



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE
NAME

CENTRE
NUMBER

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NUMBER

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CHEMISTRY

5070/22

Paper 2 Theory

October/November 2011

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.

For
Examiner's
Use

A1 Choose from the following list of elements to answer the questions below.

calcium

chlorine

hydrogen

iodine

nickel

sodium

vanadium

zinc

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

Which element

(a) forms an oxide which is amphoteric,

..... [1]

(b) is a catalyst in the hydrogenation of alkenes,

..... [1]

(c) oxidises aqueous bromide ions to bromine,

..... [1]

(d) is used in water purification to kill bacteria,

..... [1]

(e) is formed at the cathode when a dilute aqueous solution of sodium chloride is electrolysed,

..... [1]

(f) can be used in the sacrificial protection of iron?

..... [1]

[Total: 6]

A2 Pure oxygen for industrial use is obtained from the air.

For
Examiner's
Use

- (a) (i)** State the percentage by volume of oxygen in clean air.

..... [1]

- (ii)** Explain how fractional distillation is used to obtain oxygen from the air.

.....

.....

.....

..... [2]

- (b)** When acetylene, C_2H_2 , burns in oxygen it produces a very hot flame.
State one industrial use for this oxyacetylene flame.

..... [1]

- (c)** Acetylene has a triple covalent bond between its carbon atoms.
Draw a 'dot-and-cross' diagram for acetylene.
You need only show the outer electrons.

[1]

- (d) Oxygen reacts with magnesium to form magnesium oxide.
Draw diagrams to show the complete electronic structure and charges of both ions present in magnesium oxide.

For
Examiner's
Use

[2]

- (e) Oxygen, O_2 , in the atmosphere can react to form ozone, O_3 .

(i) Write an equation for this reaction.

..... [1]

(ii) In the **upper** atmosphere there is a layer of ozone surrounding the Earth.
Explain the importance of this layer in terms of human health.

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

[Total: 9]

A3 The alkanes are an homologous series of saturated hydrocarbons with the general formula C_nH_{2n+2} .

For
Examiner's
Use

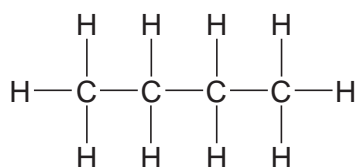
(a) What do you understand by the term *hydrocarbon*?

..... [1]

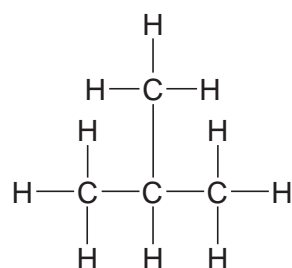
(b) Write the molecular formula for the alkane containing seven carbon atoms.

..... [1]

(c) Two different structural formulae can be written for the alkane having the molecular formula C_4H_{10} .



butane

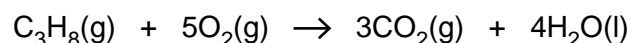


methylpropane

What term is given to compounds with the same molecular formula but different structural formulae?

..... [1]

(d) A student ignites a mixture of 15 cm^3 of propane and 100 cm^3 of oxygen. The oxygen is in excess. All measurements of volume are taken at room temperature and pressure.



Calculate

the volume of carbon dioxide formed,

..... cm^3 [1]

the volume of unreacted oxygen remaining.

..... cm^3 [1]

(e) Explain why the **incomplete** combustion of an alkane in an enclosed space is hazardous.

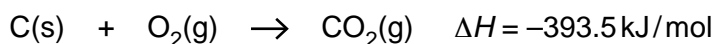
.....

..... [2]

[Total: 7]

