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

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**CHEMISTRY**

**0620/21**

Paper 2

**May/June 2014**

**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 in the spaces at the top of this page.

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 20.

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 **17** printed pages and **3** blank pages.



- 1 (a) Choose from the list of substances below to answer the following questions.

calcium oxide  
carbon dioxide  
carbon monoxide  
copper  
hydrogen  
magnesium  
methane  
oxygen  
water

Each substance may be used once, more than once or not at all.

Which substance:

- (i) releases hydrogen when it reacts with steam,  
..... [1]
- (ii) is produced at the cathode when concentrated aqueous sodium chloride is electrolysed,  
..... [1]
- (iii) is a product of the incomplete combustion of carbon,  
..... [1]
- (iv) is used in electrical wiring,  
..... [1]
- (v) is manufactured by heating limestone?  
..... [1]

- (b) Complete the following sentences about the Periodic Table of elements using words from the list below.

|       |            |         |        |
|-------|------------|---------|--------|
| argon | colour     | density | sodium |
| one   | similarity | trend   | seven  |

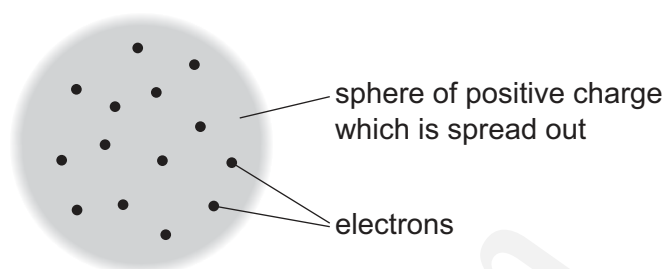
Chlorine, bromine and iodine are elements in Group ..... of the Periodic Table.

These elements show a ..... in ..... down the group.

They all react rapidly with ..... to form ionic compounds. [4]

[Total: 9]

- 2 In 1904, J. J. Thomson suggested a model of the atom. He called this the 'plum pudding' model. This model of an atom, containing 14 electrons, is shown below.



- (a) Describe how Thomson's model of the atom differs from our present ideas of the structure of an atom.

.....

.....

.....

..... [3]

- (b) Lithium has two naturally-occurring isotopes. These can be written as:



- (i) Describe the difference between these isotopes.

..... [1]

- (ii) Isotopes can be radioactive or non-radioactive. State **one** industrial use of radioactive isotopes.

..... [1]

- (c) Lithium is in Group I of the Periodic Table. The table shows some properties of the Group I elements.

| metal     | melting point / °C | atomic radius / nm |
|-----------|--------------------|--------------------|
| lithium   |                    | 0.157              |
| sodium    | 98                 | 0.191              |
| potassium | 63                 |                    |
| rubidium  | 39                 | 0.250              |
| caesium   | 29                 | 0.272              |

Deduce:

the melting point of lithium, ..... °C

the atomic radius of potassium ..... nm

[2]

(d) Lithium reacts with water. An alkaline solution and a colourless gas are formed.

(i) Complete the word equation for this reaction.

lithium + water → ..... + .....

[2]

(ii) What is the most likely pH of the alkaline solution?  
Put a ring around the correct answer.

pH 2

pH 5

pH 7

pH 13

[1]

(e) Draw the electronic structure of a potassium atom.

[2]

[Total: 12]

- 3 The table shows some fractions obtained from the distillation of petroleum.

| fraction     | number of carbon atoms | boiling point of the fraction / °C |
|--------------|------------------------|------------------------------------|
| refinery gas | 1–4                    | under 40                           |
| gasoline     | 5–10                   | 40–160                             |
| kerosene     | 10–16                  | 160–250                            |
| diesel       | 16–20                  | 250–300                            |
| fuel oil     | 20–30                  | 300–350                            |

- (a) What is the relationship between the number of carbon atoms and the boiling points of the fractions?

