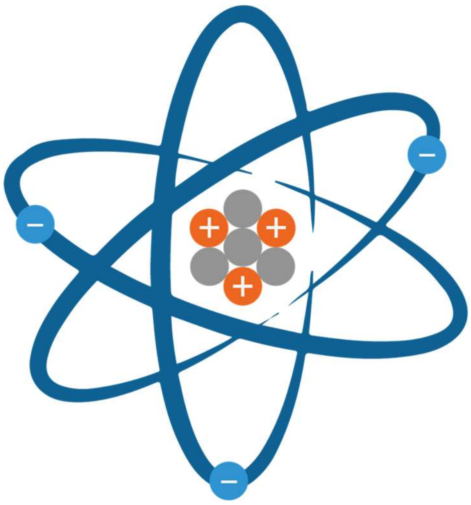
Master

Kirkcaldy High School



N4/5 Chemistry

Unit 1 - part 2

Atomic Structure

Name: ______________________

Class: ______________________

Teacher: ______________________

Assessment Page

End of topic questions

Topic title	Date	Mark/Total Mark
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Homework

Homework title	Date	Mark/Total Mark
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Check tests

Test title	Date	Mark/Total Mark
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Teacher comments

Using Command Words

Command words in questions are crucial as they guide us on the specific type of response required. Let's delve into some examples within the context of simple chemistry concepts, focusing on the states of matter. These are arranged into the level of detail that must be given and therefore their difficulty, from least to most.

In chemistry, often a drawn diagram will give you a mark instead of a written answer as long as it is labelled.

Identify:

This command word requires you to establish and name a particular item or concept.

For instance*, "Identify the three states of matter."*

In response, you would say*, "The three states of matter are solid, liquid, and gas."*

State: This command word requires you to express the main points concisely.

For instance, "State the process of changing from a solid to a gas."

Your answer would be*, "The process of changing from a solid to a gas is called sublimation."*

Indicate: This command word requires you to point out or show something.

For instance, *"Indicate whether the volume of a gas is fixed or variable."*

Your answer would be, *"The volume of a gas is variable."*

Provide/Give: These command words mean you need to present a specific item or concept, often an example.

For instance, *"Provide an example of a liquid."*

You could answer, *"An example of a liquid is water."*

Describe: Here, you are expected to provide a detailed account of a particular topic.

For example, *"Describe the properties of a solid state of matter."*

You would respond by saying*, "Solids have a definite shape and volume. The particles in solids are closely packed together and vibrate in fixed positions."*

Outline: This command word asks you to give a brief summary or overview of a topic.

For example, *"Outline the process of evaporation."*

You might respond, *"Evaporation is the process by which liquid turns into gas upon heating. It occurs when the particles of a liquid gain enough energy to leave the liquid and become gas."*

Explain: This command word asks you to make something clear or easy to understand by describing it in more detail.

For example, "Explain why gases easily fill their containers."

An appropriate answer might be, *"Gases easily fill their containers because their particles are free to move in all directions and will spread out until they occupy the entire container."*

Discuss: This command word is asking you to present a detailed and balanced argument about a specific topic.

For example, "Discuss the importance of understanding the states of matter."

Your response would involve discussing various aspects like the role of states of matter in natural phenomena, their significance in various scientific and industrial processes, etc.

Create: This command word often represents one of the highest levels of difficulty in command words. It requires not just recall or understanding of existing knowledge, but the ability to generate new ideas or products based on that knowledge. It involves synthesis, imagination, and critical thinking, and it's often used in tasks such as designing an experiment, writing an original essay, or proposing a solution to a problem.

Date: ________________

Elements and the Periodic Table

Learning Intentions

- To learn about elements and the periodic table.

Success Criteria

☐ I can find and write the symbol of elements using the data booklet.

☐ I can identify metals and non-metals in the periodic table.

☐ I can determine the state of an element at room temperature using its melting/boiling point.

☐ I can identify selected groups from the periodic table and their properties.

Introduction

The Periodic Table is like a big directory or a catalogue of all the **elements**, the basic ingredients that make up everything around us. Each **element** has its own spot on the table, represented by a unique **symbol**.

1 Hydrogen **H**	
3 Lithium **Li**	4 Beryllium **Be**
11 Sodium **Na**	12 Magnesium **Mg**

For example, there's "H" for **Hydrogen** (which is in water), "O" for **Oxygen** (what we breathe), "Au" for **Gold** (the shiny metal in jewellery), and "Fe" for Iron (used in structures and vehicles).

- The first letter in the symbol must be CAPITAL.
- If a second letter in the symbol this must be lower case.
- *e.g. Co is the symbol for Cobalt however CO is the formula for carbon monoxide*

You can use **page 4** of your data booklet to find the name and formula for each element.

Use the data booklet to find the elements symbol for the following elements:

1.	Hydrogen		11.	Calcium	
2.	Oxygen		12.	Sodium	
3.	Gold		13.	Chlorine	
4.	Iron		14.	Potassium	
5.	Helium		15.	Magnesium	
6.	Carbon		16.	Lead	
7.	Nitrogen		17.	Bromine	
8.	Silver		18.	Iodine	
9.	Copper		19.	Uranium	
10.	Neon		20.	Lithium	

Use the data booklet to find the element name from the elements symbol for the following elements:

1.	Hg		11.	Sr	
2.	Si		12.	Y	
3.	Kr		13.	Zr	
4.	Pb		14.	Mo	
5.	S		15.	Cd	
6.	Ar		16.	Xe	
7.	Co		17.	Ba	
8.	Ni		18.	Pt	
9.	Se		19.	Ti	
10.	Rb		20.	Al	

Metals and non-metals in the periodic table

With 2 coloured pens/pencils, label the metals and non-metals on the periodic table below.

Column 1	Column 2												Column 3	Column 4	Column 5	Column 6	Column 7	Column 0
1 Hydrogen H																		2 Helium He
3 Lithium Li	4 Beryllium Be												5 Boron B	6 Carbon C	7 Nitrogen N	8 Oxygen O	9 Fluorine F	10 Neon Ne
11 Sodium Na	12 Magnesium Mg							TRANSITION METALS					13 Aluminium Al	14 Silicon Si	15 Phosphorus P	16 Sulfur S	17 Chlorine Cl	18 Argon Ar
19 Potassium K	20 Calcium Ca	21 Scandium Sc		22 Titanium Ti	23 Vanadium V	24 Chromium Cr	25 Manganese Mn	26 Iron Fe	27 Cobalt Co	28 Nickel Ni	29 Copper Cu	30 Zinc Zn	31 Gallium Ga	32 Germanium Ge	33 Arsenic As	34 Selenium Se	35 Bromine Br	36 Krypton Kr
37 Rubidium Rb	38 Strontium Sr	39 Yttrium Y		40 Zirconium Zr	41 Niobium Nb	42 Molybdenum Mo	43 Technetium Tc	44 Ruthenium Ru	45 Rhodium Rh	46 Palladium Pd	47 Silver Ag	48 Cadmium Cd	49 Indium In	50 Tin Sn	51 Antimony Sb	52 Tellurium Te	53 Iodine I	54 Xenon Xe
55 Caesium Cs	56 Barium Ba	57 Lanthanum La	58–71 ●	72 Hafnium Hf	73 Tantalum Ta	74 Tungsten W	75 Rhenium Re	76 Osmium Os	77 Iridium Ir	78 Platinum Pt	79 Gold Au	80 Mercury Hg	81 Thallium Tl	82 Lead Pb	83 Bismuth Bi	84 Polonium Po	85 Astatine At	86 Radon Rn
87 Francium Fr	88 Radium Ra	89 Actinium Ac	90–103 ■	104 Rutherfordium Rf	105 Dubnium Db	106 Seaborgium Sg	107 Bohrium Bh	108 Hassium Hs	109 Meitnerium Mt	110 Darmstadtium Ds	111 Roentgenium Rg	112 Copernicium Cn		114 Flerovium Fl		116 Livermorium Lv		

●	58 Cerium Ce	59 Praseodymium Pr	60 Neodymium Nd	61 Promethium Pm	62 Samarium Sm	63 Europium Eu	64 Gadolinium Gd	65 Terbium Tb	66 Dysprosium Dy	67 Holmium Ho	68 Erbium Er	69 Thulium Tm	70 Ytterbium Yb	71 Lutetium Lu
■	90 Thorium Th	91 Protactinium Pa	92 Uranium U	93 Neptunium Np	94 Plutonium Pu	95 Americium Am	96 Curium Cm	97 Berkelium Bk	98 Californium Cf	99 Einsteinium Es	100 Fermium Fm	101 Mendelevium Md	102 Nobelium No	103 Lawrencium Lr

Key:

- ☐ **Metals**
- ☐ **Non-metals**

Questions

For the following questions, **state** whether the element is a metal or non-metal.

