



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE
NAME

CENTRE
NUMBER

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CHEMISTRY

5070/02

Paper 2 Theory

May/June 2008

1 hour 30 minutes

Candidates answer on the Question Paper.

Additional Materials: Answer Booklet/Paper

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 on any lined pages and/or separate answer paper.

A copy of the Periodic Table is printed on page 16.

The number of marks is given in brackets [] at the end of each question or part question.

At the end of the examination, fasten all your work securely together.

For Examiner's Use	
Section A	
B7	
B8	
B9	
B10	
Total	

This document consists of **16** printed pages.



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 gases to answer the questions below.

ammonia

argon

carbon monoxide

chlorine

hydrogen

nitrogen

nitrogen dioxide

oxygen

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

Name a gas which

(a) is made during the incomplete combustion of octane,

..... [1]

(b) dissolves in water to make an alkaline solution,

..... [1]

(c) is monatomic,

..... [1]

(d) is a reducing agent in a Blast Furnace,

..... [1]

(e) is used in the Contact process.

..... [1]

[Total: 5]

A2 Iron(II) sulphate, FeSO_4 , is easily oxidised to iron(III) sulphate.

(a) Calculate the percentage by mass of iron in iron(II) sulphate.

..... % [2]

(b) A sample of iron(II) sulphate is dissolved in water. Describe a test to show the presence of sulphate ions in this solution.

reagents

observation [2]

(c) In the presence of aqueous hydrogen ions and dissolved oxygen, aqueous iron(II) ions are oxidised to form iron(III) ions and water.
Write an ionic equation for this reaction.

..... [2]

(d) Aqueous iron(II) ions can also be oxidised by reaction with acidified potassium dichromate(VI), $\text{K}_2\text{Cr}_2\text{O}_7$. At the same time aqueous dichromate(VI) ions are reduced.

(i) Describe the colour change of the chromium-containing species during the reaction.

..... [1]

(ii) Describe the colour change of the iron-containing species during the reaction.

..... [1]

- (e) An impure sample of iron(II) sulphate was analysed by titration.

The sample was dissolved in 25.0 cm^3 of dilute sulphuric acid and then titrated against 0.0400 mol/dm^3 potassium dichromate(VI) solution.

19.0 cm^3 of potassium dichromate(VI) solution was required to reach the end-point.

- (i) Calculate the number of moles of potassium dichromate(VI) used in the titration.

..... moles [1]

- (ii) One mole of potassium dichromate(VI) reacts with six moles of iron(II) ions. Calculate the mass, in grams, of iron(II) ions in the sample analysed.

mass of iron(II) ions..... g [2]

[Total: 11]

- A3** A student found a copy of a Periodic Table published in the year 1930. Several elements were missing from this table because they had not yet been discovered. One of these elements was technetium, Tc.

One isotope of technetium has the symbol ${}_{43}^{98}\text{Tc}$.

- (a) Complete the table below to show the number of subatomic particles in one atom of this isotope.

number of protons	
number of electrons	
number of neutrons	

[2]

- (b) Suggest the symbol of another isotope of technetium.

..... [1]

- (c) Explain, in terms of subatomic particles and their charge, why an atom of ${}_{43}^{98}\text{Tc}$ is electrically neutral.

.....

 [2]

- (d) From its position in the modern Periodic Table predict two properties of technetium.

1

2 [2]

[Total: 7]

A4 Ethane, C_2H_6 , and ethene, C_2H_4 , are both gaseous hydrocarbons.

- (a) Describe how aqueous bromine can be used to distinguish between a sample of ethane and a sample of ethene.

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

- (b) Draw a 'dot-and-cross' diagram for ethane.
You only need to draw the outer electrons of the carbon atoms.

[2]

- (c) Ethane reacts with chlorine in the presence of ultra-violet light.
Suggest a structure for a product of this reaction.