..... [1]

- (b) State the names of **two** petroleum fractions not given in the table.

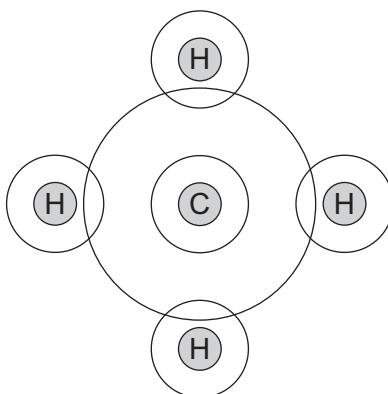
..... and ..... [2]

- (c) Two of the compounds present in refinery gas are methane and ethane.

- (i) Draw the structure of ethane. Show all atoms and bonds.

[1]

- (ii) Complete the dot and cross diagram of methane to show **all** the electrons.



[2]

- (d) Refinery gas also contains propane.  
Propane can be cracked in the presence of a catalyst to form hydrogen.

(i) Complete the symbol equation for this reaction.



[1]

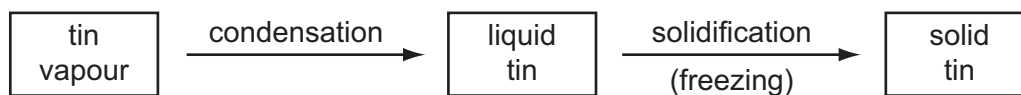
(ii) A catalyst is one condition needed to crack an alkane.

State **one** other condition needed to crack an alkane.

..... [1]

[Total: 8]

- 4 The diagram shows the changes of state when tin vapour is cooled slowly to room temperature.



- (a) Explain what happens to the arrangement and motion of the atoms during these changes.

.....

.....

.....

.....

..... [4]

- (b) Tin is a metal in Group IV of the Periodic Table.  
How many electrons does tin have in its outer shell?

..... [1]

- (c) State **one** physical property of tin.

..... [1]

- (d) The table below describes the reaction of some metals with dilute hydrochloric acid.

|           |                                                                                        |
|-----------|----------------------------------------------------------------------------------------|
| iron      | bubbles of gas produced and temperature of the mixture rises slowly                    |
| magnesium | many bubbles of gas produced rapidly and temperature of the mixture rises rapidly      |
| silver    | no bubbles of gas given off and no temperature change                                  |
| tin       | a few bubbles of gas given off slowly and temperature of the mixture rises very slowly |

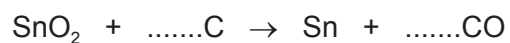
Put these metals in order of their reactivity.

least reactive 
→
 most reactive

[2]

(e) Tin is extracted by heating tin(IV) oxide with carbon.

(i) Complete the symbol equation for this reaction.



[2]

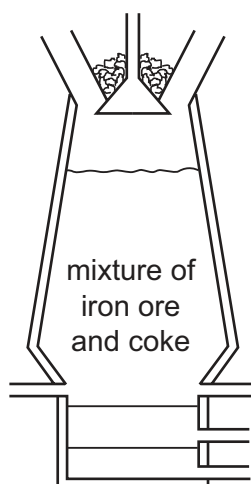
(ii) State **one** adverse effect of carbon monoxide on health.

..... [1]

[Total: 11]

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- 5 The diagram shows a blast furnace for extracting iron.



- (a) On the diagram above, write:

- the letter **A** to show where the air blast enters the furnace,
- the letter **W** to show where the waste gases exit the furnace.

[2]

- (b) Which **one** of the following is an ore of iron?  
Put a ring around the correct answer.

calcite

fluorite

hematite

halite

[1]

- (c) In the furnace, the coke burns to form carbon dioxide. This reaction is exothermic.

- (i) What is meant by the term *exothermic*?