1. Iron
2. Oxygen
3. Helium
4. hydrogen
5. Zinc
6. Mercury
7. Neon
8. Calcium

Solids, liquids and gases in the periodic table

Temperature is a measure of heat energy, it is measured in **degrees Celsius**, the units for this is **ºC.** Temperature is measured with a **thermometer**.

The **melting point** of an element is the temperature at which the element turns from a **solid** to a **liquid**.

The **boiling point** of an element is the temperature at which the element turns from a **liquid** to a **gas**.

Colour in the elements by their state (solid, liquid or gas) at room temperature (25ºC). KEEP SOLID AS WHITE and use 2 different colours for liquid and gas.

Key: Atomic Number / Name of Element / Melting Point/ °C / *Boiling Point/ °C*

1 Hydrogen −259 *−253*																	2 Helium −272 *−269*
3 Lithium 181 *1342*	4 Beryllium 1287 *2471**											5 Boron 2075 *4000*	6 Carbon †3825	7 Nitrogen −210 *−196*	8 Oxygen −219 *−183*	9 Fluorine −220 *−188*	10 Neon −249 *−246*
11 Sodium 98 *883*	12 Magnesium 650 *1090*											13 Aluminium 660 *2519*	14 Silicon 1414 *3265*	15 Phosphorus 44 *280*	16 Sulfur 115 *445*	17 Chlorine −101 *−34*	18 Argon −189 *−186*
19 Potassium 63 *759*	20 Calcium 842 *1484*	21 Scandium 1541 *2836*	22 Titanium 1668 *3287*	23 Vanadium 1910 *3407*	24 Chromium 1907 *2672*	25 Manganese 1246 *2061*	26 Iron 1538 *2861*	27 Cobalt 1495 *2927*	28 Nickel 1455 *2913*	29 Copper 1085 *2562*	30 Zinc 420 *907*	31 Gallium 30 *2204*	32 Germanium 938 *2833*	33 Arsenic *817 *†616*	34 Selenium 221 *685*	35 Bromine −7 *59*	36 Krypton −157 *−153*
37 Rubidium 39 *688*	38 Strontium 777 *1382*	39 Yttrium 1522 *3345*	40 Zirconium 1855 *4409*	41 Niobium 2477 *4744*	42 Molybdenum 2623 *4639*	43 Technetium 2157 *4265*	44 Ruthenium 2333 *4150*	45 Rhodium 1964 *3695*	46 Palladium 1555 *2963*	47 Silver 962 *2162*	48 Cadmium 321 *767*	49 Indium 157 *2072*	50 Tin 232 *2602*	51 Antimony 631 *1587*	52 Tellurium 449 *988*	53 Iodine 114 *184*	54 Xenon −112 *−108*
55 Caesium 28 *671*	56 Barium 727 *1897*	57 Lanthanum 920 *3464*	72 Hafnium 2223 *4602*	73 Tantalum 3017 *5458*	74 Tungsten 3422 *5555*	75 Rhenium 3185 *5596*	76 Osmium 3033 *5012*	77 Iridium 2446 *4428*	78 Platinum 1768 *3825*	79 Gold 1064 *2856*	80 Mercury −39 *357*	81 Thallium 304 *1473*	82 Lead 328 *1749*	83 Bismuth 271 *1564*	84 Polonium 254 *962*	85 Astatine 302	86 Radon −71 *−62*

Key: ☐ **Solid** ☐ **Liquid** ☐ **Gas**

Questions

For each of the following elements or compounds, identify whether they are typically a solid, liquid, or gas at room temperature.

1. Oxygen		1. Gold	
2. Iron		2. Nitrogen	
3. Mercury		3. Bromine	
4. Chlorine		4. Neon	

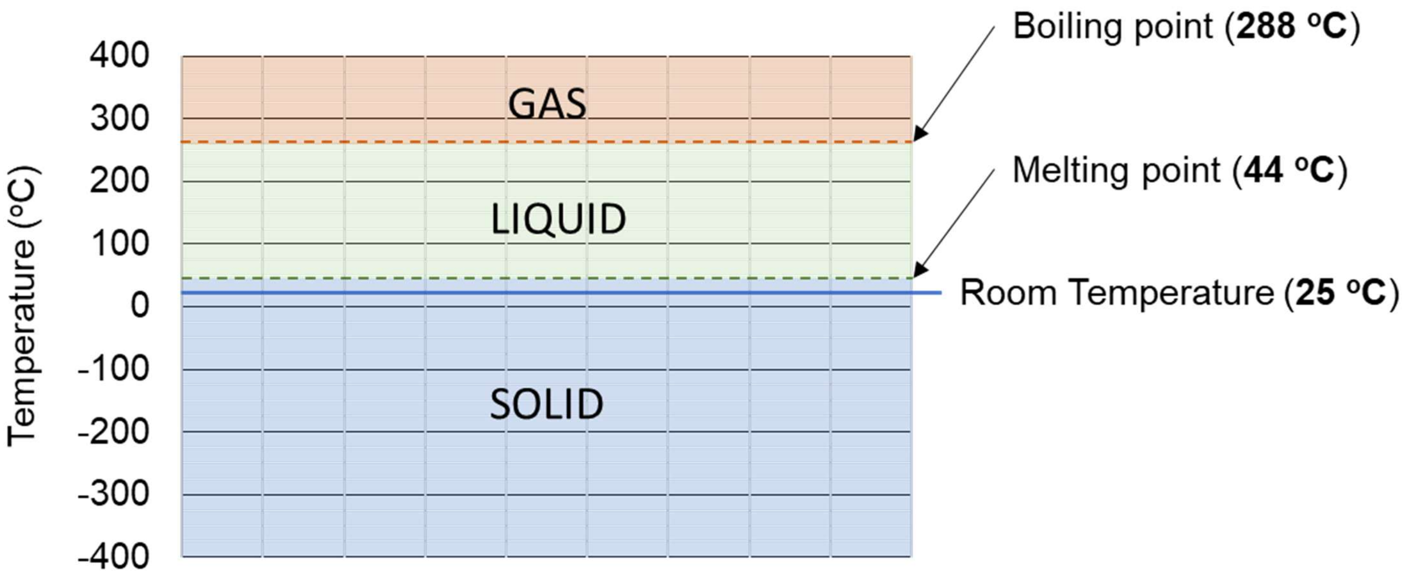
Finding the state are room temperature (optional challenge)

Using the data booklet, we can find what the state of the element will be at room temperature (25 °C). This is important because we will most of the time observe and use elements at room temperature.

Using phosphorus (P) as an example:

The melting point of phosphorus is: **44 °C.**

The boiling point of phosphorus is: **280 °C.**



At room temperature phosphorous will be a **solid** because room temperature is below the melting point.

Questions (optional challenge)

For the following questions, using just the melting point and boiling point, **state** whether the element is a solid, liquid or gas at room temperature.

You may use your data booklet and a whiteboard/blank paper to work them out.

1. Oxygen		5. Tin	
2. Hydrogen		6. Iodine	
3. Iron		7. Bromine	
4. Boron		8. Mercury	

Groups and periods

The table organizes these elements in rows and columns, and here's the neat trick: elements in the same column have similar behaviours.

Rows in the periodic table are known as **periods**.

Columns in the periodic table are known as **groups**.

So, by looking at where an element sits on the table, we can get clues about how it might act. Think of it as our ultimate guide to the building blocks of our world.

When we number and name the groups of elements, we <u>do not</u> include the **transition metals**.