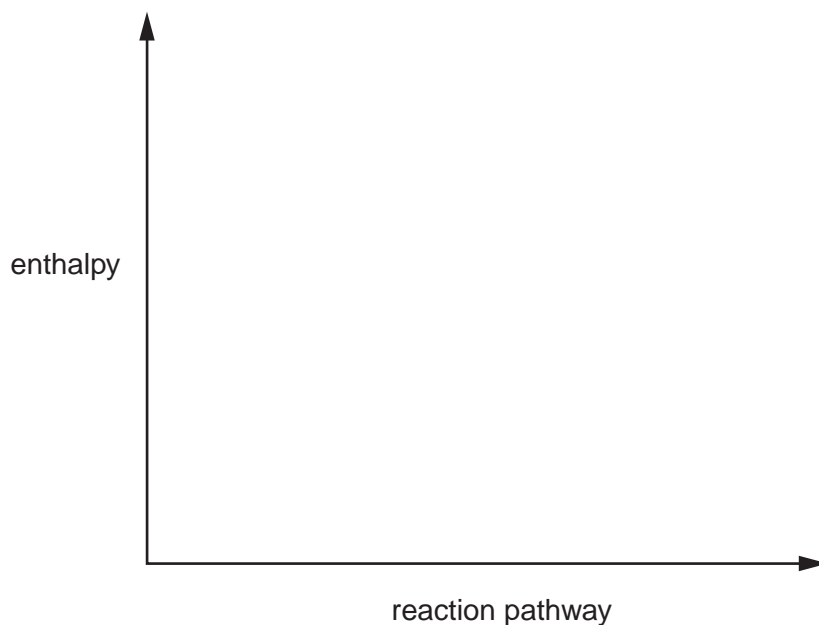
A4 Coal is largely carbon.

(a) Carbon burns in excess air to form carbon dioxide.



(i) Draw an energy profile diagram for this reaction on the axes below. On your diagram label

- the reactants and products
- the enthalpy change for the reaction
- the activation energy



[3]

(ii) Give a test for carbon dioxide.

test

observation [2]

(b) Coal contains a small amount of sulfur.

(i) Explain how the burning of coal results in the formation of acid rain.

.....
.....
.....
.....
..... [3]

(ii) State one effect of acid rain.

..... [1]

(c) Oxides of nitrogen also contribute to acid rain. They can be formed naturally in the atmosphere from nitrogen and oxygen.

(i) What condition is needed to allow nitrogen and oxygen to combine in the atmosphere?

..... [1]

(ii) Nitric acid in the atmosphere can chemically erode buildings made from carbonate rocks.

Write an equation for the reaction of nitric acid, HNO_3 , with calcium carbonate, CaCO_3 .

[2]

[Total: 12]

A5 Bromine is a halogen. It has two naturally-occurring isotopes.

For
Examiner's
Use

(a) Define the term *isotopes*.

.....
 [1]

(b) One isotope of bromine has the symbol ${}_{35}^{81}\text{Br}$.

State the number of protons, neutrons and electrons in this isotope of bromine.

protons


neutrons

electrons

[2]

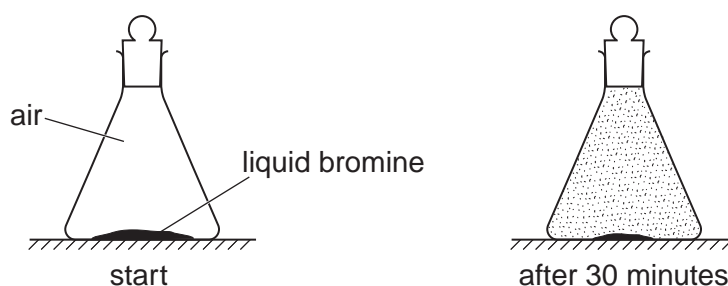
(c) Bromine is a liquid at room temperature.

(i) Draw a diagram to show the arrangement of the molecules in liquid bromine.

Show a bromine molecule as .

[2]

(ii) A small amount of liquid bromine was placed in the bottom of a sealed flask. After thirty minutes the brown colour of the bromine had spread throughout the flask.



Use the kinetic particle theory to explain these observations.

.....

 [3]

(d) Bromine forms a variety of compounds with other halogens.

- (i) Bromine reacts with fluorine to form bromine(I) fluoride, BrF.
Write an equation for this reaction.

..... [1]

- (ii) Another compound of bromine and fluorine is bromine(V) fluoride, BrF₅.
Calculate the percentage of bromine by mass in bromine(V) fluoride.

[2]

[Total: 11]

For
Examiner's
Use

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 Ammonia is made by the Haber process.

(a) (i) Write an equation for the formation of ammonia in the Haber process.

..... [1]

(ii) State the essential conditions for the Haber process.

.....
..... [3]

(b) Ammonia is used to make fertilisers.
Explain why farmers use fertilisers.

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

(c) Many fertilisers are ammonium salts.
Explain why adding calcium hydroxide to the soil can cause the loss of nitrogen from the ammonium salts added as fertilisers.