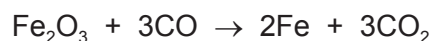
..... [1]

- (ii) Describe a test for carbon dioxide.

test .....

result ..... [2]

- (d) In the blast furnace, carbon dioxide reacts with more coke to form carbon monoxide.  
The carbon monoxide reduces iron(III) oxide to iron.

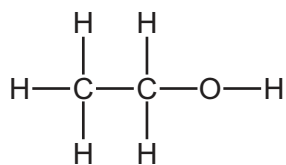


How does this equation show that iron(III) oxide is being reduced?

..... [1]

[Total: 7]

- 6 The structure of ethanol is shown below.



- (a) On the structure above, put a ring around the alcohol functional group. [1]

- (b) Ethanol can be made by fermentation.

- (i) Complete the word equation for fermentation.

..... → ethanol + ..... [2]

- (ii) What type of catalysts are used in fermentation?  
Put a ring around the correct answer.

acids

carbonates

enzymes

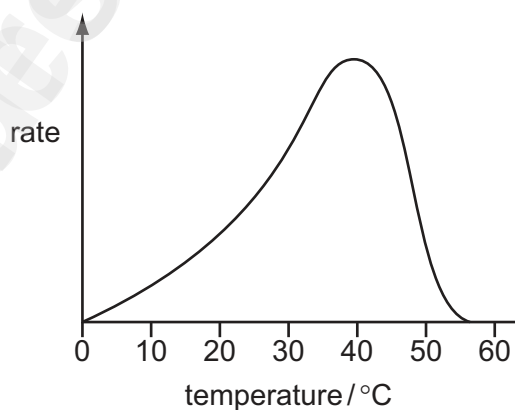
metals

[1]

- (c) Ethanol can also be made by hydration.  
Complete the symbol equation for this reaction.

..... + H<sub>2</sub>O → C<sub>2</sub>H<sub>5</sub>OH [1]

- (d) The diagram below shows how the rate of fermentation changes with temperature.



Describe how the rate of fermentation changes with temperature.

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

(e) The table shows some properties of different alcohols.

| alcohol  | formula                          | melting point<br>/ °C | boiling point<br>/ °C | density<br>in g / cm <sup>3</sup> |
|----------|----------------------------------|-----------------------|-----------------------|-----------------------------------|
| methanol | CH <sub>4</sub> O                | −94                   | 65                    |                                   |
| ethanol  | C <sub>2</sub> H <sub>6</sub> O  | −117                  | 79                    | 0.789                             |
| propanol | C <sub>3</sub> H <sub>8</sub> O  | −126                  | 98                    | 0.804                             |
| butanol  | C <sub>4</sub> H <sub>10</sub> O | −89                   | 117                   | 0.810                             |
| pentanol | C <sub>5</sub> H <sub>12</sub> O | −79                   | 138                   | 0.815                             |

(i) Describe how density changes with the number of carbon atoms in the alcohol.

..... [1]

(ii) Which **one** of these alcohols has the lowest melting point?

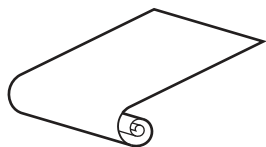
..... [1]

(iii) Is pentanol a solid, liquid or gas at room temperature?  
Explain your answer.

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

[Total: 10]

- 7 A student used chromatography to separate the dyes in the blue ink from a ball-point pen. She used the equipment shown in the diagrams below.



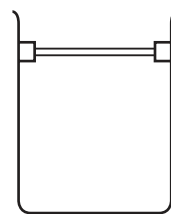
chromatography paper



solvent

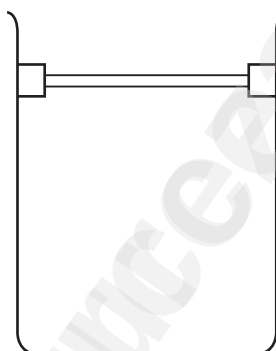


large watchglass



chromatography tank

- (a) Complete the diagram below to show how she set up the apparatus.



