CHEMISTRY

Paper 3

0620/03

October/November 2004

1 hour 15 minutes

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

Candidate Name

Centre Number

Candidate Number

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 pencil for any diagrams, graphs or rough working.

WRITE IN THE BOXES PROVIDED ON THE QUESTION PAPER

DO **NOT** WRITE IN THE BARCODE.

DO **NOT** WRITE IN THE GREY AREAS BETWEEN THE PAGES.

Do not use staples, paper clips, highlighters, glue or correction fluid.

You may use a calculator.

Answer **all** questions.

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

or part questions.

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

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
Total	

This document consists of **15** printed pages and **1** blank page.

UNIVERSITY *of* CAMBRIDGE
International Examinations

[Turn over

1 (a) Two of the gases in air are nitrogen and oxygen. Name **two** other gases present in unpolluted air.

[2]

(b) Two common pollutants present in air are sulphur dioxide and lead compounds. State the source and harmful effect of each.

sulphur dioxide

source	
harmful effect	[3]

lead compounds

source	
harmful effect	[2]

(c) Respiration and photosynthesis are two of the processes that determine the percentage of oxygen and of carbon dioxide in the air.

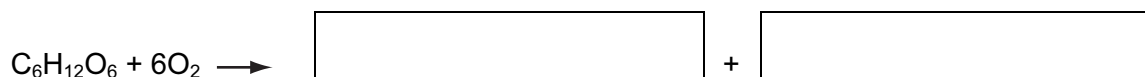(i) Name another process that changes the percentages of these two gases in air.

[1]

(ii) The equation for photosynthesis is given below.

$$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$$

This is an endothermic reaction.

Complete the reaction for respiration.

$C_6H_{12}O_6 + 6O_2 \longrightarrow$ [   ] + [   ]
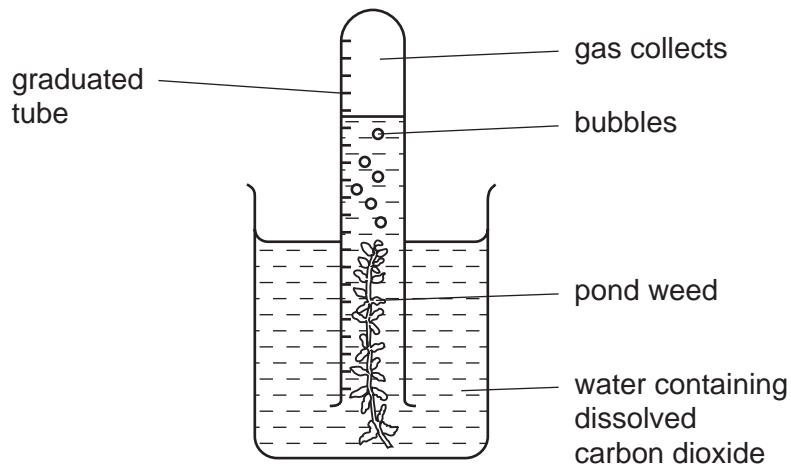
This is an [   ] reaction.

[2]

.

(d) The rate of photosynthesis of pond weed can be measured using the following experiment.

graduated tube — gas collects

— bubbles

— pond weed

— water containing dissolved carbon dioxide

(i) Describe how you could show that the gas collected in this experiment is oxygen.

[1]

(ii) What measurements are needed to calculate the rate of this reaction?

[2]

(iii) What would be the effect, and why, of moving the apparatus further away from the light?

[2]

2 The salt copper(II) sulphate can be prepared by reacting copper(II) oxide with sulphuric acid.

Complete the list of instructions for making copper(II) sulphate using **six** of the words below.

blue	cool	dilute	filter
saturated	sulphate	white	oxide

Instructions

1 Add excess copper(II) oxide to [   ] sulphuric acid in a beaker and boil it.

2 [   ] to remove the unreacted copper(II) oxide.

3 Heat the solution until it is [   ].

4 [   ] the solution to form [   ]
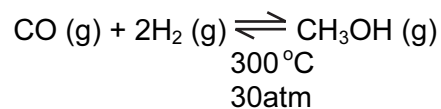
coloured crystals of copper (II) [   ].   [6]

3 The simplest alcohol is methanol.

(a) It is manufactured by the following reversible reaction.

$$CO \text{ (g)} + 2H_2 \text{ (g)} \rightleftharpoons CH_3OH \text{ (g)}$$
300 °C
30 atm

(i) Reversible reactions can come to equilibrium. Explain the term *equilibrium*.

....

[1]

(ii) At 400 °C, the percentage of methanol in the equilibrium mixture is lower than at 300 °C. Suggest an explanation.

