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		
Total		

Iron is a transition element.

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		2	trapapers.com  For Examiner's Use
Iror	ı is a	transition element.	Use
(a)	Wh	ich of the following statements about transition elements are correct?	Mille
	Tick	three boxes.	Se.Co.
	The	e metals are highly coloured e.g. yellow, green, blue.	
	The	e metals have low melting points.	I
	The	eir compounds are highly coloured.	
	The	eir compounds are colourless.	
	The	elements and their compounds are often used as catalysts.	
	The	ey have more than one oxidation state.	
(b)	(i)	In which Period in the Periodic Table is iron to be found?	[3]
			[1]
	(ii)	Use the Periodic Table to work out the number of protons and the number neutrons in one atom of iron.	er of
		number of protons = number of neutrons =	[1]
(c)		is extracted in a blast furnace. The list below gives some of the substances υ ormed in the extraction.	used
	ca	rbon monoxide coke iron ore limestone slag	
	(i)	Which substance is a mineral containing largely calcium carbonate?	
	(::\	Which are the form of the principle of the control	[1]
	(ii)	Which substance is formed when impurities in the ore react with calcium oxide?	
	(iii)	Which substance is also called hematite?	[1]
			[1]

For Examiner's Use (d) State two functions of the coke used in the blast furnace. (e) Most of the iron is converted into mild steel or stainless steel. Give one use for each. mild steel ..... stainless steel

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

e reactions c	<b>4</b> of metals <b>W</b> , <b>X</b> , <b>Y</b> and <b>Z</b> are given bel	ow.	apapers.co
metal	reaction with water	reaction with dilute hydrochloric acid	Oridge.
w	A few bubbles form slowly in cold water.	Vigorous reaction. Gas given off.	30
х	Vigorous reaction. Metal melts. Gas given off.	Explosive reaction. Should not be attempted.	
Υ	No reaction.	No reaction.	
Z	Does not react with cold water. Hot metal reacts with steam.	Steady fizzing.	

(a)	Arrange these metals in order of reactivity.			
	mos	st reactive		
	leas	st reactive		[2]
(b)	Wh	ich of these	metals could be	
	(i)	magnesiur	n,	
				[1]
	(ii)	copper?		
				[1]

(c) The equation for the reaction of  ${\bf X}$  with cold water is given below.

$$2\mathbf{X}(s) + 2H_2O(I) \longrightarrow 2\mathbf{X}OH(aq) + H_2(g)$$

	www.xtr	apapers.com
	5	For Examiner's
The	e equation for the reaction of <b>X</b> with cold water is given below.	Use
	$2\mathbf{X}(s) + 2H_2O(l) \longrightarrow 2\mathbf{X}OH(aq) + H_2(g)$	TO THE
(i)	Describe the test you would use to show that the gas evolved is hydrogen.	For Examiner's Use
		[1]
(ii)	How could you show that the water contained a compound of the type <b>X</b> OH?	
		[2]
(iii)	In which group of the Periodic Table does metal <b>X</b> belong?	
		[1]
(iv)	The ore of ${\bf X}$ is its chloride. Suggest how metal ${\bf X}$ could be extracted from chloride.	its
		[2]

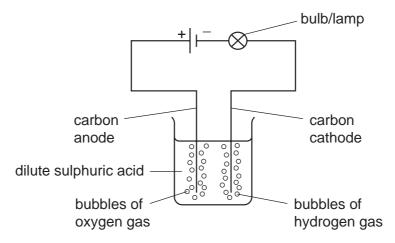
3 (a) Four bottles were known to contain aqueous ammonia, dilute hydrochloric acid, hydroxide solution and vinegar, which is dilute ethanoic acid. The bottles had lost labels. The pH values of the four solutions were 1, 4, 10 and 13.

Complete the table.

solution	рН
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.

$$HNO_3 + H_2O \longrightarrow NO_3^- + H_3O^+$$

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 <sub>2</sub>
carbon monoxide	СО
magnesium oxide	MgO
sulphur dioxide	SO <sub>2</sub>

(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]

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

For Examiner's Use (a) The element germanium has a diamond-type structure. Describe the structure of germanium. A diagram is acceptable.