[3]

- (b) Describe how chromatography could be used by the student to separate the dyes.

.....

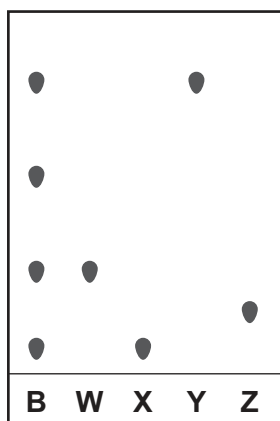
.....

..... [3]

- (c) The student used water as a solvent. Suggest a different solvent that she could use.

..... [1]

- (d) The diagram below shows the results of the chromatography using the blue ink, **B**, and several pure dyes, **W**, **X**, **Y** and **Z**.



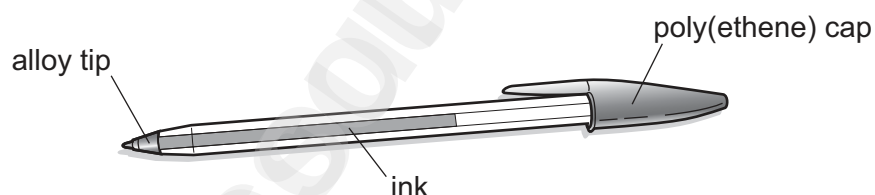
- (i) Which of the dyes, **W**, **X**, **Y** and **Z**, were in the blue ink?

..... [1]

- (ii) How many dyes in the ink had been separated by this chromatography?

..... [1]

- (e) The diagram shows the ball-point pen used in the experiment.



- (i) The cap of the pen is made of poly(ethene).

Describe the formation of poly(ethene) from ethene. In your answer, include the words:

- monomer,
- polymer.

..... [2]

- (ii) The tip of the pen is made from an alloy.

What is meant by the term *alloy*?

..... [1]

(f) The table shows some properties of four alloys.

| alloy                   | strength<br>/ GPa | density<br>in g/cm <sup>3</sup> | thermal<br>conductivity<br>in W/m/K |
|-------------------------|-------------------|---------------------------------|-------------------------------------|
| low strength steel      | 250               | 7.70                            | 60                                  |
| high strength steel     | 300               | 7.90                            | 56                                  |
| low strength aluminium  | 70                | 2.72                            | 170                                 |
| high strength aluminium | 220               | 2.80                            | 100                                 |

(i) How does the strength of the steel and aluminium alloys vary with their thermal conductivity?

..... [1]

(ii) Which **one** of these alloys is the best one to use to make the body of an aircraft?  
Give **two** reasons for your answer.

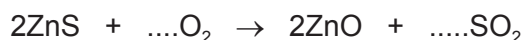
.....  
.....  
..... [3]

[Total: 16]

8 Zinc can be extracted from zinc sulfide ore in three steps.

(a) In the first step, zinc sulfide is heated in air to produce zinc oxide.

(i) Complete the symbol equation for this reaction.



[2]

(ii) The product sulfur dioxide,  $\text{SO}_2$ , is harmful to the environment.  
Explain why it is harmful to the environment and state **one** effect it has on buildings.

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

(b) In the second step, zinc oxide reacts with sulfuric acid to form zinc sulfate.



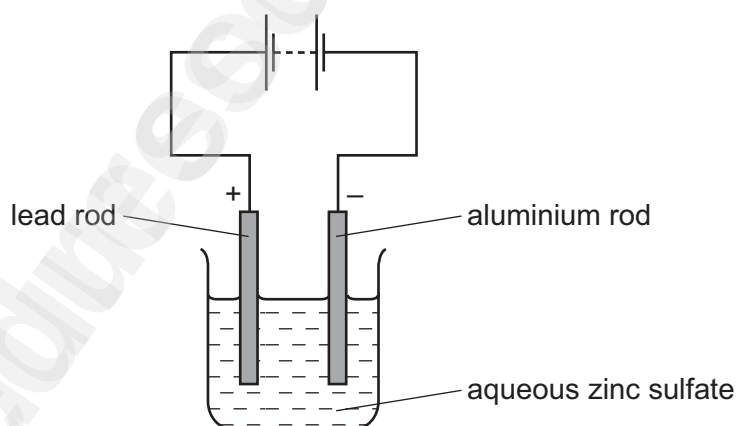
Zinc sulfate is soluble in water.

