



Rewarding Learning

General Certificate of Secondary Education  
2017

Centre Number

|  |  |  |  |  |
|--|--|--|--|--|
|  |  |  |  |  |
|--|--|--|--|--|

Candidate Number

|  |  |  |  |  |
|--|--|--|--|--|
|  |  |  |  |  |
|--|--|--|--|--|

## GCSE Chemistry

Unit 2

Higher Tier

[GCH22]

WEDNESDAY 21 JUNE, MORNING

MV18

### Time

1 hour 45 minutes, plus your additional time allowance.

### Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

**You must answer the questions in the spaces provided.**

Complete in black ink only.

Answer **all seven** questions.

### Information for Candidates

The total mark for this paper is 115.

Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.

Quality of written communication will be assessed in Question **4(d)** and **6(b)(iv)**.

A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

- 1 Aluminium metal is obtained from its ore by electrolysis.  
Aluminium is used to manufacture drinks cans.



- (a) (i) Name the ore from which aluminium is obtained.  
[1 mark]

---

- (ii) State two reasons why the purified ore is dissolved in molten cryolite. [2 marks]

1. \_\_\_\_\_

---

2. \_\_\_\_\_

---

- (iii) Write a half equation for the production of aluminium at the cathode. [3 marks]

---

(iv) Name the electrolysis product obtained at the anode and write a half equation for the reaction which occurs at the anode.

Product: [1 mark]

---

Half equation: [3 marks]

---

(b) An aluminium manufacturing company is exploring the possibility of setting up an aluminium extraction plant.

State two factors that need to be considered by the company when choosing a site for the aluminium extraction plant. [2 marks]

1. \_\_\_\_\_

---

2. \_\_\_\_\_

---

2 Organic compounds are grouped into homologous series. Alkenes are a homologous series of hydrocarbons.

(a) (i) What is meant by the term homologous series?  
[3 marks]

---

---

---

---

---

(ii) Complete the table below. [3 marks]

| Name   | Molecular formula | Physical state at room temperature |
|--------|-------------------|------------------------------------|
| ethene |                   | gas                                |
|        | $C_3H_6$          |                                    |

(iii) What is the functional group of the alkenes?  
[1 mark]

