



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE
NAME

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CHEMISTRY

0620/42

Paper 4 Theory (Extended)

May/June 2017

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 an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

A copy of the Periodic Table is printed on page 16.

You may lose marks if you do not show your working or if you do not use appropriate units.

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.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

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



1 (a) State the name of the process that is used to

(i) separate oxygen from liquid air,

..... [1]

(ii) separate the individual dyes in ink,

..... [1]

(iii) produce ethanol from simple sugars,

..... [1]

(iv) obtain water from aqueous sodium chloride,

..... [1]

(v) separate the precipitate formed when aqueous silver nitrate is added to aqueous sodium chloride.

..... [1]

(b) State what is meant by the terms

(i) *element*,

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

(ii) *compound*,

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

(iii) *ion*.

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

[Total: 8]

- 2 Carbon and silicon are elements in Group IV of the Periodic Table. Both carbon and silicon exist as more than one isotope.

(a) Define the term *isotopes*.

.....
 [2]

(b) Complete the following table which gives information about carbon atoms and silicon atoms.

	carbon	silicon
proton number		
electronic structure		
nucleon number	12	28
number of neutrons in one atom		

[3]

(c) Silicon has a giant structure which is similar to the structure of diamond.

(i) Name the type of bond which is present between silicon atoms in silicon.

..... [1]

(ii) Suggest **two** physical properties of silicon.

Use your knowledge of structure and bonding to explain why silicon has these physical properties.

property 1

reason 1

property 2

reason 2

[4]

(d) Samples of air taken from industrial areas are found to contain small amounts of carbon monoxide.

(i) Explain how this carbon monoxide is formed.

.....
 [2]

(ii) State why carbon monoxide should **not** be inhaled.

..... [1]

(e) Carbon dioxide, CO_2 , is a gas at room temperature and pressure, whereas silicon(IV) oxide, SiO_2 , is a solid.

(i) Name the type of structure which the following compounds have.

carbon dioxide [1]

silicon(IV) oxide [1]

(ii) Use your knowledge of structure and bonding to explain why carbon dioxide is a gas at room temperature and pressure, whereas silicon(IV) oxide is a solid.

.....
.....
.....
..... [3]

(f) Silicon(IV) oxide is an acidic oxide. When silicon(IV) oxide reacts with alkalis, the salts formed contain the ion SiO_3^{2-} .

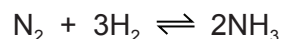
Write a chemical equation for the reaction between silicon(IV) oxide and aqueous sodium hydroxide.

..... [2]

[Total: 20]

3 This question is about nitrogen and some of its compounds.

(a) Nitrogen in the air can be converted into ammonia by the Haber process. The chemical equation for the reaction is shown.



(i) State the temperature and pressure used in the Haber process.

temperature

pressure

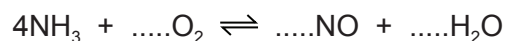
[2]

(ii) Name the catalyst used in the Haber process.

..... [1]

(b) The ammonia produced in the Haber process can be oxidised to nitrogen(II) oxide at 900 °C. The reaction is exothermic.

(i) Balance the chemical equation for this reaction.



[2]

(ii) Suggest a reason, other than cost, why a temperature greater than 900 °C is **not** used.

..... [1]

(iii) Suggest a reason why a temperature less than 900 °C is **not** used.

..... [1]

(c) Nitrogen(II) oxide can be reacted with oxygen and water to produce nitric acid as the only product.

Write a chemical equation for this reaction.

..... [2]

- (d) Describe how you would prepare a pure dry sample of copper(II) nitrate crystals in the laboratory using dilute nitric acid and solid copper(II) carbonate.
Include a series of key steps in your answer.
You should include a chemical equation for the reaction.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 15]

Question 4 starts on the next page.

4 Nickel, copper and zinc are three consecutive elements in the Periodic Table.

(a) Nickel and copper are transition elements.

State **three** chemical properties of transition elements.

.....

.....

..... [3]

(b) Copper(II) oxide is a basic oxide but zinc oxide is an amphoteric oxide. Both oxides are insoluble in water.

You are provided with a mixture of solid copper(II) oxide and solid zinc oxide. Describe how you would obtain a sample of copper(II) oxide from this mixture.

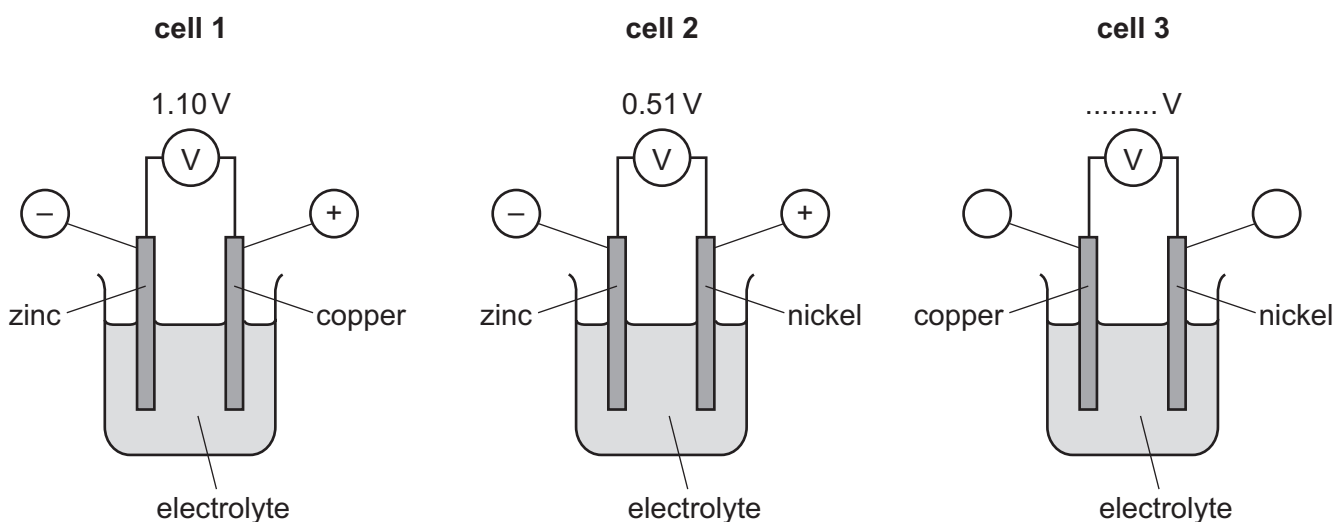
.....

