

Centre Number	Candidate Number	Name
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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]

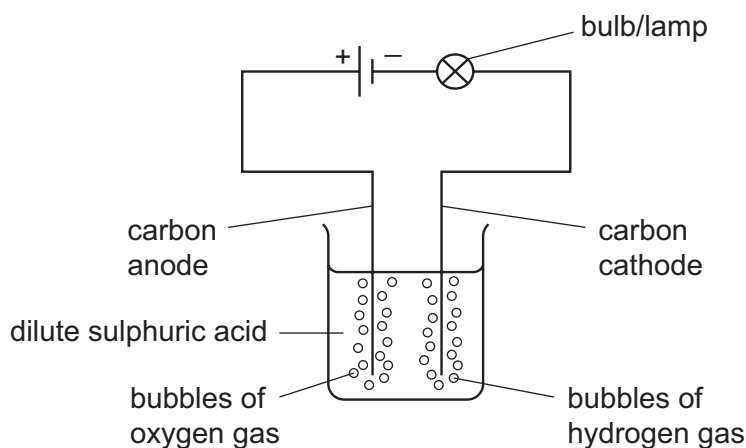
- 3 (a) Four bottles were known to contain aqueous ammonia, dilute hydrochloric acid, sodium hydroxide solution and vinegar, which is dilute ethanoic acid. The bottles had lost their labels. The pH values of the four solutions were 1, 4, 10 and 13.

Complete the table.

solution	pH
aqueous ammonia	
dilute hydrochloric acid	
sodium hydroxide solution	
vinegar	

[2]

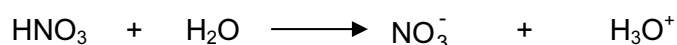
- (b) The following apparatus was set up to investigate the electrical conductivity of dilute acids.



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]

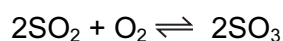
- (ii) Sulphur dioxide has other uses.  
Why is it used in the manufacture of paper?

..... [1]

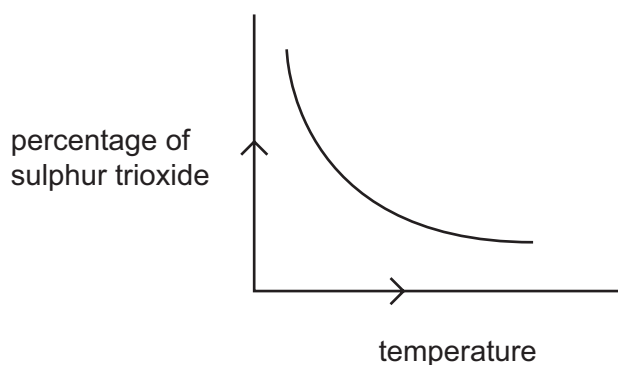
- (iii) How does it preserve food?

..... [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.

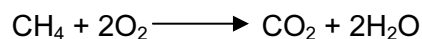
.....  
..... [2]

(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.

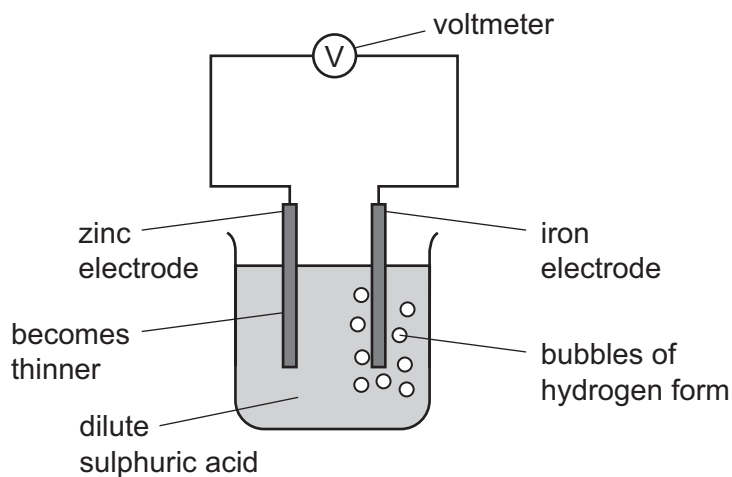
..... [2]

- (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]