---

**(b)** Vinegar contains the weak acid, ethanoic acid.

**(i)** Draw the structural formula of ethanoic acid.  
[1 mark]

**(ii)** What is meant by the term weak acid? [1 mark]

---

---

---

**(c)** Ethanoic acid undergoes typical reactions of acids.

**(i)** Write a balanced symbol equation for the reaction of ethanoic acid with magnesium. [3 marks]

**(ii)** What is observed when magnesium reacts with ethanoic acid? [3 marks]

---

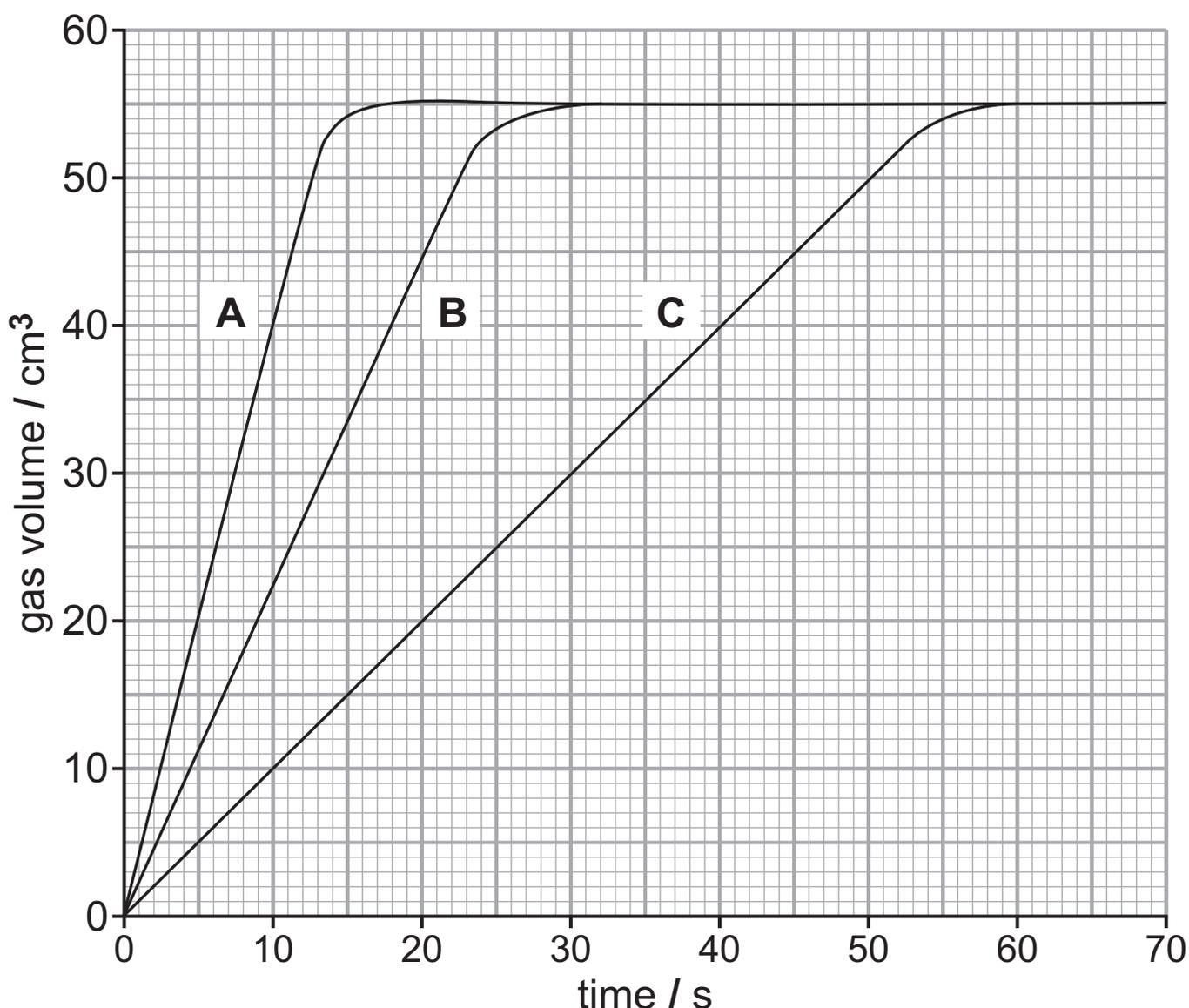
---

---

---

- 3 The rate of a chemical reaction is affected by several factors including the concentration of the reactants, temperature and presence of a catalyst.

(a) To investigate the effect of concentration of acid on the rate of reaction, a student reacted a 0.055 g strip of magnesium ribbon with solutions of hydrochloric acid of three different concentrations (0.5, 1.0 and 1.5 mol/dm<sup>3</sup>). All reactions were carried out at room temperature. The results obtained are shown on the graph below.



- (i) State and explain which line (A, B or C) was obtained using  $1.5 \text{ mol/dm}^3$  hydrochloric acid. [3 marks]

Line \_\_\_\_\_

---

---

---

---

- (ii) The student repeated the experiment using hydrochloric acid of concentration  $2.0 \text{ mol/dm}^3$ . **Sketch** a line on the same axes to represent the results obtained and label this curve D. [3 marks]

- (b) Explain in terms of particles why the rate of reaction increases as temperature increases. [3 marks]