[1]

- (d) Write both the name and the molecular formula of an alkene molecule containing four carbon atoms.

name

molecular formula [2]

[Total: 7]

A5 One of the largest uses of phosphorus is in the making of safety matches. A safety ignites when it is rubbed against the striking surface of a match box.

The match head contains the following substances.

- phosphorus, P_4
- potassium chlorate(V), $KClO_3$
- sulphur, S
- a hydrocarbon wax

(a) The friction between the match head and the striking surface generates enough heat for the phosphorus to burn.

Phosphorus burns to form phosphorus(V) oxide. This oxide is covalently bonded with a molecular structure.

(i) What is the molecular formula of phosphorus(V) oxide?

..... [1]

(ii) Suggest **one** physical and **one** chemical property of phosphorus(V) oxide.

physical property

.....

chemical property

..... [2]

(b) The heat from the combustion of phosphorus provides enough energy for the decomposition of potassium chlorate(V) to oxygen and potassium chloride. Construct the equation for the decomposition of potassium chlorate(V).

..... [2]

(c) The sulphur on the match head ignites.

Write an equation to show the combustion of sulphur.

..... [1]

(d) Finally the wax on the match head begins to combust.

One compound in the wax has the formula $C_{18}H_{38}$.

To which class of hydrocarbons does this compound belong? Explain your answer.

.....

..... [1]

[Total: 7]

A6 Sulphur dioxide, SO_2 , and nitrogen dioxide, NO_2 , are both atmospheric pollutants during the combustion of coal at a power station.

(a) (i) State another source of sulphur dioxide as an atmospheric pollutant.

..... [1]

(ii) State another source of nitrogen dioxide as an atmospheric pollutant.

..... [1]

(b) Nitrogen dioxide and sulphur dioxide both cause acid rain. They are removed from the flue gases released from the power station by reaction with moist calcium carbonate in a process called flue gas desulphurisation.

Calcium carbonate reacts with sulphur dioxide to make a solid called calcium sulphite and a gas.

(i) What is the name of this gas?

..... [1]

(ii) Nitrogen dioxide reacts with calcium carbonate to make a solid. Suggest the name of this solid.

..... [1]

(iii) Describe one environmental effect of acid rain.

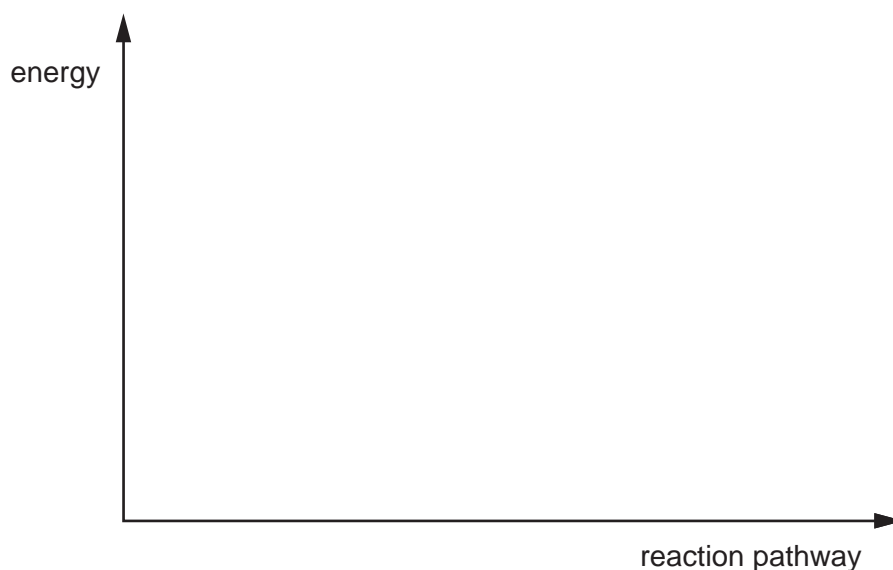
..... [1]

(c) Sulphur dioxide and nitrogen dioxide react together as shown in the equation.



