UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

7116024521

CHEMISTRY **0620/31**

Paper 3 (Extended) **October/November 2009**

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 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.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

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 questions.

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

This document consists of **14** printed pages and **2** blank pages.

UNIVERSITY of CAMBRIDGE International Examinations

For Examiner's Use

1 **(a)** The major gases in unpolluted air are 79 % nitrogen and 20 % oxygen.

(i) Name another gaseous element in unpolluted air.

.... [1]

(ii) Name **two** compounds in unpolluted air.

.... [2]

(b) Two common pollutants in air are carbon monoxide and the oxides of nitrogen.

(i) Name another pollutant in air.

.... [1]

(ii) Describe how carbon monoxide is formed.

....

....

.... [2]

(iii) How are the oxides of nitrogen formed?

....

....

.... [2]

(iv) Explain how a catalytic converter reduces the emission of these two gases.

....

....

.... [2]

[Total: 10]

For Examiner's Use

2 Oxides are classified as acidic, basic, neutral and amphoteric.

(a) Complete the table.

type of oxide	pH of solution of oxide	example
acidic		
basic		
neutral		

[6]

(b) (i) Explain the term *amphoteric*.

....

.... [1]

(ii) Name two reagents that are needed to show that an oxide is amphoteric.

....

.... [2]

[Total: 9]

3 **(a)** An important ore of zinc is zinc blende, ZnS.

For Examiner's Use

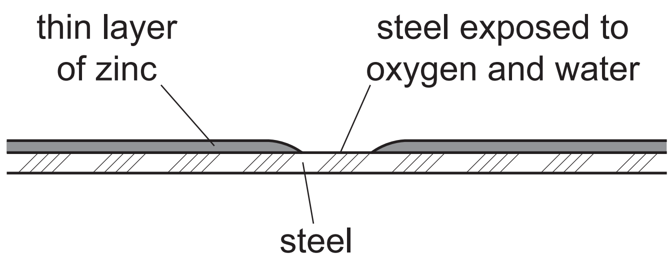
(i) How is zinc blende changed into zinc oxide?

.... [1]

(ii) Write a balanced equation for the reduction of zinc oxide to zinc by carbon.

.... [2]

(b) A major use of zinc is galvanizing; steel objects are coated with a thin layer of zinc. This protects the steel from rusting even when the layer of zinc is broken.



Explain, by mentioning ions and electrons, why the exposed steel does not rust.

....

....

....

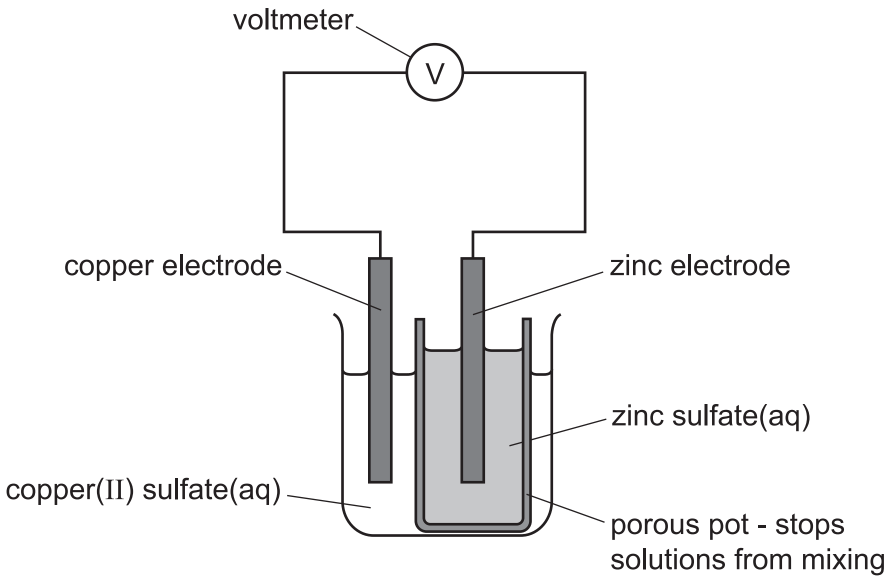
....

....

.... [3]

(c) Zinc electrodes have been used in cells for many years, one of the first was the Daniel cell in 1831.

For Examiner's Use



(i) Give an explanation for the following in terms of atoms and ions.

observation at zinc electrode – *the electrode becomes smaller*

explanation ....

.... [1]

observation at copper electrode – *the electrode becomes bigger*

explanation ....

.... [1]

(ii) When a current flows, charged particles move around the circuit.

What type of particle moves through the electrolytes?

.... [1]

Which particle moves through the wires and the voltmeter?

.... [1]

[Total: 10]

4 The distinctive smell of the seaside was thought to be caused by ozone, O_3. Ozone is a form of the element oxygen.

For Examiner's Use

(a) A mixture of oxygen and ozone is formed by passing electric sparks through oxygen.

$$3O_2 \rightleftharpoons 2O_3$$

Suggest a technique that might separate this mixture. Explain why this method separates the two forms of oxygen.

technique ....

explanation ....

....

....

.... [2]

(b) Ozone is an oxidant. It can oxidise an iodide to iodine.

$$2I^- + O_3 + 2H^+ \rightarrow I_2 + O_2 + H_2O$$

(i) What would you see when ozone is bubbled through aqueous acidified potassium iodide?

....

....

....

.... [2]

(ii) Explain in terms of electron transfer why the change from iodide ions to iodine molecules is oxidation.