---

---

---

---

---

---

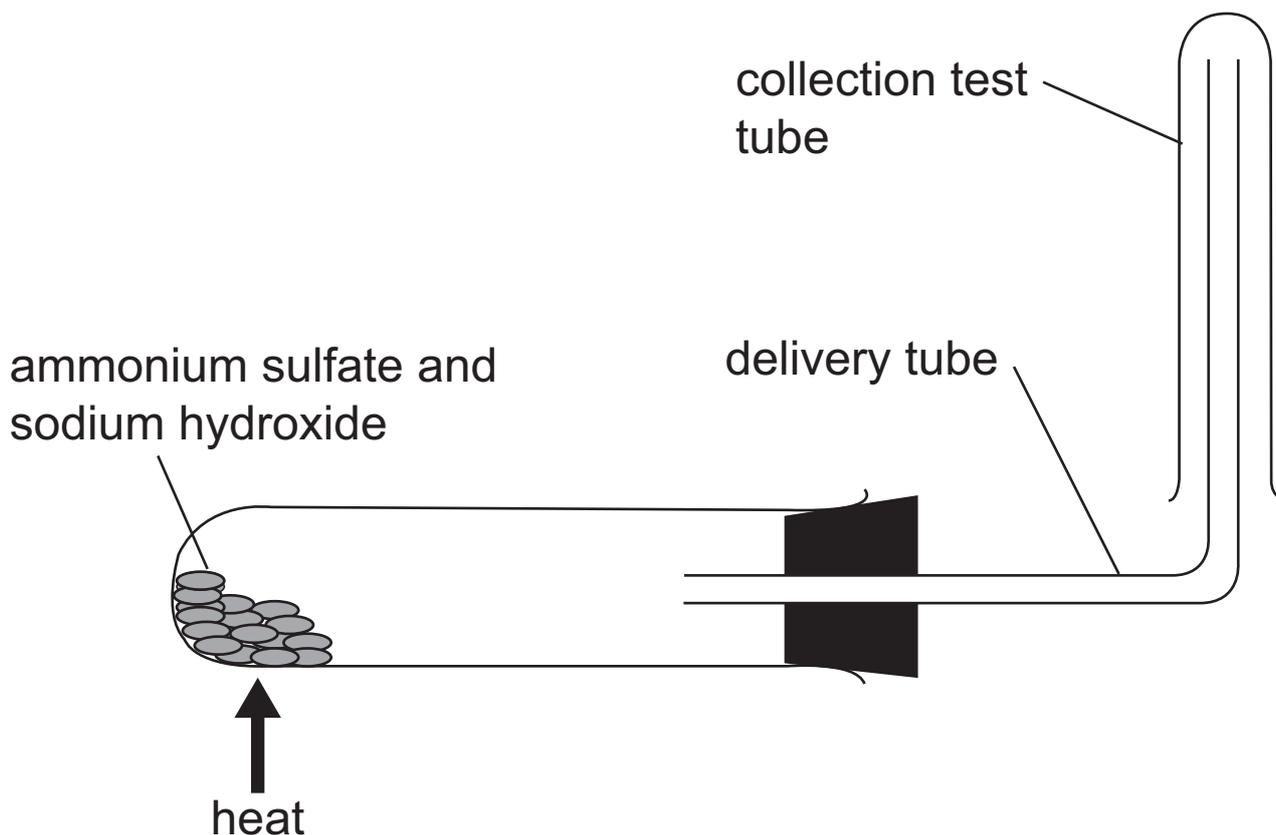
(c) The activation energy required for a reaction is affected by the presence of a catalyst. What is meant by the term activation energy? [1 mark]

---

---

4 Ammonia is an important chemical in the production of explosives and fertilisers. The Haber process is used to produce ammonia industrially.

(a) Ammonia can be prepared in the laboratory by the reaction of an ammonium compound with an alkali using the apparatus shown below.



(i) State two physical properties of ammonia gas.

[2 marks]

1. \_\_\_\_\_

2. \_\_\_\_\_

(ii) Write a balanced symbol equation for the preparation of ammonia from ammonium sulfate and sodium hydroxide. [3 marks]

(b) Nitrogen reacts with hydrogen in the Haber process according to the equation:



(i) Explain why nitrogen is described as being reduced in this reaction. [2 marks]

---

---

---

(ii) What is meant by  $\rightleftharpoons$  in the equation above? [1 mark]

---

---

(iii) Describe the test used to identify ammonia gas. [3 marks]

---

---

---

---

---

---

(c) Ammonia reacts with oxygen producing nitrogen and water.

(i) Write a balanced symbol equation for this reaction.  
[3 marks]

---

(ii) Explain why nitrogen gas is unreactive. [2 marks]

---

---

---

(d) A solution of ammonia is added slowly, until it is in excess, to separate solutions of copper(II) sulfate and magnesium sulfate. Describe the observations and write equations for the reactions. [6 marks]

Your answer should include:

- observations for both reactions
- ionic equations for the precipitation reactions.

