REVISION

I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions SCN 3-15a

NEW LEARNING

Through gaining an understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures SCN 4-15a

Atomic structure and bonding related to properties of materials National 4
1. You probably already know everything's made of atoms. How many atoms do you think are in 6ml of water?

2. If everything's made of atoms, what do you THINK atoms are made of?
REVISION

I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions SCN 3-15a

NEW LEARNING

Through gaining an Understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures SCN 4-15a

Atomic structure and bonding related to properties of materials National 4
Learning Objectives & Success Criteria

Today we will learn ...

About the scientific history of the discovery of the atom.

We will do this by ...

Researching the different scientists involved in atomic science and presenting a poster based on their work. Using each other’s posters as a learning tool and peer assessing.

We will have succeeded if...

All members of the class can complete a summary table on the key scientists involved in the scientific history of the discovery of the atom using the information extracted from classmates’ posters.
Key Scientists: Models of the Atom

Democritus
John Dalton
Joseph John Thomson
Ernest Rutherford

Neils Bohr
Werner Heisenberg
James Chadwick

Link to Discovery of Atomic Structure
BOARDWORKS
Atomic Theory Scientists

Your scientist will be one of the following:

• Ernest Rutherford
• Neils Bohr
• John Dalton
• JJ Thomson
• Werner Heisenberg

You will team up with the classmates who have part of the same photo as you.
Sources of Information

You can use the following sources to help you with your poster:

Library Books:

Class Textbooks:

Chemistry Counts p52
Standard Grade Chemistry p25
Standard Chemistry p22

The Internet:

http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1908/rutherford-bio.html
http://scienceworld.wolfram.com/biography/
http://atomictimeline.net/index.php
Your poster must include the following:

1. Name of scientist
2. Date of proposed theory
3. What did they think an atom looked like? Include a picture if available.
4. Were they correct (or did other scientists improve upon their model)?

If you want to add more information you can but be sure to include the above first of all!
Learning Objectives & Success Criteria

Today we will learn ...

About the scientific history of the discovery of the atom.

We will do this by ...

Researching the different scientists involved in atomic science and presenting a poster based on their work. Using each other’s posters as a learning tool and peer assessing.

We will have succeeded if...

All members of the class can complete a summary table on the key scientists involved in the scientific history of the discovery of the atom using the information extracted from classmates’ posters.
Tell me three things...

1. One thing you have done well
2. One thing you would like to find out more about
3. One thing you know now that you didn’t know 50 minutes ago
Lesson Starter

What were the 4 key features you were asked to include on your poster?

- Name of scientist,
- Date of proposed theory,
- What they think an atom looked like *(picture if available)* & if they were correct?

Tick each of the features you have already finished for your poster.

You now have only 20 minutes to complete the rest of your poster. We will then be placing our posters up for classmates to learn from. Do your best for each other!
REVISION

I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions SCN 3-15a

NEW LEARNING

Through gaining an understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures SCN 4-15a

Atomic structure and bonding related to properties of materials National 4
Learning Objectives & Success Criteria

Today we will learn ...

About the scientific history of the discovery of the atom.

We will do this by ...

Researching the different scientists involved in atomic science and presenting a poster based on their work. Using each other’s posters as a learning tool and peer assessing.

We will have succeeded if...

All members of the class can complete a summary table on the key scientists involved in the scientific history of the discovery of the atom using the information extracted from classmates’ posters.
<table>
<thead>
<tr>
<th>Scientist</th>
<th>Model Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rutherford</td>
<td>Solid sphere model</td>
</tr>
<tr>
<td>Thomson</td>
<td>Planetary model - electrons in specific energy levels</td>
</tr>
<tr>
<td>Dalton</td>
<td>Planetary model - discovered the nucleus</td>
</tr>
<tr>
<td>Bohr</td>
<td>Plum pudding model</td>
</tr>
</tbody>
</table>
Starter Questions

1. Name 3 scientists who were involved in discovering the structure of the atom.

2. Draw a diagram of what the inside of an atom might look like. Include the particles found inside.
REVISION
I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions SCN 3-15a

NEW LEARNING
Through gaining an understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures SCN 4-15a

Atomic structure and bonding related to properties of materials National 4
Learning Objectives & Success Criteria

Today we will learn to …

Identify the properties and locations of protons, electrons and neutrons in an atom.

We will do this by …

Hearing about what an atom is made of and memorising key facts about the 3 subatomic particles.

We will have succeeded if …

We can state the mass, charge and location of the 3 subatomic particles.
Sub-Atomic Particles

Atoms are mainly empty space, but their structure includes 3 smaller particles found within them i.e. 'sub-atomic'. These are the PROTONS, NEUTRONS and ELECTRONS.
The protons and neutrons are in the centre of the atom. Scientists call the centre of the atom the NUCLEUS. The electrons are always found outside the nucleus in electron shells.
Most of the atom is empty space!
Imagine a Helium atom the size of Wembley stadium. The nucleus would be the size of a football on the centre spot. The electrons would be the size of two peas flying around the whole stadium. The rest of it is emptiness!
The Mass of Subatomic Particles

Electrons have virtually no mass compared to a proton and a neutron (it would take 2000 electrons to equal the mass of either a proton or a neutron) so we say that they have a negligible mass.

Mass of an **electron** = 0 a.m.u. (atomic mass units)
Mass of a **proton** OR a **neutron** = 1 a.m.u.
The Charge of Subatomic Particles

Electrons have an equal and opposite charge to protons. In an atom the number of positive protons is always EQUAL TO the number of negative electrons and so an ATOM is always NEUTRAL (has no overall charge).

- Electron

- Proton

Neutrons are also NEUTRAL (have NO charge)
Complete the following table to summarise the key features about the 3 subatomic particles.

<table>
<thead>
<tr>
<th>Particle</th>
<th>Mass/amu</th>
<th>Charge</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proton (p)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electron (e)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutron (n)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Your teacher may now test your knowledge of these 3 subatomic particles using the Show-Me Boards.
Learning Objectives & Success Criteria

Today we will learn to …

Identify the properties and locations of protons, electrons and neutrons in an atom.

We will do this by …

Hearing about what an atom is made of and memorising key facts about the 3 subatomic particles.

We will have succeeded if…

We can state the mass, charge and location of the 3 subatomic particles.
Exit Task
Post-It Factcard

Write your name on a post-it note.

Choose any one sub-atomic particle and write its name alongside its mass, charge and location onto your post-it note.

Stick your post-it to the door on your way out of class.
Lesson Starter
Who am I?

Match up the description of each sub-atomic particle with its name.

