>Am</b> Americium 95	242 <b>Cm</b> Curium 96	247 <b>Bk</b> Berkelium 97	251 <b>Cf</b> Californium 98	252 <b>Es</b> Einsteinium 99	257 <b>Fm</b> Fermium 100	258 <b>Md</b> Mendelevium 101	259 <b>No</b> Nobelium 102	260 <b>Lr</b> Lawrencium 103					

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

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

a	<b>X</b>	b
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**Key**

The volume of one mole of any gas is 24dm<sup>3</sup> at room temperature and pressure (r.t.p.).