

**Wednesday 15 June 2016 – Afternoon**

**GCSE TWENTY FIRST CENTURY SCIENCE  
CHEMISTRY A/ADDITIONAL SCIENCE A**

**A172/01** Modules C4 C5 C6 (Foundation Tier)

Candidates answer on the Question Paper.  
A calculator may be used for this paper.

**OCR supplied materials:**  
None

**Other materials required:**

- Pencil
- Ruler (cm/mm)

**Duration:** 1 hour



|                       |  |                      |  |
|-----------------------|--|----------------------|--|
| Candidate<br>forename |  | Candidate<br>surname |  |
|-----------------------|--|----------------------|--|

|               |  |  |  |  |  |                  |  |  |  |  |
|---------------|--|--|--|--|--|------------------|--|--|--|--|
| Centre number |  |  |  |  |  | Candidate number |  |  |  |  |
|---------------|--|--|--|--|--|------------------|--|--|--|--|

**INSTRUCTIONS TO CANDIDATES**

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

**INFORMATION FOR CANDIDATES**

- The quality of written communication is assessed in questions marked with a pencil (✎).
- The number of marks is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.
- A list of qualitative tests for ions is printed on page **2**.
- The Periodic Table is printed on the back page.

# **TWENTY FIRST CENTURY SCIENCE DATA SHEET**

## **Qualitative analysis**

### **Tests for ions with a positive charge**

| Ion                           | Test                        | Observation                                                                                  |
|-------------------------------|-----------------------------|----------------------------------------------------------------------------------------------|
| calcium<br>$\text{Ca}^{2+}$   | add dilute sodium hydroxide | a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide      |
| copper<br>$\text{Cu}^{2+}$    | add dilute sodium hydroxide | a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide |
| iron(II)<br>$\text{Fe}^{2+}$  | add dilute sodium hydroxide | a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide      |
| iron(III)<br>$\text{Fe}^{3+}$ | add dilute sodium hydroxide | a red-brown precipitate forms; the precipitate does not dissolve in excess sodium hydroxide  |
| zinc<br>$\text{Zn}^{2+}$      | add dilute sodium hydroxide | a white precipitate forms; the precipitate dissolves in excess sodium hydroxide              |

### **Tests for ions with a negative charge**

| Ion                             | Test                                                        | Observation                                                                                                  |
|---------------------------------|-------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| carbonate<br>$\text{CO}_3^{2-}$ | add dilute acid                                             | the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky) |
| chloride<br>$\text{Cl}^-$       | add dilute nitric acid, then add silver nitrate             | a white precipitate forms                                                                                    |
| bromide<br>$\text{Br}^-$        | add dilute nitric acid, then add silver nitrate             | a cream precipitate forms                                                                                    |
| iodide<br>$\text{I}^-$          | add dilute nitric acid, then add silver nitrate             | a yellow precipitate forms                                                                                   |
| sulfate<br>$\text{SO}_4^{2-}$   | add dilute acid, then add barium chloride or barium nitrate | a white precipitate forms                                                                                    |

3

Answer **all** the questions.

- 1 In 1864, a chemist called John Newlands had an idea of arranging the elements in order, depending on their chemical properties.

He called his idea the 'Law of Octaves'.

- (a) Newlands put elements with similar properties together.

He put lithium, sodium and potassium together.

Give **two** ways that the properties of lithium, sodium and potassium are similar.

.....

.....

.....

..... [2]

- (b) The table shows Newlands' arrangement of some of the elements.

He put elements with similar properties into the same row of his table.

| Row |    |    |    |
|-----|----|----|----|
| 1   | H  | F  | Cl |
| 2   | Li | Na | K  |
| 3   | Gf | Mg | Ca |
| 4   | Bo | Al | Cr |
| 5   | C  | Si | Ti |
| 6   | N  | P  | Mn |
| 7   | O  | S  | Fe |

Newlands based the order of the elements on their relative atomic masses.

- (i) Find the relative atomic masses for the elements in Row 1 of Newlands' table.  
Use the **Periodic Table** on page 20 to help you.

Relative atomic masses H ..... F ..... Cl ..... [1]

- (ii) Use your answer to describe the trend in relative atomic masses across Row 1.

.....

..... [1]

- (iii) The Periodic Table that is used today was developed after Newlands' table.

In **Newlands' table**, the elements H, F and Cl are all together in Row 1.

In the **Periodic Table**, these elements are not all together in the same group.

