CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

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.

[Turn over

Section A

Answer **all** the questions in this section in the spaces provided.

The total mark for this section is 45.

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.

   (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]

4

(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}.

(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}.
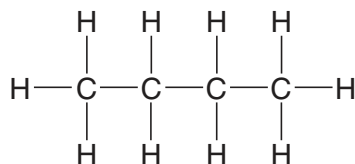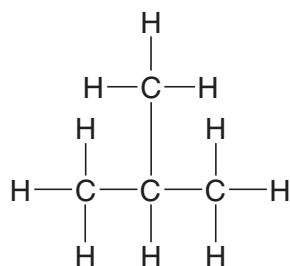
butane   methylpropane

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.

$$C_3H_8(g) \ + \ 5O_2(g) \ \rightarrow \ 3CO_2(g) \ + \ 4H_2O(l)$$
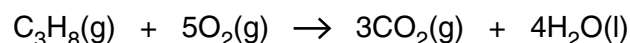
Calculate

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.

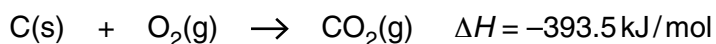..

.... [2]

[Total: 7]

A4 Coal is largely carbon.

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

$$C(s) \quad + \quad O_2(g) \quad \rightarrow \quad CO_2(g) \quad \Delta H = -393.5 \, kJ/mol$$

(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

reaction pathway
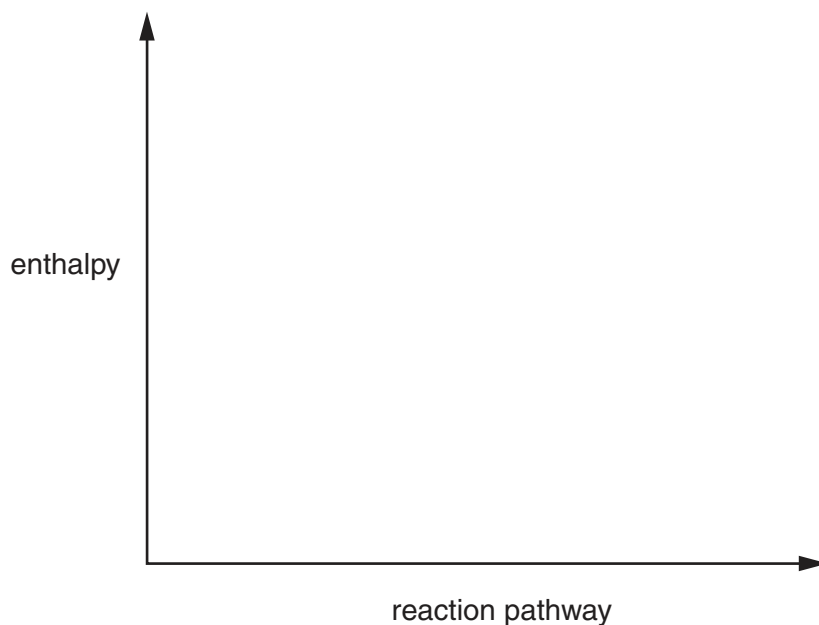
[3]

(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.

(a) Define the term *isotopes*.

....

.... [1]

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

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.

air — liquid bromine

start   after 30 minutes
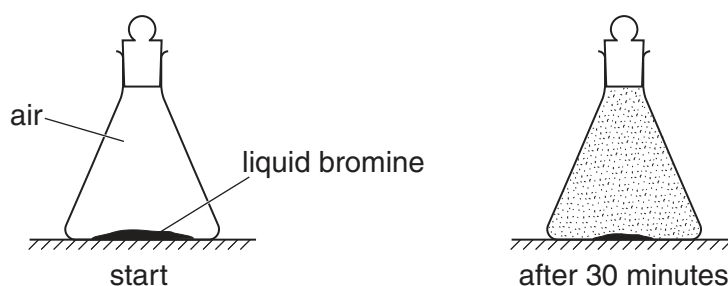
Use the kinetic particle theory to explain these observations.

....

....

....

....

.... [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, BrF_5.
Calculate the percentage of bromine by mass in bromine(V) fluoride.

[2]

[Total: 11]

Section B

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

The total mark for this section is 30.

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.

(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.

$$Mg(s) \quad + \quad H_2SO_4(aq) \quad \rightarrow \quad MgSO_4(aq) \quad + \quad H_2(g)$$
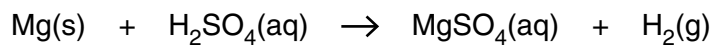
(i) Describe how you can follow the progress of this reaction.
What measurements can you use to calculate the speed of the reaction?

....

....

....

....

....

.... [3]

(ii) A student reacts 3.0 g of magnesium with 2.5 mol/dm^3 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.

carboxylic acid	formula	boiling point/°C
methanoic acid	HCO_2H	101
ethanoic acid	CH_3CO_2H	118
propanoic acid	$C_2H_5CO_2H$	141
butanoic acid	■	166
pentanoic acid	$C_4H_9CO_2H$	■

(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)

$$\left[\begin{array}{cc} & CH_3CO \\ H & | \\ | & O \\ -C & -C- \\ | & | \\ H & H \end{array} \right]_n$$
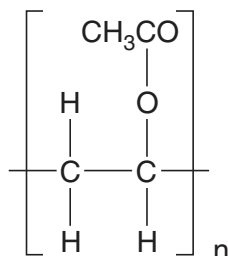
    Draw the structure of the monomer used to make poly(ethenyl ethanoate).

[1]

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

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

[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.

(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.

$$3BaO \ + \ 2Al \ \rightarrow \ 3Ba \ + \ Al_2O_3$$
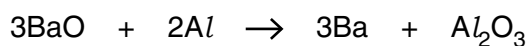
Explain how this equation shows that aluminium is a reducing agent.

....

.... [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	0
								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		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		115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56		204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	209 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86
223 **Fr** Francium 87	226 **Ra** Radium 88							

Transition elements:

45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30
89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	101 **Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48
139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80
227 **Ac** Actinium 89 †									

1 **H** Hydrogen 1

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

| 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 | 159 **Tb** Terbium 65 | 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 | 247 **Bk** Berkelium 97 | 251 **Cf** Californium 98 | 252 **Es** Einsteinium 99 | 257 **Fm** Fermium 100 | 258 **Md** Mendelevium 101 | 259 **No** Nobelium 102 | 260 **Lr** Lawrencium 103 |

Key

a
X
b

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.).