Colour in the alkali metals, alkali earth metals, halogens and noble gases:

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 0
1 Hydrogen H							2 Helium He
3 Lithium Li	4 Beryllium Be	5 Boron B	6 Carbon C	7 Nitrogen N	8 Oxygen O	9 Fluorine F	10 Neon Ne
11 Sodium Na	12 Magnesium Mg	13 Aluminium Al	14 Silicon Si	15 Phosphorus P	16 Sulfur S	17 Chlorine Cl	18 Argon Ar
19 Potassium K	20 Calcium Ca	31 Gallium Ga	32 Germanium Ge	33 Arsenic As	34 Selenium Se	35 Bromine Br	36 Krypton Kr
37 Rubidium Rb	38 Strontium Sr	49 Indium In	50 Tin Sn	51 Antimony Sb	52 Tellurium Te	53 Iodine I	54 Xenon Xe
55 Caesium Cs	56 Barium Ba	81 Thallium Tl	82 Lead Pb	83 Bismuth Bi	84 Polonium Po	85 Astatine At	86 Radon Rn
87 Francium Fr	88 Radium Ra						

Key: ☐ **alkali metals** ☐ **alkali earth metals** ☐ **halogens** ☐ **noble gases**

Questions

For each element below, state the number and name of the group they belong to:

Element	Group Number	Group Name
1. Lithium		
2. Magnesium		
3. Chlorine		
4. Argon		
5. Helium		
6. Strontium		
7. Sodium		
8. Iodine		
9. Hydrogen		
10. Xenon		

Properties of groups 1, 2, 7 and 0/8

Group 1 elements are known as the **alkali metals**.

Properties: **soft**, highly **reactive**, especially with water, with **low** melting points

Group 2 elements are known as the **alkali earth metals**.

Properties: **harder** than alkali metals, **less** reactive than alkali metals but still reactive, **higher** melting points than alkali metals.

Group 7 elements are known as the **halogens**.

Properties: **highly** reactive **non-metals** with **low** melting points.

Group 0/8 elements are known as the **noble gases**.

Properties: colourless, odourless, **extremely low** reactivity.

Date: _______________

Atomic Structure

Learning Intentions

- To learn about the structure of the atom.

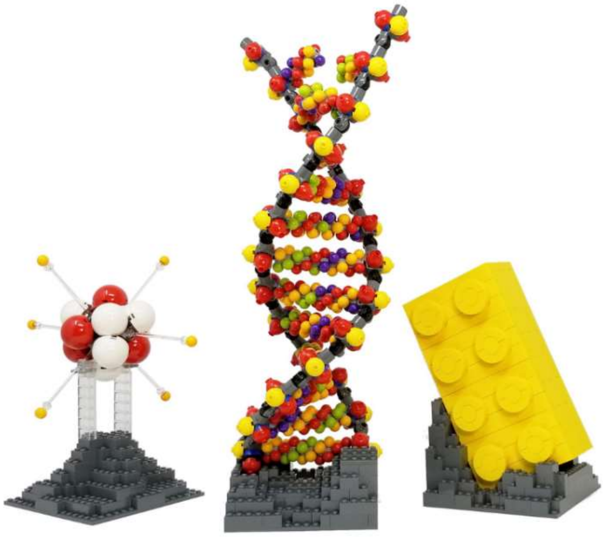
Success Criteria

☐ I can state where the sub-atomic particles of an atom are located within the atom.

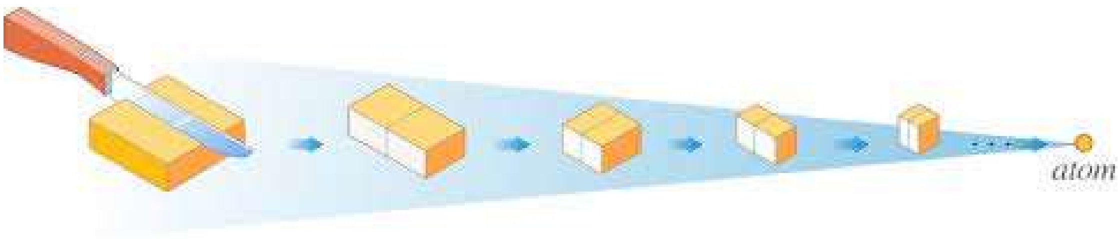
☐ I can state the names, charges and masses of each sub-atomic particle.

Introduction to the Atom

Atoms are the tiny **building blocks** of everything around us. Imagine a LEGO set; just as you can build vast and varied structures using different combinations of small LEGO pieces, everything in our **universe** is **made** up of different **combinations** of **atoms**.



The word "atom" comes from the ancient Greek word "atomos," which means "**indivisible**" or "**uncuttable**." The ancient Greeks believed that if you kept cutting matter into smaller and smaller pieces, you'd eventually reach a point where you couldn't cut it any further. They called this smallest piece "atomos."

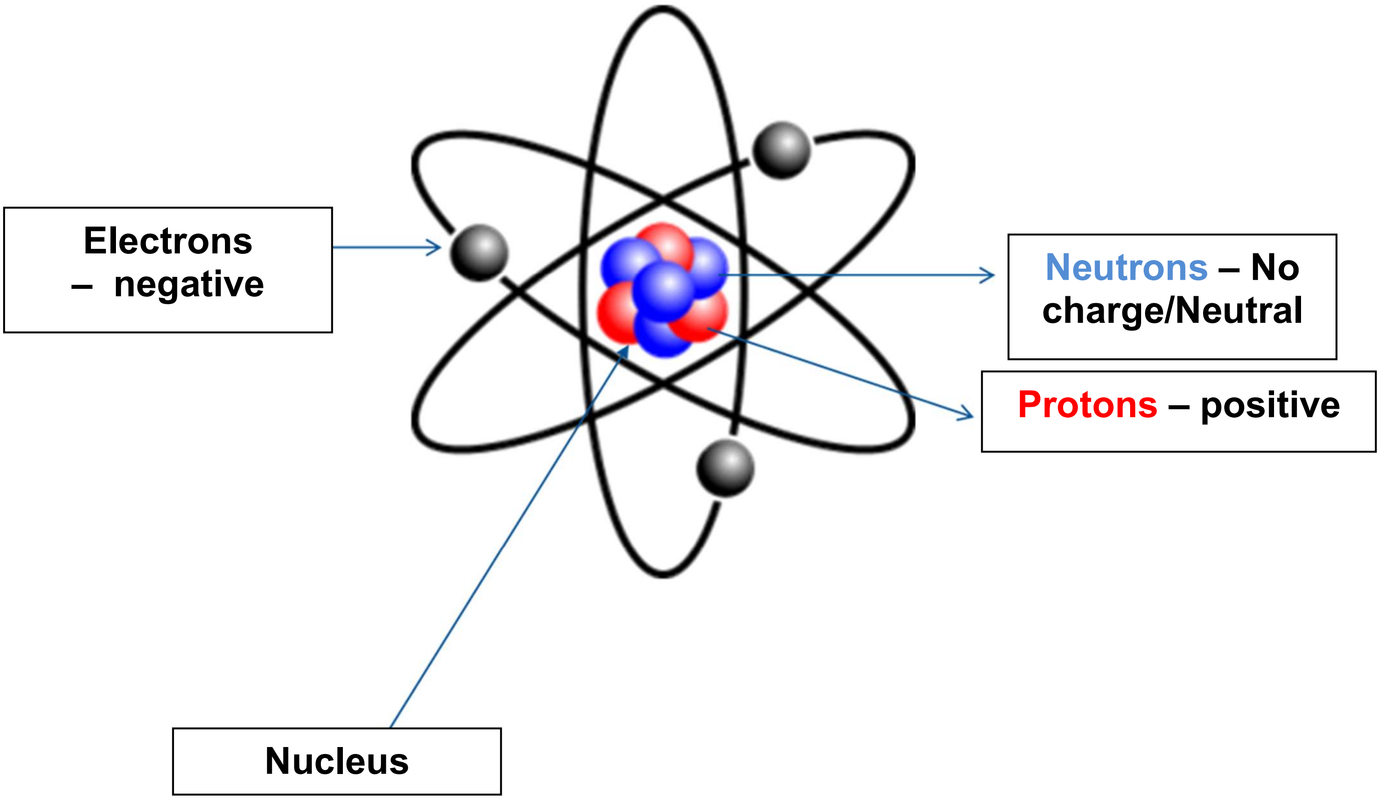


Today, we know atoms can be split into even tinier particles, but the name has stuck.

Structure of the Atom

An atom itself is made up of a **nucleus**, which contains **protons** and **neutrons**, and **electrons** that orbit around this **nucleus**. Each smaller component of the atom is called a **sub-atomic particle**.