Where are these elements placed in the Periodic Table?

.....

.....

.....

..... [2]

- (iv) One group of elements on the Periodic Table is completely missing from Newlands' table.

Which group is completely missing?

Use the Periodic Table to help you.

Put a ring around the correct answer.

**Group 4      Group 5      Group 6      Group 0      [1]**

- (v) What is the most likely reason for Newlands missing these elements out of his table?

Put a tick (✓) in the box next to the best answer.

|                                                    |                          |
|----------------------------------------------------|--------------------------|
| He only wanted to classify a few elements.         | <input type="checkbox"/> |
| These elements were not discovered at the time.    | <input type="checkbox"/> |
| He did not know the symbols for these elements.    | <input type="checkbox"/> |
| These elements do not have a relative atomic mass. | <input type="checkbox"/> |

[1]

- (vi) The symbols that Newlands used for some of the elements are different to those used today.

Complete the table to show the symbols used today for elements Gl and Bo.  
Use the Periodic Table to help you.

| Newlands' symbol | Relative atomic mass | Symbol used today |
|------------------|----------------------|-------------------|
| Gl               | 9                    |                   |
| Bo               | 11                   |                   |

[2]

5

- (c) Newlands' arrangement was based on putting the elements in order of their relative atomic masses.

What decides the order of elements in the Periodic Table today?

Put a tick (✓) in the box next to the correct answer.

the number of neutrons in the atom

☐

the proton number

☐

the type of bonds the elements form

☐

the relative atomic mass

☐

[1]

[Total: 11]

He looks up the flame colours for some Group 1 elements.

| Element   | Flame colour  |
|-----------|---------------|
| lithium   | red           |
| sodium    | yellow-orange |
| potassium | pale purple   |
| rubidium  | purple        |

These are his results.

| Mineral  | Flame colour  |
|----------|---------------|
| <b>A</b> | yellow-orange |
| <b>B</b> | purple        |
| <b>C</b> | green         |

Write down what conclusions you can make about which elements each mineral contains and explain why there is not enough information to identify all of the elements in the minerals.



*The quality of written communication will be assessed in your answer.*

..... [6

**[Total: 6]**

7

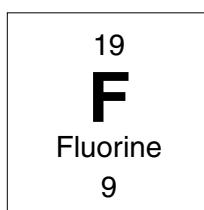
3 The halogens have different colours and states at room temperature.

(a) Draw straight lines to connect each **element** to its correct **colour** and **state** at room temperature.

| colour | element  | state  |
|--------|----------|--------|
| grey   | chlorine | solid  |
| green  | bromine  | liquid |
| orange | iodine   | gas    |

[3]

(b) This is the symbol for fluorine on the Periodic Table.



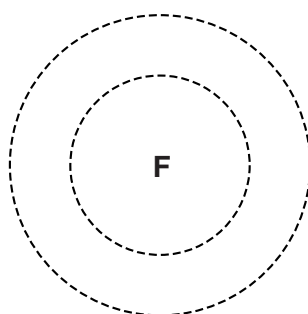
(i) Complete the sentence.

The nucleus of a fluorine atom contains 9 protons and 10 .....

[1]

(ii) The diagram shows part of the structure of a fluorine atom.

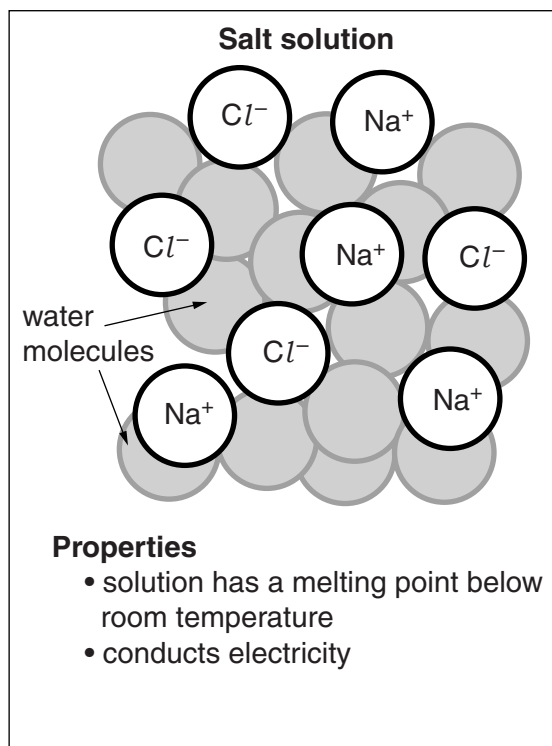
Complete the diagram to show the arrangement of electrons.  
Use **x** to represent each electron.