1  I am found inside the nucleus. I have no charge and a mass of 1.

2  I am found outside the nucleus in shells. I have a negative charge and a mass of 0.

3  I am found inside the nucleus. I have a positive charge and a mass of 1.

neutron  proton  electron
S3 Chemistry

Atomic Structure and Bonding

Lesson 4 - Electron Arrangement

**REVISION**

I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions SCN 3-15a

**NEW LEARNING**

Through gaining an understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures SCN 4-15a

Atomic structure and bonding related to properties of materials National 4
Learning Objectives & Success Criteria

Today we will learn ...
How electrons are arranged in atoms.

We will do this by ...
Using the numbers of each sub-atomic particle to draw our own atoms. Using the data book to find the electron arrangement of atoms.

We will have succeeded if...
We can correctly draw the structure of any atom if told how many of each sub-atomic particle there are.
We can use the data book to find the electron arrangement of any atom.
Electron Arrangement

Electrons are arranged in shells around an atom’s nucleus. Each shell has a maximum number of electrons that it can hold. Electrons will fill the shells nearest the nucleus first.

This atom has 18 electrons. The electron arrangement is written as 2,8,8.
Writing Electron Arrangements

Write the electron arrangement for the following atoms:

BERYLIUM has 4 electrons

OXYGEN has 8 electrons

ALUMINIUM has 13 electrons

CHLORINE has 17 electrons

CALCIUM has 20 electrons
### Writing Electron Arrangements

Write the electron arrangement for the following atoms (use p6 of the Chemistry Data Booklet for National 5):

<table>
<thead>
<tr>
<th>Atom</th>
<th>Electron Arrangement</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARBON</td>
<td>2, 4</td>
</tr>
<tr>
<td>NEON</td>
<td>2, 8</td>
</tr>
<tr>
<td>HYDROGEN</td>
<td>1</td>
</tr>
<tr>
<td>NITROGEN</td>
<td>2, 5</td>
</tr>
<tr>
<td>SODIUM</td>
<td>2, 8, 1</td>
</tr>
<tr>
<td>PHOSPHORUS</td>
<td>2, 8, 5</td>
</tr>
</tbody>
</table>
Which element is this?

HINT - use p6 of the Chemistry Data Booklet for National 5 to see which element has 3 electrons in its atom.
## Drawing More Atom Diagrams

Draw atom diagrams containing the following number of particles:

<table>
<thead>
<tr>
<th>Example 1</th>
<th>Example 2</th>
<th>Example 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Protons</td>
<td>5 Protons</td>
<td>9 Protons</td>
</tr>
<tr>
<td>2 Electrons</td>
<td>5 Electrons</td>
<td>9 Electrons</td>
</tr>
<tr>
<td>2 Neutrons</td>
<td>6 Neutrons</td>
<td>10 Neutrons</td>
</tr>
</tbody>
</table>
Use p6 of the Chemistry Data Booklet for National 5 to identify the 3 elements drawn in the last task.

**Example 1**
- 2 Protons
- 2 Electrons
- 2 Neutrons

**Example 2**
- 5 Protons
- 5 Electrons
- 6 Neutrons

**Example 3**
- 9 Protons
- 9 Electrons
- 10 Neutrons

- Helium
- Boron
- Fluorine
**Drawing Electron Arrangement**

At National 4/5 you will only be asked to draw the **electron arrangement** of atoms (not what is inside the nucleus).

*Draw the electron arrangement of the elements listed below (Use p6 of the Chemistry Data Booklet for National 5).*

<table>
<thead>
<tr>
<th>BERYLIUM</th>
<th>CARBON</th>
<th>PHOSPHORUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>OXYGEN</td>
<td>NEON</td>
<td></td>
</tr>
<tr>
<td>ALUMINIUM</td>
<td>HYDROGEN</td>
<td></td>
</tr>
<tr>
<td>CHLORINE</td>
<td>NITROGEN</td>
<td></td>
</tr>
<tr>
<td>CALCIUM</td>
<td>SODIUM</td>
<td></td>
</tr>
</tbody>
</table>
Learning Objectives & Success Criteria

Today we will learn ... 
How electrons are arranged in atoms.

We will do this by ... 
Using the numbers of each sub-atomic particle to draw our own atoms. Using the data book to find the electron arrangement of atoms.

We will have succeeded if... 
We can correctly draw the structure of any atom if told how many of each sub-atomic particle there are.
We can use the data book to find the electron arrangement of any atom.
Exit Task

Rate your understanding of today’s lesson using your fingers.

Fist to Five
I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions SCN 3-15a

Through gaining an Understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures SCN 4-15a

Atomic structure and bonding related to properties of materials National 4
Learning Objectives & Success Criteria

Today we will learn ...

What is meant by the terms **atomic number** and **mass number** and how to use these two numbers to work out the numbers of each subatomic particle in an atom.

We will do this by ...

Carrying out simple calculations using **atomic number** and **mass number**. Using the periodic table and data book to help find these two numbers.

We will have succeeded if...

We can work out the number of protons, electrons and neutrons from the nuclide notation or when given the **atomic number** and **mass number**.
Starter Questions

1. NITROGEN has 7 electrons: write its electron arrangement.

2. BERYLIUM has 4 protons, 4 electrons, and 5 neutrons. Draw a diagram of a beryllium atom.

3. Summarise the three key features of a neutron:
   Mass =
   Charge =
   Location =
Where do you think each number that appears on the periodic table for Lithium come from?
Where do you think each number that appears on the periodic table for Beryllium come from?
Where do you think each number that appears on the periodic table for Fluorine come from?
Atomic Number & Mass Number

In most periodic tables two important numbers are shown:

The number of **protons plus neutrons** in an atom is known as its **MASS NUMBER**.

The number of **protons** in an atom is known as its **ATOMIC NUMBER**.
# Atomic Number & Mass Number: Which Is Which?

<table>
<thead>
<tr>
<th></th>
<th>Sodium</th>
<th>Iron</th>
<th>Tin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic Number</td>
<td>11</td>
<td>26</td>
<td>50</td>
</tr>
<tr>
<td>Mass Number</td>
<td>23</td>
<td>56</td>
<td>119</td>
</tr>
</tbody>
</table>

**CLUE -** Which is the biggest? Think MASSive!!!
Using Atomic Number & Mass Number To Work Out P, E and N.

If we know the Atomic Number and the mass number of an atom we can work out the number of each subatomic particle:

- Protons (P), Electrons (E) and Neutrons (N).

**Number of Protons = Atomic Number**

**Number of Electrons = Number of Protons = Atomic Number**

**Number of Neutrons = Mass Number - Atomic Number**
Using Atomic Number & Mass Number To Work Out P, E and N.

<table>
<thead>
<tr>
<th>Atom</th>
<th>Protons</th>
<th>Neutrons</th>
<th>Electrons</th>
<th>Atomic number</th>
<th>Mass number</th>
</tr>
</thead>
<tbody>
<tr>
<td>boron</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>potassium</td>
<td></td>
<td></td>
<td></td>
<td>19</td>
<td>39</td>
</tr>
<tr>
<td>chromium</td>
<td>24</td>
<td>28</td>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mercury</td>
<td>80</td>
<td>121</td>
<td></td>
<td>18</td>
<td>40</td>
</tr>
<tr>
<td>argon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Using Atomic Number & Mass Number To Work Out P, E and N.