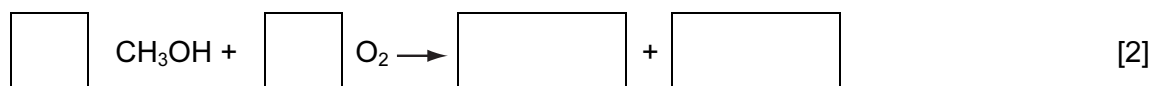..

[2]

(iii) Suggest two advantages of using high pressure for this reaction.
Give a reason for each advantage.

advantage	
reason	

advantage	
reason	

[5]

(b) (i) Complete the equation for the combustion of methanol in an excess of oxygen.

| | CH_3OH + | | $O_2 \longrightarrow$ | | + | | [2] |

(ii) Complete the word equation.

methanol + ethanoic acid $\longrightarrow$ | .... | + | | [2]
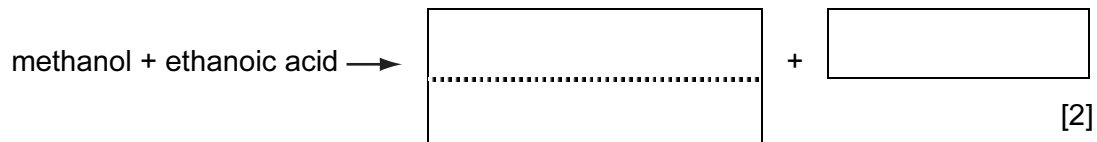
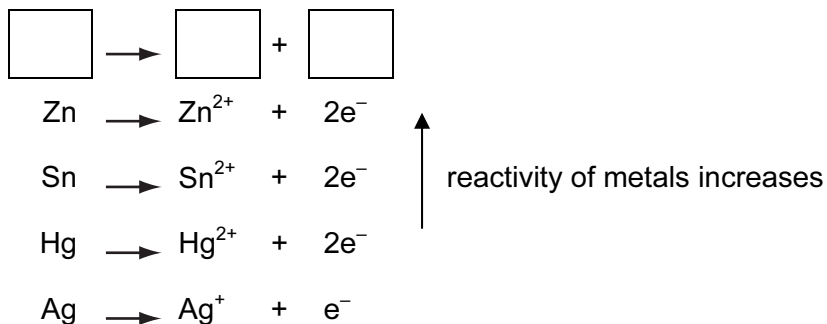**(iii)** Methanol can be oxidised to an acid. Name this acid.

| | [1]

.

4 In the following list of ionic equations, the metals are in order of reactivity.

$$\boxed{} \longrightarrow \boxed{} + \boxed{}$$

$Zn \longrightarrow Zn^{2+} + 2e^-$

$Sn \longrightarrow Sn^{2+} + 2e^-$ ⎤ reactivity of metals increases

$Hg \longrightarrow Hg^{2+} + 2e^-$

$Ag \longrightarrow Ag^+ + e^-$

(a) (i) In the space at the top of the series, write an ionic equation that includes a more reactive metal. [1]

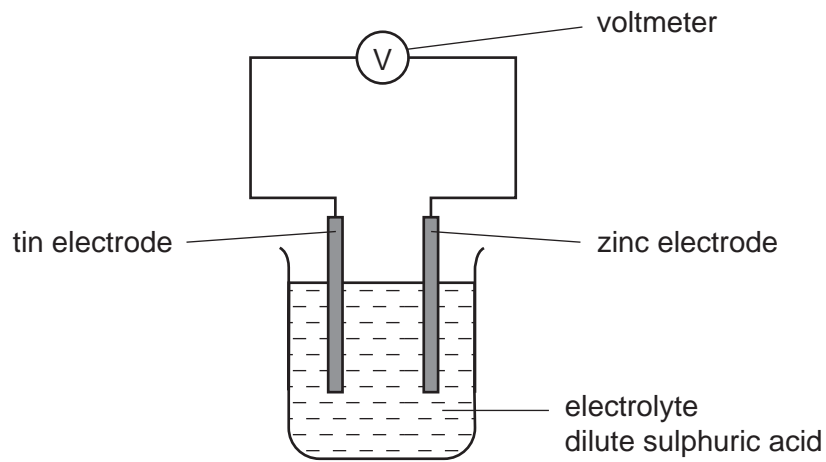**(ii)** Define *oxidation* in terms of electron transfer.

....

[1]

(iii) Explain why the positive ions are likely to be oxidising agents.

[1]

(iv) Which positive ion(s) can oxidise mercury metal (Hg)?

[1]

(b) The following diagram shows a simple cell.

voltmeter

V

tin electrode

zinc electrode

electrolyte
dilute sulphuric acid

(i) Predict how the voltage of the cell would change if the tin electrode was replaced with a silver one.

[1]

(ii) Which electrode would go into the solution as positive ions? Give a reason for your choice.

