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**Edexcel GCSE**

Centre Number

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Candidate Number

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# Chemistry

## Unit C3: Chemistry in Action

**Higher Tier**

Wednesday 21 June 2017 – Morning

**Time: 1 hour**

Paper Reference

**5CH3H/01**

**You must have:**

Calculator, ruler

Total Marks

### Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*

### Information

- The total mark for this paper is 60.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (\*) are ones where the quality of your written communication will be assessed  
– *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*

### Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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P 4 8 5 8 4 A 0 1 2 0



Pearson

# The Periodic Table of the Elements

| 1                                    | 2                                  | Key                                                                     |                                            |                                      |                                         |                                       |                                      |                                         |                                           |                                          |                                                                                     | 3                                  | 4                                  | 5                                  | 6                                    | 7                                    | 0                                 |  |
|--------------------------------------|------------------------------------|-------------------------------------------------------------------------|--------------------------------------------|--------------------------------------|-----------------------------------------|---------------------------------------|--------------------------------------|-----------------------------------------|-------------------------------------------|------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------|------------------------------------|------------------------------------|--------------------------------------|--------------------------------------|-----------------------------------|--|
|                                      |                                    | relative atomic mass<br>atomic symbol<br>name<br>atomic (proton) number |                                            |                                      |                                         |                                       |                                      |                                         |                                           |                                          |                                                                                     |                                    |                                    |                                    |                                      |                                      |                                   |  |
| 7<br><b>Li</b><br>lithium<br>3       | 9<br><b>Be</b><br>beryllium<br>4   |                                                                         |                                            |                                      |                                         |                                       |                                      |                                         |                                           |                                          |                                                                                     | 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     |  |
| 23<br><b>Na</b><br>sodium<br>11      | 24<br><b>Mg</b><br>magnesium<br>12 |                                                                         |                                            |                                      |                                         |                                       |                                      |                                         |                                           |                                          |                                                                                     | 27<br><b>Al</b><br>aluminium<br>13 | 28<br><b>Si</b><br>silicon<br>14   | 31<br><b>P</b><br>phosphorus<br>15 | 32<br><b>S</b><br>sulfur<br>16       | 35.5<br><b>Cl</b><br>chlorine<br>17  | 40<br><b>Ar</b><br>argon<br>18    |  |
| 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           | 63.5<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     | [98]<br><b>Tc</b><br>technetium<br>43 | 101<br><b>Ru</b><br>ruthenium<br>44  | 103<br><b>Rh</b><br>rhodium<br>45       | 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 | 128<br><b>Te</b><br>tellurium<br>52  | 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  | [209]<br><b>Po</b><br>polonium<br>84 | [210]<br><b>At</b><br>astatine<br>85 | [222]<br><b>Rn</b><br>radon<br>86 |  |
| [223]<br><b>Fr</b><br>francium<br>87 | [226]<br><b>Ra</b><br>radium<br>88 | [227]<br><b>Ac*</b><br>actinium<br>89                                   | [261]<br><b>Rf</b><br>rutherfordium<br>104 | [262]<br><b>Db</b><br>dubnium<br>105 | [266]<br><b>Sg</b><br>seaborgium<br>106 | [264]<br><b>Bh</b><br>bohrium<br>107  | [277]<br><b>Hs</b><br>hassium<br>108 | [268]<br><b>Mt</b><br>meitnerium<br>109 | [271]<br><b>Ds</b><br>darmstadtium<br>110 | [272]<br><b>Rg</b><br>roentgenium<br>111 | Elements with atomic numbers 112-116 have been reported but not fully authenticated |                                    |                                    |                                    |                                      |                                      |                                   |  |

|                                |
|--------------------------------|
| 1<br><b>H</b><br>hydrogen<br>1 |
|--------------------------------|

|                                                                                |
|--------------------------------------------------------------------------------|
| relative atomic mass<br><b>atomic symbol</b><br>name<br>atomic (proton) number |
|--------------------------------------------------------------------------------|

Key

\* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

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**Questions begin on next page.**

## Answer ALL questions

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

### Alcohols

- 1 (a) The names and formulae of the first three alcohols in the homologous series of alcohols are given in the table.

| name of alcohol | formula                         |
|-----------------|---------------------------------|
| methanol        | $\text{CH}_3\text{OH}$          |
| ethanol         | $\text{C}_2\text{H}_5\text{OH}$ |
| propanol        | $\text{C}_3\text{H}_7\text{OH}$ |

- (i) Pentanol is another member of the alcohol homologous series.  
A molecule of pentanol contains five carbon atoms.

Predict the formula of a molecule of pentanol.