<table>
<thead>
<tr>
<th>Atom</th>
<th>Protons</th>
<th>Neutrons</th>
<th>Electrons</th>
<th>Atomic number</th>
<th>Mass number</th>
</tr>
</thead>
<tbody>
<tr>
<td>boron</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>potassium</td>
<td>19</td>
<td>20</td>
<td>19</td>
<td>19</td>
<td>39</td>
</tr>
<tr>
<td>chromium</td>
<td>24</td>
<td>28</td>
<td>24</td>
<td>24</td>
<td>52</td>
</tr>
<tr>
<td>mercury</td>
<td>80</td>
<td>121</td>
<td>80</td>
<td>80</td>
<td>201</td>
</tr>
<tr>
<td>argon</td>
<td>18</td>
<td>22</td>
<td>18</td>
<td>18</td>
<td>40</td>
</tr>
</tbody>
</table>
Try the nuclide notation extension activities then use the answers to self check your work.

<table>
<thead>
<tr>
<th>nuclide notation</th>
<th>name of element</th>
<th>atomic number</th>
<th>mass number</th>
<th>number of protons</th>
<th>number of neutrons</th>
<th>number of electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{12}_{6}\text{C}$</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>$^{32}_{16}\text{Sulphur}$</td>
<td></td>
<td></td>
<td>32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$^{23}_{11}\text{Na}$</td>
<td></td>
<td>11</td>
<td></td>
<td></td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>$^{200}_{80}\text{Hg}$</td>
<td>Mercury</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>80</td>
</tr>
<tr>
<td>$^{17}_{17}\text{Cl}$</td>
<td></td>
<td>17</td>
<td></td>
<td></td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>$^{35}_{17}\text{Chlorine}$</td>
<td></td>
<td></td>
<td>17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$^{64}_{29}\text{Cu}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ACTIVITY 1
Try the nuclide notation extension activities then use the answers to self check your work.

**Atomic Maths**

<table>
<thead>
<tr>
<th>Element</th>
<th>Symbol</th>
<th>Atomic Number</th>
<th>Mass Number</th>
<th>No of protons</th>
<th>No of Electrons</th>
<th>No of Neutrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium</td>
<td>Li</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Carbon</td>
<td>C</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td>O</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iodine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>74</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Cl</td>
<td>11</td>
<td>35</td>
<td>11</td>
<td></td>
<td>125</td>
</tr>
<tr>
<td>Lead</td>
<td>Pb</td>
<td>11</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argon</td>
<td></td>
<td>18</td>
<td>40</td>
<td></td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>P</td>
<td>14</td>
<td>31</td>
<td></td>
<td>56</td>
<td>74</td>
</tr>
</tbody>
</table>
Learning Objectives & Success Criteria

Today we will learn ...

What is meant by the terms **atomic number** and **mass number** and how to use these two numbers to work out the numbers of each subatomic particle in an atom.

We will do this by ...

Carrying out simple calculations using **atomic number** and **mass number**. Using the periodic table and data book to help find these two numbers.

We will have succeeded if...

We can work out the number of protons, electrons and neutrons from the nuclide notation or when given the **atomic number** and **mass number**.
What? How?

Explain *what* you have learnt today and *how* you have learnt it.
Lesson Starter

1. What is the atomic number and mass number of this element?

![Fluorine Element]

- Atomic number = 9
- Mass Number = 19

2. Write the number of protons, electrons and neutrons in this element.

![Sodium Element]

- P = 11
- E = 11
- N = 12

3. Write the electron arrangement of the atom from question 2.

- 2, 8, 1
I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions SCN 3-15a

Through gaining an understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures SCN 4-15a

Atomic structure and bonding related to properties of materials National 4
Learning Objectives & Success Criteria

Today we will learn ...
How to use nuclide notation or atomic number and mass number to work out the structure of an atom.

We will do this by ...
Carrying out simple calculations using the atomic number and mass number. Drawing the structure of an atom using these numbers. Building a model of an atom using these numbers.

We will have succeeded if...
We can work out the number of protons, electrons and neutrons from the nuclide notation and can remember how electrons are arranged in atoms.
Drawing Atoms 
Using Atomic Number & Mass Number

We can use nuclide notation or atomic number and mass number to work out the structure of an atom. We do so by the following 4 steps:

Step 1 - Use mass number & atomic number to work out PEN

Step 2 - Use the number of electrons to work out the electron arrangement

Step 3 - Draw the particles which belong in the nucleus

Step 4 - Draw the electron shells then fill them in order (inside to outside)
Drawing Atoms Using Atomic Number & Mass Number

<table>
<thead>
<tr>
<th>Element</th>
<th>Protons (P)</th>
<th>Electrons (E)</th>
<th>Neutrons (N)</th>
<th>Electron Affinity (E.A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Boron</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>2, 3</td>
</tr>
<tr>
<td>Carbon</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>2, 4</td>
</tr>
<tr>
<td>Oxygen</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>2, 6</td>
</tr>
</tbody>
</table>
Drawing Atoms Using
Atomic Number & Mass Number

Hydrogen

Boron

Carbon

Oxygen
Building Model Atoms

1 Select a card at random from the bag. This is the atom which you are going to build a model of.

2 Use the pipe cleaners, string, clingfilm/sellotape and 3 different colours of pony beads to build yourself a model atom (including the nucleus, electron shells and each of the 3 subatomic particles).
Today we will learn ...
How to use nuclide notation or atomic number and mass number to work out the structure of an atom.

We will do this by ...
Carrying out simple calculations using the atomic number and mass number. Drawing the structure of an atom using these numbers. Building a model of an atom using these numbers.

We will have succeeded if...
We can work out the number of protons, electrons and neutrons from the nuclide notation and can remember how electrons are arranged in atoms.
Exit Task
From Model to Nuclide Notation

Choose 3 other group’s model atoms and after viewing them write down the nuclide notation for those atoms.
I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions SCN 3-15a.

Through gaining an understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures SCN 4-15a.

Atomic structure and bonding related to properties of materials National 4.
Lesson Starter

1. What do you think we mean when we say “a property of an element”?
   A property is any characteristic of an element.

2. Give some examples of properties of elements.

   Physical properties (what they are like: colour, size, density, melting point, boiling point, odour).

   Chemical properties (what they can react with).
Learning Objectives & Success Criteria

Today we will learn ...

About the properties of elements. We will also revise our knowledge of the periodic table and the special groups within it from S2.

We will do this by ...

Carrying out conductivity tests on elements. Watching video clips about certain groups of elements.

We will have succeeded if ...

