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

Cambridge IGCSE

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

**CHEMISTRY** 0620/32

Paper 3 (Extended) **October/November 2015**

**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.

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

**1** Use your copy of the Periodic Table to help you answer some of these questions.

**(a)** Predict the formulae of the following compounds.

   **(i)** nitrogen fluoride ...................................................................................................................

  **(ii)** phosphorus sulfide .............................................................................................................
                                                      [2]

**(b)** Deduce the formulae of the following ions.

   **(i)** selenide ...........................................................................................................................

  **(ii)** gallium .............................................................................................................................
                                                      [2]

**(c)** Use the following ions to determine the formulae of the compounds.

  **ions**   $OH^-$   $Cr^{3+}$   $Ba^{2+}$   $SO_4^{2-}$

  **compounds**

   **(i)** chromium(III) sulfate .........................................................................................................

  **(ii)** barium hydroxide .............................................................................................................
                                                      [2]

                                                      [Total: 6]

**2** **(a)** Polluted air contains two oxides of carbon and two oxides of nitrogen. A major source of these pollutants is motor vehicles.

**(i)** Describe how carbon dioxide and carbon monoxide are formed in motor vehicle engines.

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**(ii)** State **one** adverse effect of each of these gases.

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**(iii)** Nitrogen monoxide, NO, is released by motor vehicle exhausts.

Explain how nitrogen monoxide is formed in motor vehicle engines.

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**(iv)** When nitrogen monoxide is released into the atmosphere, nitrogen dioxide, $NO_2$, is formed.

Suggest an explanation why this happens.

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**(b)** Predict the possible adverse effect on the environment when this non-metal oxide, $NO_2$, reacts with water and oxygen.

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**(c)** How are the amounts of carbon monoxide and nitrogen monoxide emitted by modern motor vehicles reduced? Include an equation in your answer.

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[Total: 13]

**3**  Two of the main uses of zinc are for galvanising and for making alloys.

One of the main ores of zinc is zinc blende, ZnS. There are two stages in the extraction of zinc from this ore.

**(a) Stage 1**  Zinc oxide is made from zinc blende.

Describe how this is done and write a word equation for the reaction.

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**(b) Stage 2**  Zinc oxide is reduced to zinc.

Write a word equation for the reduction of zinc oxide by coke.

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**(c)**  The zinc produced by this process is impure. It can be purified by electrolysis using a method which is similar to the purification of copper. Under the conditions used in the process, zinc is the product at the negative electrode (cathode).

Complete the following description of this purification.

The electrolyte is aqueous ................................................................................................ . [1]

The negative electrode (cathode) is made of  ................................................................ . [1]

The positive electrode (anode) is impure zinc.

The equation for the reaction at the cathode is  ............................................................ . [1]

The equation for the reaction at the anode is  ............................................................... . [1]

Explain why the concentration of the electrolyte does **not** change.

...........................................................................................................................................................

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

**(d)** Brass is an alloy which contains zinc.

**(i)** Name the other metal in brass.

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**(ii)** Suggest **two** reasons why an alloy such as brass is preferred to either of its constituent metals.

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**(e)** In an experiment to investigate the rate of rusting of steel, three pieces of steel were used. One piece of steel was completely coated with copper, one piece completely coated with zinc and the third piece was left uncoated. All three pieces were left exposed to the atmosphere.