		[2]
(b)	Unl	ke 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)		bon dioxide and silicon( $\operatorname{IV}$ ) oxide have similar formulae but different types of cture.
	(i)	Give the formulae of these oxides.
		[1]
	(ii)	How are their structures different?
		[2]
(d)	hyd	these elements form compounds with hydrogen called hydrides. The saturated rides of carbon are the alkanes. Predict the formula of the hydride of germanium ch contains two germanium atoms.
		[1]

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

## $\textbf{sulphur} \rightarrow \textbf{sulphur dioxide} \rightarrow \textbf{sulphur trioxide} \rightarrow \textbf{sulphuric acid}$

(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]

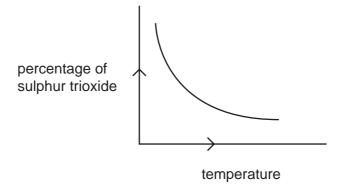
(iii) How does it preserve food?

[1]

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

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

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  $2SO_2 + O_2 \rightleftharpoons 2SO_3$  exothermic or endothermic? Give a reason for your choice.

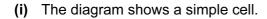
[2

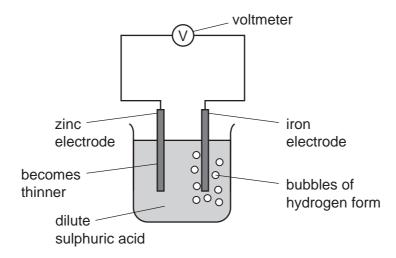
For Examiner's Use (iii) Explain, mentioning both rate and percentage yield, why the temperature the Contact process is 450°C. ..... (iv) Describe how the sulphur trioxide is changed into concentrated sulphuric acid.

(a) Exothermic reactions produce heat energy. 6

		www.xtrapa
		thermic reactions produce heat energy.  important fuel is methane, natural gas. The equation for its combustion is as follow $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ In chemical reactions bonds are broken and new bonds are formed.
(a)	Exc	othermic reactions produce heat energy.
	An	important fuel is methane, natural gas. The equation for its combustion is as follow
		$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$
	(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)	Sor	ne 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 heat energy.

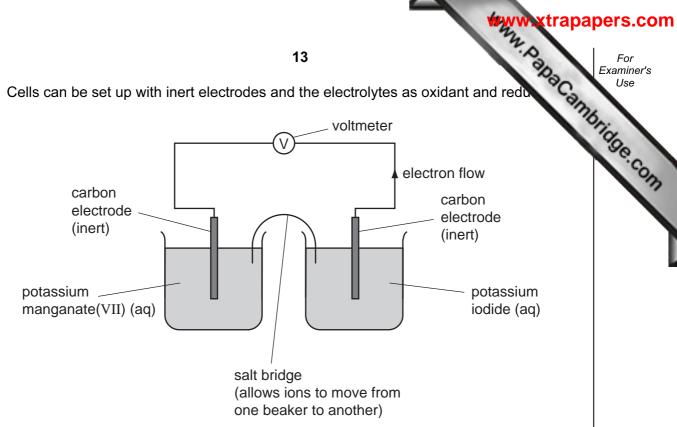




Which substance in this cell is the reductant and which ion is the oxidant?

	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 reaction?	cell
		[1]

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



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]

[2]

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

$C_8H_{18}$	<b></b>	$C_4H_{10}$	+	$C_4H_8$
octane		butane		butenes

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

$$C_8H_{18} \longrightarrow +$$
 [1]

(ii) The cracking of octane can produce isomers with the molecular formula C<sub>4</sub>H<sub>8</sub>. Draw the structural formulae of two of these isomers.

