UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

| CANDIDATE NAME | |
|---|---|

| CENTRE NUMBER | | | | | | CANDIDATE NUMBER | | | | |
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*4888728650*

**CHEMISTRY** **0620/32**

Paper 3 (Extended) **October/November 2011**

**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 12.

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 | |

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**1** Cobalt is an element in Period 4 of the Periodic Table.

**(a)** Use your copy of the Periodic Table to help you complete the table below.

| particle | number of protons | number of neutrons | number of electrons |
|---|---|---|---|
| Co | | | |
| $Co^{2+}$ | | | |

[2]

**(b)** $^{60}Co$ is a cobalt isotope.

**(i)** Explain the term *isotope*.

.....

.....

..... [2]

**(ii)** Explain why two isotopes of the same element have identical chemical properties.

..... [1]

**(iii)** State **one** industrial use and **one** medical use of radioactive isotopes.

industrial use ..... [1]

medical use ..... [1]

[Total: 7]

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**2** Sulfur is needed for the production of sulfuric acid. Two of the major sources of sulfur are

- underground deposits of the element sulfur,
- sulfur compounds from natural gas and petroleum.

**(a)** Explain why sulfur and its compounds are removed from these fuels before they are burned.

.....

..... [2]

**(b)** Sulfur dioxide is made by spraying molten sulfur into air. The sulfur ignites and sulfur dioxide is formed.

**(i)** Suggest why molten sulfur is used in the form of a fine spray.

.....

..... [2]

**(ii)** Explain why traces of sulfur dioxide act as a preservative in fruit juices.

..... [1]

**(iii)** State another use of sulfur dioxide.

..... [1]

**(c)** Describe how sulfur dioxide is changed into sulfur trioxide. Give the reaction conditions and an equation.

.....

.....

.....

..... [4]

**(d)** Complete the following equations for the formation of sulfuric acid from sulfur trioxide.

$SO_3$ + ..... $\rightarrow$ $H_2S_2O_7$

$H_2S_2O_7$ + ……. $\rightarrow$ .....$H_2SO_4$ [2]

[Total: 12]

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**3** Antimony, Sb, is an element in Group V.

**(a)** The main ore of antimony is its sulfide. The extraction of antimony is similar to that of zinc.
Describe how each of these changes in the extraction of antimony is carried out.

**(i)** antimony sulfide to antimony oxide

..... [1]

**(ii)** antimony oxide to antimony

..... [1]

**(b)** Antimony oxide is a white powder which is insoluble in water.
Describe how you would find out if it is a basic, an acidic or an amphoteric oxide.

.....

.....

.....

..... [4]

**(c)** When antimony chloride is added to water, a faint white precipitate forms and the mixture slowly goes cloudy.

$$SbCl_3(aq) + H_2O(l) \underset{\text{backward}}{\overset{\text{forward}}{\rightleftharpoons}} 2HCl(aq) + SbOCl(s)$$

colourless white

**(i)** Explain why after some time the appearance of the mixture remains unchanged.

.....

..... [2]

**(ii)** When a few drops of concentrated hydrochloric acid are added to the mixture, it changes to a colourless solution. Suggest an explanation.

.....

..... [1]

**(iii)** Suggest how you could make the colourless solution go cloudy.

..... [1]

[Total: 10]

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**4** The structure of an element or compound determines its physical properties. Scandium fluoride and silicon(IV) oxide have giant structures.

**(a)** Scandium fluoride is an ionic compound.

**(i)** The valency of scandium is three. Draw a diagram which shows the formula of the compound, the charges on the ions and the arrangement of the valency electrons around the negative ion.
Use x to represent an electron from a scandium atom.
Use o to represent an electron from a fluorine atom.

[3]

**(ii)** The melting point of scandium fluoride is 1552 °C. Explain why scandium fluoride has a high melting point.

.....

..... [1]

**(b)** Silicon(IV) oxide has a macromolecular structure.

**(i)** Describe the structure of silicon(IV) oxide. You may use a diagram.

[3]

**(ii)** How does the electrical conductivity of these two compounds differ?

.....

..... [1]

**(iii)** Explain the difference in conductivity.

.....

..... [2]

[Total: 10]

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**5** The alcohols form a homologous series. Two characteristics of a homologous series are that the physical properties of the members vary in a predictable way and they have similar chemical properties.

**(a)** Complete the table.

| name | formula | mass of one mole / g | boiling point / °C |
|---|---|---|---|
| methanol | $CH_3-OH$ | 32 | 64 |
| ethanol | $CH_3-CH_2-OH$ | 46 | 78 |
| propan-1-ol | $CH_3-CH_2-CH_2-OH$ | 60 | 98 |
| butan-1-ol | $CH_3-CH_2-CH_2-CH_2-OH$ | 74 | 118 |
| pentan-1-ol | | | 138 |
| hexan-1-ol | $CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-OH$ | 102 | |

[3]

**(b)** Give **two** other characteristics of a homologous series.

.....

..... [2]

**(c)** Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound methanol.
Use x to represent an electron from a carbon atom.
Use o to represent an electron from an oxygen atom.
Use ● to represent an electron from a hydrogen atom.

