

Centre Number

Candidate Number

Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

**CHEMISTRY****0620/03**

Paper 3

May/June 2006

**1 hour 15 minutes**

Candidates answer on the Question Paper.  
No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name in the spaces at the top of this page.  
Write in dark blue or black pen.  
You may use a pencil for any diagrams, graphs or rough working.  
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.  
A copy of the Periodic Table is printed on page 16.

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**

1	
2	
3	
4	
5	
6	
7	
<b>Total</b>	

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



1 Iron is a transition element.

(a) Which of the following statements about transition elements are correct?

Tick **three** boxes.

The metals are highly coloured e.g. yellow, green, blue.

The metals have low melting points.

Their compounds are highly coloured.

Their compounds are colourless.

The elements and their compounds are often used as catalysts.

They have more than one oxidation state.

[3]

(b) (i) In which Period in the Periodic Table is iron to be found?

..... [1]

(ii) Use the Periodic Table to work out the number of protons and the number of neutrons in one atom of iron.

number of protons = ..... number of neutrons = ..... [1]

(c) Iron is extracted in a blast furnace. The list below gives some of the substances used or formed in the extraction.

**carbon monoxide**

**coke**

**iron ore**

**limestone**

**slag**

(i) Which substance is a mineral containing largely calcium carbonate?

..... [1]

(ii) Which substance is formed when impurities in the ore react with calcium oxide?

..... [1]

(iii) Which substance is also called hematite?

..... [1]

(d) State **two** functions of the coke used in the blast furnace.

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

(e) Most of the iron is converted into mild steel or stainless steel. Give **one** use for each.

mild steel .....  
stainless steel ..... [2]

2 Some reactions of metals **W**, **X**, **Y** and **Z** are given below.

metal	reaction with water	reaction with dilute hydrochloric acid
<b>W</b>	A few bubbles form slowly in cold water.	Vigorous reaction. Gas given off.
<b>X</b>	Vigorous reaction. Metal melts. Gas given off.	Explosive reaction. Should not be attempted.
<b>Y</b>	No reaction.	No reaction.
<b>Z</b>	Does not react with cold water. Hot metal reacts with steam.	Steady fizzing.

(a) Arrange these metals in order of reactivity.

most reactive .....

.....

.....

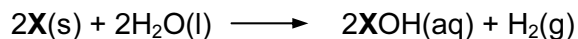
least reactive ..... [2]

(b) Which of these metals could be

(i) magnesium,  
..... [1]

(ii) copper?  
..... [1]

(c) The equation for the reaction of **X** with cold water is given below.



(i) Describe the test you would use to show that the gas evolved is hydrogen.

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

(ii) How could you show that the water contained a compound of the type **XOH**?

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

(iii) In which group of the Periodic Table does metal **X** belong?

..... [1]

(iv) The ore of **X** is its chloride. Suggest how metal **X** could be extracted from its chloride.

..... [2]

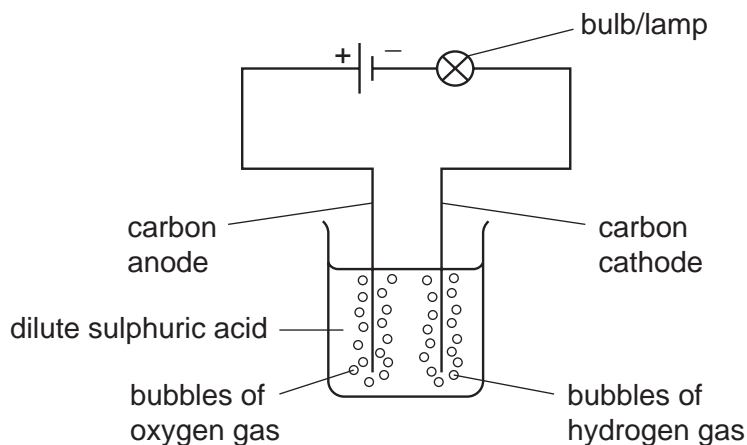
- 3 (a) Four bottles were known to contain aqueous ammonia, dilute hydrochloric acid, sodium hydroxide solution and vinegar, which is dilute ethanoic acid. The bottles had lost their labels. The pH values of the four solutions were 1, 4, 10 and 13.

Complete the table.

solution	pH
aqueous ammonia	
dilute hydrochloric acid	
sodium hydroxide solution	
vinegar	

[2]

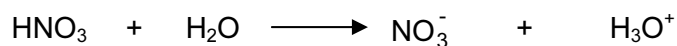
- (b) The following apparatus was set up to investigate the electrical conductivity of dilute acids.