[2]

[Total: 6]

**(a)** The information shows the properties and arrangement of particles in solid salt and in salt solution.



*The quality of written communication will be assessed in your answer.*

..... [6

- (b) Salt is put on roads in winter because it lowers the freezing point of water.

Liz does some experiments to investigate whether salt can be used to stop water from freezing in extreme weather conditions.

She adds different masses of salt to  $100\text{cm}^3$  of water and records the temperature when the water freezes.

Here are her results.

| Mass of salt added to $100\text{cm}^3$ water in g | Freezing point in $^{\circ}\text{C}$ |
|---------------------------------------------------|--------------------------------------|
| 0.0                                               | 0                                    |
| 5.0                                               | -3                                   |
| 10.0                                              | -6                                   |
| 15.0                                              | -9                                   |

Liz talks about her results.



My data shows that there is a relationship between the freezing point and the mass of salt added.

I can use this data to predict the freezing point of water when higher masses of salt are added.

**Liz**

- (i) What is the relationship shown in this data between the mass of salt added and the freezing point?

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

- (ii) Use the relationship to predict the freezing point when  $25.0\text{g}$  of salt are added.

Show your working.

Freezing point = .....  $^{\circ}\text{C}$  [2]

10

- (c) Liz does another experiment using 35.0 g of salt.

The table shows her results

| Mass of salt added to<br>100 cm <sup>3</sup> water in g | Freezing point in °C |
|---------------------------------------------------------|----------------------|
| 35.0                                                    | −6                   |

- (i) Liz thinks that this result may be an outlier.  
Explain why she thinks this.

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

- (ii) What should Liz do to check whether this result is an outlier?

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

- (iii) Liz wants to investigate the relationship between mass of salt and the freezing point of water when she adds up to 50.0 g of salt.

Describe what experiments she should do.

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

[Total: 15]

- 5 The table gives some information about three substances that are extracted from the Earth.

| Substance          | Where found | Solubility in water | Melting and boiling point |
|--------------------|-------------|---------------------|---------------------------|
| graphite           | rocks       | does not dissolve   | very high                 |
| oxygen             | atmosphere  | low solubility      | below room temperature    |
| potassium chloride | sea         | very soluble        | very high                 |

- (a) Oxygen is found in the atmosphere. Potassium chloride is found in the sea.  
Use the information to explain why oxygen and potassium chloride are not found in surface rocks.

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

- (b) Complete the table to show the missing **formulae** and **elements** in each substance.

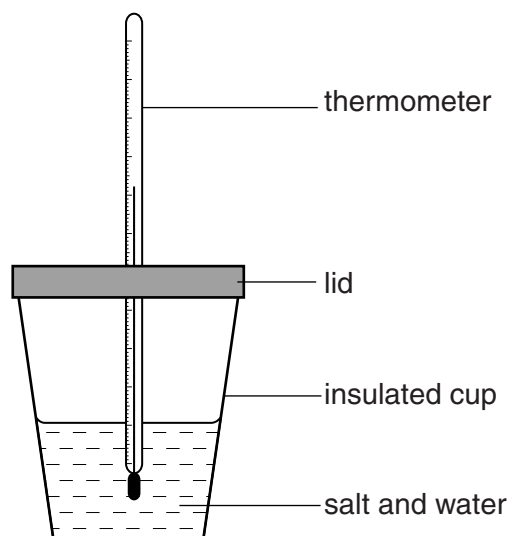
| Substance          | Formula | Elements in substance |
|--------------------|---------|-----------------------|
| graphite           |         | carbon only           |
| oxygen             |         | oxygen only           |
| potassium chloride | KCl     |                       |

[2]

[Total: 4]

## 12

- 6 Rose investigates the energy changes when three salts dissolve in water.
- She adds the same amount of each salt to the same amount of water.
- She measures the maximum temperature change when each salt dissolves.

