Cambridge IGCSE

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

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*3291778503*

**CHEMISTRY** **0620/42**

Paper 4 Theory (Extended) **May/June 2016**

**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 12.
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 **12** printed pages.

**1** **(a)** For each of the following, give the name of an element from Period 2 (lithium to neon), which matches the description.
Elements may be used once, more than once or not at all.

**(i)** an element which is gaseous at room temperature and pressure

..... [1]

**(ii)** an element which forms an oxide that is a reactant in photosynthesis

..... [1]

**(iii)** an element that is a product of photosynthesis

..... [1]

**(iv)** an element that makes up approximately 78% by volume of the air

..... [1]

**(v)** an element which has atoms with a full outer shell of electrons

..... [1]

**(vi)** an element which exists as both diamond and graphite

..... [1]

**(vii)** an element that reacts vigorously with cold water

..... [1]

**(viii)** a soft metallic element which is stored in oil

..... [1]

**(b)** Give the formula of a compound that contains

**(i)** only boron and oxygen, ..... [1]

**(ii)** only lithium and nitrogen. ..... [1]

[Total: 10]

**2** **(a)** **(i)** Define the term *atomic number*.

..... [1]

**(ii)** Define the term *nucleon number*.

.....

..... [2]

**(b)** The table shows the number of protons, neutrons and electrons in some atoms or ions.

Complete the table. The first line is given as an example.

| particle | number of protons | number of electrons | number of neutrons | symbol or formula |
|---|---|---|---|---|
| A | 6 | 6 | 6 | $^{12}_{6}C$ |
| B | 12 | 12 | 12 | |
| C | 8 | | | $^{16}_{8}O^{2-}$ |
| D | 11 | 10 | 13 | |

[6]

[Total: 9]

**3** Gallium is a metallic element in Group III. It has similar properties to aluminium.

**(a) (i)** Describe the structure and bonding in a metallic element.
You should include a labelled diagram in your answer.

.....

..... [3]

**(ii)** Explain why metallic elements such as gallium are good conductors of electricity.

..... [1]

**(b)** Give the formula of

gallium(III) chloride, .....

gallium(III) sulfate. .....
[2]

**(c)** Gallium(III) oxide, $Ga_2O_3$, is amphoteric.

**(i)** Write the chemical equation for the reaction between gallium(III) oxide and dilute nitric acid to form a salt and water only.

..... [2]

**(ii)** The reaction between gallium(III) oxide and sodium hydroxide solution forms only water and a salt containing the negative ion $Ga_2O_4^{2-}$.

Write the chemical equation for this reaction.

..... [2]

**(d)** Alloys of gallium and other elements are often more useful than the metallic element itself.

Suggest **two** reasons why alloys of gallium are more useful than the metallic element.

.....

..... [2]

[Total: 12]

**4** Hydrogen can be manufactured from methane by steam reforming.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

The reaction is carried out using a nickel catalyst at temperatures between 700 °C and 1100 °C and using a pressure of one atmosphere.

The forward reaction is endothermic.

**(a)** What is meant by the term *catalyst*?

.....

..... [2]

**(b)** Suggest **two** reasons why a temperature lower than 700 °C is not used.

.....

..... [2]

**(c)** Suggest **one** advantage of using a pressure greater than one atmosphere.

..... [1]

**(d)** Suggest **one** disadvantage of using a pressure greater than one atmosphere.

..... [1]

**(e)** Hydrogen can also be manufactured by electrolysis. The electrolyte is concentrated aqueous sodium chloride. The electrodes are inert.

The products of electrolysis are hydrogen, chlorine and sodium hydroxide.

**(i)** Define the term *electrolysis*.

.....

..... [2]

**(ii)** Name a substance that can be used as the inert electrodes.

..... [1]

**(iii)** Write an ionic half-equation for the reaction in which hydrogen is produced.

..... [1]

**(iv)** Where is hydrogen produced in the electrolytic cell?

..... [1]

**(v)** Describe a test for chlorine.

test .....

result .....
[2]

**(f)** The electrolysis of concentrated aqueous sodium chloride can be represented by the following word equation.

sodium chloride + water → sodium hydroxide + hydrogen + chlorine

Construct a chemical equation to represent this reaction. Do not include state symbols.

..... [2]

**(g)** State one use of

chlorine, .....

sodium hydroxide, .....

hydrogen. .....
[3]

[Total: 18]

**5** **(a)** Hydrocarbons are compounds which contain hydrogen and carbon only.

- 10 $cm^3$ of a gaseous hydrocarbon, $C_xH_y$, are burned in 100 $cm^3$ of oxygen, which is an excess of oxygen.
- After cooling to room temperature and pressure, there is 25 $cm^3$ of unreacted oxygen, 50 $cm^3$ of carbon dioxide and some liquid water.

All volumes are measured under the same conditions of temperature and pressure.