Dilute sulphuric acid is a strong acid. If it was replaced by a weak acid, what **two** differences in the observations would you expect to make?

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

- (c) When nitric acid is added to water the following reaction occurs.



Give the name and the formula of the particle which is transferred from nitric acid to water.

name .....

formula .....

[2]

(d) This question is concerned with the following oxides.

aluminium oxide      $Al_2O_3$

calcium oxide         $CaO$

carbon dioxide       $CO_2$

carbon monoxide      $CO$

magnesium oxide     $MgO$

sulphur dioxide       $SO_2$

(i) Which of the above oxides will react with hydrochloric acid but not with aqueous sodium hydroxide?

..... [1]

(ii) Which of the above oxides will react with aqueous sodium hydroxide but not with hydrochloric acid?

..... [1]

(iii) Which of the above oxides will react both with hydrochloric acid and with aqueous sodium hydroxide?

..... [1]

(iv) Which of the above oxides will react neither with hydrochloric acid nor with aqueous sodium hydroxide?

..... [1]

4 The first three elements in Group IV are carbon, silicon, germanium.

(a) The element germanium has a diamond-type structure. Describe the structure of germanium. A diagram is acceptable.

[2]

(b) Unlike diamond, graphite is soft and is a good conductor of electricity.

(i) Explain why graphite has these properties.

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

(ii) Give a use of graphite that depends on one of these properties.

property .....

use ..... [1]

(c) Carbon dioxide and silicon(IV) oxide have similar formulae but different types of structure.

(i) Give the formulae of these oxides.

..... [1]

(ii) How are their structures different?

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

(d) All these elements form compounds with hydrogen called hydrides. The saturated hydrides of carbon are the alkanes. Predict the formula of the hydride of germanium which contains two germanium atoms.

..... [1]



5 Sulphuric acid is made by the Contact process in the following sequence of reactions.



(a) (i) How is sulphur dioxide made from sulphur?

..... [1]

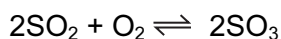
(ii) Sulphur dioxide has other uses.  
Why is it used in the manufacture of paper?

..... [1]

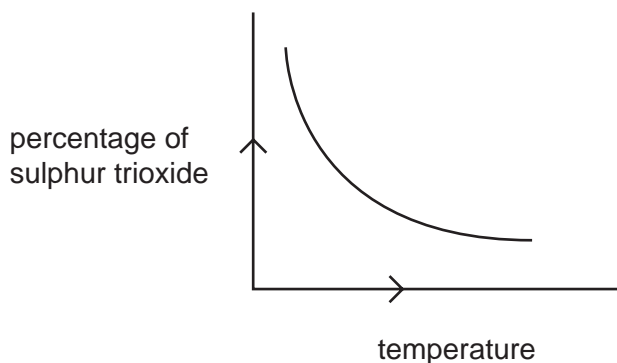
(iii) How does it preserve food?

..... [1]

(b) The equation for a stage of the Contact process is



The percentage of sulphur trioxide in the equilibrium mixture varies with temperature.



(i) How does the percentage of sulphur trioxide in the equilibrium mixture vary as the temperature increases? Circle the correct answer.

**increases                      stays the same                      decreases** [1]

(ii) Is the forward reaction in the equilibrium  $2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3$  exothermic or endothermic? Give a reason for your choice.

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

**(iii)** Explain, mentioning both rate and percentage yield, why the temperature used in the Contact process is 450°C.

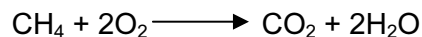
.....  
..... [2]

**(iv)** Describe how the sulphur trioxide is changed into concentrated sulphuric acid.

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

- 6 (a) Exothermic reactions produce heat energy.

An important fuel is methane, natural gas. The equation for its combustion is as follows.



- (i) In chemical reactions bonds are broken and new bonds are formed. Using this reaction give an example of

a bond that is broken, .....

a bond that is formed. .... [2]

- (ii) Explain, using the idea of bonds forming and breaking, why this reaction is exothermic, that is it produces heat energy.

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

- (b) Some radioactive isotopes are used as nuclear fuels.

- (i) Give the symbol and the nucleon number of an isotope that is used as a nuclear fuel.