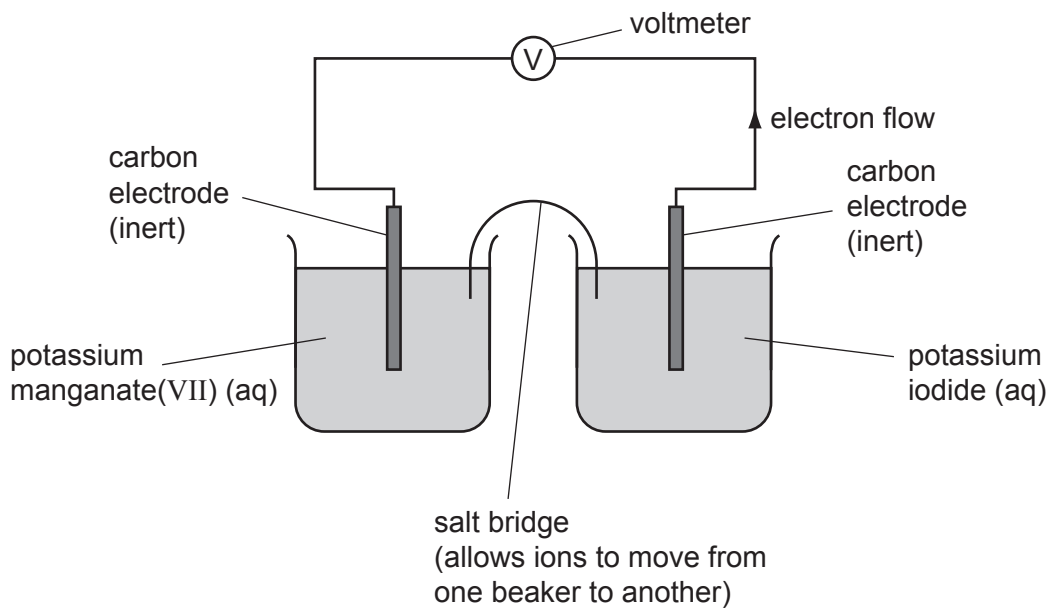
(ii) How could the voltage of this cell be increased?

..... [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.

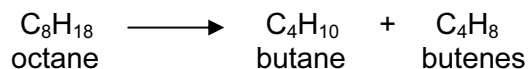
(i) Describe the colour change that would be observed in the left hand beaker.

..... [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.

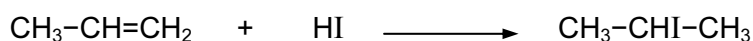
(i) water

[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	9	1							2	4
3	4	1							9	10
11	12	13	14	15	16	17	18	19	20	
19	20	21	22	23	24	25	26	27	28	
37	38	39	40	41	42	43	44	45	46	
55	56	57	58	59	60	61	62	63	64	
87	88	89	90	91	92	93	94	95	96	
119	120	121	122	123	124	125	126	127	128	
151	152	153	154	155	156	157	158	159	160	
183	184	185	186	187	188	189	190	191	192	
223	224	225	226	227	228	229	230	231	232	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20																																																																				
H Hydrogen	He Helium	Li Lithium	Be Beryllium	B Boron	C Carbon	N Nitrogen	O Oxygen	F Fluorine	Ne Neon	Na Sodium	Mg Magnesium	Al Aluminium	Si Silicon	P Phosphorus	S Sulphur	Cl Chlorine	Ar Argon	K Potassium	Ca Calcium	Sc Scandium	Ti Titanium	V Vanadium	Cr Chromium	Mn Manganese	Fe Iron	Co Cobalt	Ni Nickel	Cu Copper	Zn Zinc	Ga Gallium	Ge Germanium	As Arsenic	Se Selenium	Br Bromine	Kr Krypton	Rb Rubidium	Sr Strontium	Y Yttrium	Zr Zirconium	Nb Niobium	Mo Molybdenum	Tc Technetium	Ru Ruthenium	Rh Rhodium	Pd Palladium	Ag Silver	Cd Cadmium	In Indium	Sn Tin	Sb Antimony	Te Tellurium	I Iodine	Xe Xenon	Cs Caesium	Ba Barium	La Lanthanum	Ce Cerium	Pr Praseodymium	Nd Neodymium	Pm Promethium	Sm Samarium	Eu Europium	Gd Gadolinium	Tb Terbium	Dy Dysprosium	Ho Holmium	Er Erbium	Tm Thulium	Yb Ytterbium	Lu Lutetium	Fr Francium	Ra Radium	Ac Actinium	Th Thorium	Pa Protactinium	U Uranium	Np Neptunium	Pu Plutonium	Am Americium	Cm Curium	Bk Berkelium	Cf Californium	Es Einsteinium	Fm Fermium	Md Mendelevium	No Nobelium	Lr Lawrencium

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

a	X	b
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Key  
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.).