....

.... [1]

(iii) Explain, using your answer to **b(ii)**, why ozone is the oxidant in this reaction.

....

.... [1]

(c) It is now known that the smell of the seaside is due to the chemical dimethyl sulfide, $(CH_3)_2S$.

For Examiner's Use

(i) Draw a diagram that shows the arrangement of the valency electrons in one molecule of this covalent compound.
Use x to represent an electron from a carbon atom.
Use o to represent an electron from a hydrogen atom.
Use ● to represent an electron from a sulfur atom.

[3]

(ii) Name the **three** compounds formed when dimethyl sulfide is burnt in excess oxygen.

....

....

.... [2]

[Total: 11]

For Examiner's Use

5 The first three elements in Group IV are carbon, silicon and germanium.
The elements and their compounds have similar properties.

(a) The compound, silicon carbide, has a macromolecular structure similar to that of diamond.

(i) A major use of silicon carbide is to reinforce aluminium alloys which are used in the construction of spacecraft. Suggest **three** of its physical properties.

....

....

.... [3]

(ii) Complete the following description of the structure of silicon carbide.

Each carbon atom is bonded to four .... atoms.

Each silicon atom is bonded to .... carbon atoms. [2]

(b) Germanium(IV) oxide, GeO_2, has the same macromolecular structure as silicon(IV) oxide. Draw the structural formula of germanium(IV) oxide.

[3]

For Examiner's Use

(c) Germanium forms a series of hydrides comparable to the alkanes.

(i) Draw the structural formula of the hydride which contains four germanium atoms per molecule.

[1]

(ii) Predict the products of the complete combustion of this hydride.

.... [2]

[Total: 11]

6 **(a)** Sulfuric acid is made by the Contact process.

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

This is carried out in the presence of a catalyst at 450 °C and 2 atmospheres pressure.

(i) How is the sulfur dioxide made?

....

.... [1]

(ii) Give another use of sulfur dioxide.

.... [1]

(iii) Name the catalyst used.

.... [1]

(iv) If the temperature is decreased to 300 °C, the yield of sulfur trioxide increases. Explain why this lower temperature is not used.

....

.... [1]

(v) Sulfur trioxide is dissolved in concentrated sulfuric acid. This is added to water to make more sulfuric acid. Why is sulfur trioxide not added directly to water?

....

.... [1]

For Examiner's Use

(b) Sulfuric acid was first made in the Middle East by heating the mineral, green vitriol, $FeSO_4.7H_2O$. The gases formed were cooled.

$FeSO_4.7H_2O(s) \rightarrow FeSO_4(s) + 7H_2O(g)$
green crystals yellow powder

$2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$

On cooling

$SO_3 + H_2O \rightarrow H_2SO_4$ sulfuric acid
$SO_2 + H_2O \rightarrow H_2SO_3$ sulfurous acid

(i) How could you show that the first reaction is reversible?

....

.... [2]

(ii) Sulfurous acid is a reductant. What would you see when acidified potassium manganate(VII) is added to a solution containing this acid?

....

.... [2]

(iii) Suggest an explanation why sulfurous acid in contact with air changes into sulfuric acid.

.... [1]

(c) 9.12 g of anhydrous iron(II) sulfate was heated. Calculate the mass of iron(III) oxide formed and the volume of sulfur trioxide, at r.t.p., formed.

$2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$

mass of one mole of $FeSO_4$ = 152 g

number of moles of $FeSO_4$ used = ...

number of moles of Fe_2O_3 formed = ...

mass of one mole of Fe_2O_3 = ... g

mass of iron(III) oxide formed = ... g

number of moles of SO_3 formed = ...

volume of sulfur trioxide formed = ... dm^3

[6]

[Total: 16]

For Examiner's Use

7 Butan-1-ol is used as a solvent for paints and varnishes, to make esters and as a fuel. Butan-1-ol can be manufactured from but-1-ene, which is made from petroleum.

Biobutanol is a fuel of the future. It can be made by the fermentation of almost any form of biomass - grain, straw, leaves etc.

(a) But-1-ene can be obtained from alkanes such as decane, $C_{10}H_{22}$, by cracking.

(i) Give the reaction conditions.

....

.... [2]

(ii) Complete an equation for the cracking of decane, $C_{10}H_{22}$, to give but-1-ene.

$C_{10}H_{22} \rightarrow$ .... [2]

(iii) Name the reagent that reacts with but-1-ene to form butan-1-ol.

.... [1]

(b) **(i)** Balance the equation for the complete combustion of butan-1-ol.

.... C_4H_9OH + ... $O_2 \rightarrow$ .... CO_2 + ... H_2O [2]

(ii) Write a word equation for the preparation of the ester butyl methanoate.

.... [2]

For Examiner's Use

(c) The fermentation of biomass by bacteria produces a mixture of products which include biobutanol, propanol, hydrogen and propanoic acid.

(i) Draw the structural formula of propanol and of propanoic acid. Show all the bonds.

propanol

propanoic acid

[2]

(ii) Why is it important to develop these fuels, such as biobutanol, as alternatives to petroleum?

.... [1]

(d) How could you show that butanol made from petroleum and biobutanol are the same chemical?

....

.... [1]

[Total: 13]

BLANK PAGE

BLANK PAGE

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										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** Sulfur 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	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	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	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	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	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	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 †															

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

*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^3 at room temperature and pressure (r.t.p.).