We can use the position of an element in the periodic table to predict its properties.
Atoms & Elements

An element is a substance made up of only one type of atom.

Copper is an element made up of copper atoms only.

Oxygen is an element made up of oxygen atoms only.

Carbon is an element made up of carbon atoms only.
Classification: How do we sort elements?
Metals, Non-Metals & the Periodic Table

In terms of the ZIG ZAG line, where do we find metals & non-metals?

??? on LEFT

??? on RIGHT
 Metals, Non-Metals & the Periodic Table

<table>
<thead>
<tr>
<th>Metals</th>
<th>Non-Metals</th>
</tr>
</thead>
</table>

Metals on LEFT, Non-metals on RIGHT

Careful - Hydrogen (non-metal) found on left (ABOVE zig-zig)
Metals, Non-Metals & the Periodic Table

Use your copy of the periodic table to decide whether each of the following are metals (M) or non-metals (NM):

1. sulphur
2. chlorine
3. sodium
4. iron
5. carbon
6. silver
Metals, Non-Metals & the Periodic Table

Use your copy of the periodic table to decide whether each of the following are metals (M) or non-metals (NM):

1. sulphur
2. chlorine
3. sodium
4. iron
5. carbon
6. silver
Testing the Conductivity of Elements

Use the equipment shown to test the conductivity of various metal and non-metal elements.

THINK - What do you expect to see if the element is a conductor of electricity?
Elements: Conductors or Non-Conductors?

What kind of element conducts electricity?

What can be said about all the elements that do not conduct? Which element is the exception? (Think about the electrodes.)

Does mercury conduct electricity? Do metals in the liquid state conduct electricity?
All metals conduct electricity.

All non-metals except carbon (graphite) are non-conductors (insulators).

Mercury, the only metal which is a liquid at room temperature, can conduct electricity. All metals in the liquid state can conduct electricity.
# Periodic Table - Important Areas

<table>
<thead>
<tr>
<th>Metal Groups</th>
<th>Non-Metals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2</td>
<td>3 4 5 6 7 8</td>
</tr>
</tbody>
</table>

**KEY**
- Alkali Metals
- Transition Metals
- Halogens
- Noble Gases

- The columns are called **groups**.
- The rows are called **periods**.
Periodic Table - Important Areas Summary

Group 1 - _______Metals - very _ _ _ _ _ _ _ _ metals (stored in oil). React violently with water to produce an alkali and hydrogen gas. Soft and can be cut with a knife. Members become _ _ _ _ reactive as you move down the group.

Group 7 - _____________ - very _ _ _ _ _ _ _ _ non-metals. All coloured elements. Members become _ _ _ _ reactive as you move down the group.

Group 8/0 - ______________ - extremely _ _ _ _ _ _ _ _ _ _ gases. They do not readily _ _ _ _ _ _ _ with other elements to form compounds.

______________ - middle block elements - Form brightly coloured compounds. Several are used as _ _ _ _ _ _ _ _ to speed up chemical reactions.
**Group 1 - Alkali Metals** - very reactive metals (stored in oil). React violently with water to produce an alkali and hydrogen gas. Soft and can be cut with a knife. Members become more reactive as you move down the group.

**Group 7 - Halogens** - very reactive non-metals. All coloured elements. Members become less reactive as you move down the group.

**Group 8/0 - Noble Gases** - extremely unreactive gases. They do not readily combine with other elements to form compounds.

**Transition Metals** - middle block elements - Form brightly coloured compounds. Several are used as **catalysts** to speed up chemical reactions.
Today we will learn ...

About the properties of elements. We will also revise our knowledge of the periodic table and the special groups within it from S2.

We will do this by ...

Carrying out conductivity tests on elements. Watching video clips about certain groups of elements.

We will have succeeded if...

We can use the position of an element in the periodic table to predict its properties.
Exit Task

Mind Map

Produce a mind map to summarise the lesson today.
Lesson Starter - Match Up

Match the description to the group name.

**Alkali Metals**
- Extremely unreactive gases.

**Transition Metals**
- Very reactive metals. React violently with water.

**Halogenes**
- Middle block elements. Brightly coloured compounds.

**Noble Gases**
- Very reactive non-metals.
REVISION

I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions. 

NEW LEARNING

Through gaining an understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures.

Atomic structure and bonding related to properties of materials.

National 4
Learning Objectives & Success Criteria

Today we will learn …

About the properties of elements and how electron arrangement links to properties of elements. We will also revise compounds and how to name them.

We will do this by …

Using the data book to learn about the electron arrangements within groups and try to spot any patterns. Identifying all the elements present in compounds from their names.

We will have succeeded if…

We can use the position of an element in the periodic table to predict its properties.
Consider the electron arrangements of the first 20 elements in the periodic table.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2,1</td>
<td>2,2</td>
<td>2,3</td>
<td>2,4</td>
<td>2,5</td>
</tr>
<tr>
<td>2</td>
<td>2,8,1</td>
<td>2,8,2</td>
<td>2,8,3</td>
<td>2,8,4</td>
<td>2,8,5</td>
<td>2,8,6</td>
<td>2,8,7</td>
</tr>
<tr>
<td>3</td>
<td>2,8,8,1</td>
<td>2,8,8,2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What is the pattern of outer shell electrons in a group?
Elements in the same group have similar chemical properties. This is because elements in the same group have the same number of outer electrons.

When an element has an incomplete outer shell of electrons it is unstable and it reacts with (forms bonds with) other elements to achieve stability.
Stability Of The Noble Gases

Elements in group 8 (0) each have a **full outer electron shell** giving the noble gases a special stability.

This means noble gases do not need to form bonds with other elements i.e. **do not form compounds**.
**REMEMBER**

Compounds & Mixtures

A compound is a substance made up of two or more types of atom joined.

A mixture is a substance made up of two or more types of substances (atoms/elements/compounds) NOT JOINED
Naming Compounds

Compound names are recognisable because they have 2 parts e.g. sodium chloride (sodium & chlorine).

If a compound name ends in **IDE** that compound only contains the **2 elements obvious from its name.**

Except where the **second** part of the compound name is hydroxide or cyanide.

e.g. sodium hydroxide = sodium, hydrogen and oxygen
sodium cyanide = sodium, carbon and nitrogen

If a compound name ends in **ATE** or **ITE** that compound contains the **2 elements obvious from its name PLUS OXYGEN**
e.g. sodium carbonate (sodium, carbon & oxygen).
# What’s In a Compound - Revision

Name all the elements present in the following 5 compounds.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Aluminium bromide</td>
<td>Aluminium &amp; bromine</td>
</tr>
<tr>
<td>2. Hydrogen oxide</td>
<td>Hydrogen &amp; oxygen</td>
</tr>
<tr>
<td>3. Sodium hydroxide</td>
<td>Sodium &amp; hydrogen &amp; oxygen</td>
</tr>
<tr>
<td>4. Nitrogen hydride</td>
<td>Nitrogen &amp; hydrogen</td>
</tr>
<tr>
<td>5. Nickel sulfate</td>
<td>Nickel &amp; sulfur &amp; oxygen</td>
</tr>
</tbody>
</table>
Learning Objectives & Success Criteria

Today we will learn …

About the properties of elements and how electron arrangement links to properties of elements. We will also revise compounds and how to name them.