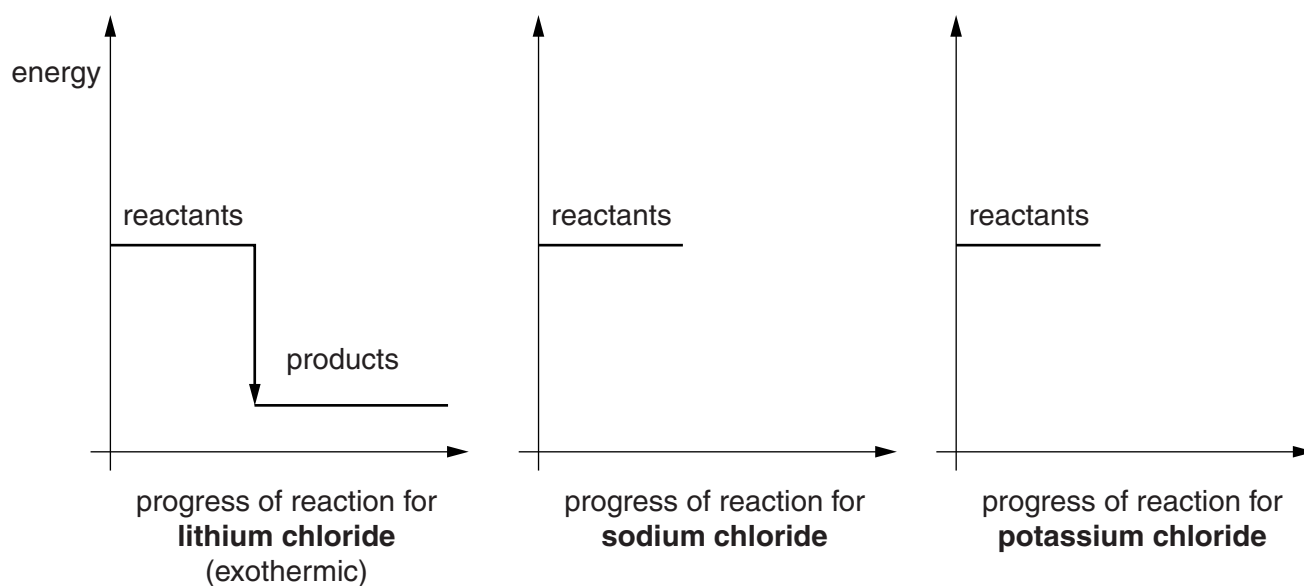


The table shows her results.

| Salt               | Temperature change in °C | Type of energy change |
|--------------------|--------------------------|-----------------------|
| lithium chloride   | +7.0                     | exothermic            |
| sodium chloride    | −0.5                     | endothermic           |
| potassium chloride | −4.0                     | endothermic           |

13

Complete and label the energy level diagrams. Compare the changes in temperature and energy that happen when each salt dissolves.



*The quality of written communication will be assessed in your answer.*

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

- 7 Matt finds out about the bonding in some compounds. He dissolves them in water and uses a pH meter to find out if each compound is an acid or an alkali.

The table shows his results.

| Compound          | Bonding in compound | Acid or alkali? |
|-------------------|---------------------|-----------------|
| sodium hydroxide  | ionic               | alkali          |
| ammonia           | covalent            | alkali          |
| hydrogen chloride | covalent            | acid            |
| ethanoic acid     | covalent            | acid            |
| calcium hydroxide | ionic               | alkali          |

- (a) How does a pH meter show whether each compound is an acid or an alkali?

.....

.....

.....

..... [2]

- (b) Matt has an idea.

The alkalis in the table have different types of bonding.



Do you agree with Matt's idea?  
Use examples from the table to explain your reasoning.

.....

.....

.....

..... [2]

15

(c) The pure compounds in the table have different states at room temperature and pressure.

They all dissolve in water to form a solution.

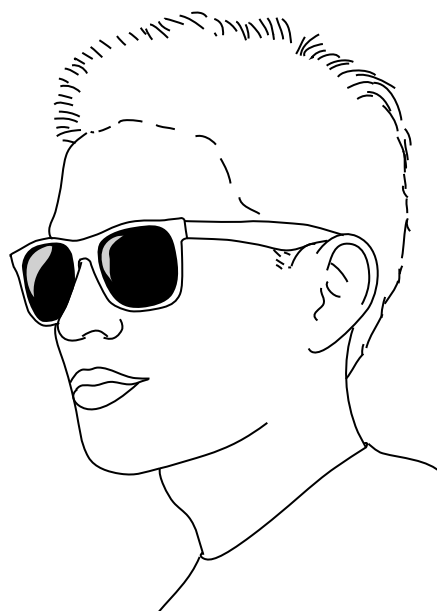
Draw straight lines to connect each **substance** to the correct **state symbol**.

| substance                     | state symbol |
|-------------------------------|--------------|
| solid sodium hydroxide        | (g)          |
| hydrogen chloride gas         | (l)          |
| liquid ethanoic acid          | (s)          |
| a solution dissolved in water | (aq)         |

[2]

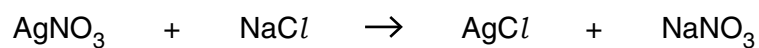
[Total: 6]

- 8 Silver chloride is a salt that is used to make lenses that darken in bright light.



