Cambridge IGCSE

**Cambridge International Examinations**
Cambridge International General Certificate of Secondary Education

| | |
|---|---|
| CANDIDATE NAME | |
| CENTRE NUMBER | |
| CANDIDATE NUMBER | |

*5924154296*

**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]



**[Turn over**

**(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.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

**(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.

$$4NH_3 + .....O_2 \rightleftharpoons .....NO + .....H_2O$$

[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]



**[Turn over**

**(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.

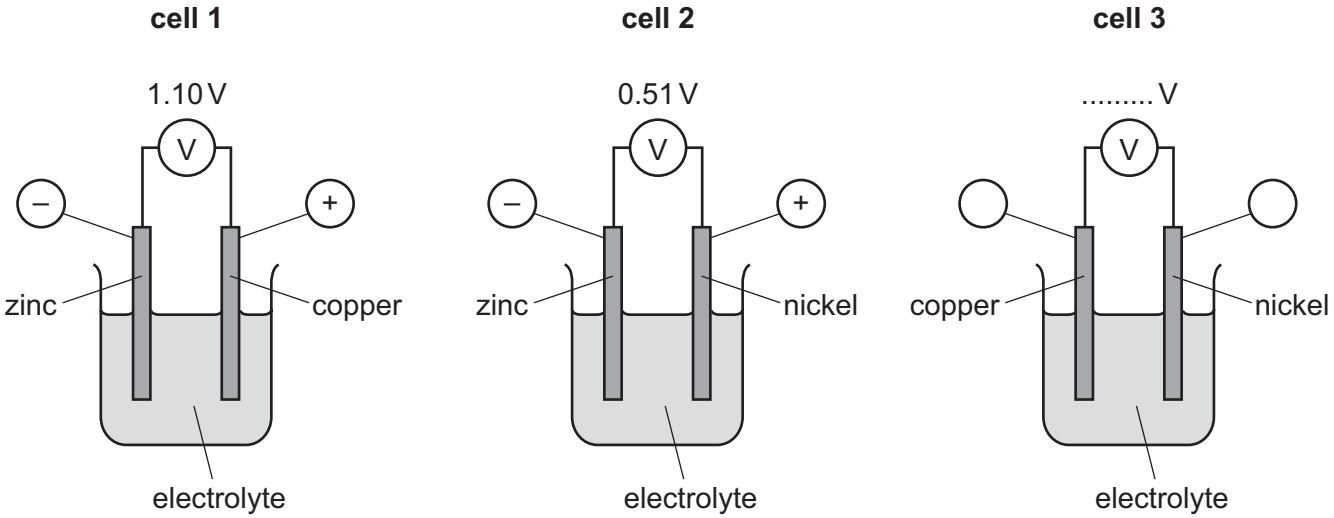
.....

.....

.....

..... [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.

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

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, AgC*l*, is 143.5.

Calculate the number of moles in 2.87 g of AgC*l*.

moles of AgC*l* = ..... 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 AgC*l*.

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.

$$I_2 + Cl_2 \rightarrow 2ICl$$

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.

$$I_2 + Cl_2 \rightarrow 2ICl$$

..... kJ / mol [1]

[Total: 15]



**[Turn over**

**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]

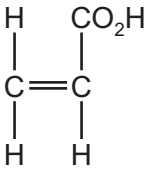
**(b)** Propan-1-ol is a member of the homologous series of alcohols. It reacts in the same way as ethanol with acidified potassium manganate(VII) and with carboxylic acids.

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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## The Periodic Table of Elements

| Group | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | II | | | | | | | | | | | III | IV | V | VI | VII | VIII |
| | | | | | | | 1 H hydrogen 1 | | | | | | | | | | 2 He helium 4 |
| 3 Li lithium 7 | 4 Be beryllium 9 | | | | | | | | | | | 5 B boron 11 | 6 C carbon 12 | 7 N nitrogen 14 | 8 O oxygen 16 | 9 F fluorine 19 | 10 Ne neon 20 |
| 11 Na sodium 23 | 12 Mg magnesium 24 | | | | | | | | | | | 13 Al aluminium 27 | 14 Si silicon 28 | 15 P phosphorus 31 | 16 S sulfur 32 | 17 Cl chlorine 35.5 | 18 Ar argon 40 |
| 19 K potassium 39 | 20 Ca calcium 40 | 21 Sc scandium 45 | 22 Ti titanium 48 | 23 V vanadium 51 | 24 Cr chromium 52 | 25 Mn manganese 55 | 26 Fe iron 56 | 27 Co cobalt 59 | 28 Ni nickel 59 | 29 Cu copper 64 | 30 Zn zinc 65 | 31 Ga gallium 70 | 32 Ge germanium 73 | 33 As arsenic 75 | 34 Se selenium 79 | 35 Br bromine 80 | 36 Kr krypton 84 |
| 37 Rb rubidium 85 | 38 Sr strontium 88 | 39 Y yttrium 89 | 40 Zr zirconium 91 | 41 Nb niobium 93 | 42 Mo molybdenum 96 | 43 Tc technetium – | 44 Ru ruthenium 101 | 45 Rh rhodium 103 | 46 Pd palladium 106 | 47 Ag silver 108 | 48 Cd cadmium 112 | 49 In indium 115 | 50 Sn tin 119 | 51 Sb antimony 122 | 52 Te tellurium 128 | 53 I iodine 127 | 54 Xe xenon 131 |
| 55 Cs caesium 133 | 56 Ba barium 137 | 57–71 lanthanoids | 72 Hf hafnium 178 | 73 Ta tantalum 181 | 74 W tungsten 184 | 75 Re rhenium 186 | 76 Os osmium 190 | 77 Ir iridium 192 | 78 Pt platinum 195 | 79 Au gold 197 | 80 Hg mercury 201 | 81 Tl thallium 204 | 82 Pb lead 207 | 83 Bi bismuth 209 | 84 Po polonium – | 85 At astatine – | 86 Rn radon – |
| 87 Fr francium – | 88 Ra radium – | 89–103 actinoids | 104 Rf rutherfordium – | 105 Db dubnium – | 106 Sg seaborgium – | 107 Bh bohrium – | 108 Hs hassium – | 109 Mt meitnerium – | 110 Ds darmstadtium – | 111 Rg roentgenium – | 112 Cn copernicium – | | 114 Fl flerovium – | | 116 Lv livermorium – | | |

**Key**

atomic number
atomic symbol
name
relative atomic mass

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lanthanoids | 57 La lanthanum 139 | 58 Ce cerium 140 | 59 Pr praseodymium 141 | 60 Nd neodymium 144 | 61 Pm promethium – | 62 Sm samarium 150 | 63 Eu europium 152 | 64 Gd gadolinium 157 | 65 Tb terbium 159 | 66 Dy dysprosium 163 | 67 Ho holmium 165 | 68 Er erbium 167 | 69 Tm thulium 169 | 70 Yb ytterbium 173 | 71 Lu lutetium 175 |
| actinoids | 89 Ac actinium – | 90 Th thorium 232 | 91 Pa protactinium 231 | 92 U uranium 238 | 93 Np neptunium – | 94 Pu plutonium – | 95 Am americium – | 96 Cm curium – | 97 Bk berkelium – | 98 Cf californium – | 99 Es einsteinium – | 100 Fm fermium – | 101 Md mendelevium – | 102 No nobelium – | 103 Lr lawrencium – |

The volume of one mole of any gas is 24 $dm^3$ at room temperature and pressure (r.t.p.).