Draw an energy profile diagram for this reaction.

Indicate both the enthalpy change and the activation energy on your diagram.



[3]

Section B

Answer **three** questions from this section.

The total mark for this section is 30.

B7 This question is about the chemistry of chlorine and some of its compounds.

- (a) Describe, with the aid of an ionic equation, the reaction of chlorine with aqueous potassium bromide. Explain why this reaction involves the reduction of chlorine. [3]
- (b) Magnesium reacts with chlorine to form magnesium chloride.
Draw diagrams to show the electronic structures and charges of both ions present in magnesium chloride. [2]
- (c) Silver chloride is an insoluble salt.
Outline the preparation of pure, dry silver chloride, starting from solid silver nitrate. [4]
- (d) State **one** environmental problem associated with the molecule $C_2F_3Cl_3$. [1]

[Total: 10]

- B8** Crude oil is a raw material which is processed in an oil refinery. Two of the processes used are fractional distillation and cracking.

The table shows the percentage by mass of some different fractions in crude oil. The table also shows the demand for each fraction expressed as a percentage.

fraction	number of carbon atoms per molecule	percentage in crude oil	percentage needed by the oil refinery to supply demand
petroleum gases	1 - 4	4%	11%
gasoline	5 - 9	11%	22%
kerosene	10 - 14	12%	20%
gas oil	14 - 20	18%	15%
waxes and bitumen	over 20	23%	4%

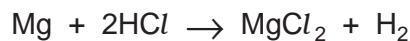
- (a) The variation in which physical property is used to separate crude oil by fractional distillation? [1]
- (b) (i) Define the term *cracking*. [2]
- (ii) Use information from the table to explain how cracking helps an oil refinery match the supply of gasoline with the demand for gasoline. [2]
- (c) The hydrocarbon $C_{15}H_{32}$ can be cracked to make propene and one other hydrocarbon.
- (i) Draw the structure of propene. [1]
- (ii) Write an equation for this reaction. [1]
- (d) Propene is used to make alcohols and poly(propene).
- (i) Describe how propene can be converted into an alcohol and draw the structure of this alcohol. [2]
- (ii) Draw the structure of poly(propene) showing at least two repeat units. [1]

[Total: 10]

B9 Dilute ethanoic acid and dilute hydrochloric acid both react with magnesium ribbon to produce hydrogen.

(a) Give the formula of one ion found in both of these dilute acids. [1]

(b) Magnesium ribbon reacts with hydrochloric acid as shown in the equation.



A 0.24 g sample of magnesium ribbon is added to 5.0 cm³ of 2.0 mol/dm³ hydrochloric acid.

(i) Which reactant, magnesium or hydrochloric acid, is in excess? Use calculations to explain your answer. [2]

(ii) Calculate the maximum mass of magnesium chloride that can be formed in this reaction. [2]

(iii) A 0.24 g sample of magnesium ribbon is added to 5.0 cm³ of 2.0 mol/dm³ ethanoic acid.

Explain why this reaction forms the same volume of hydrogen but takes place much more slowly than the reaction of the same mass of magnesium with 5.0 cm³ of 2.0 mol/dm³ hydrochloric acid. [3]

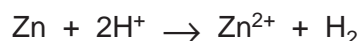
(c) (i) Write an equation for the reaction between dilute ethanoic acid and sodium carbonate. [1]

(ii) What observations would be made during this reaction? [1]

[Total: 10]

B10 Brass is an alloy of zinc and copper.

- (a) Describe, with the aid of a labelled diagram, the structure of a metal such as copper. [2]
- (b) Explain, in terms of their structures, why both zinc and copper are good conductors of electricity. [1]
- (c) A 1.2 g sample of powdered brass was analysed by reaction with excess dilute sulphuric acid.
The zinc reacts as shown in the equation to form 0.072 dm³ of hydrogen measured at room temperature and pressure.