**(i)** Explain why the uncoated piece started to rust.

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

**(ii)** The coating on both of the other two pieces was scratched, exposing the steel.



exposed steel does not rust

thin layer of zinc
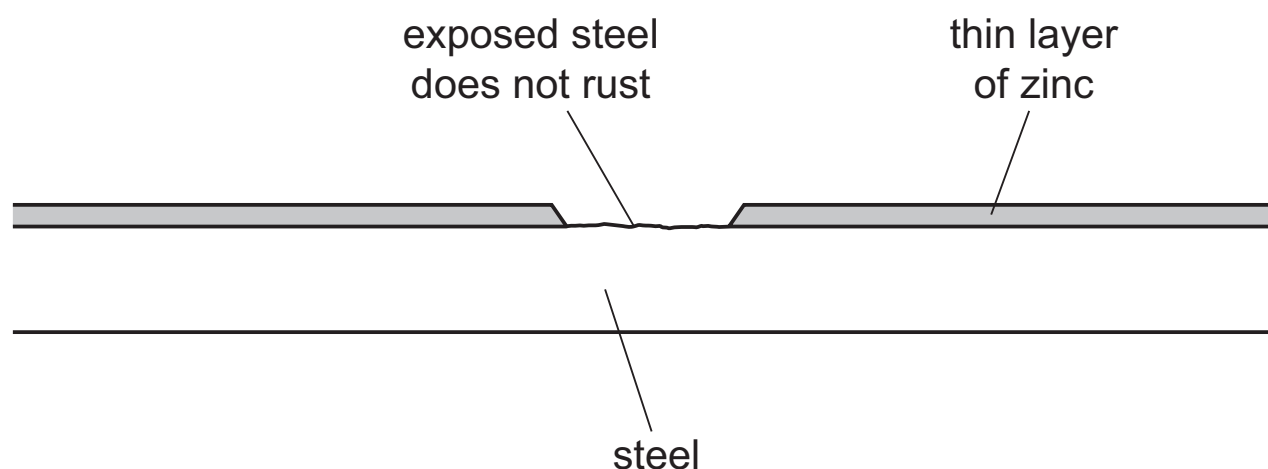
steel

The piece of steel coated with zinc still did not rust but the copper-coated piece of steel rusted very rapidly.

Explain these observations in terms of the formation of ions and the transfer of electrons.

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[Total: 17]

**4** **(a)** Propane reacts with chlorine to form a mixture of chloropropanes. This is a photochemical reaction.

**(i)** What is meant by the phrase *photochemical reaction*?

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**(ii)** The products of this reaction include two isomers, one of which has the following structural formula.

$$\begin{array}{c} \quad\;\; H \quad\;\; H \quad\;\; H \\ \quad\;\; | \qquad | \qquad | \\ H - C - C - C - Cl \\ \quad\;\; | \qquad | \qquad | \\ \quad\;\; H \quad\;\; H \quad\;\; H \end{array}$$
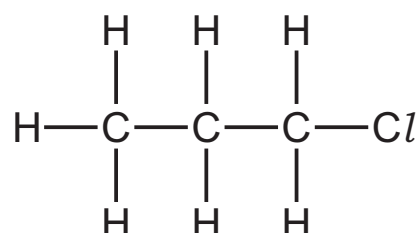
Draw the structural formula of the other isomer.

[1]

**(iii)** Explain why these two different compounds are isomers.

.................................................................................................................................................

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

**(b)** Bond breaking is an endothermic change and bond forming is an exothermic change.

Bond energy is the amount of energy in kJ/mol needed to break one mole of the specified bond.

$$
\begin{array}{ccccccc}
& \text{H} \quad \text{H} \quad \text{H} & & & & \text{H} \quad \text{H} \quad \text{H} & \\
& | \quad\; | \quad\; | & & & & | \quad\; | \quad\; | & \\
\text{H}-\text{C}-\text{C}-\text{C}-\text{H} & + & \text{C}l-\text{C}l & \rightarrow & \text{H}-\text{C}-\text{C}-\text{C}-\text{C}l & + & \text{H}-\text{C}l \\
& | \quad\; | \quad\; | & & & & | \quad\; | \quad\; | & \\
& \text{H} \quad \text{H} \quad \text{H} & & & & \text{H} \quad \text{H} \quad \text{H} &
\end{array}
$$
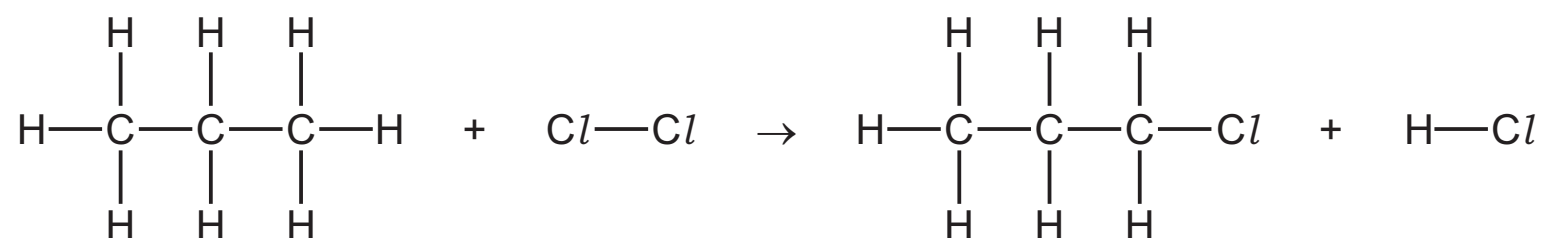
Use the following bond energies to determine whether this reaction is exothermic or endothermic. You must show your reasoning.