We will do this by …

Using the data book to learn about the electron arrangements within groups and try to spot any patterns. Identifying all the elements present in compounds from their names.

We will have succeeded if …

We can use the position of an element in the periodic table to predict its properties.
The electron arrangement of 3 elements are shown below:

A  2, 8, 8, 1  B  2, 7  C  2, 8, 8

Answer the questions which follow by selecting from the elements shown above:

1. Which element is a stable noble gas with a full outer shell of electrons?
2. Which element is a very reactive alkali metal which reacts violently with water?
3. Which element belongs to the family of halogens (the very reactive non-metals)?
Lesson Starter

1 Name all the elements present in:
   a  Lithium chloride
   b  Sodium carbonate
   c  Phosphorus hydride

2 State to which family the following elements belong (from the properties described below):
   a  The element with the electron arrangement 2, 8, 1.
   b  An extremely reactive non-metal.
   c  An extremely unreactive non-metal.
S3 Chemistry
Atomic Structure and Bonding
Lesson 9 - Lose, Gain, Share: Making Compounds

**REVISION**

I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions SCN 3-15a

**NEW LEARNING**

Through gaining an Understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures SCN 4-15a

Atomic structure and bonding related to properties of materials National 4
Learning Objectives & Success Criteria

Today we will learn ...

About the types of bonding which exist.

We will do this by ...

Considering which types of elements are joining together in compounds and learning the rules about when atoms LOSE, GAIN or SHARE electrons.

We will have succeeded if...

We can use the name of a compound to predict the type of bonding within it.
We learned in the last lesson that all elements except the noble gases have an incomplete outer electron shell and must form bonds to achieve stability.

**Achieving A Noble Gas Arrangement**

When elements bond they are able to achieve a full outer shell of electrons like a noble gas by LOSING, GAINING or SHARING electrons.
Achieving A Noble Gas Arrangement

For the elements which follow:

1 Write down the original element's electron arrangement.

2 Write down the electron arrangement and name of the Noble Gas with the closest electron arrangement.

3 Write down what would have to happen (in terms of electrons) to achieve that Noble Gas electron arrangement.
Achieving A Noble Gas Arrangement - Examples

Example 1 - Lithium

Electron Arrangement =

Closest Noble Gas electron arrangement =

Change to electrons =
Achieving A Noble Gas Arrangement - Examples

Example 2 - Fluorine

Electron Arrangement =

Closest Noble Gas electron arrangement =

Change to electrons =
Achieving A Noble Gas Arrangement - Examples

Example 3 - Oxygen

Electron Arrangement =

Closest Noble Gas electron arrangement =

Change to electrons =
Achieving A Noble Gas Arrangement - Examples

Example 4- Aluminium

Electron Arrangement =

Closest Noble Gas electron arrangement =

Change to electrons =
Achieving A Noble Gas Arrangement - Examples

Example 5 - Carbon

Electron Arrangement =

Closest Noble Gas electron arrangement =

Change to electrons =
Type of Compound

When two non-metals join they form a COVALENT compound.

When a metal joins with a non-metal they form an IONIC compound.

For the compounds on the next two slides decide whether they are COVALENT or IONIC

HINT - Use the data book p8 to help you decide
Type of Compound

Lithium Chloride, LiCl

Carbon Fluoride, CF₄

Magnesium oxide, MgO

Aluminium fluoride, AlF₃

Glucose, C₆H₁₂O₆
Type of Compound

Water, $H_2O$

Copper (II) oxide, $CuO$

Hydrogen Sulphide, $H_2S$

Calcium Carbonate, $CaCO_3$

Chlorine, $Cl_2$
Lose, Gain, Share

• **Ionic** compounds form by a metal atom *losing* electrons and a non-metal atom *gaining* electrons to form ions.

• **Covalent** compounds form by two or more non-metal atoms *sharing* electrons.
Learning Objectives & Success Criteria

Today we will learn ...
About the types of bonding which exist.

We will do this by ...
Considering which types of elements are joining together in compounds and learning the rules about when atoms LOSE, GAIN or SHARE electrons.

We will have succeeded if...
We can use the name of a compound to predict the type of bonding within it.
Mr Wrong

Explain why this student statement is wrong...

“Sodium chloride, like other covalent compounds, bonds by sharing electrons”
Lesson Starter

Name the type of bonding (compound type) in the following compounds:

A  Phosphorus chloride  covalent  
B  Copper chloride  ionic  
C  Hydrogen oxide  covalent  
D  Nitrogen hydride  covalent  
E  Lithium sulfate  ionic
I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions SCN 3-15a

Through gaining an understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures SCN 4-15a

Atomic structure and bonding related to properties of materials National 4
Today we will learn ...
How non-metal atoms join together via covalent bonds to form covalent compounds.

We will do this by ...
Hearing about what a covalent bond is. Drawing covalent molecules and building them using molecular model kits.

We will have succeeded if...
We can state the definitions of the terms covalent bond, covalent molecule and diatomic. We can use our periodic table to find and name the 7 diatomic elements.
Covalent Bonding

When two non-metal atoms form a covalent bond their outer energy levels overlap and the shared pair(s) of electrons lie in the overlap region.
Covalent bonds can form between two atoms of the same element (forming a diatomic molecule of that element).

chlorine atom  chlorine atom  chlorine diatomic molecule
Covalent Compounds

Covalent bonds can form between two atoms of different elements (forming a diatomic molecule of that compound).

hydrogen atom  chlorine atom  hydrogen chloride diatomic molecule
Covalent Molecules

A small (usually) **group of non-metal atoms** joined together by **covalent bonds**.
Using the molecular model kits (molymods) and the colour key shown opposite build a diatomic molecule of the 4 elements shown in the key. Remember diatomic means 2 atoms.

How many bonds does each molecule have joining the 2 atoms? Remember that where there is a hole in the model atom a bond must be inserted and all bonds must be joined to something (except with Nitrogen).
Learning Objectives & Success Criteria

Today we will learn ...

How non-metal atoms join together via covalent bonds to form covalent compounds.

We will do this by ...

Hearing about what a covalent bond is. Drawing covalent molecules and building them using molecular model kits.

We will have succeeded if ...

We can state the definitions of the terms covalent bond, covalent molecule and diatomic. We can use our periodic table to find and name the 7 diatomic elements.
Choose three new words you have learnt today and write dictionary definitions.
I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions.

NEW LEARNING

Through gaining an understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures.