(1)

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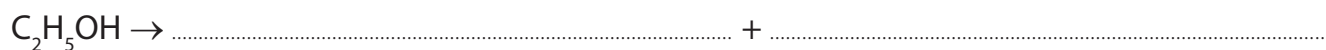
- (ii) Draw the structure of a molecule of ethanol,  $\text{C}_2\text{H}_5\text{OH}$ , showing all the bonds.

(1)

- (b) When ethanol vapour is passed over hot aluminium oxide, the ethanol forms water and one other product.

- (i) Complete the balanced equation for this reaction.

(2)



(ii) Which type of reaction occurs when ethanol forms the products in this reaction?

Put a cross (X) in the box next to your answer.

(1)

☐ **A** dehydration

☐ **B** distillation

☐ **C** hydration

☐ **D** oxidation

(c) Ethanol can be used as a fuel.

Which of these is the balanced equation for the complete combustion of ethanol?

Put a cross (X) in the box next to your answer.

(1)

☐ **A**  $\text{C}_2\text{H}_5\text{OH} + 2\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O}$

☐ **B**  $2\text{C}_2\text{H}_5\text{OH} + 5\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$

☐ **C**  $\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O}$

☐ **D**  $2\text{C}_2\text{H}_5\text{OH} + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$

(Total for Question 1 = 6 marks)

## Carboxylic acids and esters

- 2 (a) Complete the sentence by putting a cross (☒) in the box next to your answer.

(1)

Ethanol can react to form ethanoic acid,  $\text{CH}_3\text{COOH}$ .

In this reaction ethanol is

- ☐ A neutralised  
☐ B oxidised  
☐ C precipitated  
☐ D reduced

- (b) Draw the structure of a molecule of ethanoic acid,  $\text{CH}_3\text{COOH}$ , showing all the bonds.

(1)

- (c) When a piece of magnesium ribbon is added to dilute ethanoic acid, a reaction occurs.

- (i) Complete the word equation for this reaction.

(2)

magnesium +  $\begin{array}{c} \text{ethanoic} \\ \text{acid} \end{array} \rightarrow$  +

- (ii) State what is **seen** during this reaction.

(1)

.....

.....

(d) Esters are useful organic compounds.

Describe a use of esters.

(2)

(e) Describe how a fat can be reacted to form a soap.

(2)

**(Total for Question 2 = 9 marks)**

## Salts and solutions

- 3 (a) Give the name or the formula of an ion that causes hardness in water.

(1)

- (b) **A**, **B** and **C** are samples of hard water from three different sources.

A 10 cm<sup>3</sup> sample of each is tested for hardness by adding soap solution, from a burette, until a permanent lather is formed.

Another 10 cm<sup>3</sup> sample of each of **A**, **B** and **C** was boiled and then tested in the same way.

The results are shown.

| water sample | volume of soap solution needed to form permanent lather / cm <sup>3</sup> |               |
|--------------|---------------------------------------------------------------------------|---------------|
|              | before boiling                                                            | after boiling |
| <b>A</b>     | 10.2                                                                      | 0.1           |
| <b>B</b>     | 20.0                                                                      | 20.0          |
| <b>C</b>     | 35.3                                                                      | 12.2          |

There are two types of hardness, temporary and permanent.

Explain, using the information in the table, the types of hardness in each of the hard waters **A**, **B** and **C**.

(3)

(c) A solution of zinc chloride,  $\text{ZnCl}_2$ , is prepared by reacting zinc carbonate,  $\text{ZnCO}_3$ , with dilute hydrochloric acid.

(i) Write the balanced equation for this reaction.

(3)

(ii) A solution of zinc chloride,  $\text{ZnCl}_2$ , has a concentration of  $0.25 \text{ mol dm}^{-3}$ .

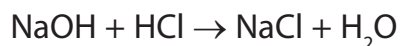
Calculate the concentration of this solution in  $\text{g dm}^{-3}$ .

(relative atomic masses:  $\text{Zn} = 65$ ,  $\text{Cl} = 35.5$ )

(2)

concentration of solution = .....  $\text{g dm}^{-3}$

(d) In an experiment,  $25.0 \text{ cm}^3$  samples of a solution of sodium hydroxide,  $\text{NaOH}$ , were titrated with  $0.095 \text{ mol dm}^{-3}$  hydrochloric acid,  $\text{HCl}$ .



$18.5 \text{ cm}^3$  of the hydrochloric acid neutralised  $25.0 \text{ cm}^3$  of the sodium hydroxide solution.

Calculate the concentration of the sodium hydroxide solution,  $\text{NaOH}$ , in  $\text{mol dm}^{-3}$ .

(2)

concentration of sodium hydroxide solution = .....  $\text{mol dm}^{-3}$

**(Total for Question 3 = 11 marks)**

### Analysis

- 4 (a) Excess dilute sulfuric acid is added to a solid sample of a copper compound.  
A gas is given off and a blue solution is formed.