Each sub-atomic particle has a particular **charge**, **mass** and **position** in the atom.



Think of the nucleus as the sun in a solar system, and the electrons as the planets revolving around it.

Fill in the table below about the charge, mass and position of each sub-atomic particle.

Particle name	Mass (a.m.u*)	Charge	Where sub-particle is found in atom
Proton	1	+1	Inside the nucleus
Electron	0	-1	Outside the nucleus
Neutron	1	0 (neutral)	Inside the nucleus

a.m.u.* = **atomic mass units**

Date: ________________

Atomic Number

Learning Intentions

- To learn how the atomic structure relates to which element it is.

Success Criteria

☐ I can state which sub-atomic particle relates to atomic number.

☐ Given the atom is neutral I can identify the number of electrons in an atom.

Introduction to atomic number

Every atom is **unique** and can be identified by its **atomic number** (which can be found on pages 4 – 6 of the data booklet). The **atomic number** tells us the **number** of **protons** in the nucleus of an atom.

For example, **hydrogen** has an atomic number of **1** because it has one proton, while **helium** has an atomic number of **2** because it has two protons.

When an atom is **neutral**, where it has **equal numbers** of **positive** protons and **negative** electrons, the **atomic** number is also the number of **electrons**.

> **Atomic Number**: Number of **protons** in the nucleus.
>
> When **neutral**, atomic number = number of electrons also

Questions

*For the following elements with **neutral** atoms, find the atomic number, number of protons and number of electrons.*

Element	Symbol	Atomic Number	Number of protons	Number of electrons
Hydrogen				
Helium				
Carbon				
Fluorine				
Neon				
Calcium				
Iron				
Gold				

Date: ________________

Mass number, isotopes and relative atomic mass

Learning Intentions

- To learn how the atomic structure relates to mass number.
- To learn about isotopes and relative atomic mass.

Success Criteria

☐ I can state which sub-atomic particles relate to mass number.

☐ I can use nuclide notation to identify the numbers of each sub-atomic particle.

Introduction to mass number

The **mass number** is the total number of **protons** and **neutrons** in an atom's nucleus. Electrons are much lighter and don't significantly contribute to an atom's mass. So, if an atom has 2 protons and 2 neutrons, its mass number is 4.

If you are given the mass number and atomic number (number of protons) you can calculate the number of neutrons. To do this, you can subtract the mass number from the atomic number.

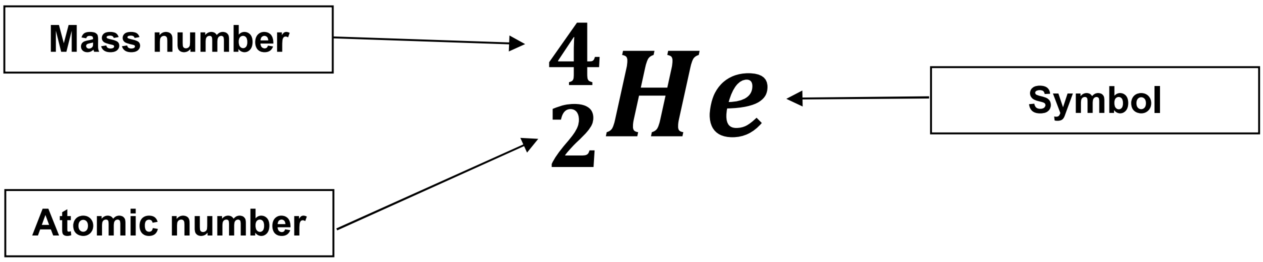
> **Mass Number:** Total number of protons and neutrons in the nucleus.
>
> **Mass number** = protons + neutrons
>
> To find the number of neutrons given mass number and atomic number:
>
> **Number of Neutrons** = mass number – atomic number

Nuclide notation

Nuclide notation is a shorthand way to represent different atoms (or nuclides) and provide information about their atomic number and mass number.

The elements symbol is in the **centre**, the **atomic number** is on the **bottom left** and the mass number is on the **top left**.

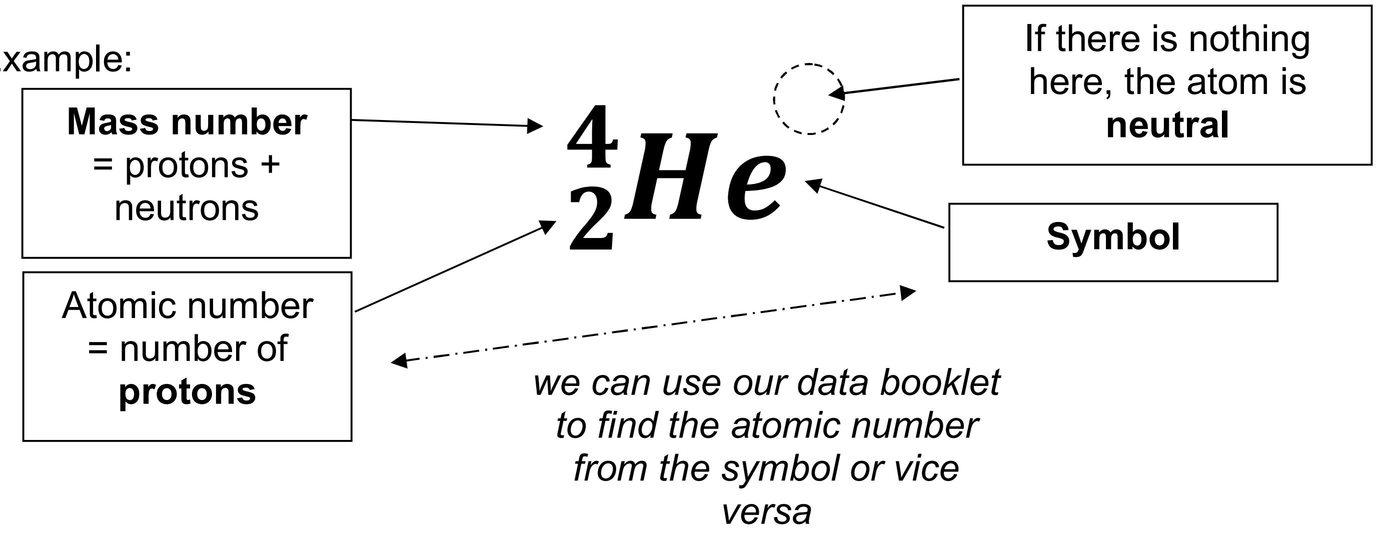
Example:



Sub-atomic particles from Nuclide notation

Nuclide notation can be used to find the number of protons, neutrons, and electrons. Again, we will assume that the atom is neutral (protons = electrons).

Example:



Questions

Complete the table below, filling out the atomic number, mass number, number of protons, neutrons, and electrons from the nuclide notation.

Nuclide Notation	Atomic Number	Number of protons	Mass Number	Number of neutrons	Number of electrons
${}^{1}_{1}H$	1	1	1	0	1
${}^{2}_{1}H$					
${}^{4}_{2}He$					
${}^{7}_{3}Li$					
${}^{12}_{6}C$					
${}^{14}_{7}N$					
${}^{16}_{8}O$					
${}^{19}_{9}F$					
${}^{23}_{11}Na$					
${}^{24}_{12}Mg$					

Questions (extension)

Complete the table below, filling out the atomic number, mass number, number of protons, neutrons, and electrons from the nuclide notation like before. **However, this time you must use your data booklet to <u>complete the nuclide notation.</u>**

Nuclide Notation	Atomic Number	Number of protons	Mass Number	Number of neutrons	Number of electrons
$^{1}_{\_\_}H$					
$^{2}_{1}\_\_$					
$^{4}_{2}\_\_$					
$^{10}_{\_\_}Ne$					
$^{12}_{6}\_\_$					
$^{14}_{\_\_}N$					
$^{16}_{8}\_\_$					
$^{19}_{\_\_}F$					
$^{20}_{\_\_}Ne$					
$^{23}_{11}\_\_$					
$^{40}_{\_\_}Ca$					
$^{45}_{21}\_\_$					
$^{50}_{\_\_}Cr$					
$^{52}_{24}\_\_$					
$^{55}_{\_\_}Mn$					
$^{58}_{\_\_}Ni$					
$^{75}_{33}\_\_$					

Date: ________________

Isotopes and relative atomic mass

Learning Intentions

- To learn how to identify isotopes.
- To learn about relative atomic mass and use it to identify the most common isotope.