- (i) Suggest why brass was used in a powdered rather than lump form. [1]
- (ii) Calculate the mass of zinc in the sample of brass. [2]
- (iii) Calculate the percentage of zinc in the sample of brass. [1]
- (d) Describe how aqueous ammonia can be used to show that only the zinc in the sample reacted with the acid. [3]

[Total: 10]

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DATA SHEET
The Periodic Table of the Elements

		Group																																																																																																												
I	II	III	IV	V	VI	VII	0					0																																																																																																		
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1	11 B Boron 5	12 C Carbon 6	13 Al Aluminium 13	14 N Nitrogen 7	15 O Oxygen 8	16 F Fluorine 9	17 Ne Neon 10	18 Ar Argon 18	19 K Potassium 19	20 Ca Calcium 20	21 Sc Scandium 21	22 Ti Titanium 22	23 V Vanadium 23	24 Cr Chromium 24	25 Mn Manganese 25	26 Fe Iron 26	27 Co Cobalt 27	28 Ni Nickel 28	29 Cu Copper 29	30 Zn Zinc 30	31 Ga Gallium 31	32 Ge Germanium 32	33 As Arsenic 33	34 Se Selenium 34	35 Br Bromine 35	36 Kr Krypton 36	37 Rb Rubidium 37	38 Sr Strontium 38	39 Y Yttrium 39	40 Zr Zirconium 40	41 Nb Niobium 41	42 Mo Molybdenum 42	43 Tc Technetium 43	44 Ru Ruthenium 44	45 Rh Rhodium 45	46 Pd Palladium 46	47 Ag Silver 47	48 Cd Cadmium 48	49 In Indium 49	50 Sn Tin 50	51 Sb Antimony 51	52 Te Tellurium 52	53 I Iodine 53	54 Xe Xenon 54	55 Cs Caesium 55	56 Ba Barium 56	57 La Lanthanum 57	58 Ce Cerium 58	59 Pr Praseodymium 59	60 Nd Neodymium 60	61 Pm Promethium 61	62 Sm Samarium 62	63 Eu Europium 63	64 Gd Gadolinium 64	65 Tb Terbium 65	66 Dy Dysprosium 66	67 Ho Holmium 67	68 Er Erbium 68	69 Tm Thulium 69	70 Yb Ytterbium 70	71 Lu Lutetium 71	72 Fr Francium 72	73 Ra Radium 73	74 Ac Actinium 74	75 Rh Rhenium 75	76 Os Osmium 76	77 Ir Iridium 77	78 Pt Platinum 78	79 Au Gold 79	80 Hg Mercury 80	81 Tl Thallium 81	82 Pb Lead 82	83 Bi Bismuth 83	84 Po Polonium 84	85 At Astatine 85	86 Rn Radon 86	87 Fr Francium 87	88 Ra Radium 88	89 Ac Actinium 89	90 Th Thorium 90	91 Pa Protactinium 91	92 U Uranium 92	93 Np Neptunium 93	94 Pu Plutonium 94	95 Am Americium 95	96 Cm Curium 96	97 Bk Berkelium 97	98 Cf Californium 98	99 Es Einsteinium 99	100 Fm Fermium 100	101 Md Mendelevium 101	102 No Nobelium 102	103 Lr Lawrencium 103	104 Rf Rutherfordium 104	105 Db Dubnium 105	106 Sg Seaborgium 106	107 Bh Bohrium 107	108 Hs Hassium 108	109 Mt Meitnerium 109	110 Ds Darmstadtium 110	111 Rg Roentgenium 111	112 Cn Copernicium 112	113 Nh Nihonium 113	114 Fl Flerovium 114	115 Mc Moscovium 115	116 Lv Livermorium 116	117 Ts Tennessine 117	118 Og Oganesson 118

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.).