- (a) Terry uses silver nitrate to make some silver chloride in a precipitation reaction.

This is the symbol equation for the reaction.



Use these words to write a word equation for this reaction.

**sodium chloride**  
**silver chloride**  
**sodium nitrate**  
**silver nitrate**

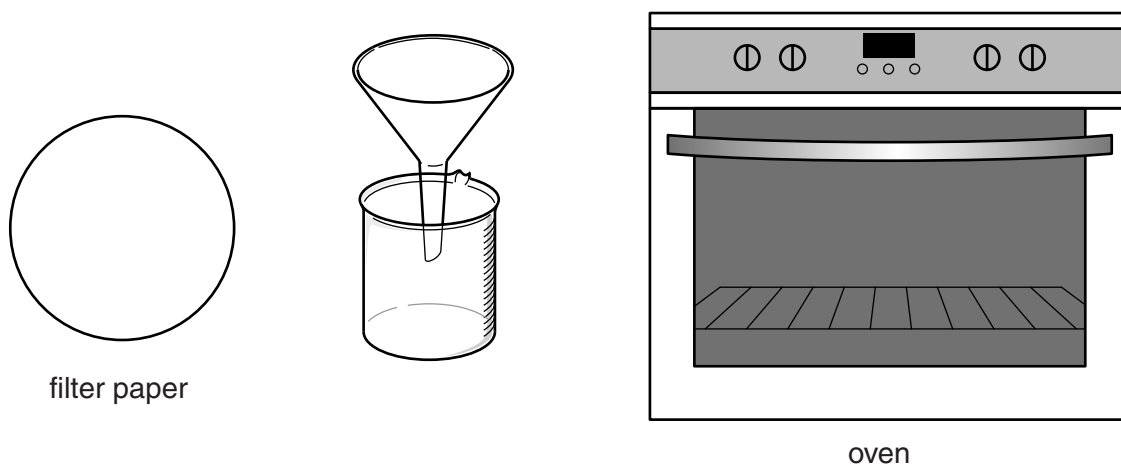
[2]

17

- (b) In the reaction, silver chloride forms as a precipitate.

Terry wants to make a pure, dry sample of silver chloride from the reaction mixture.

The diagram shows the apparatus he uses.



Describe how Terry should use this apparatus to make a pure, dry sample of silver chloride.

.....

.....

.....

..... [3]

- (c) The lenses go dark because a solid forms when light shines on silver chloride.

The solid is silver metal.

What is the name of the other element that forms in the reaction?

Put a (ring) around the correct answer.

carbon

chlorine

hydrogen

iodine

water

[1]

[Total: 6]

END OF QUESTION PAPER



This image shows a blank sheet of white paper designed for writing. It features a series of evenly spaced horizontal blue lines across its entire width. A single vertical red line runs down the left side, creating a narrow margin. The paper is otherwise completely empty, with no text or markings.