[1]

(iii) State how you can predict the direction of the electron flow in cells of this type.

[1]

5 Strontium and sulphur chlorides both have a formula of the type XCl_2 but they have different properties.

property	strontium chloride	sulphur chloride
appearance	white crystalline solid	red liquid
melting point / ^{o}C	873	-80
particles present	ions	molecules
electrical conductivity of solid	poor	poor
electrical conductivity of liquid	good	poor

(a) The formulae of the chlorides are similar because both elements have a valency of 2. Explain why Group II and Group VI elements both have a valency of 2.

....

[2]

(b) Draw a diagram showing the arrangement of the valency electrons in one covalent molecule of sulphur chloride.
Use x to represent an electron from a sulphur atom.
Use o to represent an electron from a chlorine atom.

[3]

(c) Explain the difference in electrical conductivity between the following.

**(i)** solid and liquid strontium chloride

[1]

(ii) liquid strontium chloride and liquid sulphur chloride

[1]

6 Polymers are extensively used in food packaging. Poly(dichloroethene) is used because gases can only diffuse through it very slowly. Polyesters have a high thermal stability and food can be cooked in a polyester bag.

(a) (i) The structure of poly(dichloroethene) is given below.

$$\left(\begin{array}{cc} H & Cl \\ | & | \\ -C & -C- \\ | & | \\ H & Cl \end{array}\right)_n$$
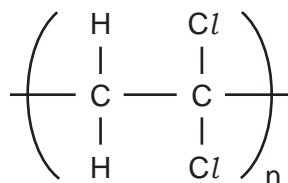
Draw the structural formula of the monomer.

[1]

(ii) Explain why oxygen can diffuse faster through the polymer bag than carbon dioxide can.

[2]

(b) (i) A polyester can be formed from the monomers $HO-CH_2CH_2-OH$ and $HOOC-C_6H_4-COOH$. Draw the structure of this polyester.

[2]

(Ii) Name a naturally occurring class of compounds that contains the ester linkage.

[1]

(iii) Suggest what is meant by the term *thermal stability.*

[1]

(c) (i) Describe **two** environmental problems caused by the disposal of plastic (polymer) waste.

[2]

(ii) The best way of disposing of plastic waste is recycling to form new plastics. What is another advantage of recycling plastics made from petroleum?

[1]

7 (a) (i) Write a symbol equation for the action of heat on zinc hydroxide.

[2]

(ii) Describe what happens when solid **sodium** hydroxide is heated strongly.

[1]

(b) What would be **observed** when copper(II) nitrate is heated?

[3]

(c) Iron(III) sulphate decomposes when heated. Calculate the mass of iron(III) oxide formed and the volume of sulphur trioxide produced when 10.0 g of iron(III) sulphate was heated.

Mass of one mole of $Fe_2(SO_4)_3$ is 400 g.

$$Fe_2(SO_4)_3 \ (s) \longrightarrow Fe_2O_3 \ (s) + 3SO_3 \ (g)$$

Number of moles of $Fe_2(SO_4)_3$ =

Number of moles of Fe_2O_3 formed =

Mass of iron(III) oxide formed =   g

Number of moles of SO_3 produced =

Volume of sulphur trioxide at r.t.p. = dm^3 [5]

8   The alkenes are a homologous series of unsaturated hydrocarbons.

(a) The table below gives the names, formulae and boiling points of the first members of the series.

name	formula	boiling point/$^{\circ}$C
ethene	C_2H_4	-102
propene	C_3H_6	-48
butene	C_4H_8	-7
pentene	C_5H_{10}	30
hexene		

(i) Complete the table by giving the formula of hexene and by predicting its boiling point.

[2]

(ii) Deduce the formula of the alkene which has a relative molecular mass of 168. Show your working.

[2]

(b) Describe a test that will distinguish between the two isomers, but-2-ene and cyclobutane.

test	
result with but-2-ene	
result with cyclobutane	[3]

(c) Alkenes undergo addition reactions.

(i) What class of organic compound is formed when an alkene reacts with water?

[1]

(ii) Predict the structural formula of the compound formed when hydrogen chloride reacts with but-2-ene.

[1]

(iii) Draw the structure of the polymer formed from but-2-ene.

[2]

15

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DATA SHEET
The Periodic Table of the Elements

Group

I	II						III	IV	V	VI	VII	0
												4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4						11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12						27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulphur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89										

Transition elements (central block):

56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29
101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47
190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79

65 **Zn** Zinc 30		
112 **Cd** Cadmium 48		
201 **Hg** Mercury 80		

1 **H** Hydrogen 1

*58-71 Lanthanoid series
90-103 Actinoid series

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

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 dm³ at room temperature and pressure (r.t.p.).