**In this question you will be assessed on your written communication skills including the use of specialist scientific terms.**

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

**5** Copper is a transition metal and it forms many coloured compounds.

**(a)** Copper reacts when heated in air.

Write a balanced symbol equation for the reaction which occurs when copper is heated in air. [3 marks]

---

**(b)** Copper(II) carbonate decomposes when heated.

**(i)** What colour change is observed in this reaction?  
[2 marks]

From \_\_\_\_\_ to \_\_\_\_\_

**(ii)** Write a balanced symbol equation for the decomposition of copper(II) carbonate on heating.  
[2 marks]

---

**(c)** Copper(II) oxide may be reduced in the laboratory by heating in a stream of hydrogen.

**(i)** Write the balanced symbol equation for the reaction.  
[2 marks]

---

(ii) Draw a labelled diagram of the assembled apparatus used to safely heat a sample of copper(II) oxide in a stream of hydrogen in the laboratory. [4 marks]

(d) The reduction of copper(II) oxide may be carried out in the laboratory using methane instead of hydrogen. The reaction produces copper, carbon dioxide and water.

(i) Write a balanced symbol equation for the reduction of copper(II) oxide using methane. [3 marks]

---

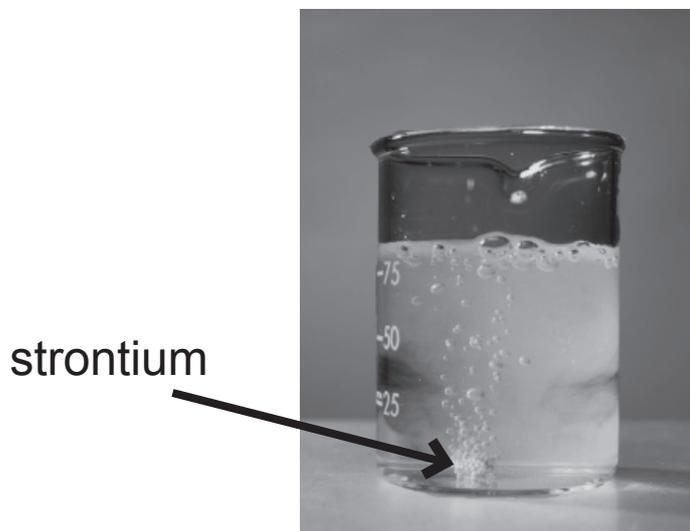
(ii) Anhydrous copper(II) sulfate is used to test for water. What is meant by the term anhydrous? [1 mark]

---

---

6 Strontium is a typical Group 2 metal. It is toxic to humans in low doses.

(a) The photograph below shows the vigorous reaction of strontium with water.



(i) Write a balanced symbol equation for the reaction of strontium with water. [3 marks]

---

(ii) **Compare** the observations made when strontium reacts with water with the observations made when potassium reacts with water. [3 marks]

---

---

---

---

---

---

---

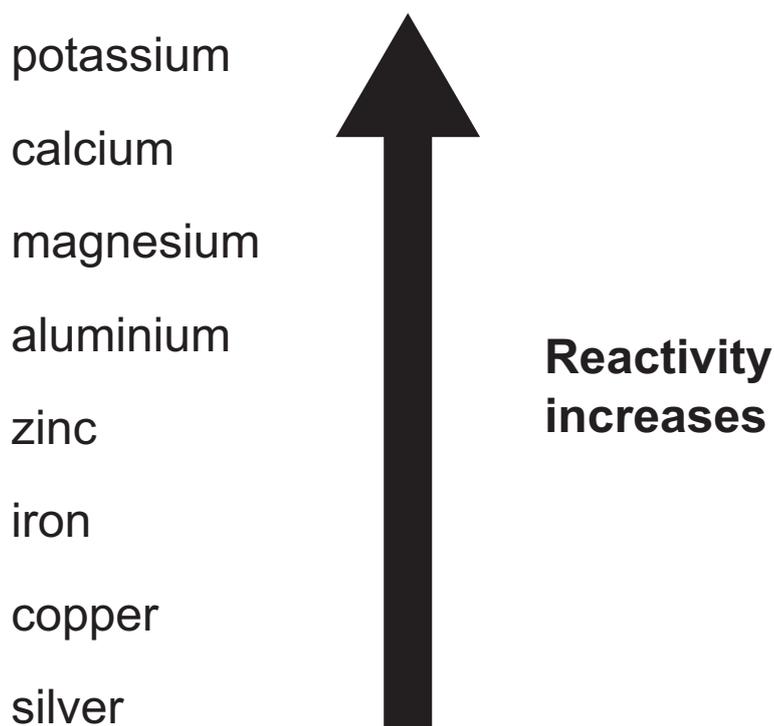
(b) The table below shows if a displacement occurs (✓) when a metal is added to a solution of a metal ion.

