

# UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS General Certificate of Education Ordinary Level

CANDIDATE NAME		
CENTRE NUMBER	CANDIDATE NUMBER	



CHEMISTRY

Paper 2 Theory

May/June 2008

5070/02

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		
В7		
В8		
В9		
B10		
Total		

This document consists of 16 printed pages.



# Section A

For Examiner's Use

[Total: 5]

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]

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**A2** Iron(II) sulphate, FeSO<sub>4</sub>, 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), K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>. At the same time aqueous dichromate(VI) ions are reduced.

(e)	An impure sample of iron(II) sulphate was analysed by titration.				
(0)	Exar				
	The sample was dissolved in 25.0 cm <sup>3</sup> of dilute sulphuric acid and then titrated against 0.0400 mol/dm <sup>3</sup> potassium dichromate(VI) solution.  19.0 cm <sup>3</sup> 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.			
	(ii)				
		mass of iron(II) ionsg [2]			
		[Total: 11]			

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А3	mis		ble because they had	_	D. Several elements were . One of these elements
	One	e isotope of tech	netium has the symbol	<sup>98</sup> Tc.	
	(a)	Complete the taisotope.	able below to show the	number of subatomic par	rticles in one atom of this
			number of protons		
			number of electrons		
			number of neutrons		
					[2]
	(b)	Suggest the sy	mbol of another isotope	of technetium.	
					[1]
	(c)	Explain, in ter electrically neu		cles and their charge, v	why an atom of $^{98}_{43}$ Tc is

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

[Total: 7]

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<b>A</b> 4	Ethane, C <sub>2</sub> H <sub>6</sub> , and ethene, C <sub>2</sub> H <sub>4</sub> , are both gaseous hydrocarbons.				
	(a)	Describe how aqueous bromine can be used to distinguish between a sample of ethane and a sample of ethene.	Examiner's Use		
		[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 match ignites when it is rubbed against the striking surface of a match box.

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[Total: 7]

The match head contains the following substances.

- phosphorus, P<sub>4</sub>
- potassium chlorate(V), KClO<sub>3</sub>
- sulphur, S
- a hydrocarbon wax

	·a	nydrocarbon wax	
(a)	the Pho	friction between the match head and the striking surface generates enough heat phosphorus to burn. sphorus burns to form phosphorus(V) oxide. This oxide is covalently bonded with ecular structure.	
		What is the molecular formula of phosphorus(V) oxide?	
			[1]
	(ii)	Suggest <b>one</b> physical and <b>one</b> chemical property of phosphorus(V) oxide.	
		physical property	
		chemical property	
			[2]
(b)	dec	heat from the combustion of phosphorus provides enough energy for to composition of potassium chlorate $(V)$ to oxygen and potassium chloride. Instruct the equation for the decomposition of potassium chlorate $(V)$ .	the
			[2]
(c)		sulphur on the match head ignites. te an equation to show the combustion of sulphur.	
			[1]
(d)	One	ally the wax on the match head begins to combust. compound in the wax has the formula $C_{18}H_{38}$ . which class of hydrocarbons does this compound belong? Explain your answer.	

<b>A</b> 6	Sulphur dioxide, SO <sub>2</sub> , and nitrogen dioxide, NO <sub>2</sub> , are both atmospheric pollutants formed 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)	Sul	phur dioxide and nitrogen dioxide react together as shown in the equation.	
			$SO_2 + NO_2 \rightarrow SO_3 + NO$ $\Delta H = +43 \text{ kJ/mol}$	
	Draw an energy profile diagram for this reaction. Indicate both the enthalpy change and the activation energy on your diagram.			
	energy			

[3]

reaction pathway

## **Section B**

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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.
  - (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]

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

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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]

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

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[1]

- (a) Give the formula of one ion found in both of these dilute acids.
- (b) Magnesium ribbon reacts with hydrochloric acid as shown in the equation.

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

A 0.24g sample of magnesium ribbon is added to 5.0 cm<sup>3</sup> of 2.0 mol/dm<sup>3</sup> 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.
- (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]

B10 Brass is an alloy of zinc and copper.