Some insoluble impurities in the zinc oxide do not react with the sulfuric acid.

Suggest how these insoluble impurities are removed from the zinc sulfate solution.

..... [1]

(c) In the third step, zinc is extracted from zinc sulfate by electrolysis using the cell shown below.



(i) Which word best describes the aluminium rod?  
Put a ring around the correct answer.

anion      anode      cathode      cation      electrolyte      product

[1]

- (ii) Suggest which statement about this electrolysis is completely correct.  
Tick **one** box.

Zinc is formed at the positive electrode and  
hydrogen at the negative electrode.

☐

Zinc is formed at the positive electrode and  
oxygen at the negative electrode.

☐

Zinc is formed at the negative electrode and  
hydrogen at the positive electrode.

☐

Zinc is formed at the negative electrode and  
oxygen at the positive electrode.

☐

[1]

[Total: 7]

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**DATA SHEET**  
**The Periodic Table of the Elements**

| Group                                                                       |                                    |                                     |                                    |                                    |                                     |                                     |                                     |                                   |                                    |                                  |                                   |                                    |                                    |                                   |                                    |                                    |                                  |
|-----------------------------------------------------------------------------|------------------------------------|-------------------------------------|------------------------------------|------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-----------------------------------|------------------------------------|----------------------------------|-----------------------------------|------------------------------------|------------------------------------|-----------------------------------|------------------------------------|------------------------------------|----------------------------------|
| I                                                                           | II                                 |                                     |                                    |                                    |                                     |                                     |                                     |                                   |                                    |                                  |                                   | III                                | IV                                 | V                                 | VI                                 | VII                                | 0                                |
| 7<br><b>Li</b><br>Lithium<br>3                                              | 9<br><b>Be</b><br>Beryllium<br>4   | 1<br><b>H</b><br>Hydrogen<br>1      |                                    |                                    |                                     |                                     |                                     |                                   |                                    |                                  |                                   |                                    |                                    |                                   |                                    |                                    |                                  |
|                                                                             |                                    |                                     |                                    |                                    |                                     |                                     |                                     |                                   |                                    |                                  |                                   |                                    |                                    |                                   |                                    |                                    |                                  |
| 23<br><b>Na</b><br>Sodium<br>11                                             | 24<br><b>Mg</b><br>Magnesium<br>12 |                                     |                                    |                                    |                                     |                                     |                                     |                                   |                                    |                                  |                                   | 11<br><b>B</b><br>Boron<br>5       | 12<br><b>C</b><br>Carbon<br>6      | 14<br><b>N</b><br>Nitrogen<br>7   | 16<br><b>O</b><br>Oxygen<br>8      | 19<br><b>F</b><br>Fluorine<br>9    | 20<br><b>Ne</b><br>Neon<br>10    |