| bond | bond energies in kJ/mol |
|------|-------------------------|
| C–Cl | 338 |
| C–H | 412 |
| Cl–Cl | 242 |
| H–Cl | 431 |
| C–C | 348 |

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

**(c) (i)** Chloropropane can be hydrolysed to propanol, $CH_3CH_2CH_2OH$, by sodium hydroxide.

Write the equation for this reaction.

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**(ii)** Propanol can be dehydrated. It loses a water molecule to form a hydrocarbon.

Give the name and structural formula of this hydrocarbon.

name ...............................................

structural formula

[2]

**(iii)** Propanol is oxidised to a carboxylic acid by acidified potassium manganate(VII).

Deduce the name of this acid.

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

**(d)** Propanol reacts with methanoic acid to form the ester propyl methanoate.

$$CH_3CH_2CH_2OH \ + \ HCOOH \ \rightarrow \ HCOOCH_2CH_2CH_3 \ + \ H_2O$$
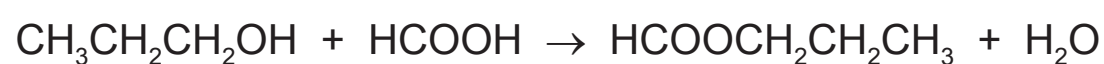
4.0 g of methanoic acid was reacted with 6.0 g of propanol.

**(i)** Calculate the $M_r$ of methanoic acid = ....................................... [1]

**(ii)** Calculate the $M_r$ of propanol = ....................................... [1]

**(iii)** Determine which one is the limiting reagent. Show your reasoning.

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**(iv)** Calculate the maximum yield in grams of propyl methanoate, $M_r$ = 88.

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

[Total: 17]

**5** Iron is extracted from its ore, hematite, in a blast furnace.

Substances added to the furnace are:
- iron ore, hematite, containing impurities such as silica, $SiO_2$
- air
- coke, C
- limestone, $CaCO_3$

Substances formed in the blast furnace are:
- molten iron
- molten slag
- waste gases such as carbon dioxide

**(a)** State the **two** functions of the coke used in the blast furnace.

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**(b)** Write an equation for the conversion of hematite, $Fe_2O_3$, to iron.

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**(c)** Explain how the silica impurity is removed and separated from the molten iron.

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**(d)** The molten iron from the furnace is impure.
It contains impurities which include the element carbon.

Explain how the carbon is removed. Include an equation in your answer.

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[Total: 10]

**6** The table below shows the elements in the third period of the Periodic Table, the number of electrons in their outer energy level, their oxidation state in their common compounds and their melting points.

| element | Na | Mg | A$l$ | Si | P | S | C$l$ | Ar |
|---|---|---|---|---|---|---|---|---|
| number of outer electrons | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| oxidation state | +1 | +2 | +3 | +4/−4 | −3 | −2 | −1 | 0 |
| melting point/°C | 98 | 650 | 660 | 1414 | 317 | 115 | −101 | −189 |

**(a)** Describe and explain the variation in oxidation state across the period.

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**(b)** The first three elements, Na, Mg and A$l$, are metals.

Describe the structure of a typical metal.

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

**(c)** Explain why Na, Mg and A$l$ are good conductors of electricity.

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**(d)** Which element exists as diatomic molecules of the type $X_2$?

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**(e)** Silicon has a similar structure to diamond.

Explain why silicon has the highest melting point in the period.

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**(f)** Sodium chloride is a crystalline solid with a high melting point. It dissolves in water to give a neutral solution. Phosphorus trichloride is a liquid at room temperature. It reacts with water to form an acidic solution.