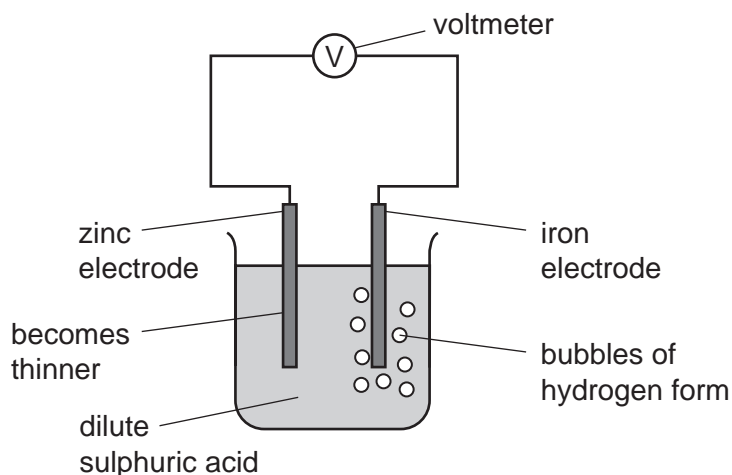
..... [2]

- (ii) Give another use of radioactive isotopes.

..... [1]

(c) Cell reactions are both exothermic and redox. They produce electrical energy as well as heat energy.

(i) The diagram shows a simple cell.



Which substance in this cell is the reductant and which ion is the oxidant?

reductant .....

oxidant ..... [2]

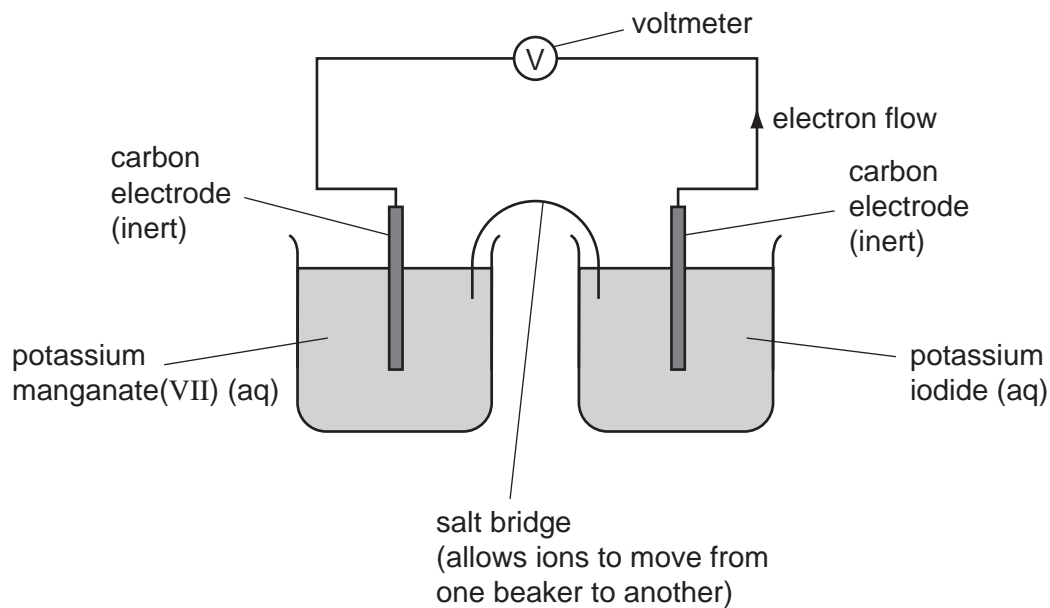
(ii) How could the voltage of this cell be increased?

..... [1]

(iii) What is the important large scale use, relating to iron and steel, of this type of cell reaction?

..... [1]

(d) Cells can be set up with inert electrodes and the electrolytes as oxidant and reductant.



The potassium manganate(VII) is the oxidant and the potassium iodide is the reductant.

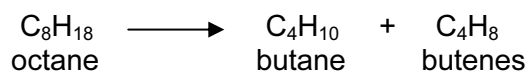
(i) Describe the colour change that would be observed in the left hand beaker.

..... [2]

(ii) Write an ionic equation for the reaction in the right hand beaker.

..... [2]

- 7 The fractional distillation of crude oil usually produces large quantities of the heavier fractions. The market demand is for the lighter fractions and for the more reactive alkenes. The heavier fractions are cracked to form smaller alkanes and alkenes as in the following example.



- (a) (i) Write a different equation for the cracking of octane.



- (ii) The cracking of octane can produce isomers with the molecular formula  $\text{C}_4\text{H}_8$ . Draw the structural formulae of two of these isomers.

[2]

- (b) (i) Give the essential condition for the reaction between chlorine and butane.