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

(d) Fertilisers such as ammonium nitrate and ammonium phosphate are solids.
They can get into lakes and cause excessive growth of algae.

(i) Explain how these fertilisers get into lakes.

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

(ii) What name is given to the enrichment of lakes with nitrates and phosphates which leads to the death of plant and animal life in the lakes?

..... [1]

[Total: 10]

B7 Sulfuric acid is a strong acid. Ethanoic acid is a weak acid.

For
Examiner's
Use

(a) What do you understand by the terms *strong acid* and *weak acid*?

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

(b) Compare and explain the difference in the electrical conductivity between a strong and a weak acid.

..... [1]

(c) A dilute solution of sulfuric acid contains hydrogen ions, hydroxide ions and sulfate ions. When this solution is electrolysed, hydrogen gas is formed at the cathode and oxygen gas is formed at the anode.

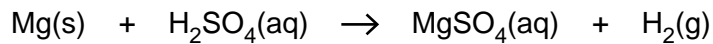
(i) Explain why hydrogen is formed at the cathode.

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

(ii) Write the ionic equation for the reaction at the anode.

..... [2]

(d) Magnesium reacts with dilute sulfuric acid.



For
Examiner's
Use

- (i) Describe how you can follow the progress of this reaction.
What measurements can you use to calculate the speed of the reaction?

.....
.....
.....
.....
.....
..... [3]

- (ii) A student reacts 3.0 g of magnesium with 2.5 mol/dm³ sulfuric acid.
Calculate the minimum volume of sulfuric acid that reacts with all the magnesium.

[2]

[Total: 10]

B8 The table gives some information about the first five members of the carboxylic acid homologous series.

For
Examiner's
Use

carboxylic acid	formula	boiling point/°C
methanoic acid	HCO ₂ H	101
ethanoic acid	CH ₃ CO ₂ H	118
propanoic acid	C ₂ H ₅ CO ₂ H	141
butanoic acid		166
pentanoic acid	C ₄ H ₉ CO ₂ H	

(a) (i) Estimate the boiling point of pentanoic acid.

..... [1]

(ii) Draw the structure of butanoic acid.
Show all atoms and bonds.

[1]

(iii) Ethanoic acid reacts with sodium.
Write an equation for this reaction.

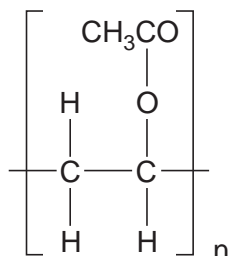
..... [1]

(b) Carboxylic acids react with alcohols to form esters.

(i) Name the ester formed when ethanoic acid reacts with ethanol.

..... [1]

(ii) The diagram shows the repeat unit of poly(ethenyl ethanoate)



Draw the structure of the monomer used to make poly(ethenyl ethanoate).

[1]

(c) Carboxylic acid **X** contains 55.8% carbon, 7.0% hydrogen and 37.2% oxygen.

(i) Calculate the empirical formula of **X**.

For
Examiner's
Use

[2]

(ii) A molecule of carboxylic acid **X** contains four carbon atoms. What is its molecular formula?

..... [1]

(iii) Carboxylic acid **X** is an unsaturated compound.
Give a test for an unsaturated compound.

test

observation [2]

[Total: 10]

B9 Barium is a reactive metal in Group II of the Periodic Table.
Barium reacts with water in a similar way to sodium. The products of the reaction are aqueous barium hydroxide and a colourless gas.

For
Examiner's
Use

(a) (i) Write an equation, including state symbols, for this reaction.

..... [3]

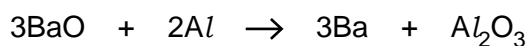
(ii) Aqueous barium hydroxide is neutralised by hydrochloric acid.
Write the simplest ionic equation for this reaction.

..... [1]

(b) Explain why barium metal conducts electricity.

..... [1]

(c) Barium oxide reacts with aluminium.



Explain how this equation shows that aluminium is a reducing agent.

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

(d) Barium sulfate is an insoluble compound.
Describe how a pure dry sample of barium sulfate is prepared from aqueous barium nitrate.