| 39<br><b>K</b><br>Potassium<br>19                                           | 40<br><b>Ca</b><br>Calcium<br>20   | 45<br><b>Sc</b><br>Scandium<br>21   | 48<br><b>Ti</b><br>Titanium<br>22  | 51<br><b>V</b><br>Vanadium<br>23   | 52<br><b>Cr</b><br>Chromium<br>24   | 55<br><b>Mn</b><br>Manganese<br>25  | 56<br><b>Fe</b><br>Iron<br>26       | 59<br><b>Co</b><br>Cobalt<br>27   | 59<br><b>Ni</b><br>Nickel<br>28    | 64<br><b>Cu</b><br>Copper<br>29  | 65<br><b>Zn</b><br>Zinc<br>30     | 70<br><b>Ga</b><br>Gallium<br>31   | 73<br><b>Ge</b><br>Germanium<br>32 | 75<br><b>As</b><br>Arsenic<br>33  | 79<br><b>Se</b><br>Selenium<br>34  | 80<br><b>Br</b><br>Bromine<br>35   | 84<br><b>Kr</b><br>Krypton<br>36 |
| 85<br><b>Rb</b><br>Rubidium<br>37                                           | 88<br><b>Sr</b><br>Strontium<br>38 | 89<br><b>Y</b><br>Yttrium<br>39     | 91<br><b>Zr</b><br>Zirconium<br>40 | 93<br><b>Nb</b><br>Niobium<br>41   | 96<br><b>Mo</b><br>Molybdenum<br>42 | 101<br><b>Ru</b><br>Ruthenium<br>44 | 106<br><b>Pd</b><br>Palladium<br>46 | 108<br><b>Ag</b><br>Silver<br>47  | 112<br><b>Cd</b><br>Cadmium<br>48  | 115<br><b>In</b><br>Indium<br>49 | 119<br><b>Sn</b><br>Tin<br>50     | 122<br><b>Sb</b><br>Antimony<br>51 | 127<br><b>I</b><br>Iodine<br>53    | 131<br><b>Xe</b><br>Xenon<br>54   |                                    |                                    |                                  |
| 133<br><b>Cs</b><br>Caesium<br>55                                           | 137<br><b>Ba</b><br>Barium<br>56   | 139<br><b>La</b><br>Lanthanum<br>57 | 178<br><b>Hf</b><br>Hafnium<br>72  | 181<br><b>Ta</b><br>Tantalum<br>73 | 184<br><b>W</b><br>Tungsten<br>74   | 186<br><b>Re</b><br>Rhenium<br>75   | 190<br><b>Os</b><br>Osmium<br>76    | 192<br><b>Ir</b><br>Iridium<br>77 | 195<br><b>Pt</b><br>Platinum<br>78 | 197<br><b>Au</b><br>Gold<br>79   | 201<br><b>Hg</b><br>Mercury<br>80 | 204<br><b>Tl</b><br>Thallium<br>81 | 207<br><b>Pb</b><br>Lead<br>82     | 209<br><b>Bi</b><br>Bismuth<br>83 | 210<br><b>Po</b><br>Polonium<br>84 | 210<br><b>At</b><br>Astatine<br>85 | 210<br><b>Rn</b><br>Radon<br>86  |
| 87<br><b>Fr</b><br>Francium                                                 | 88<br><b>Ra</b><br>Radium          | 89<br><b>Ac</b><br>Actinium         |                                    |                                    |                                     |                                     |                                     |                                   |                                    |                                  |                                   |                                    |                                    |                                   |                                    |                                    |                                  |
| 58-71 Lanthanoid series                                                     |                                    |                                     |                                    |                                    |                                     |                                     |                                     |                                   |                                    |                                  |                                   |                                    |                                    |                                   |                                    |                                    |                                  |
| 90-103 Actinoid series                                                      |                                    |                                     |                                    |                                    |                                     |                                     |                                     |                                   |                                    |                                  |                                   |                                    |                                    |                                   |                                    |                                    |                                  |
| a = relative atomic mass<br>X = atomic symbol<br>b = proton (atomic) number |                                    |                                     |                                    |                                    |                                     |                                     |                                     |                                   |                                    |                                  |                                   |                                    |                                    |                                   |                                    |                                    |                                  |
| Key                                                                         | X                                  | a                                   |                                    |                                    |                                     |                                     |                                     |                                   |                                    |                                  |                                   |                                    |                                    |                                   |                                    |                                    |                                  |

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).

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