Success Criteria

- ☐ I can state the definition of isotopes.
- ☐ I can identify isotopes using nuclide notations.
- ☐ I can explain what the relative atomic mass is.
- ☐ I can identify the most common isotope using relative atomic mass.
- ☐ I can calculate the relative atomic mass.

S

Introduction to Isotopes

An element is defined by its atomic number (the number of protons), but the number of neutrons in its atoms can vary.

> **Isotopes**: Atoms of the same **element** that have the **same** number of **protons** but **different** numbers of **neutrons**.*

*This means that while they have the same **atomic number** (which determines the element), but they have **different mass numbers**.

For example, there are 3 isotopes of carbon:

Nuclide notation:	$^{12}_{6}C$	$^{13}_{6}C$	$^{14}_{6}C$
<u>Number of</u>			
Protons:	________	________	________
Neutrons:	________	________	________
Electrons:	________	________	________

Match the Isotope

Using a ruler, match the isotopes by drawing a line between them. There may be more than one line.

$^{1}_{1}H$	$^{13}_{6}C$
$^{14}_{6}C$	$^{17}_{8}O$
$^{16}_{6}O$	$^{3}_{1}H$
$^{2}_{1}H$	$^{22}_{11}Na$
$^{18}_{8}O$	$^{12}_{6}C$
$^{4}_{2}He$	$^{21}_{10}Ne$
$^{23}_{11}Na$	$^{5}_{2}He$
$^{20}_{10}Ne$	$^{18}_{9}F$
$^{19}_{9}F$	$^{42}_{20}Ca$
$^{40}_{20}Ca$	$^{15}_{8}O$

Match the Isotope (challenge)

Using a ruler, match the isotopes by drawing a line between them. There may be more than one line. You will need to complete the nuclide notation before you begin matching them.

${}^{7}_{3}\underline{\quad}$	${}^{37}_{17}\underline{\quad}$
${}^{31}_{\underline{\quad}}P$	${}^{26}_{12}\underline{\quad}$
${}^{24}_{12}\underline{\quad}$	${}^{6}_{\underline{\quad}}Li$
${}^{35}_{\underline{\quad}}Cl$	${}^{32}_{15}\underline{\quad}$
${}^{28}_{\underline{\quad}}Si$	${}^{26}_{\underline{\quad}}K$
${}^{40}_{18}\underline{\quad}$	${}^{26}_{13}\underline{\quad}$
${}^{27}_{\underline{\quad}}Al$	${}^{22}_{11}\underline{\quad}$
${}^{23}_{\underline{\quad}}Na$	${}^{38}_{\underline{\quad}}Ar$
${}^{39}_{19}\underline{\quad}$	${}^{25}_{\underline{\quad}}Mg$
${}^{30}_{\underline{\quad}}Mg$	${}^{29}_{14}\underline{\quad}$

Relative atomic mass (R.A.M.)

Relative atomic mass represents the **average mass** of the atoms of an element, considering all its different isotopes.

It's measured against the mass of the carbon-12 atom, which is set as a standard.

This average is crucial because elements can exist in various isotopes, each with a different mass.

Using carbon as an example:

Isotope:	$^{12}_{6}C$	$^{13}_{6}C$	$^{14}_{6}C$
Natural Abundance (%)	**98.9**	**1.1**	**0.0000000001**

If we were to average the mass of these isotopes, the relative atomic mass would be **12.01**.

Since we mostly have carbon-12, the average is closest to it. This tells us that carbon-12 is the most common isotope, even if we did not have the percentages.

The natural abundance is always referring to a sample. For example, the carbon atoms in a lump of coal.

To illustrate what this means, lets imagine we had 1,000,000 (a million) carbon atoms. Using the percentages in this sample of coal we would have:

Isotope	Mass (a.m.u)	Number of atoms
Carbon-12	12	989,000
Carbon-13	13	11,000
Carbon-14	14	0.001 (essentially 0 in practical terms)

Samples contain far too many atoms to think about them atom-by-atom. So instead of thinking about the mass of each atom and adding them up, we just find the average of these numbers, which is 12.01.

By using the relative atomic mass chemists can make accurate calculations in experiments and reactions. *We will come back to these calculations later.*

Isotope questions (identifying the most common isotope)

Identify the most common isotope based on the given nuclide notation and relative atomic mass:

1. **Oxygen**
   Isotopes : $^{15}_{8}O$, $^{16}_{8}O$, $^{17}_{8}O$, $^{18}_{8}O$

   R.A.M: 15.999

   Which isotope is most common: ___________________

2. **Carbon**
   Isotopes : $^{12}_{6}C$, $^{13}_{6}C$

   R.A.M: 12.011

   Which isotope is most common: ___________________

3. **Hydrogen**
   Isotopes : $^{1}_{1}H$, $^{2}_{1}H$, $^{3}_{1}H$

   R.A.M: 1.008

   Which isotope is most common: ___________________

4. **Nitrogen**
   Isotopes : $^{14}_{7}N$, $^{15}_{7}N$

   R.A.M: 14.007

   Which isotope is most common: ___________________

5. **Chlorine**
   Isotopes : $^{37}_{17}Cl$, $^{37}_{17}Cl$

   R.A.M: 35.453

   Which isotope is most common: ___________________

6. **Boron**

Isotopes : $^{10}_{5}B,\ ^{11}_{5}B$

R.A.M: 10.811

Which isotope is most common: ___________________

7. **Lithium**

Isotopes : $^{6}_{3}Li,\ ^{7}_{3}Li$

R.A.M: 6.94

Which isotope is most common: ___________________

8. **Neon**

Isotopes : $^{20}_{10}Ne,\ ^{21}_{10}Ne,\ ^{22}_{10}Ne$

R.A.M: 20.180

Which isotope is most common: ___________________

9. **Potassium**

Isotopes : $^{39}_{19}K,\ ^{40}_{19}K,\ ^{41}_{19}K$

R.A.M: 39.098

Which isotope is most common: ___________________

10. **Magnesium**

Isotopes : $^{24}_{12}Mg,\ ^{26}_{12}Mg$

R.A.M: 25.000

Given the provided isotopes and the relative atomic mass, what does this suggest about the proportion of each isotope in the sample?

____

____

<u>Optional challenge</u> – Isotope questions (calculating relative atomic mass)

The relative atomic mass (r.a.m.) of a sample can be calculated given the following equation:

$$r.a.m. = \frac{(mass\ of\ isotope\ X\ \times \%\ of\ X) + (mass\ of\ isotope\ Y\ \times \%\ of\ Y)}{100}$$

Calculate the relative atomic mass of each of the following samples using the equation above.

1) Element: Chlorine (Cl)
   - Isotope X: ^{35}Cl
     - Mass of X: 35.0 amu
     - % of X: 75.8%
   - Isotope Y: ^{37}Cl
     - Mass of isotope Y: 37 amu
     - % of Y: 24.2%

2) Element: Carbon (C)
   - Isotope X: ^{12}C
     - Mass of X : 12.0 amu
     - % of X: 98.9%
   - Isotope Y: ^{13}C
     - Mass of isotope Y: 12.0 amu
     - % of Y: 1.1%

3) Element: Boron (B)
- Isotope X: ^{10}B
    - Mass of X : 10.0 amu
    - % of X: 19.9%
- Isotope Y: ^{11}B
    - Mass of isotope Y: 11.0 amu
    - % of Y: 80.1%

4) Element: Lithium (Li)
- Isotope X: ^{6}Li
    - Mass of X : 6.0 amu
    - % of X: 7.6%
- Isotope Y: ^{7}Li
    - Mass of isotope Y: 7.0 amu
    - % of Y: 92.4%

Date: ________________

Electron Arrangements

Learning Intentions

- To learn about electron arrangements and how they relate to each element.

Success Criteria

☐ I can use the data booklet to find the electron arrangements.

☐ I can draw electron energy level diagrams.