(i) The gas turns limewater cloudy.

Explain how this result is used to identify the anion in the copper compound.

(2)

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- (ii) When sodium hydroxide solution is added to the blue solution,  
a pale blue precipitate is formed.

Give the name or the formula of the pale blue precipitate.

(1)

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- (iii) The blue solution contains sulfate ions.  
Barium chloride solution is added to this blue solution.  
A white precipitate of barium sulfate forms.

Write the ionic equation, including state symbols, for this reaction.

(3)

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(b) A colourless solution contains a halide ion.

Describe a test to show which of the halide ions, chloride,  $\text{Cl}^-$ , bromide,  $\text{Br}^-$ , or iodide,  $\text{I}^-$ , is present in the colourless solution.

(4)

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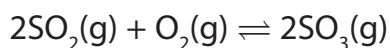
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**(Total for Question 4 = 10 marks)**

## Gases

- 5 (a) Sulfur dioxide combines with oxygen to form sulfur trioxide in an exothermic reaction.



The reaction can reach equilibrium.

At 2 atmospheres pressure, 450°C and using a vanadium(V) oxide catalyst, the equilibrium yield of sulfur trioxide,  $\text{SO}_3$ , is 96%.

- (i) When a temperature higher than 450°C is used, the equilibrium yield of sulfur trioxide decreases. All the other conditions are unchanged.

Explain why the equilibrium yield of sulfur trioxide decreases.

(2)

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- (ii) When a pressure higher than 2 atmospheres is used, the equilibrium yield of sulfur trioxide increases. All the other conditions are unchanged.

Explain why the equilibrium yield of sulfur trioxide increases.

(2)

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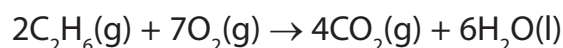
(iii) Which of the following shows the effect of adding a catalyst on the rate of the forward reaction and on the rate of the reverse reaction?

Put a cross (☒) in the box next to your answer.

(1)

| effect of a catalyst on    |                          |                          |
|----------------------------|--------------------------|--------------------------|
|                            | rate of forward reaction | rate of reverse reaction |
| <input type="checkbox"/> A | decreases                | decreases                |
| <input type="checkbox"/> B | decreases                | increases                |
| <input type="checkbox"/> C | increases                | decreases                |
| <input type="checkbox"/> D | increases                | increases                |

(b) The equation for the complete combustion of ethane is



Which row of the table shows volumes of ethane and oxygen that react together and the volume of carbon dioxide they produce when they react as shown in this equation?

(all volumes of gases are measured under the same conditions of temperature and pressure)

Put a cross (☒) in the box next to your answer.

(1)

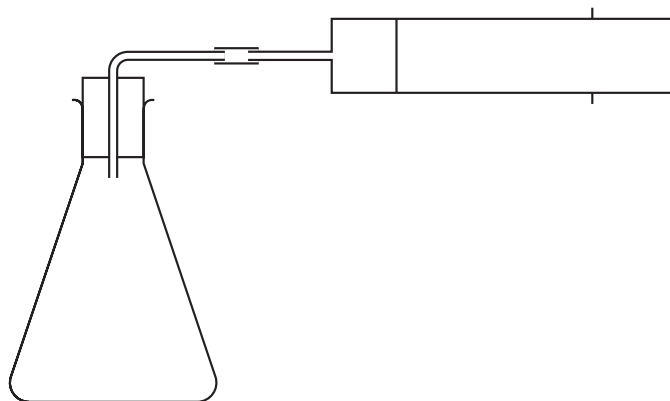
| gas volumes / cm <sup>3</sup> |        |        |                |
|-------------------------------|--------|--------|----------------|
|                               | ethane | oxygen | carbon dioxide |
| <input type="checkbox"/> A    | 5      | 35     | 10             |
| <input type="checkbox"/> B    | 5      | 70     | 20             |
| <input type="checkbox"/> C    | 10     | 35     | 20             |
| <input type="checkbox"/> D    | 10     | 70     | 40             |

\*(c) The reaction between a known mass of magnesium ribbon and excess dilute sulfuric acid can be used to determine the volume occupied by one mole of hydrogen gas,  $H_2$ , at room temperature and pressure.



In an experiment, 0.048 grams of magnesium formed 48 cm<sup>3</sup> of hydrogen, at room temperature and pressure.

Describe how the apparatus below can be used to obtain these results, showing how the results can be used to find the volume occupied by one mole of hydrogen gas,  $\text{H}_2$ , at room temperature and pressure.