Atomic structure and bonding related to properties of materials.
Lesson Starter

1. What is a covalent bond?
   A shared pair of electrons between 2 non-metal atoms.

2. Why do the atoms of some elements form bonds?
   To achieve stability by obtaining a full outer electron shell like a noble gas.

3. What are the 7 diatomic elements (hint - use your periodic table to help)?
   Hydrogen, Oxygen, Nitrogen, Fluorine, Chlorine, Bromine, Iodine.
Learning Objectives & Success Criteria

Today we will learn ...
How to write simple chemical formulae.

We will do this by ...
Using diagrams to work out formulae.
Using prefixes to work out formulae.

We will have succeeded if...
We can work out the formula for a compound from a diagram or from a name including a prefix.
Chemical Formulae For Covalent Molecules

This formula tells you the number of atoms of each type of element in a compound. It uses the symbols of the elements and when there is more than one atom of each element, the number of atoms is always written after the symbol as a subscript.

- **Carbon Dioxide**
  
  \[
  \text{carbon atom} = 1 \\
  \text{oxygen atoms} = 2 \\
  \text{formula} = \text{CO}_2
  \]

- **Water**
  
  \[
  \text{hydrogen atoms} = 2 \\
  \text{oxygen atom} = 1 \\
  \text{formula} = \text{H}_2\text{O}
  \]
Hydrogen oxide - water

Hydrogen chloride

Carbon hydride

Chlorine
Hydrogen

\[ H_2 \]

Carbon chloride

\[ CCl_4, Cl_4C \]

Nitrogen hydride

\[ NH_3 \]
Chemical Formulae From Diagrams

1. **CH₄**
2. **O₂**
3. **C₂H₆O**
4. **H₂C=CH₂**
5. **B**
6. **H₂C=CH-COOH**
Sometimes the name of a compound contains a prefix which allows us to write the formula.

Prefixes when present before the name of an element tell you how many atoms of that element are present in the formula of that compound.

e.g. sulfur di oxide

Contains 1 sulfur and 2 oxygens.
Complete the table on the right.

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>mono</td>
<td>one</td>
</tr>
<tr>
<td>di</td>
<td>two</td>
</tr>
<tr>
<td>tri</td>
<td>three</td>
</tr>
<tr>
<td>tetra</td>
<td>four</td>
</tr>
<tr>
<td>penta</td>
<td>five</td>
</tr>
<tr>
<td>hexa</td>
<td>six</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbon dioxide</td>
<td>CO₂</td>
</tr>
<tr>
<td>carbon monoxide</td>
<td></td>
</tr>
<tr>
<td>sulphur trioxide</td>
<td></td>
</tr>
<tr>
<td>phosphorus pentachloride</td>
<td></td>
</tr>
<tr>
<td>carbon tetrachloride</td>
<td></td>
</tr>
<tr>
<td>uranium hexafluoride</td>
<td></td>
</tr>
</tbody>
</table>
Learning Objectives & Success Criteria

Today we will learn ... 
How to write simple chemical formulae.

We will do this by ... 
Using diagrams to work out formulae. 
Using prefixes to work out formulae.

We will have succeeded if... 
We can work out the formula for a compound from a diagram or from a name including a prefix.
Exit Task

Reach For The Stars - Rating Exercise

Rate your understanding of the 2 Key Areas covered today:
A  Writing Formulae from diagrams/models
B  Writing Formulae from names with a prefix
Lesson Starter

1. Write the formulae for the following molecules:
   a)\[ \text{CCI}_4 \]
   b)\[ \text{C}_3\text{H}_8 \]

2. Write the formula for **nitrogen trifluoride**.
   *Hint - Does the name have a prefix?* \[ \text{NF}_3 \]

3. Write the formula for **sulfur dioxide**.
   *Hint - Does the name have a prefix?* \[ \text{SO}_2 \]
I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions.

Through gaining an understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures.

Atomic structure and bonding related to properties of materials.

National 4
Learning Objectives & Success Criteria

Today we will learn ...
How metal and non-metal atoms become ions and how they subsequently join together via ionic bonding to form ionic compounds.

We will do this by ...
Reflecting on what we learned in our lose, gain, share lesson. Learning the definition for an ion and how ions bond together.

We will have succeeded if...
We can state what happens to metals and non-metals when they bond to form ionic compounds.
Ionic Bonding

In ionic bonding **electrons are lost** (transferred) **from metal** atoms and **gained by non-metal** atoms to form charged particles called **ions**.
Ionic Bonding

Example 1: lithium chloride

\[ \text{Li} \quad \text{electron arrangement:} \quad 2, 1 \]

\[ \text{Cl} \quad \text{electron arrangement:} \quad 2, 8, 7 \]

The transfer of one electron from the lithium atom to the chlorine atom produces the lithium ion (+ve) and the chloride ion (-ve).
Ionic Lattice

Note that when lithium chloride actually forms it is not just one single lithium ion which bonds on to one single chloride ion.

Lots of these oppositely charged ions bond together to form a huge structure called an ionic lattice.
Learning Objectives & Success Criteria

Today we will learn ...
How metal and non-metal atoms become ions and how they subsequently join together via ionic bonding to form ionic compounds.

We will do this by ...
Reflecting on what we learned in our lose, gain, share lesson. Learning the definition for an ion and how ions bond together.

We will have succeeded if...
We can state what happens to metals and non-metals when they bond to form ionic compounds.
Exit Task

Draw a mindmap to summarise the different types of bonding you have learned about and what is different in each type.
1. What is an ion?
An ion is an atom which has lost or gained electrons.

2. Fill in the missing words in the passage below.

In ionic bonding electrons are _____ lost _____ from metal atoms and _____ gained _____ by non-metal atoms to form charged particles called ions.

Metal atoms form _____ positive _____ charged ions and non-metals form _____ negative _____ charged ions.
S3 Chemistry
Atomic Structure, Bonding & Properties
Lesson 13 - Word Equations

REVISION
I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions SCN 3-15a

NEW LEARNING
Through gaining an Understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures SCN 4-15a

Atomic structure and bonding related to properties of materials National 4
Today we will learn ...

How to write equations which summarise the chemicals involved and how they change in a chemical reaction.

We will do this by ...

Learning about what must be and what must not be included in word equations. Practising writing word equations from descriptions of chemical reactions.

We will have succeeded if...

We can write a word equation for any chemical reaction which is described for us.
Word Equations

• A word equation describes what we start with (reactants) during a chemical reaction and what we end up with (products).

• It is similar to a recipe with reactants being like the ingredients and the product(s) being what we have made using those ingredients.

• The ingredients or reactants appear on the left of the equation while the products appear on the right.
Word Equations

These give a concise way to describe what is going on in a reaction. They only include the chemicals we start with (reactants) and the chemicals we finish with (products) as well as + symbols and →.

hydrogen + oxygen → water

plus Changes into OR Reacts to produce

Reactants appear on the left of the arrow and products appear on the right.
Word Equations

When you are given a sentence telling you how a chemical reaction has taken place, you should be able to write a word equation from that.