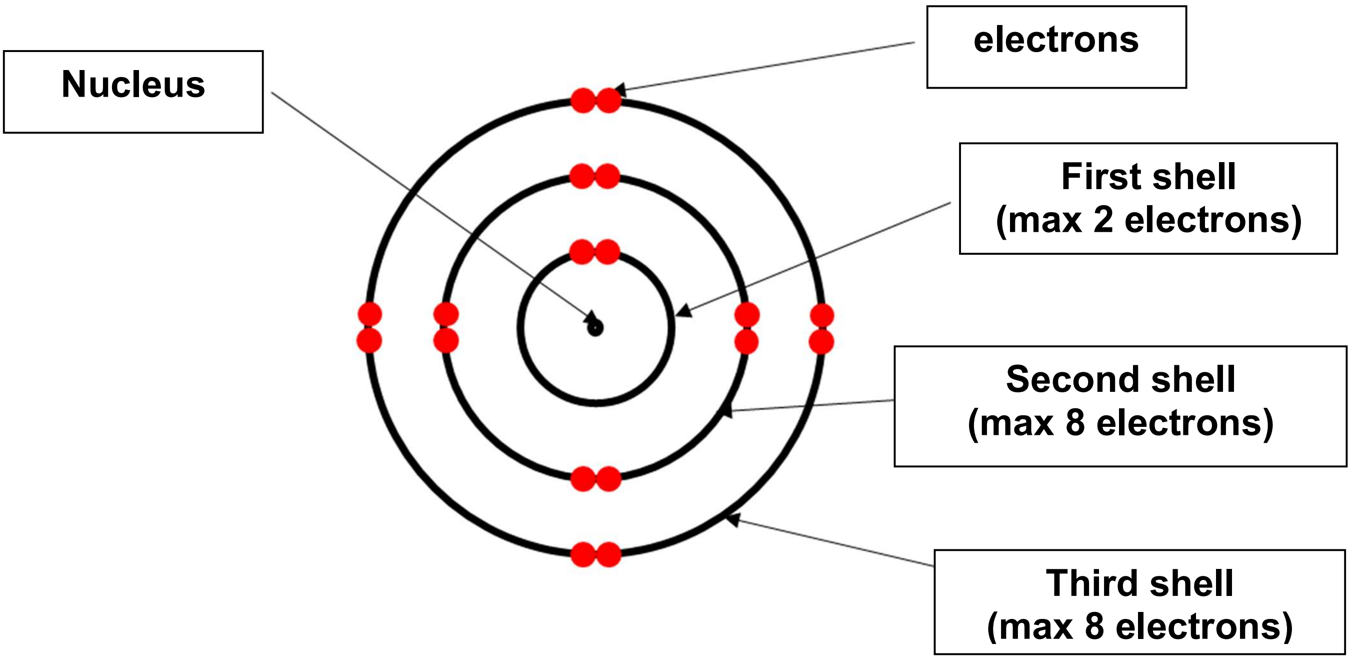
☐ I can state the 2,8,8 rule.

Introduction to electron arrangements

Atoms consist of a nucleus (containing protons and neutrons) and electrons that move around the nucleus in specific regions called **energy levels** or **shells**. The arrangement of electrons in these shells is known as the **electron arrangement**.

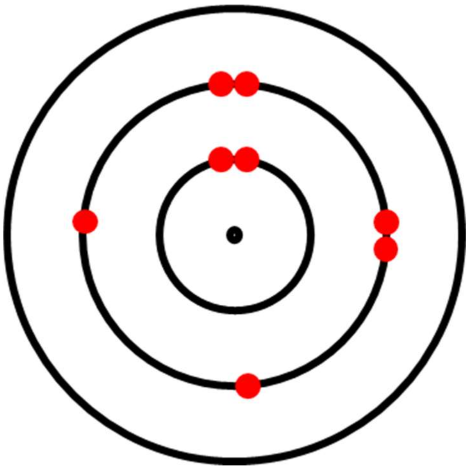
Shells/Energy Levels: Electrons occupy spaces called **shells** around the **nucleus**. These shells can hold a **specific** number of electrons:

- The **first** shell (closest to the nucleus) can hold up to **2** electrons.
- The **second** and **third** shells can each hold up to **8** electrons.



Electron arrangement: This refers to the distribution of electrons in the shells. This can be found on page 6 of your data booklet.

For example, oxygen has 8 electrons. Its electron configuration is 2,6, meaning 2 electrons in the first shell and 6 in the second. A diagram for this is shown below



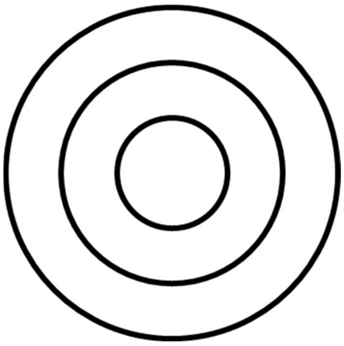
Oxygen

Electron configuration: 2,8

The electrons are filled from the inside out. Each shell must have the correct maximum number of electrons (2,8,8).

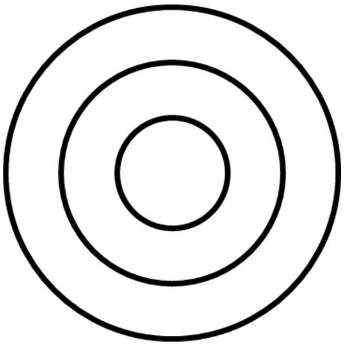
Your teacher will show you the correct order for filling the shells with 8 electrons.

Fill out the following electron shell diagrams with your teacher.



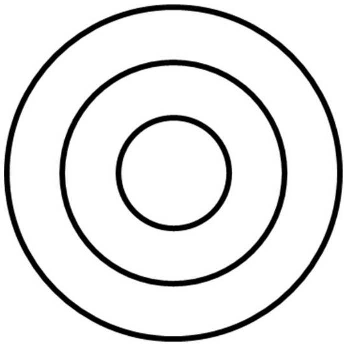
Carbon
Electron arrangement

____



Fluorine
Electron arrangement

____

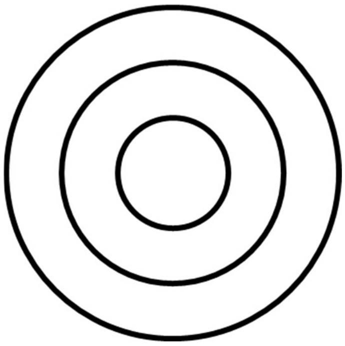


Neon
Electron arrangement

____

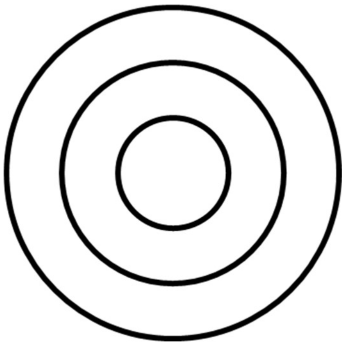
Electron Arrangement Questions

Fill out the following the diagrams and complete the information below it.



