



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

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**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	
<b>Total</b>	

This document consists of **12** printed pages.



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 <sup>2+</sup>			

[2]

(b) <sup>60</sup>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]

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]

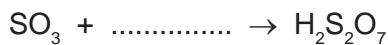
(iii) State another use of sulfur dioxide.

..... [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.



[Total: 12]

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

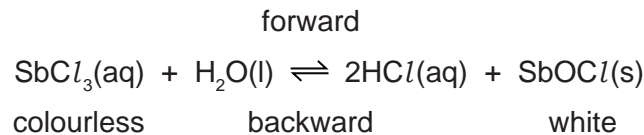
..... [1]

(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.



(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]

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]

- 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	$\text{CH}_3\text{-OH}$	32	64
ethanol	$\text{CH}_3\text{-CH}_2\text{-OH}$	46	78
propan-1-ol	$\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH}$	60	98
butan-1-ol	$\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-OH}$	74	118
pentan-1-ol			138
hexan-1-ol	$\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-OH}$	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]

(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]

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?

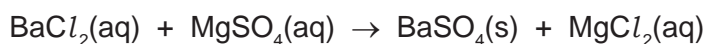
.....  
..... [1]

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

.....  
.....  
.....  
..... [4]



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



This reaction can be used to find  $x$  in the formula for hydrated magnesium sulfate  $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$ .

A known mass of hydrated magnesium sulfate,  $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$ , 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  $\text{BaSO}_4$  = 233 g

The number of moles of  $\text{BaSO}_4$  formed = ..... [1]

The number of moles of  $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$  = ..... [1]

The mass of one mole of  $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$  = ..... g [1]

The mass of one mole of  $\text{MgSO}_4$  = 120 g

The mass of  $x\text{H}_2\text{O}$  in one mole of  $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$  = ..... [1]

$x$  = ..... [1]

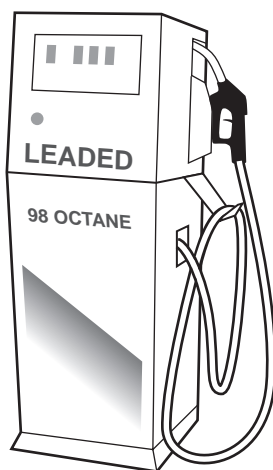
[Total: 15]

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.

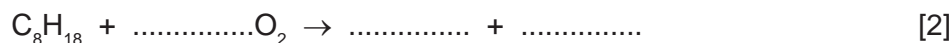
(a) Petrol is obtained from the gasoline fraction, boiling point range 40 °C to 100 °C, from the distillation of petroleum. Explain the term *fraction*.

.....  
 ..... [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.



(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]

- (c) An analysis of the compound,  $\text{Pb}(\text{C}_2\text{H}_5)_n$ , showed that 0.026 moles of Pb was combined with 0.104 moles of  $\text{C}_2\text{H}_5$  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]