..... [1]

- (ii) What type of reaction is this?

..... [1]

- (iii) This reaction produces a mixture of products. Give the names of **two** products that contain four carbon atoms per molecule.

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

- (c) Alkenes are more reactive than alkanes and are used to make a range of organic chemicals. Propene,  $\text{CH}_3\text{-CH=CH}_2$ , is made by cracking. Give the structural formula of the addition product when propene reacts with the following.

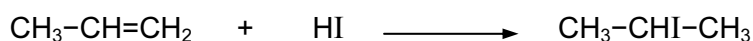
(i) water

[1]

(ii) bromine

[1]

- (d) Propene reacts with hydrogen iodide to form 2-iodopropane.



1.4 g of propene produced 4.0 g of 2-iodopropane.

Calculate the percentage yield.

moles of  $\text{CH}_3\text{-CH=CH}_2$  reacted = .....

maximum moles of  $\text{CH}_3\text{-CHI-CH}_3$  that could be formed = .....

mass of one mole of  $\text{CH}_3\text{-CHI-CH}_3 = 170 \text{ g}$

maximum mass of 2-iodopropane that could be formed = .....

percentage yield .....%

[4]

**DATA SHEET**  
**The Periodic Table of the Elements**

		Group																															
I	II	III	IV	V	VI	VII	0																										
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4	1 <b>H</b> Hydrogen 1	12 <b>C</b> Carbon 6	14 <b>N</b> Nitrogen 7	16 <b>O</b> Oxygen 8	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10	27 <b>Al</b> Aluminium 13	28 <b>Si</b> Silicon 14	31 <b>P</b> Phosphorus 15	32 <b>S</b> Sulphur 16	35.5 <b>Cl</b> Chlorine 17	40 <b>Ar</b> Argon 18																				
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	56 <b>Fe</b> Iron 26	70 <b>Ga</b> Gallium 31	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	80 <b>Br</b> Bromine 35	84 <b>Kr</b> Krypton 36	85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	91 <b>Zr</b> Zirconium 40	93 <b>Nb</b> Niobium 41	101 <b>Ru</b> Ruthenium 44	115 <b>In</b> Indium 49	119 <b>Sn</b> Tin 50	122 <b>Sb</b> Antimony 51	127 <b>I</b> Iodine 53	131 <b>Xe</b> Xenon 54																
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	146 <b>Pm</b> Promethium 61	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	162 <b>Dy</b> Dysprosium 66	165 <b>Ho</b> Holmium 67	167 <b>Er</b> Erbium 68	169 <b>Tm</b> Thulium 69	173 <b>Yb</b> Ytterbium 70	175 <b>Lu</b> Lutetium 71	226 <b>Ra</b> Radium 88	227 <b>Ac</b> Actinium 89	204 <b>Pb</b> Lead 82	207 <b>Bi</b> Bismuth 83	209 <b>Po</b> Polonium 84	210 <b>At</b> Astatine 85	210 <b>Rn</b> Radon 86												
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12	51 <b>V</b> Vanadium 23	52 <b>Cr</b> Chromium 24	55 <b>Mn</b> Manganese 25	59 <b>Co</b> Cobalt 27	59 <b>Ni</b> Nickel 28	64 <b>Cu</b> Copper 29	65 <b>Zn</b> Zinc 30	73 <b>Ge</b> Germanium 32	77 <b>Ir</b> Iridium 77	78 <b>Pt</b> Platinum 78	81 <b>Tl</b> Thallium 81	82 <b>Pb</b> Lead 82	83 <b>Bi</b> Bismuth 83	84 <b>Po</b> Polonium 84	85 <b>At</b> Astatine 85	86 <b>Rn</b> Radon 86	87 <b>Fr</b> Francium 87	89 <b>Ac</b> Actinium 89	90 <b>Th</b> Thorium 90	91 <b>Pa</b> Protactinium 91	92 <b>U</b> Uranium 92	93 <b>Np</b> Neptunium 93	94 <b>Pu</b> Plutonium 94	95 <b>Am</b> Americium 95	96 <b>Cm</b> Curium 96	97 <b>Bk</b> Berkelium 97	98 <b>Cf</b> Californium 98	99 <b>Es</b> Einsteinium 99	100 <b>Fm</b> Fermium 100	101 <b>Md</b> Mendelevium 101	102 <b>No</b> Nobelium 102	103 <b>Lr</b> Lawrencium 103

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

**Key**

a	X
	b

a = relative atomic mass  
X = atomic symbol  
b = proton (atomic) number

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).