| metal \ metal ion solution | Strontium nitrate | Calcium nitrate | Cadmium(II) nitrate | Copper(II) nitrate | Iron(II) nitrate | Silver nitrate |
|----------------------------|-------------------|-----------------|---------------------|--------------------|------------------|----------------|
| Strontium                  |                   | ✓               | ✓                   | ✓                  | ✓                | ✓              |
| Calcium                    | x                 |                 | ✓                   | ✓                  | ✓                | ✓              |
| Cadmium                    | x                 | x               |                     | ✓                  | x                | ✓              |
| Copper                     | x                 | x               | x                   |                    | x                | ✓              |
| Iron                       | x                 | x               | ✓                   | ✓                  |                  | ✓              |
| Silver                     | x                 | x               | x                   | x                  | x                |                |

- (i) Write a balanced symbol equation for the reaction between strontium and silver nitrate. [3 marks]
- 

- (ii) Name the products when calcium reacts with cadmium(II) nitrate solution. [2 marks]
- 
- 

- (iii) On the reactivity series below indicate the position of strontium and cadmium clearly using the information from the reactions in (a) and (b). [3 marks]





(c) A barium meal medical test uses a compound of another Group 2 metal, barium. This compound allows soft tissues like the stomach and upper intestine to be X-rayed.

(i) Name the barium compound used. [1 mark]

---

(ii) State why this compound is used despite the toxicity of barium compounds. [1 mark]

---

---

7 Barium hydroxide forms crystals with the formula  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$ .

(a) Calculate the mass of barium hydroxide crystals,  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$ , required to make  $1000\text{ cm}^3$  of a  $0.25\text{ mol/dm}^3$  solution of barium hydroxide. [2 marks]  
(Relative atomic masses: H = 1; O = 16; Ba = 137)

Mass = \_\_\_\_\_ g

(b) A different solution of a metal hydroxide,  $M(OH)_2$ , was made by dissolving 15.25 g of solid  $M(OH)_2$  in  $250 \text{ cm}^3$  of water.

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

[1 mark]

Concentration = \_\_\_\_\_  $\text{g/dm}^3$

(c) To determine the identity of  $M(OH)_2$ , a titration was carried out.  $25.0\text{ cm}^3$  of the  $M(OH)_2$  solution from (b) were placed in a conical flask with a few drops of bromothymol blue indicator. The conical flask was placed on a white tile and titrated with  $1.25\text{ mol/dm}^3$  hydrochloric acid until the end-point.

| Indicator        | Colour in acid solution | Colour in neutral solution | Colour in alkaline solution |
|------------------|-------------------------|----------------------------|-----------------------------|
| bromothymol blue | yellow                  | green                      | blue                        |

(i) Why is a white tile used in this practical technique?  
[1 mark]

---

---

(ii) Use the table above to determine the colour change of the indicator at the end-point. [1 mark]

From \_\_\_\_\_ to \_\_\_\_\_

(iii) State two ways in which the end-point may be determined accurately. [2 marks]

1. \_\_\_\_\_

\_\_\_\_\_

2. \_\_\_\_\_

\_\_\_\_\_

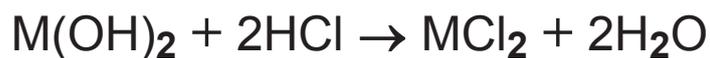
(d) The results obtained in the titration are shown in the table below.