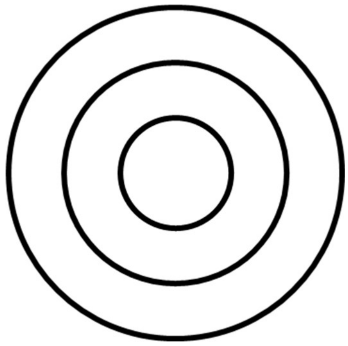
Hydrogen
Electron arrangement

____



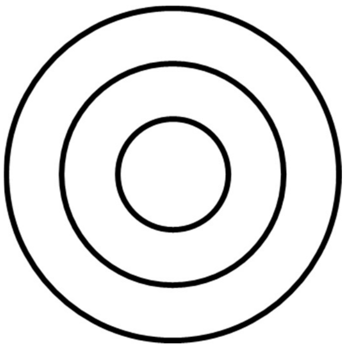
Helium
Electron arrangement

____



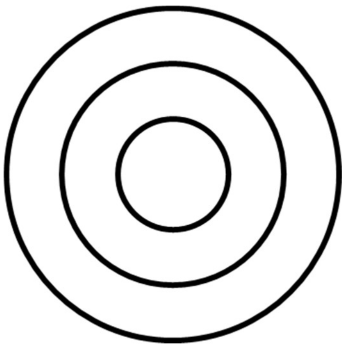
Beryllium
Electron arrangement

____



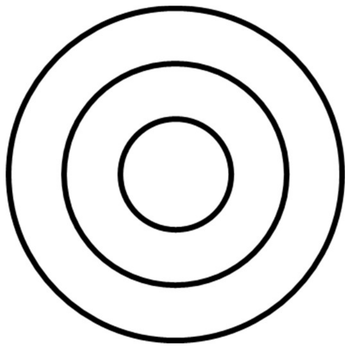
Boron
Electron arrangement

____



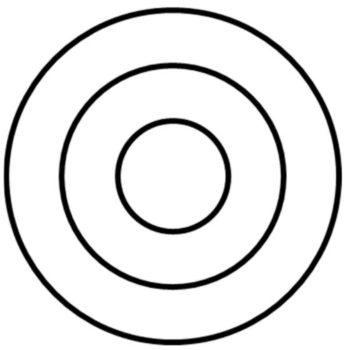
Nitrogen
Electron arrangement

____



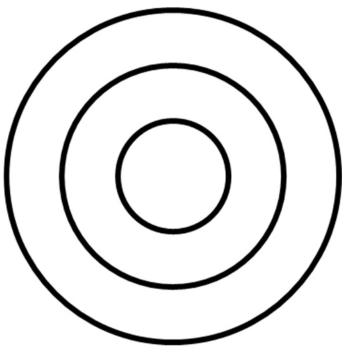
Sodium
Electron arrangement

____



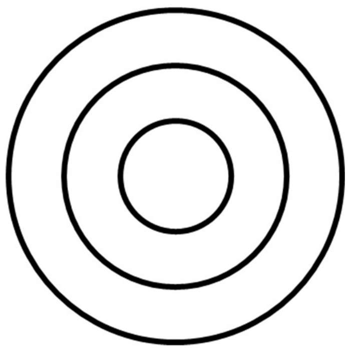
Aluminium
Electron arrangement

____



Phosphorus
Electron arrangement

____



Chlorine
Electron arrangement

____

Date: ________________

Electron Arrangements and Ions

Learning Intentions

- To learn about ions and their electron arrangements.

Success Criteria

☐ I can state the definition of an ion.

☐ I can identify if an ion will become positive or negative.

☐ I can use the 2,8,8 rule to find the charge of an ion.

☐ I can write the electron arrangement for an ion given its charge.

☐ I can identify isoelectronic ions.

Introduction to Ions

An **ion** is an atom or group of atoms that has **gained** or **lost** one or more electrons, resulting in a net **positive** or **negative charge**.

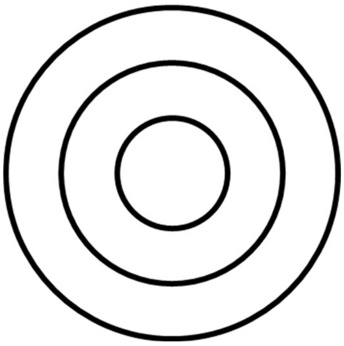
Ions are formed when atoms seek to achieve a full outer shell, making them more **stable**.

- If an atom's outer shell is not full, it might either borrow or give away electrons to achieve a full shell, turning the atom into an ion in the process.

Atoms are **neutral**, they have the **same** number of protons and electrons. **Ions** are **charged** because they have a **different** number of protons and electrons.

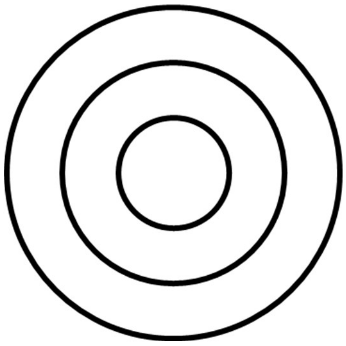
There are two main types of ions:

- **Positive ions** are formed when an atom **loses** electrons. For instance, sodium (Na) has a single electron in its third shell. By giving away this electron, sodium achieves a full second shell and becomes a positively charged ion, represented as Na^{+}.



Sodium atom (Na)
Electron arrangement

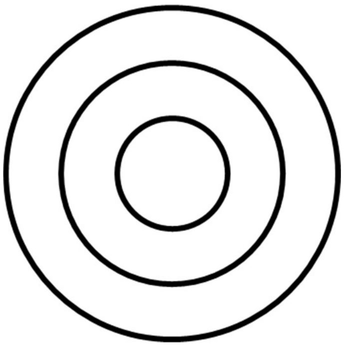
____



Sodium ion (Na^{+})
Electron arrangement

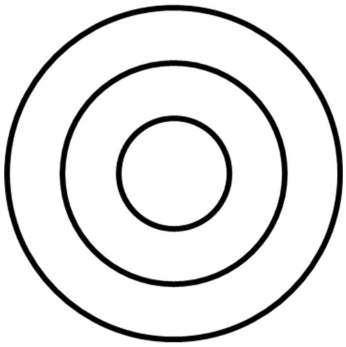
____

- **Negative ions** are formed when an atom **gains** electrons. Chlorine (Cl), for example, has seven electrons in its third shell. To complete this shell, chlorine can borrow an electron, turning it into a negatively charged ion, represented as Cl^{-}.



Chlorine atom (Cl)
Electron arrangement

____



Chlorine ion (Cl^{-})
Electron arrangement

____

With a full shell, ions will have the **same** electron arrangement as the nearest **noble gas** on the periodic table to that element. Remember, the noble gases are very **unreactive** and stable.

Using the 2,8,8 rule to find the charge

The 2,8,8 rule is particularly useful as it provides insights into the behaviour of atoms.

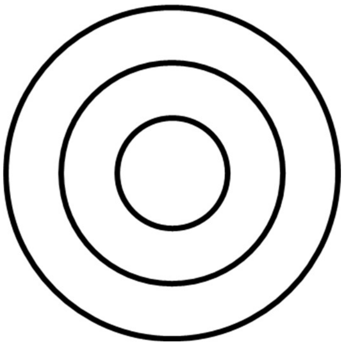
- Atoms with 1, 2, or 3 electrons in their outer shell might find it more favourable to **lose** these **electrons**, becoming **positive** ions.
    - Atoms losing 2/3 electrons become 2+/3+ charge, e.g. Mg^{2+}, Al^{3+}

- Conversely, atoms with 5, 6, or 7 electrons in their outer shell often tend to **gain** additional electrons to achieve a **full** shell, thus becoming **negative** ions.
    - Atoms gaining 2/3 electrons become 2-/3- charge, e.g. O^{2-}, N^{3-}

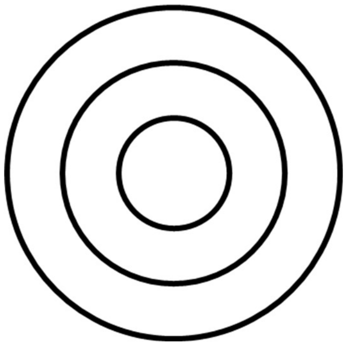
- Atoms that already have a **full** outer shell, like the noble gases, are inherently **stable** and typically don't form ions.

Questions

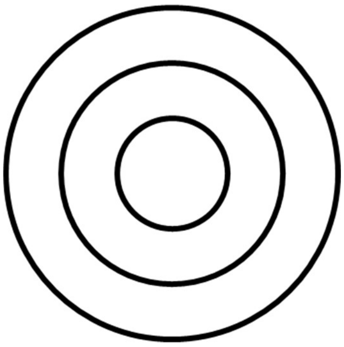
Fill out the following electron shell diagrams for the following atoms and ions of each element. Fill out the symbol for the ion and



Lithium atom (Li)
Electron arrangement
____

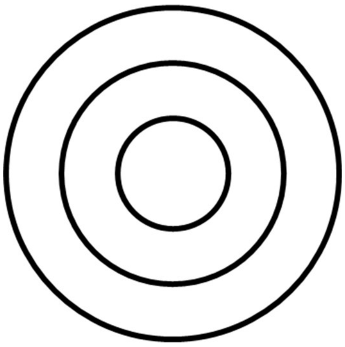


Lithium ion (____)
Electron arrangement
____



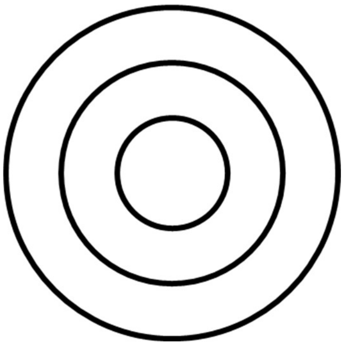
Beryllium atom (Be)
Electron arrangement