Suggest an explanation for these differences in properties.

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**(g)** Describe how you could show that magnesium oxide is a basic oxide and not an amphoteric oxide.

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

**(h)** Draw a dot-and-cross diagram showing the bonding in magnesium oxide. Show outer electrons only.

[3]

[Total: 17]

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DATA SHEET
The Periodic Table of the Elements

Group

| I | II | | | | | | | | | | | | III | IV | V | VI | VII | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1 **H** Hydrogen 1 | | | | | | | | | | | 4 **He** Helium 2 |
| 7 **Li** Lithium 3 | 9 **Be** Beryllium 4 | | | | | | | | | | | | 11 **B** Boron 5 | 12 **C** Carbon 6 | 14 **N** Nitrogen 7 | 16 **O** Oxygen 8 | 19 **F** Fluorine 9 | 20 **Ne** Neon 10 |
| 23 **Na** Sodium 11 | 24 **Mg** Magnesium 12 | | | | | | | | | | | | 27 **A***l* Aluminium 13 | 28 **Si** Silicon 14 | 31 **P** Phosphorus 15 | 32 **S** Sulfur 16 | 35.5 **C***l* Chlorine 17 | 40 **Ar** Argon 18 |
| 39 **K** Potassium 19 | 40 **Ca** Calcium 20 | 45 **Sc** Scandium 21 | 48 **Ti** Titanium 22 | 51 **V** Vanadium 23 | 52 **Cr** Chromium 24 | 55 **Mn** Manganese 25 | 56 **Fe** Iron 26 | 59 **Co** Cobalt 27 | 59 **Ni** Nickel 28 | 64 **Cu** Copper 29 | 65 **Zn** Zinc 30 | 70 **Ga** Gallium 31 | 73 **Ge** Germanium 32 | 75 **As** Arsenic 33 | 79 **Se** Selenium 34 | 80 **Br** Bromine 35 | 84 **Kr** Krypton 36 |
| 85 **Rb** Rubidium 37 | 88 **Sr** Strontium 38 | 89 **Y** Yttrium 39 | 91 **Zr** Zirconium 40 | 93 **Nb** Niobium 41 | 96 **Mo** Molybdenum 42 | **Tc** Technetium 43 | 101 **Ru** Ruthenium 44 | 103 **Rh** Rhodium 45 | 106 **Pd** Palladium 46 | 108 **Ag** Silver 47 | 112 **Cd** Cadmium 48 | 115 **In** Indium 49 | 119 **Sn** Tin 50 | 122 **Sb** Antimony 51 | 128 **Te** Tellurium 52 | 127 **I** Iodine 53 | 131 **Xe** Xenon 54 |
| 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 **T***l* Thallium 81 | 207 **Pb** Lead 82 | 209 **Bi** Bismuth 83 | **Po** Polonium 84 | **At** Astatine 85 | **Rn** Radon 86 |
| **Fr** Francium 87 | 226 **Ra** Radium 88 | 227 **Ac** Actinium 89 † | | | | | | | | | | | | | | | |

| 140 **Ce** Cerium 58 | 141 **Pr** Praseodymium 59 | 144 **Nd** Neodymium 60 | **Pm** Promethium 61 | 150 **Sm** Samarium 62 | 152 **Eu** Europium 63 | 157 **Gd** Gadolinium 64 | 159 **Tb** Terbium 65 | 162 **Dy** Dysprosium 66 | 165 **Ho** Holmium 67 | 167 **Er** Erbium 68 | 169 **Tm** Thulium 69 | 173 **Yb** Ytterbium 70 | 175 **Lu** Lutetium 71 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 232 **Th** Thorium 90 | 231 **Pa** Protactinium 91 | 238 **U** Uranium 92 | **Np** Neptunium 93 | **Pu** Plutonium 94 | **Am** Americium 95 | **Cm** Curium 96 | **Bk** Berkelium 97 | **Cf** Californium 98 | **Es** Einsteinium 99 | **Fm** Fermium 100 | **Md** Mendelevium 101 | **No** Nobelium 102 | **Lr** Lawrencium 103 |

*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 dm$^3$ at room temperature and pressure (r.t.p.).

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