**DATA SHEET**  
**The Periodic Table of the Elements**

		Group																																																																																																																															
I	II	III	IV	V	VI	VII	0																																																																																																																										
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4	1 <b>H</b> Hydrogen 1	11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	13 <b>Al</b> Aluminium 13	14 <b>N</b> Nitrogen 7	15 <b>O</b> Oxygen 8	16 <b>F</b> Fluorine 9	17 <b>Ne</b> Neon 10	18 <b>Ar</b> Argon 18	19 <b>K</b> Potassium 19	20 <b>Ca</b> Calcium 20	21 <b>Sc</b> Scandium 21	22 <b>Ti</b> Titanium 22	23 <b>V</b> Vanadium 23	24 <b>Cr</b> Chromium 24	25 <b>Mn</b> Manganese 25	26 <b>Fe</b> Iron 26	27 <b>Co</b> Cobalt 27	28 <b>Ni</b> Nickel 28	29 <b>Cu</b> Copper 29	30 <b>Zn</b> Zinc 30	31 <b>Ga</b> Gallium 31	32 <b>Ge</b> Germanium 32	33 <b>As</b> Arsenic 33	34 <b>Se</b> Selenium 34	35 <b>Br</b> Bromine 35	36 <b>Kr</b> Krypton 36	37 <b>Rb</b> Rubidium 37	38 <b>Sr</b> Strontium 38	39 <b>Y</b> Yttrium 39	40 <b>Zr</b> Zirconium 40	41 <b>Nb</b> Niobium 41	42 <b>Mo</b> Molybdenum 42	43 <b>Tc</b> Technetium 43	44 <b>Ru</b> Ruthenium 44	45 <b>Rh</b> Rhodium 45	46 <b>Pd</b> Palladium 46	47 <b>Ag</b> Silver 47	48 <b>Cd</b> Cadmium 48	49 <b>In</b> Indium 49	50 <b>Sn</b> Tin 50	51 <b>Sb</b> Antimony 51	52 <b>Te</b> Tellurium 52	53 <b>I</b> Iodine 53	54 <b>Xe</b> Xenon 54	55 <b>Cs</b> Caesium 55	56 <b>Ba</b> Barium 56	57 <b>La</b> Lanthanum 57	72 <b>Hf</b> Hafnium 72	73 <b>Ta</b> Tantalum 73	74 <b>W</b> Tungsten 74	75 <b>Re</b> Rhenium 75	76 <b>Os</b> Osmium 76	77 <b>Ir</b> Iridium 77	78 <b>Pt</b> Platinum 78	79 <b>Au</b> Gold 79	80 <b>Hg</b> Mercury 80	81 <b>Tl</b> Thallium 81	82 <b>Pb</b> Lead 82	83 <b>Bi</b> Bismuth 83	84 <b>Po</b> Polonium 84	85 <b>At</b> Astatine 85	86 <b>Rn</b> Radon 86	87 <b>Fr</b> Francium 87	88 <b>Ra</b> Radium 88	89 <b>Ac</b> Actinium 89	†	90 <b>Th</b> Thorium 90	91 <b>Pa</b> Protactinium 91	92 <b>U</b> Uranium 92	93 <b>Np</b> Neptunium 93	94 <b>Pu</b> Plutonium 94	95 <b>Am</b> Americium 95	96 <b>Cm</b> Curium 96	97 <b>Bk</b> Berkelium 97	98 <b>Cf</b> Californium 98	99 <b>Es</b> Einsteinium 99	100 <b>Fm</b> Fermium 100	101 <b>Md</b> Mendelevium 101	102 <b>No</b> Nobelium 102	103 <b>Lr</b> Lawrencium 103	133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	139 <b>La</b> Lanthanum 57	178 <b>Hf</b> Hafnium 72	181 <b>Ta</b> Tantalum 73	184 <b>W</b> Tungsten 74	186 <b>Re</b> Rhenium 75	190 <b>Os</b> Osmium 76	192 <b>Ir</b> Iridium 77	195 <b>Pt</b> Platinum 78	197 <b>Au</b> Gold 79	201 <b>Hg</b> Mercury 80	204 <b>Tl</b> Thallium 81	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	212 <b>Po</b> Polonium 84	214 <b>At</b> Astatine 85	216 <b>Rn</b> Radon 86	226 <b>Ra</b> Radium 88	227 <b>Ac</b> Actinium 89	†	232 <b>Th</b> Thorium 90	238 <b>U</b> Uranium 92	238 <b>Np</b> Neptunium 93	238 <b>Pu</b> Plutonium 94	238 <b>Am</b> Americium 95	238 <b>Cm</b> Curium 96	238 <b>Bk</b> Berkelium 97	238 <b>Cf</b> Californium 98	238 <b>Es</b> Einsteinium 99	238 <b>Fm</b> Fermium 100	238 <b>Md</b> Mendelevium 101	238 <b>No</b> Nobelium 102	238 <b>Lr</b> Lawrencium 103	140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	159 <b>Tb</b> Terbium 65	162 <b>Dy</b> Dysprosium 66	165 <b>Ho</b> Holmium 67	167 <b>Er</b> Erbium 68	169 <b>Tm</b> Thulium 69	173 <b>Yb</b> Ytterbium 70	175 <b>Lu</b> Lutetium 71

\*58-71 Lanthanoid series  
†90-103 Actinoid series

Key

a	<b>X</b>
b	

a = relative atomic mass  
X = atomic symbol  
b = proton (atomic) number

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

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