(6)

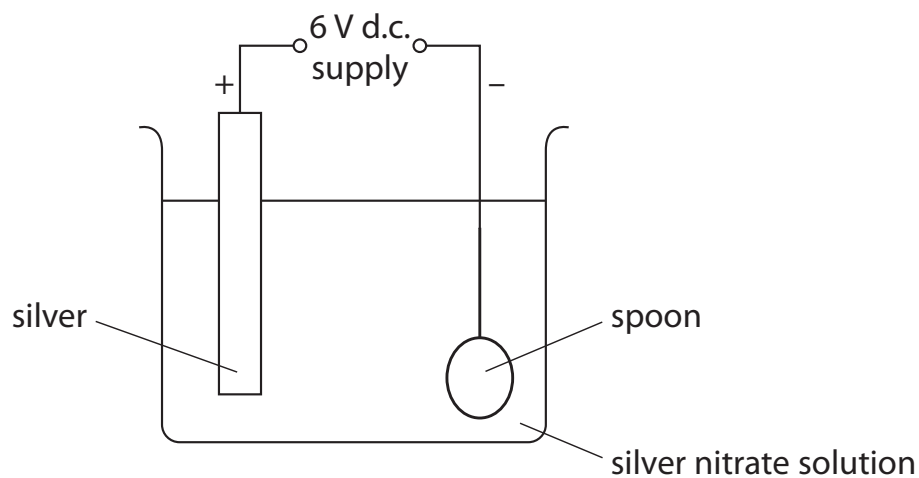
Handwriting practice area with 20 sets of dotted lines for tracing on a lined background.

**(Total for Question 5 = 12 marks)**

## Electrolysis

- 6 (a) A metal spoon is plated with silver using electrolysis.

The diagram shows the apparatus used.



- (i) In this electrolysis, oxidation occurs at the silver electrode.

State, in terms of electrons, what is meant by oxidation.

(1)

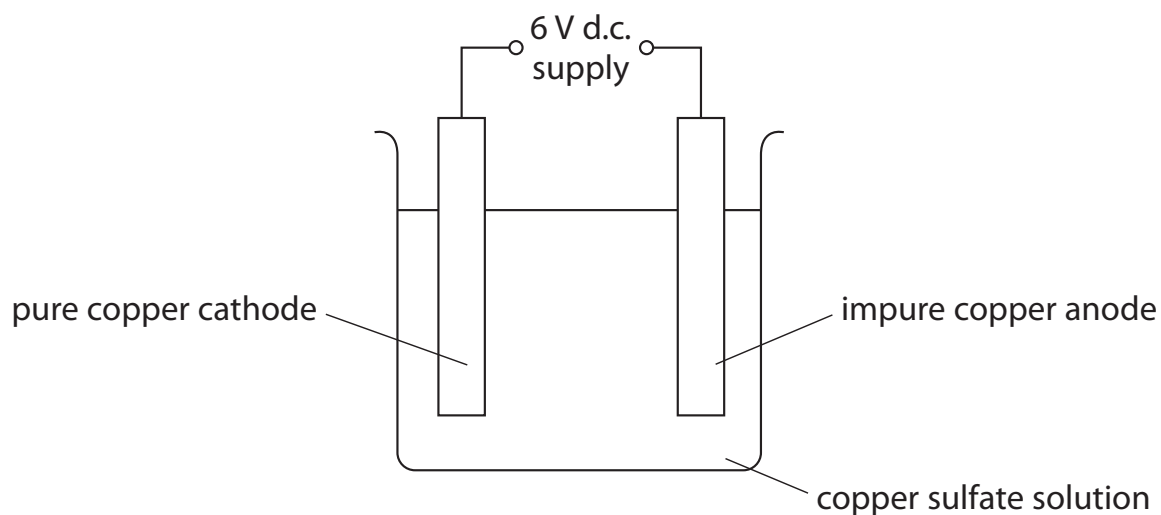
- (ii) Which is the formula of silver nitrate?

Put a cross (☒) in the box next to your answer.

(1)

- ☐ **A**  $\text{AgNO}_2$
- ☐ **B**  $\text{Ag}_2\text{NO}_3$
- ☐ **C**  $\text{AgNO}_3$
- ☐ **D**  $\text{Ag}(\text{NO}_3)_2$

- (b) The diagram shows the apparatus used for the electrolysis of copper sulfate solution using a pure copper cathode and impure copper anode.



During the electrolysis the size of the cathode increases, the size of the anode decreases and a solid deposit appears under the anode. The colour of the solution remains the same throughout.

Explain these observations.

(4)

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\*(c) The products of electrolysis can vary depending on whether the salt forming the electrolyte is molten or in aqueous solution.

Explain this statement by referring to the products of electrolysis of molten sodium chloride and of electrolysis of sodium chloride solution.

Include in your answer the names of all the ions present in each electrolyte and how the product at each electrode is formed from ions present.

You may use half-equations if you wish.

(6)

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**(Total for Question 6 = 12 marks)**

**TOTAL FOR PAPER = 60 MARKS**

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