Example 1

Sodium reacts with chlorine to produce sodium chloride

Sodium + chlorine → sodium chloride
Example 2

Acid reacts with alkali to produce salt and water.

\[
\text{Acid} + \text{Alkali} \rightarrow \text{Salt} + \text{Water}
\]
Example 3

Nitrogen and hydrogen combine to form nitrogen hydride.
Example 4

Mercury oxide decomposes on heating to form mercury and oxygen.
Example 5

Calcium carbonate fizzes up when it is added to nitric acid. This is because carbon dioxide gas is being made. Calcium nitrate and water are left in the beaker at the end of the reaction.
Example 6

Your body uses **food and oxygen** to make carbon dioxide and water in a process called **respiration**.
Example 7

Rusting happens when iron reacts with the oxygen in air to form iron oxide
Word Equation Extension Task

Try the 2 sheets of examples on writing word equations. The examples in the first sheet have been partially done for you.

DO NOT WRITE ON THE SHEETS
Copy and complete the word equations into your jotter for both exercises.
Learning Objectives & Success Criteria

Today we will learn …

How to write equations which summarise the chemicals involved and how they change in a chemical reaction.

We will do this by …

Learning about what must be and what must not be included in word equations. Practising writing word equations from descriptions of chemical reactions.

We will have succeeded if…

We can write a word equation for any chemical reaction which is described for us.
Exit Task - Spot the Blooper!

State what is wrong with each of the following word equations.

1. carbon + oxygen gas → carbon dioxide

2. zinc + hydrochloric acid = zinc chloride + hydrogen

3. Lead iodide and potassium nitrate are produced when lead nitrate and potassium iodide are reacted together

Lead iodide + potassium iodide → lead nitrate + potassium iodide
I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions SCN 3-15a

Through gaining an Understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures SCN 4-15a

Atomic structure and bonding related to properties of materials National 4
Lesson Starter

Copy the table then sort each substance name under the correct heading.

<table>
<thead>
<tr>
<th>Metal element</th>
<th>Non-metal element</th>
<th>Ionic compound</th>
<th>Covalent compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>iron</td>
<td>copper chloride</td>
<td>carbon (graphite)</td>
<td>wax ($C_{12}H_{52}$)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bromine</td>
<td>potassium sulfide</td>
<td>glucose ($C_6H_{12}O_6$)</td>
<td>sodium bromide</td>
</tr>
</tbody>
</table>
Learning Objectives & Success Criteria

Today we will learn ...
About the properties of compounds and how properties link to the bonding type in compounds.

We will do this by ...
Examining the state of different compounds at room temperature.
Testing the solubility of various compounds.
Spotting any patterns linked to the bonding type of compounds.

We will have succeeded if ...
We can make statements about how bonding type links to the state of different compounds at room temperature and their solubility.
Why is it safe to put sodium chloride on fish and chips...

...but not safe to use sodium and chlorine?

The properties of compounds are usually very different to the properties of the elements they are made from.
## Physical State And Bonding Type

The physical state of a compound at room temperature is an indication of the type of bonding in that compound.

*View the compound display then complete the table to show the state of each compound at room temperature and the bonding type.*

<table>
<thead>
<tr>
<th>Compound</th>
<th>Solid, liquid or gas</th>
<th>Type of bonding</th>
</tr>
</thead>
<tbody>
<tr>
<td>sodium chloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>water (H$_2$O)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>methane (CH$_4$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>calcium oxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>paraffin wax (C$<em>{12}$H$</em>{52}$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>carbon dioxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>acetone (C$_2$H$_6$O)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>potassium iodide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sugar (C$<em>{12}$H$</em>{22}$O$_{11}$)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Ionic substances are always found in the ________ state at room temperature.

Covalent substances can be found in ________ state at room temperature (__________ , ________ or ________).
# Solubility And Bonding Type Experiment

Test the solubility of each of the substances listed below and try to spot any patterns based on bonding type.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Type of Bonding</th>
<th>Soluble / Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper chloride (CuCl₂)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sucrose (C₁₂H₂₂O₁₁)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium chloride (NaCl)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand / Silicon dioxide (SiO₂)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium thiosulfate (Na₂S₂O₃)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starch (C₆H₁₀O₅)ₙ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paraffin Wax (C₁₂H₅₂)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Solubility And Bonding Type Conclusions

Copy the following conclusions about solubility and bonding, selecting the correct option in each case.

Ionic compounds, containing a metal element and a non-metal element are usually **soluble / insoluble** in water.

Covalent compounds containing 2 **metal / non-metal** elements can vary in their solubility. Some are **soluble / insoluble** in water (they **do** dissolve) and others are **soluble / insoluble** in water (they **do not** dissolve).

Sometimes covalent compounds which do not dissolve in water do dissolve in other solvents.
Learning Objectives & Success Criteria

Today we will learn ...
About the properties of compounds and how properties link to the bonding type in compounds.

We will do this by ...
Examining the state of different compounds at room temperature.
Testing the solubility of various compounds.
Spotting any patterns linked to the bonding type of compounds.

We will have succeeded if ...
We can make statements about how bonding type links to the state of different compounds at room temperature and their solubility.
Exit Task

<table>
<thead>
<tr>
<th>Topic:</th>
<th>Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>K</strong></td>
<td><strong>W</strong></td>
</tr>
<tr>
<td>What I already know</td>
<td>What I want to know</td>
</tr>
<tr>
<td><strong>L</strong></td>
<td></td>
</tr>
<tr>
<td>What I learned</td>
<td></td>
</tr>
</tbody>
</table>

KWL (Know, Want, Learned)
Starter Questions

1. In which state(s) do we find ionic compounds?

2. In which state(s) do we find covalent compounds?

3. Are ionic compounds soluble in water?

4. Are covalent compounds soluble in water?
I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions SCN 3-15a.

Through gaining an understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures SCN 4-15a.

Atomic structure and bonding related to properties of materials National 4.
Learning Objectives & Success Criteria

Today we will learn ...
About the properties of compounds and how properties link to the bonding type in compounds.

We will do this by ...
Carrying out electrical conductivity tests on different compounds.
Spotting any patterns linked to the bonding type of compounds.

We will have succeeded if ...
We can make statements about how bonding type links to the electrical conductivity of different compounds.
Electrical Conductivity

Electricity is a flow of charged particles.
Testing the Conductivity of Compounds
## Testing the Conductivity of Compounds

Test the conductivity of each of the substances listed below and try to spot any patterns based on bonding type.