.....

.....

..... [3]

(c) Three cells are set up each using two metals.



(i) Write the ionic half-equation for the reaction occurring at the zinc electrode in **cell 1**.

..... [2]

(ii) Put the **three** metals, copper, nickel and zinc, in order of reactivity.

most reactive



.....

least reactive

[1]

(iii) Complete the labelling in **cell 3** by writing the polarity (+/–) of each electrode in the circles and calculating the reading on the voltmeter. [2]

[Total: 11]

- 5 (a) The elements in Group VII are known as the halogens. Some halogens react with aqueous solutions of halides.

- (i) Complete the table by adding a ✓ to indicate when a reaction occurs and a ✗ to indicate when no reaction occurs.

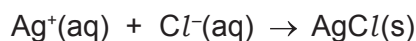
	aqueous potassium chloride	aqueous potassium bromide	aqueous potassium iodide
chlorine	✗	✓	
bromine		✗	
iodine			✗

[3]

- (ii) Write a chemical equation for the reaction between chlorine and aqueous potassium bromide.

..... [1]

- (b) A sample of vanadium chloride was weighed and dissolved in water. An excess of aqueous silver nitrate, acidified with dilute nitric acid, was added. A precipitate of silver chloride was formed. The ionic equation for this reaction is shown.



The mass of silver chloride formed was 2.87 g.

- (i) State the colour of the precipitate of silver chloride.

..... [1]

- (ii) The relative formula mass of silver chloride, AgCl , is 143.5.

Calculate the number of moles in 2.87 g of AgCl .

moles of AgCl = mol [1]

- (iii) Use your answer to (b)(ii) and the ionic equation to deduce the number of moles of chloride ions, Cl^- , that produced 2.87 g of AgCl .

moles of Cl^- = mol [1]

- (iv) The amount of vanadium chloride in the sample was 0.01 moles.

Use this and your answer to (b)(iii) to deduce the **whole number** ratio of moles of vanadium chloride : moles of chloride ions.
Deduce the formula of vanadium chloride.

moles of vanadium chloride : moles of chloride ions :

formula of vanadium chloride

[2]

(c) Astatine is at the bottom of Group VII. Use your knowledge of the properties of the halogens to

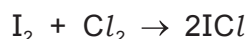
(i) predict the physical state of astatine at room temperature and pressure,

..... [1]

(ii) write a chemical equation for the reaction between sodium and astatine.

..... [2]

(d) Iodine reacts with chlorine. The chemical equation is shown.



Use the bond energies to answer the questions.

bond	bond energy in kJ/mol
I–I	151
Cl–Cl	242
I–Cl	208

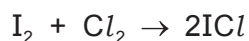
(i) Calculate the total amount of energy required to break the bonds in 1 mole of I_2 and 1 mole of Cl_2 .

..... kJ [1]

(ii) Calculate the total amount of energy given out when the bonds in 2 moles of ICl are formed.

..... kJ [1]

(iii) Use your answers to (d)(i) and (d)(ii) to calculate the overall energy change for the reaction.



..... kJ/mol [1]

[Total: 15]

6 (a) An homologous series is a 'family' of organic compounds whose names have the same ending.

(i) Name the homologous series for which the names of the organic compounds end in *-ene* and *-oic acid*.

-ene [1]

-oic acid [1]

(ii) State **two** characteristics of an homologous series.

.....
..... [2]

(b) Propan-1-ol is a member of the homologous series of alcohols. It reacts in the same way as ethanol with acidified potassium manganate(VII) and with carboxylic acids.

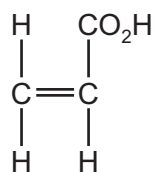
Name the **type** of compound that is formed when propan-1-ol is heated with

acidified potassium manganate(VII),

ethanoic acid and a suitable catalyst.

[2]

(c) The structure of prop-2-enoic (acrylic) acid is shown.



- (i) What would you see if prop-2-enoic acid were added to
 aqueous bromine,
 a solution of sodium carbonate.

[2]

- (ii) Prop-2-enoic acid can be polymerised to form poly(acrylic acid).
 Suggest the type of polymerisation that occurs and draw **one** repeat unit of the polymer.
 type of polymerisation
 repeat unit

[3]

[Total: 11]

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