



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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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	
Total	

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 ²⁺			

[2]

(b) ⁶⁰Co 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]

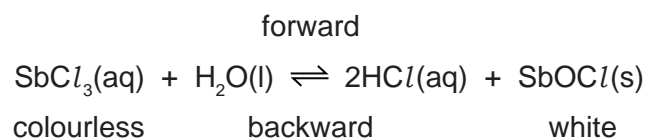
(b) Antimony oxide is a white powder which is insoluble in water.

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.

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(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.

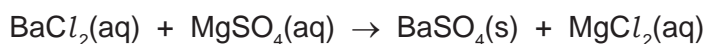
(i) Why must a different experimental method be used for this preparation?

.....
..... [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 BaSO_4 = 233 g

The number of moles of 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 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]

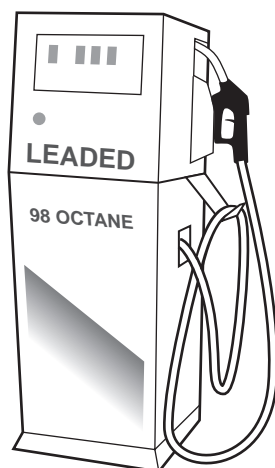
[Total: 15]

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.

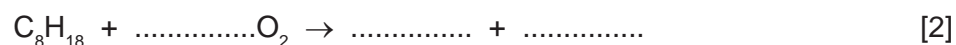
(a) Petrol is obtained from the gasoline fraction, boiling point range 40 °C to 100 °C, from the distillation of petroleum. Explain the term *fraction*.

.....
 [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 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]

DATA SHEET
The Periodic Table of the Elements

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

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

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