|   | <b>Rough titration</b> | <b>Accurate titration 1</b> | <b>Accurate titration 2</b> |
|---|------------------------|-----------------------------|-----------------------------|
| <b>Final</b> burette reading (cm <sup>3</sup> )   | 20.9                   | 40.8                        | 20.1                        |
| <b>Initial</b> burette reading (cm <sup>3</sup> ) | 0.0                    | 20.9                        | 0.0                         |
| <b>Titre</b> (cm <sup>3</sup> )                   | 20.9                   | 19.9                        | 20.1                        |

(i) Calculate the average titre. [2 marks]

Average titre = \_\_\_\_\_ cm<sup>3</sup>

The equation for the reaction is represented by:



(ii) Calculate the concentration of  $\text{M(OH)}_2$  in  $\text{mol/dm}^3$ .  
[5 marks]

Concentration = \_\_\_\_\_  $\text{mol/dm}^3$

**(iii)** Use your answers from **(b)** and **(d)(ii)** to calculate the relative formula mass of  $M(OH)_2$  and state the identity of element M. Show your working out clearly. [3 marks]

Identity of M = \_\_\_\_\_

---

**THIS IS THE END OF THE QUESTION PAPER**

---





**SOURCES**

Q1. . . . . Photograph showing Coca Cola tin © Science Photo Library

Q5 . . . . . Source: *sciencephoto: C024/4014*

Q6 . . . . . Photograph showing strontium © *Andrew Lambert Photography / Science Photo Library*

| For Examiner's use only |       |
|-------------------------|-------|
| Question Number         | Marks |
| 1                       |       |
| 2                       |       |
| 3                       |       |
| 4                       |       |
| 5                       |       |
| 6                       |       |
| 7                       |       |

|                    |  |
|--------------------|--|
| <b>Total Marks</b> |  |
|--------------------|--|

Examiner Number

Permission to reproduce all copyright material has been applied for.  
In some cases, efforts to contact copyright holders may have been unsuccessful and CCEA will be happy to rectify any omissions of acknowledgement in future if notified.

## SYMBOLS OF SELECTED IONS

### Positive ions

| Name          | Symbol           |
|---------------|------------------|
| Ammonium      | $\text{NH}_4^+$  |
| Chromium(III) | $\text{Cr}^{3+}$ |
| Copper(II)    | $\text{Cu}^{2+}$ |
| Iron(II)      | $\text{Fe}^{2+}$ |
| Iron(III)     | $\text{Fe}^{3+}$ |
| Lead(II)      | $\text{Pb}^{2+}$ |
| Silver        | $\text{Ag}^+$    |
| Zinc          | $\text{Zn}^{2+}$ |

### Negative ions

| Name               | Symbol                       |
|--------------------|------------------------------|
| Carbonate          | $\text{CO}_3^{2-}$           |
| Dichromate         | $\text{Cr}_2\text{O}_7^{2-}$ |
| Ethanoate          | $\text{CH}_3\text{COO}^-$    |
| Hydrogen carbonate | $\text{HCO}_3^-$             |
| Hydroxide          | $\text{OH}^-$                |
| Methanoate         | $\text{HCOO}^-$              |
| Nitrate            | $\text{NO}_3^-$              |
| Sulfate            | $\text{SO}_4^{2-}$           |
| Sulfite            | $\text{SO}_3^{2-}$           |

## DATA LEAFLET

For the use of candidates taking  
 Science: Chemistry,  
 Science: Double Award  
 or Science: Single Award

**Copies must be free from notes or additions of any kind. No other type of data booklet or information sheet is authorised for use in the examinations.**

### SOLUBILITY IN COLD WATER OF COMMON SALTS, HYDROXIDES AND OXIDES

| <b>Soluble</b>  |
|---|
| All sodium, potassium and ammonium salts  |
| All nitrates  |
| Most chlorides, bromides and iodides<br>EXCEPT<br>silver and lead chlorides, bromides and iodides |
| Most sulfates<br>EXCEPT<br>lead and barium sulfates<br>Calcium sulfate is slightly soluble        |

| <b>Insoluble</b>   |
|--|
| Most carbonates<br>EXCEPT<br>sodium, potassium and ammonium carbonates               |
| Most hydroxides<br>EXCEPT<br>sodium, potassium and ammonium hydroxides               |
| Most oxides<br>EXCEPT<br>sodium, potassium and calcium oxides which react with water |

| Contents                       | Page |
|--------------------------------|------|
| Periodic Table of the Elements | 2–3  |
| Symbols of Selected Ions       | 4    |
| Solubility of Common Salts     | 4    |