### Copyright Information

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

# The Periodic Table of the Elements

© OCR 2016

| 1                             | 2                           | Key                                                                     |                                     |                               |                                  |                                |                               |                                  |                                    |                                   |                                                                                     | 3                           | 4                           | 5                           | 6                             | 7                             | 0                          |  |  |
|-------------------------------|-----------------------------|-------------------------------------------------------------------------|-------------------------------------|-------------------------------|----------------------------------|--------------------------------|-------------------------------|----------------------------------|------------------------------------|-----------------------------------|-------------------------------------------------------------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|-------------------------------|----------------------------|--|--|
|                               |                             | relative atomic mass<br>atomic symbol<br>name<br>atomic (proton) number |                                     |                               |                                  |                                |                               |                                  |                                    |                                   |                                                                                     |                             |                             |                             |                               |                               |                            |  |  |
| 7<br>Li<br>lithium<br>3       | 9<br>Be<br>beryllium<br>4   |                                                                         |                                     |                               |                                  |                                |                               |                                  |                                    |                                   |                                                                                     | 11<br>B<br>boron<br>5       | 12<br>C<br>carbon<br>6      | 14<br>N<br>nitrogen<br>7    | 16<br>O<br>oxygen<br>8        | 19<br>F<br>fluorine<br>9      | 20<br>Ne<br>neon<br>10     |  |  |
| 23<br>Na<br>sodium<br>11      | 24<br>Mg<br>magnesium<br>12 |                                                                         |                                     |                               |                                  |                                |                               |                                  |                                    |                                   |                                                                                     | 27<br>Al<br>aluminium<br>13 | 28<br>Si<br>silicon<br>14   | 31<br>P<br>phosphorus<br>15 | 32<br>S<br>sulfur<br>16       | 35.5<br>Cl<br>chlorine<br>17  | 40<br>Ar<br>argon<br>18    |  |  |
| 39<br>K<br>potassium<br>19    | 40<br>Ca<br>calcium<br>20   | 45<br>Sc<br>scandium<br>21                                              | 48<br>Ti<br>titanium<br>22          | 51<br>V<br>vanadium<br>23     | 52<br>Cr<br>chromium<br>24       | 55<br>Mn<br>manganese<br>25    | 56<br>Fe<br>iron<br>26        | 59<br>Co<br>cobalt<br>27         | 59<br>Ni<br>nickel<br>28           | 63.5<br>Cu<br>copper<br>29        | 65<br>Zn<br>zinc<br>30                                                              | 70<br>Ga<br>gallium<br>31   | 73<br>Ge<br>germanium<br>32 | 75<br>As<br>arsenic<br>33   | 79<br>Se<br>selenium<br>34    | 80<br>Br<br>bromine<br>35     | 84<br>Kr<br>krypton<br>36  |  |  |
| 85<br>Rb<br>rubidium<br>37    | 88<br>Sr<br>strontium<br>38 | 89<br>Y<br>yttrium<br>39                                                | 91<br>Zr<br>zirconium<br>40         | 93<br>Nb<br>niobium<br>41     | 96<br>Mo<br>molybdenum<br>42     | [98]<br>Tc<br>technetium<br>43 | 101<br>Ru<br>ruthenium<br>44  | 103<br>Rh<br>rhodium<br>45       | 106<br>Pd<br>palladium<br>46       | 108<br>Ag<br>silver<br>47         | 112<br>Cd<br>cadmium<br>48                                                          | 115<br>In<br>indium<br>49   | 119<br>Sn<br>tin<br>50      | 122<br>Sb<br>antimony<br>51 | 128<br>Te<br>tellurium<br>52  | 127<br>I<br>iodine<br>53      | 131<br>Xe<br>xenon<br>54   |  |  |
| 133<br>Cs<br>caesium<br>55    | 137<br>Ba<br>barium<br>56   | 139<br>La*<br>lanthanum<br>57                                           | 178<br>Hf<br>hafnium<br>72          | 181<br>Ta<br>tantalum<br>73   | 184<br>W<br>tungsten<br>74       | 186<br>Re<br>rhenium<br>75     | 190<br>Os<br>osmium<br>76     | 192<br>Ir<br>iridium<br>77       | 195<br>Pt<br>platinum<br>78        | 197<br>Au<br>gold<br>79           | 201<br>Hg<br>mercury<br>80                                                          | 204<br>Tl<br>thallium<br>81 | 207<br>Pb<br>lead<br>82     | 209<br>Bi<br>bismuth<br>83  | [209]<br>Po<br>polonium<br>84 | [210]<br>At<br>astatine<br>85 | [222]<br>Rn<br>radon<br>86 |  |  |
| [223]<br>Fr<br>francium<br>87 | [226]<br>Ra<br>radium<br>88 | [227]<br>Ac*<br>actinium<br>89                                          | [261]<br>Rf<br>rutherfordium<br>104 | [262]<br>Db<br>dubnium<br>105 | [266]<br>Sg<br>seaborgium<br>106 | [264]<br>Bh<br>bohrium<br>107  | [277]<br>Hs<br>hassium<br>108 | [268]<br>Mt<br>meitnerium<br>109 | [271]<br>Ds<br>darmstadtium<br>110 | [272]<br>Rg<br>roentgenium<br>111 | Elements with atomic numbers 112-116 have been reported but not fully authenticated |                             |                             |                             |                               |                               |                            |  |  |

\* 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.