.....
.....
.....
.....
.....
.....
.....
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.....
.....
..... [4]

[Total:10]

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DATA SHEET The Periodic Table of the Elements

		Group																									
			I	II	III	IV	V	VI	VII	O																	
			1 H Hydrogen 1									2 He Helium 4															
3 Li Lithium 7	4 Be Beryllium 9											5 B Boron 11	6 C Carbon 12	7 N Nitrogen 14	8 O Oxygen 16	9 F Fluorine 19	10 Ne Neon 20										
11 Na Sodium 23	12 Mg Magnesium 24											13 Al Aluminium 27	14 Si Silicon 28	15 P Phosphorus 31	16 S Sulfur 32	17 Cl Chlorine 35.5	18 Ar Argon 40										
19 K Potassium 39	20 Ca Calcium 40											21 Sc Scandium 45	22 Ti Titanium 48	23 V Vanadium 51	24 Cr Chromium 52	25 Mn Manganese 55	26 Fe Iron 56	27 Co Cobalt 59	28 Ni Nickel 59	29 Cu Copper 64	30 Zn Zinc 65	31 Ga Gallium 70	32 Ge Germanium 73	33 As Arsenic 75	34 Se Selenium 79	35 Br Bromine 80	36 Kr Krypton 84
37 Rb Rubidium 85	38 Sr Strontium 88											39 Y Yttrium 89	40 Zr Zirconium 91	41 Nb Niobium 93	42 Mo Molybdenum 96	43 Tc Technetium 98	44 Ru Ruthenium 101	45 Rh Rhodium 103	46 Pd Palladium 106	47 Ag Silver 108	48 Cd Cadmium 112	49 In Indium 115	50 Sn Tin 119	51 Sb Antimony 122	52 Te Tellurium 128	53 I Iodine 127	54 Xe Xenon 131
55 Cs Caesium 133	56 Ba Barium 137											57 La Lanthanum 139	58 Hf Hafnium 178	59 Ta Tantalum 181	60 W Tungsten 184	61 Re Rhenium 186	62 Os Osmium 190	63 Ir Iridium 192	64 Pt Platinum 195	65 Au Gold 197	66 Hg Mercury 201	67 Tl Thallium 204	68 Pb Lead 207	69 Bi Bismuth 209	70 Po Polonium 209	71 At Astatine 210	72 Rn Radon 222
87 Fr Francium 223	88 Ra Radium 226											89 Ac Actinium 227															

		162 Dy Dysprosium 66	159 Tb Terbium 65	157 Gd Gadolinium 64	152 Eu Europium 63	150 Sm Samarium 62	147 Pm Promethium 61	144 Nd Neodymium 60	141 Pr Praseodymium 59	140 Ce Cerium 58	173 Yb Ytterbium 70	169 Tm Thulium 69	167 Er Erbium 68	165 Ho Holmium 67	162 Dy Dysprosium 66	159 Tb Terbium 65	157 Gd Gadolinium 64	152 Eu Europium 63	150 Sm Samarium 62	147 Pm Promethium 61	144 Nd Neodymium 60	141 Pr Praseodymium 59	140 Ce Cerium 58	175 Lu Lutetium 71	173 Yb Ytterbium 70	169 Tm Thulium 69	167 Er Erbium 68	165 Ho Holmium 67	162 Dy Dysprosium 66	159 Tb Terbium 65	157 Gd Gadolinium 64	152 Eu Europium 63	150 Sm Samarium 62	147 Pm Promethium 61	144 Nd Neodymium 60	141 Pr Praseodymium 59	140 Ce Cerium 58	175 Lu Lutetium 71	173 Yb Ytterbium 70	169 Tm Thulium 69	167 Er Erbium 68	165 Ho Holmium 67	162 Dy Dysprosium 66	159 Tb Terbium 65	157 Gd Gadolinium 64	152 Eu Europium 63	150 Sm Samarium 62	147 Pm Promethium 61	144 Nd Neodymium 60	141 Pr Praseodymium 59	140 Ce Cerium 58	260 Lr Lawrencium 103	259 No Nobelium 102	258 Md Mendelevium 101	257 Fm Fermium 100	252 Es Einsteinium 99	251 Cf Californium 98	247 Bk Berkelium 97	247 Cm Curium 96	243 Am Americium 95	244 Pu Plutonium 94	237 Np Neptunium 93	238 U Uranium 92	231 Pa Protactinium 91	232 Th Thorium 90
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		a	X	b
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* 58–71 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.).