**(i)** What is meant by an *excess* of oxygen?

..... [1]

**(ii)** What was the volume of oxygen that reacted with the hydrocarbon?

..... [1]

**(iii)** Complete the table below to express the smallest whole number ratio of

volume of hydrocarbon reacted : volume of oxygen reacted : volume of carbon dioxide produced

| | volume of hydrocarbon reacted | volume of oxygen reacted | volume of carbon dioxide produced |
|---|---|---|---|
| **smallest** whole number ratio of volumes | | | |

[1]

**(iv)** Use your answer to **(a)(iii)** to find the mole ratio in the equation below. Complete the equation and deduce the formula of the hydrocarbon.

$$.....C_xH_y(g) + .....O_2(g) \rightarrow .....CO_2(g) + .....H_2O(l)$$

formula of hydrocarbon = .....

[2]

**(b)** Cracking is used to convert long chain alkanes into shorter chain alkanes and alkenes. Alkenes are unsaturated compounds.

Decane, $C_{10}H_{22}$, can be cracked to give propene and one other product.

**(i)** Complete the chemical equation.

$$C_{10}H_{22} \rightarrow C_3H_6 + \text{.....}$$

[1]

**(ii)** What is meant by the term *unsaturated*?

..... [1]

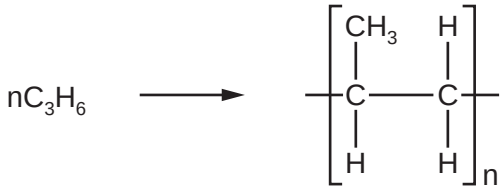
**(iii)** Describe a test to show that propene is an unsaturated compound.

test .....

result .....

[2]

**(c)** Propene can be polymerised. The only product is polypropene. The equation for the polymerisation is:




**(i)** Name the type of polymerisation that occurs.

..... [1]

**(ii)** Deduce the maximum mass of polypropene that could be produced from 1 kg of propene.

..... kg [1]

**(iii)** Give the empirical formula of

propene, .....

polypropene. .....

[2]

[Total: 13]

**6** Zinc is extracted from an ore called zinc blende, which consists mainly of zinc sulfide, ZnS.

**(a) (i)** The zinc sulfide in the ore is first converted into zinc oxide.

Describe how zinc oxide is made from zinc sulfide.

.....

..... [1]

**(ii)** Write a chemical equation for the reaction in **(a)(i)**.

..... [2]

**(b)** Zinc oxide is converted into zinc. Zinc oxide and coke are fed into a furnace. Hot air is blown into the bottom of the furnace.

Zinc has a melting point of 420 °C and a boiling point of 907 °C. The temperature inside the furnace is over 1000 °C.

**(i)** Explain how zinc oxide is converted into zinc. Your answer should include details of how the heat is produced and equations for all the reactions you describe.

.....

.....

.....

.....

..... [3]

**(ii)** Explain why the zinc produced inside the furnace is a gas.

..... [1]

**(iii)** State the name of the physical change for conversion of gaseous zinc into molten zinc.

..... [1]

**(c)** Rusting of steel can be prevented by coating the steel with a layer of zinc.

Explain, in terms of electron transfer, why steel does **not** rust even if the layer of zinc is scratched so that the steel is exposed to air and water.

.....

.....

.....

.....

..... [4]

**(d)** When a sample of steel is added to dilute hydrochloric acid, an aqueous solution of iron(II) chloride, $FeCl_2$, is formed.

When a sample of rust is added to dilute hydrochloric acid, an aqueous solution of iron(III) chloride, $FeCl_3$, is formed.

**(i)** Aqueous sodium hydroxide is added to the solutions of iron(II) chloride and iron(III) chloride.

Complete the table below, showing the observations you would expect to make.

| | iron(II) chloride solution | iron(III) chloride solution |
|---|---|---|
| aqueous sodium hydroxide | | |

[2]

Solutions of iron(II) chloride and iron(III) chloride were added to solutions of potassium iodide and acidified potassium manganate(VII). The results are shown in the table.

| | iron(II) chloride solution | iron(III) chloride solution |
|---|---|---|
| potassium iodide solution | no change | solution turns from colourless to brown |
| acidified potassium manganate(VII) solution | solution turns from purple to colourless | no change |

**(ii)** What **types** of substance cause potassium iodide solution to turn from colourless to brown?

..... [1]

**(iii)** What **types** of substance cause acidified potassium manganate(VII) solution to turn from purple to colourless?

..... [1]

**(iv)** Which **ion** in iron(III) chloride solution causes potassium iodide solution to turn from colourless to brown?

..... [1]

**(v)** Which **ion** in iron(II) chloride solution causes acidified potassium manganate(VII) solution to turn from purple to colourless?

..... [1]

[Total: 18]

## The Periodic Table of Elements

| Group I | Group II | | | | | | | | | | | Group III | Group IV | Group V | Group VI | Group VII | Group 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.)