UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

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.

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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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[Turn over

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]

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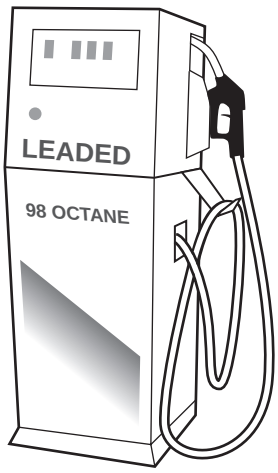
7 Petrol is a mixture of hydrocarbons and additives. The combustion of petrol in car engines is a major source of air pollution. This is reduced by catalytic converters.

(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	II									III	IV	V	VI	VII	0
																4 **He** Helium 2
				1 **H** Hydrogen 1							11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
	7 **Li** Lithium 3	9 **Be** Beryllium 4									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
	23 **Na** Sodium 11	24 **Mg** Magnesium 12									70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
	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	112 **Cd** Cadmium 48	119 **In** Indium 49	122 **Sn** Tin 50	128 **Sb** Antimony 51	127 **Te** Tellurium 52	131 **I** Iodine 53	131 **Xe** Xenon 54
	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	222 **Rn** Radon 86
	223 **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	a = relative atomic mass
X	X = atomic symbol
b	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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