# gcse . Science

## chemistry double award single award



# THE PERIODIC TABLE OF ELEMENTS

## Group

| 1                                  |                                    | 2                                     |  |                                    |                                       |                                     |                                     |                                       |   |  |  |                                    |                                    | 3                                  | 4                                   | 5                                   | 6                                | 7 | 0 |                               |
|------------------------------------|------------------------------------|---------------------------------------|--|------------------------------------|---------------------------------------|-------------------------------------|-------------------------------------|---------------------------------------|---|--|--|------------------------------------|------------------------------------|------------------------------------|-------------------------------------|-------------------------------------|----------------------------------|---|---|-------------------------------|
|                                    |                                    |                                       |  |                                    |                                       |                                     |                                     |                                       |   |  |  |                                    |                                    |                                    |                                     |                                     |                                  |   |   | 4<br><b>He</b><br>Helium<br>2 |
| 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         | 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   | 99<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  | 210<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 | 263<br><b>Sg</b><br>Seaborgium<br>106 | 262<br><b>Bh</b><br>Bohrium<br>107  | 265<br><b>Hs</b><br>Hassium<br>108  | 266<br><b>Mt</b><br>Meitnerium<br>109 | 269<br><b>Ds</b><br>Darmstadtium<br>110 | 272<br><b>Rg</b><br>Roentgenium<br>111 | 285<br><b>Cn</b><br>Copernicium<br>112 |                                    |                                    |                                    |                                     |                                     |                                  |   |   |                               |

\* 58 – 71 Lanthanum series

† 90 – 103 Actinium series

|   |   |
|---|---|
| a | x |
| b |   |

a = relative atomic mass (approx)  
x = atomic symbol  
b = atomic number

|                                   |  |                                     |                                      |                                     |                                     |                                      |                                     |                                       |                                       |                                    |  |                                     |                                       |
|-----------------------------------|--|-------------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|---------------------------------------|---------------------------------------|------------------------------------|--|-------------------------------------|---------------------------------------|
| 140<br><b>Ce</b><br>Cerium<br>58  | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 147<br><b>Pm</b><br>Promethium<br>61 | 150<br><b>Sm</b><br>Samarium<br>62  | 152<br><b>Eu</b><br>Europium<br>63  | 157<br><b>Gd</b><br>Gadolinium<br>64 | 159<br><b>Tb</b><br>Terbium<br>65   | 162<br><b>Dy</b><br>Dysprosium<br>66  | 165<br><b>Ho</b><br>Holmium<br>67     | 167<br><b>Er</b><br>Erbium<br>68   | 169<br><b>Tm</b><br>Thulium<br>69      | 173<br><b>Yb</b><br>Ytterbium<br>70 | 175<br><b>Lu</b><br>Lutetium<br>71    |
| 232<br><b>Th</b><br>Thorium<br>90 | 231<br><b>Pa</b><br>Protactinium<br>91 | 238<br><b>U</b><br>Uranium<br>92    | 237<br><b>Np</b><br>Neptunium<br>93  | 242<br><b>Pu</b><br>Plutonium<br>94 | 243<br><b>Am</b><br>Americium<br>95 | 247<br><b>Cm</b><br>Curium<br>96     | 245<br><b>Bk</b><br>Berkelium<br>97 | 251<br><b>Cf</b><br>Californium<br>98 | 254<br><b>Es</b><br>Einsteinium<br>99 | 253<br><b>Fm</b><br>Fermium<br>100 | 256<br><b>Md</b><br>Mendelevium<br>101 | 254<br><b>No</b><br>Nobelium<br>102 | 257<br><b>Lr</b><br>Lawrencium<br>103 |