<table>
<thead>
<tr>
<th>Compound</th>
<th>State</th>
<th>Type of Bonding</th>
<th>Conductor/ Non-conductor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper chloride (CuCl₂)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper chloride (CuCl₂) solution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium chloride (NaCl)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium chloride (NaCl) solution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium thiosulfate (Na₂S₂O₃)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium thiosulfate (Na₂S₂O₃) solution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sucrose (C₁₂H₂₂O₁₁)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sucrose (C₁₂H₂₂O₁₁) solution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starch (C₆H₁₀O₅)ₙ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paraffin Wax (C₁₂H₅₂)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand / Silicon dioxide (SiO₂)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Testing the Conductivity of Molten Compounds

In class it is difficult to test the conductivity of some molten compounds as the melting points can be very high. Watch the demonstration for 2 compounds which can be tested and note how the conductivity of each type of compound varies.

paraffin wax, \( \text{C}_{12}\text{H}_{52} \)

sodium thiosulphate, \( \text{Na}_2\text{S}_2\text{O}_3 \)
Testing the Conductivity of Compounds—Results

1. Do solid ionic compounds conduct electricity?

2. Do ionic compounds conduct when dissolved in water (i.e. in solution)?

3. Do ionic compounds conduct when melted (i.e. liquid state)?

4. Do covalent compounds in any state conduct electricity?
Conductivity of Substances SUMMARY

- substances
  - elements
    - Non conductor (except graphite)
    - conductor
  - Compounds
    - ionic
      - (s)
      - (l)
      - (aq)
    - covalent
      - (s)
      - (l)
      - (aq)
Today we will learn ... About the properties of compounds and how properties link to the bonding type in compounds.

We will do this by ... Carrying out electrical conductivity tests on different compounds. Spotting any patterns linked to the bonding type of compounds.

We will have succeeded if... We can make statements about how bonding type links to the electrical conductivity of different compounds.
Exit Task

Properties of Compounds OVERALL SUMMARY

Complete the table below using the information you have learned over the last few lessons:

<table>
<thead>
<tr>
<th>Property</th>
<th>Ionic Compounds</th>
<th>Covalent Compounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>State(s) at room temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative melting &amp; boiling points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solubility in water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical conductivity (solid)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical conductivity (solution)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical conductivity (molten)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lesson 15
HINT – some key words you might want to include:
Metals, non-metals, ionic, covalent, physical
state, solubility, electrical conductivity.
I have developed my knowledge of the Periodic Table by considering the properties and uses of a variety of elements relative to their positions SCN 3-15a

Through gaining an understanding of the structure of atoms and how they join, I can begin to connect the properties of substances with their possible structures SCN 4-15a

Atomic structure and bonding related to properties of materials National 4
Learning Objectives & Success Criteria

Today we will learn ...

To explain the conductivity of substances and how properties link to the structure and bonding type.

We will do this by ...

Learning about the bonding and structure in different types of substances. Making links between bonding type and conductivity in those substances.

We will have succeeded if...

We can explain why substances conduct electricity in terms of their bonding and structure.
Why Metals Conduct Electricity

REM тоMBER - Atoms are made up of a nucleus that contains positive particles. Negatively charged particles called electrons move around outside the nucleus.

All metals have a special property. Their outer electrons are loosely held and can move from atom to atom.

Electricity is a flow of charged particles.

In metals this is a flow of the loosely held electrons (delocalised electrons) in a definite direction.
Why Graphite Conducts Electricity

The one exception to non-metals not being able to conduct electricity is **carbon in the form of graphite**. This is because there are also some free moving (delocalised) electrons between the layers in the structure of graphite. Other non-metal elements DO NOT have this property.
Elements: Conductors or Non-Conductors?

Sort the list of elements under the correct headings:

<table>
<thead>
<tr>
<th>Conductor</th>
<th>Non-conductor</th>
</tr>
</thead>
<tbody>
<tr>
<td>solid copper</td>
<td></td>
</tr>
<tr>
<td>liquid nitrogen</td>
<td></td>
</tr>
<tr>
<td>molten magnesium</td>
<td></td>
</tr>
<tr>
<td>solid iodine</td>
<td></td>
</tr>
<tr>
<td>molten iron</td>
<td></td>
</tr>
<tr>
<td>argon gas</td>
<td></td>
</tr>
<tr>
<td>chlorine gas</td>
<td></td>
</tr>
<tr>
<td>solid graphite</td>
<td></td>
</tr>
<tr>
<td>liquid mercury</td>
<td></td>
</tr>
<tr>
<td>solid sodium</td>
<td></td>
</tr>
<tr>
<td>liquid bromine</td>
<td></td>
</tr>
</tbody>
</table>
Why Covalent Compounds Are Non-Conductors

Covalent compounds are (usually) made up of **atoms** of only non-metal elements.

Electricity is a flow of **charged** particles.

**Atoms** do **not** have an overall **charge**.

Therefore **covalent compounds do not conduct** electricity no matter what physical state they are in.
Ionic Compounds: Conductors Or Non-Conductors?

Compounds that contain both a metal and a non-metal element are called ionic compounds. Ionic compounds are made up of charged particles called ions.

In the solid, the ions are locked together. Since electricity is a flow of charged particles, ionic substances will only conduct when they can flow, i.e. when (aq) or (l) but not when (s).
**Conductors Or Non-Conductors?**

Sort the list of compounds under the correct headings:

<table>
<thead>
<tr>
<th>Conductor</th>
<th>Non-conductor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

liquid hexene (C₆H₁₂)  | molten sodium chloride  
molten aluminium fluoride  
solid silver bromide  
liquid ethanol (C₂H₅OH)  
liquid selenium chloride  
barium nitrate solution  
solid carbon tetrachloride  
solid magnesium chloride  
sodium sulphate solution
Learning Objectives & Success Criteria

Today we will learn …

To explain the conductivity of substances and how properties link to the structure and bonding type.

We will do this by …

Learning about the bonding and structure in different types of substances. Making links between bonding type and conductivity in those substances.

We will have succeeded if…

We can explain why substances conduct electricity in terms of their bonding and structure.
Exit Task - Elements & Compounds

Sort the list of substances (containing both elements and compounds) under the correct headings below.

<table>
<thead>
<tr>
<th>Conductor</th>
<th>Non-conductor</th>
</tr>
</thead>
<tbody>
<tr>
<td>solid iron</td>
<td>solid copper chloride</td>
</tr>
<tr>
<td>solid carbon (graphite)</td>
<td>solid carbon (graphite)</td>
</tr>
<tr>
<td>molten wax ((\text{C}<em>{12}\text{H}</em>{52}))</td>
<td>liquid potassium sulphide</td>
</tr>
<tr>
<td>liquid bromine</td>
<td>liquid bromine</td>
</tr>
<tr>
<td>glucose solution ((\text{C}<em>{6}\text{H}</em>{12}\text{O}_{6}))</td>
<td>sodium bromide solution</td>
</tr>
</tbody>
</table>