(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 <b>two</b> product that contain four carbon atoms per molecule.	ts
		and	ſΩI

- WANN, PAPAC CAMBridge, COM (c) Alkenes are more reactive than alkanes and are used to make a range of chemicals. Propene, CH<sub>3</sub>-CH=CH<sub>2</sub>, is made by cracking. Give the structural for of the addition product when propene reacts with the following.
  - (i) water

(ii) bromine

[1]

[1]

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

CH<sub>3</sub>−CH=CH<sub>2</sub> + HI — CH<sub>3</sub>−CHI−CH<sub>3</sub>

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

Calculate the percentage yield.

moles of CH<sub>3</sub>-CH=CH<sub>2</sub> reacted =

maximum moles of CH<sub>3</sub>–CHI–CH<sub>3</sub> that could be formed =

mass of one mole of CH<sub>3</sub>-CHI-CH<sub>3</sub> = 170 g

maximum mass of 2- iodopropane that could be formed =

percentage yield

[4]

DATA SHEET
The Periodic Table of the Elements

		0	4 <b>He</b>		0;	<u>e</u>	Neon	01	<u>ار</u>	Argon	4	ح	Krypton	131	و	non		Rn	uopi				75		atium
				2		_	10 N	4	_	18			99		_	. 54 									Lutetium 71
		<b>=</b>			19	ш	Fluorine 9		C1	17	80	ğ	Bromine 35	127	Τ	lodine 53		Ą	Astatine 85				173	Yp	Ytterbium
		>					Oxygen 8	32	ဟ	Sulphur 16	62	Se	Selenium 34	128	<u>e</u>	Tellurium 52		S.	Polonium 84				169	Ę	Thulium
		>			41	z	Nitrogen 7	31	<b>a</b>	Phosphorus 15	75	As	Arsenic 33	122	Sp	Antimony 51	209	Ö	Bismuth 83				167	ш	Erbium
		≥			12	ပ	Carbon 6	28	S	Silicon 14	73	Ge	Germanium 32	119	Sn	Tin 50	207	Pb	Lead 82				165	운	Holmium 67
		=			1	Ω	Boron 5	27	Αl	Aluminium 13	70	Ga	Gallium 31		In	4		11	2				162	۵	Dysprosium
													Zinc 30	112		Cadmium 48		£	Mercury 80				159	T	Terbium
															Ag	Silver 47	197	Au	Gold 79				157	Gd	Gadolinium
	Group										59	Z	Nickel 28	106		Palladium 46		ፚ	Platinum 78				152	Ш	Europium
	Ď										29	ဝိ	Cobalt 27	103	Rh	Rhodium 45	192	ľ	Iridium 77						Samarium
2			1 <b>T</b>	<b>-</b>									lron 26	101	Ru	Ruthenium 44	190	SO	Osmium 76					Pm	Promethium 64
											55	M	Manganese 25			Technetium 43	186	Re	Rhenium 75				144	N	Neodymium
											52	ပ်	Chromium 24	96	Mo	Molybdenum 42	184	≥	Tungsten 74				141	Ą	Praseodymium
											51	>	Vanadium 23	93	Q N	Niobium 41	181	Та	Tantalum 73				140	ပိ	Cerium
											48	F	Titanium 22	91	Zr	Zirconium 40	178	Ŧ	Hafnium 72				_		
											45	လွ	Scandium 21	88	>	Yttrium 39	139	Гa	Lanthanum 57 *	227	Ac	Actinium 89		Selles .	eries
		=			6	Be	Beryllium 4	24	M	Magnesium 12	40	Ca	Calcium 20	88	Ş	Strontium 38	137	Ba	Barium 56	226	Ra	Radium 88	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	58-71 Lanthahold series	190-103 Actinoid series
		_			7	=	2 Lithium	23	Na	Sodium 11	39	¥	Potassium 19	85	Rb	Rubidium 37	133	S	Caesium 55		ъ	Francium 87	1	20-71 Le	190-1037

b = proton (atomic) number a = relative atomic mass X = atomic symbol **м** × Key

WANN, PAPAC Ambridge, Com Md Mendelevium 101 Fm Fermium **ES** Einsteinium 99 Californium Bk Berkelium Curium 96 Am
Americium
95 Pu Plutonium Pa Protactinium 232 **4** Thorium 06

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