



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 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

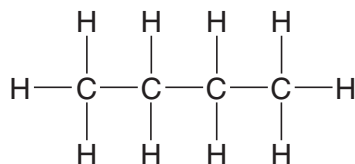
(a) What do you understand by the term *hydrocarbon*?

..... [1]

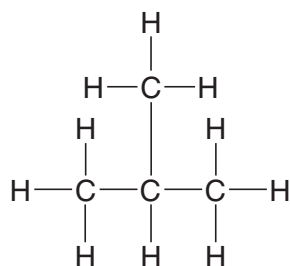
(b) Write the molecular formula for the alkane containing seven carbon atoms.

..... [1]

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



butane

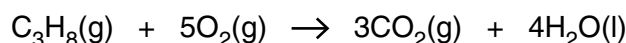


methylpropane

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.

.....

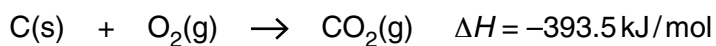
..... [2]

[Total: 7]

A4 Coal is largely carbon.

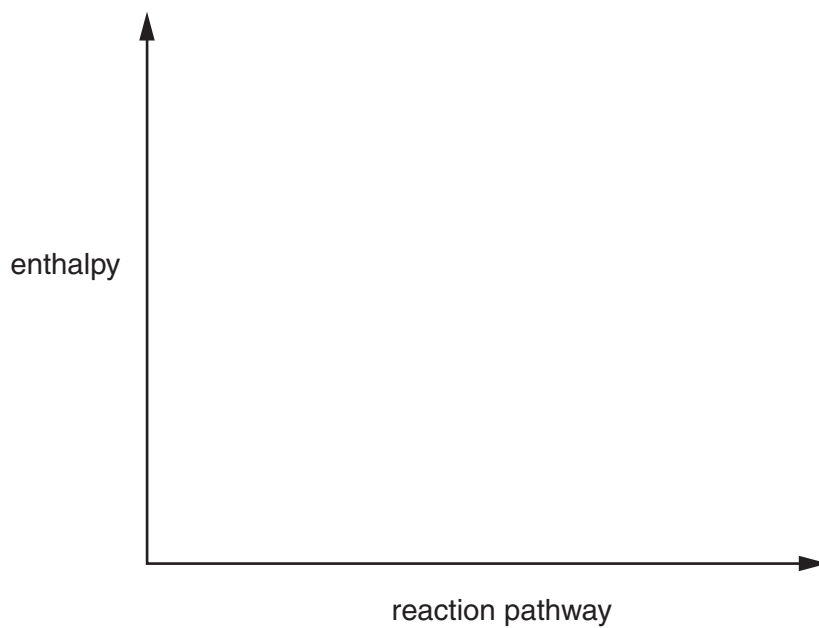
For
Examiner's
Use

(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]

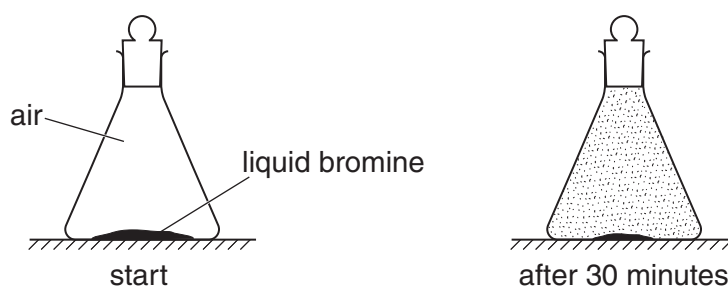
(c) Bromine is a liquid at room temperature.

(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.

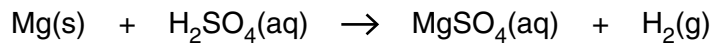
(i) Explain why hydrogen is formed at the cathode.

.....
..... [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.

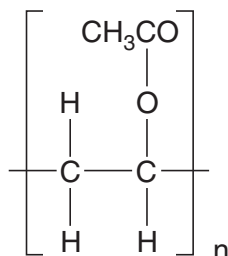
..... [1]

(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]

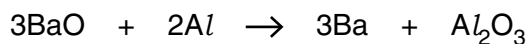
(ii) Aqueous barium hydroxide is neutralised by hydrochloric acid.
Write the simplest ionic equation for this reaction.

..... [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.

.....
.....
.....
.....
.....
.....
.....
.....
.....
..... [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					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							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							91 Ti Titanium 22	91 Zr Zirconium 40	91 Hf Hafnium 72	95 Mo Molybdenum 42	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	127 I Iodine 53	131 Xe Xenon 54																			
133 Cs Caesium 55	137 Ba Barium 56							141 Pr Praseodymium 59	144 Nd Neodymium 60	147 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 At Astatine 85	222 Rn Radon 86																		
223 Fr Francium 87	226 Ra Radium 88							186 Re Rhenium 75	186 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																							
																		227 Ac Actinium 89																						
																		* 58–71 Lanthanoid series † 90–103 Actinoid series																						
																		<div style="display: flex; justify-content: center; align-items: center; gap: 10px;"> <div style="border: 1px solid black; padding: 2px;">a</div> <div style="font-weight: bold; font-size: 1.2em;">X</div> <div style="border: 1px solid black; padding: 2px;">b</div> </div> <p style="text-align: center; margin-top: 5px;"> a = relative atomic mass X = atomic symbol b = atomic (proton) number </p>																						
																		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	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	251 Cf Californium 98	252 Es Einsteinium 99	257 Fm Fermium 100	258 Md Mendelevium 101	259 No Nobelium 102	260 Lr Lawrencium 103										

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