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- (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 1.2g 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 dm<sup>3</sup> of hydrogen measured at room temperature and pressure.

$$Zn + 2H^+ \rightarrow Zn^{2+} + H_2$$

- (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]

If you use these lined pages to complete an answer to any question, the question number <b>must</b> be clearly shown.	For Examiner's Use

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DATA SHEET
The Periodic Table of the Elements

		0	4 <b>He</b> Helium	20 <b>Ne</b> Neon 10	40 <b>Ar</b> Argon	84 <b>Kr</b> Krypton 36	131 <b>Xe</b> Xenon 54	222 <b>Rn</b> Radon 86	
		IIA		19 Fluorine	35.5 <b>C1</b> Chlorine	80 <b>Br</b> Bromine	127 <b>T</b> lodine 53	210 <b>At</b> Astatine 85	
		IN		16 Oxygen	32 <b>S</b> Suphur 16	79 Se Selenium 34	128 <b>Te</b> Tellurium 52	209 <b>Po</b> Polonium 84	
		^		14 <b>N</b> Nitrogen 7	31 <b>P</b> Phosphorus 15	75 <b>As</b> Arsenic 33	122 <b>Sb</b> Antimony 51	209 <b>Bi</b> Bismuth 83	
		N		12 Carbon 6	28 <b>Si</b> Silicon	73 <b>Ge</b> Germanium	Sn Tin 50	207 <b>Pb</b> Lead 82	
		III		11 Boron 5	27 <b>A I</b> Aluminium 13	70 <b>Ga</b> Gallium 31	115 Indium 49	204 <b>T l</b> Thallium	
ıs						65 <b>Zn</b> Znc 30	112 <b>Cd</b> Cadmium 48	201 <b>Hg</b> Mercury	
Elemen						64 <b>Cu</b> Copper	108 <b>Ag</b> Silver 47	197 <b>Au</b> Gold	
The Periodic Table of the Elements	Group					59 <b>Ni</b> Nickel	106 Pd Palladium 46	195 <b>Pt</b> Platinum 78	
dic Tabl	Gre					59 <b>Co</b> Cobalt	103 <b>Rh</b> Rhodium 45	192 <b>Ir</b> Iridium	
he Perio			1 <b>H</b> Hydrogen			56 <b>Fe</b> Iron 26	101 <b>Ru</b> Ruthenium 44	190 <b>Os</b> Osmium 76	
_						55 <b>Mn</b> Manganese 25	Tc Technetium 43	186 <b>Re</b> Rhenium 75	
						52 <b>Cr</b> Chromium 24	96 <b>Mo</b> Molybdenum 42	184 <b>W</b> Tungsten 74	
						51 V Vanadium 23	93 <b>Nb</b> Niobium 41	181 <b>Ta</b> Tantalum 73	
						48 <b>Ti</b> Titanium 22	91 <b>Zr</b> Zirconium 40	178 <b>Hf</b> Hafnium 72	
						45 <b>Sc</b> Scandium 21	89 <b>Y</b>	139 <b>La</b> Lanthanum 57 *	227 <b>Ac</b> Actinium 89
		II		Be Beryllium	24 Mg Magnesium	40 <b>Ca</b> Calcium 20	Strontium	137 <b>Ba</b> Barium 56	226 <b>Ra</b> Radium 88
		_		7 <b>Li</b> Lithium	23 Na Sodium	39  K Potassium 19	85 <b>Rb</b> Rubidium 37	CS Caesium 55	223 <b>Fr</b> Francium 87

nanoid series inoid series	<b>C</b> 140	141 <b>Q</b>	44 <b>N</b>	147 <b>Pm</b>	150 <b>Sm</b>	152 <b>Eu</b>	157 <b>Gd</b>	159 <b>Tb</b>	162 <b>Dy</b>	165 <b>H</b>	167 <b>Er</b>	169 <b>Tm</b>	<b>7 7 8</b>	175 <b>Lu</b>
	Cerium 58	Praseodymium 59	Neodymium 60	Promethium 61	9	Europium 63	Gadolinium 64	Terbium 65	Dysprosium 66	Holmium 67	Erbium 68	Thulium 69	Ytterbium 70	Lutetium 71
a = rela ive atomic mass	232	231	238	237	244	243	247	247	251	252	257	258	259	260
X = atomic symbol	드	Pa	<b>-</b>	8 N	Pu	Am	Cm	Ж	₽	Es	Fa	Md	9	ځ
b = atomic (proton) number	Thorium 90	Protactinium 91	Uranium 92	Neptunium 93	Plutonium 94	Americium 95	Curium 96	Berkelium 97	Californium 98	Einsteinium 99	Fermium 100	Mendelevium 101	Nobelium 102	Lawrencium 103

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

Key

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