[3]

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**(d)** Alcohols can be oxidised to carboxylic acids by heating with acidic potassium manganate(VII).

**(i)** Draw the structural formula of the carboxylic acid formed by the oxidation of propan-1-ol. Show all the bonds.

[1]

**(ii)** Describe how ethanol could be oxidised to ethanoic acid by fermentation.

.....

..... [2]

**(e)** Propan-1-ol and ethanoic acid react together to form an ester. Give its name and structural formula.

name ..... [1]

formula

[1]

[Total: 13]

For Examiner's Use

**6** Soluble salts can be made by the neutralisation of an acid by a base. Insoluble salts can be made by precipitation.

**(a)** The following is a brief description of the preparation of the soluble salt, nickel(II) chloride-6-water, from the insoluble base nickel(II) carbonate.

Nickel(II) carbonate is added in small amounts to hot dilute hydrochloric acid until it is in excess. The mixture is filtered. The filtrate is partially evaporated and then allowed to cool until crystals of nickel(II) chloride-6-water form.

**(i)** Why is it necessary to use excess carbonate?

.....

..... [1]

**(ii)** Explain why it is necessary to filter.

..... [1]

**(iii)** Why partially evaporate rather than evaporate to dryness?

.....

..... [1]

**(iv)** What additional steps are needed to obtain dry crystals?

.....

..... [2]

**(b)** Potassium chloride can be made from hydrochloric acid and potassium carbonate.

**(i)** Why must a different experimental method be used for this preparation?

.....

..... [1]

**(ii)** Give a description of the different method used for this salt preparation.

.....

.....

.....

..... [4]

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**(c)** Insoluble salts are made by precipitation. An equation for the preparation of barium sulfate is given below.

$$BaCl_2(aq) + MgSO_4(aq) \rightarrow BaSO_4(s) + MgCl_2(aq)$$

This reaction can be used to find x in the formula for hydrated magnesium sulfate $MgSO_4.xH_2O$.

A known mass of hydrated magnesium sulfate, $MgSO_4.xH_2O$, was dissolved in water. Excess aqueous barium chloride was added. The precipitate of barium sulfate was filtered, washed and dried. Finally it was weighed.

Mass of hydrated magnesium sulfate = 1.476 g

Mass of barium sulfate formed = 1.398 g

The mass of one mole of $BaSO_4$ = 233 g

The number of moles of $BaSO_4$ formed = ..... [1]

The number of moles of $MgSO_4.xH_2O$ = ..... [1]

The mass of one mole of $MgSO_4.xH_2O$ = ..... g [1]

The mass of one mole of $MgSO_4$ = 120 g

The mass of $xH_2O$ in one mole of $MgSO_4.xH_2O$ = ..... [1]

x = ..... [1]

[Total: 15]

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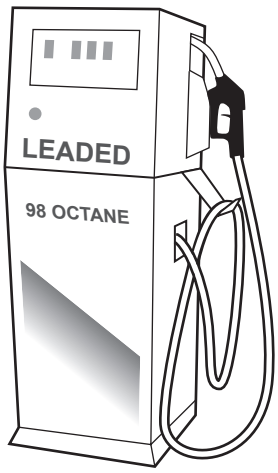
**7** Petrol is a mixture of hydrocarbons and additives. The combustion of petrol in car engines is a major source of air pollution. This is reduced by catalytic converters.

**(a)** Petrol is obtained from the gasoline fraction, boiling point range 40 °C to 100 °C, from the distillation of petroleum. Explain the term *fraction*.

.....

..... [2]

**(b)** In many countries, a lead compound of the type $Pb(C_2H_5)_n$ used to be added to petrol to improve its combustion. After combustion, lead oxide was formed.




**(i)** Octane is a constituent of petrol. Write the equation for the complete combustion of octane.

$C_8H_{18}$ + .....$O_2$ → ..... + ..... [2]

**(ii)** Dibromoethane was added to petrol to remove the lead oxide from inside the engine. Lead bromide was formed which escaped into the environment through the exhaust. Leaded petrol cannot be used with a catalytic converter. Give another reason why leaded petrol is no longer used.

..... [1]

**(iii)** What does each of the following tell you about the structure of dibromoethane?

*dibromo* .....

*eth* .....

*ane* ..... [2]

**(iv)** What additional information is needed to draw the structural formula of dibromoethane?

..... [1]

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**(c)** An analysis of the compound, $Pb(C_2H_5)_n$ , showed that 0.026 moles of Pb was combined with 0.104 moles of $C_2H_5$ groups.
What is the value of n? Show how you arrived at your answer.

.....

..... [2]

**(d)** Some of the pollutants emitted by vehicle exhausts are carbon monoxide, oxides of nitrogen and unburnt hydrocarbons. Explain how the emission of these gases is reduced by a catalytic converter.

.....

.....

..... [3]

[Total: 13]

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# DATA SHEET
## The Periodic Table of the Elements

| Group I | Group II | | | | | | | | | | | Group III | Group IV | Group V | Group VI | Group VII | Group 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** | a = relative atomic mass |
| b | **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.).

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