____



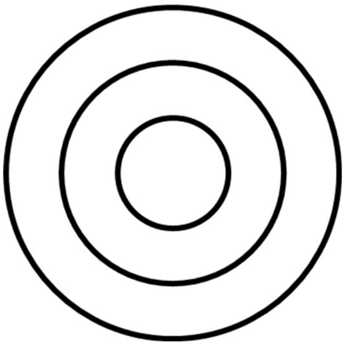
Beryllium ion (____)
Electron arrangement

____



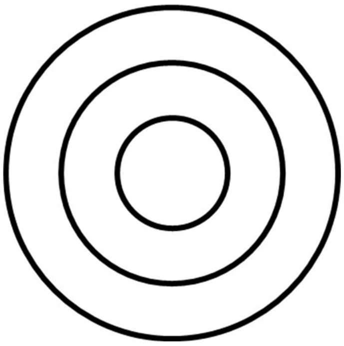
Boron atom (B)
Electron arrangement

____



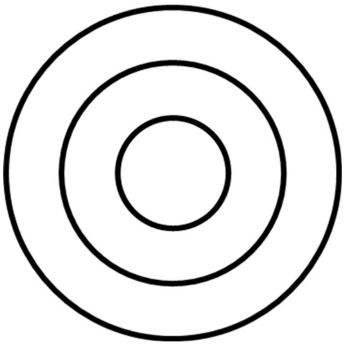
Boron ion (____)
Electron arrangement

____



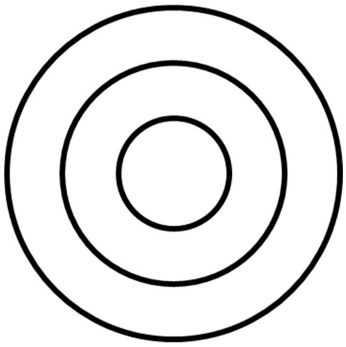
Nitrogen atom (N)
Electron arrangement

____



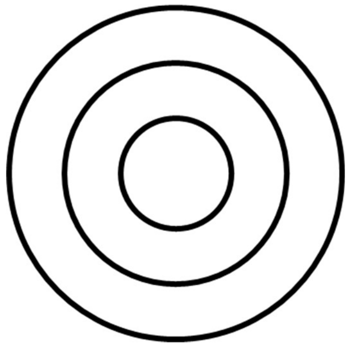
Nitrogen ion (____)
Electron arrangement

____



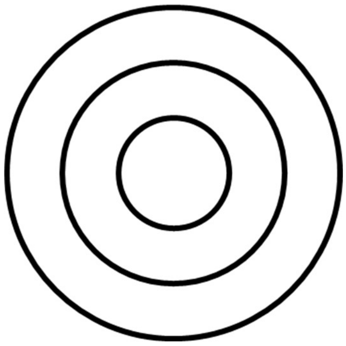
Oxygen atom (O)
Electron arrangement

____



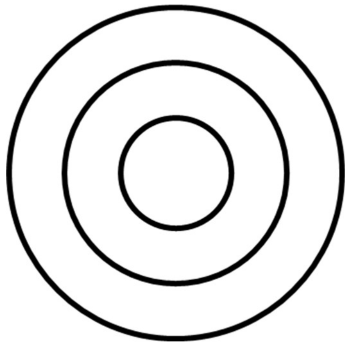
Oxygen ion (____)
Electron arrangement

____



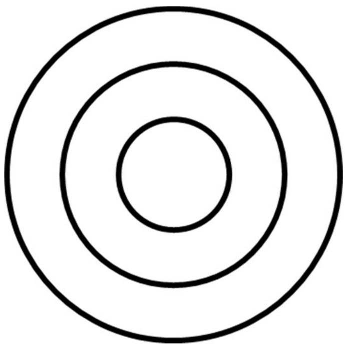
Fluorine atom (F)
Electron arrangement

____



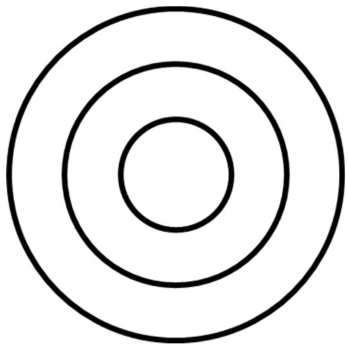
Fluorine ion (____)
Electron arrangement

____



Fluorine atom (S)
Electron arrangement

____



Fluorine ion (____)
Electron arrangement

____

Questions (electron arrangements of ions)

Complete the following table

Nuclide Notation	Number of protons	Mass Number	Number of neutrons	Number of electrons	Electron arrangement
$^{1}_{1}H^{+}$	1	1	0		
$^{4}_{2}He$					
$^{7}_{3}Li^{+}$					
$^{14}_{7}N^{3-}$					
$^{16}_{8}O^{2-}$					
$^{19}_{9}F^{-}$					
$^{23}_{11}Na^{+}$					
$^{24}_{12}Mg^{2+}$					
$^{32}_{16}S^{2-}$					
$^{35}_{17}Cl^{-}$					
$^{41}_{20}Ca^{2+}$					
$^{80}_{35}Br^{-}$					

Do you notice pattern with the electron arrangement of ions?

___

Which group in the periodic table do ions have the same electron arrangements? **Explain** why this is significant.

___

___

___

PHET Atom builder (laptop required - *(google: <u>PHET atom builder</u>)*

Follow the tasks below and tick the box once you have completed each task.

Part 1: Basic Atomic Structure

- ☐ **Task 1.1:** Open the "Build an Atom" simulation.
- ☐ **Task 1.2:** Drag 1 proton onto the nucleus. Note the element's name.
- ☐ **Task 1.3:** Add 1 electron. Observe the atom's charge.
- ☐ **Task 1.4:** Keep add protons up to 5, noting the element's name after each addition.

Part 2: Neutrons and Isotopes

- ☐ **Task 2.1:** Start with an atom having 3 protons and 3 electrons.
- ☐ **Task 2.2:** Add 1 neutron. Note any changes in the atom's name or symbol.
- ☐ **Task 2.3:** Continue adding neutrons up to 5. Observe the atom's mass number.

Part 3: Ions

- ☐ **Task 3.1:** Begin with a neutral helium atom (2 protons, 2 electrons).
- ☐ **Task 3.2:** Remove 1 electron to form a cation. Note the charge.
- ☐ **Task 3.3:** Add back 3 electrons to form an anion. Observe the charge.

Part 4: Challenge Tasks

- ☐ **Task 4.1:** Create an atom with a mass number of 7 and a +1 charge. Identify the element.
- ☐ **Task 4.2:** Construct a neutral carbon isotope. Determine its mass number.
- ☐ **Task 4.3:** Build a negative ion of oxygen. Note its electron configuration.

Part 5: Periodic Table Exploration

- ☐ **Task 5.1:** Navigate to the "Periodic Table" tab.
- ☐ **Task 5.2:** Hover over elements to see their atomic details.
- ☐ **Task 5.3:** Pick an element and replicate it in the "Build an Atom" section.

Part 6: Test Your Knowledge

- ☐ **Task 6.1:** Click on the "Game" tab.
- ☐ **Task 6.2:** Complete at least 5 challenges, building or identifying atoms as instructed.

Questions (challenge)

Isoelectronic refers to different atomic or ionic species that have the same number of electrons and hence the **same electronic arrangement**.

1. Which of the following pairs of ions are isoelectronic, meaning they have the same number of electrons?
    a. Na^{+} and Mg^{2+}
    b. O^{2-} and F^{-}
    c. N^{3-} and O^{2-}
    d. Ca^{2+} and Ar
2. Which of the following pairs of ions are isoelectronic?
    a. K^{+} and Cl^{-}
    b. S^{2-} and Cl^{-}
    c. Mg^{2+} and Ne
    d. Li^{+} and H^{-}
3. Which ion is <u>not</u> isoelectronic with Ne?
    a. Li^{+}
    b. O^{2-}
    c. F^{-}
    d. Mg^{2+}
4. Which pair of ions <u>do not have</u> the same electron arrangement?
    a. P^{3-} and S^{2-}
    b. Al^{3+} and Ne
    c. K^{+} and Ar
    d. Ca^{2+} and Ne
5. Which ion is <u>not</u> isoelectronic with Ar?
    a. K^{+}
    b. Cl^{-}
    c. Ca^{2+}
    d. O^{2-}

Date: ________________

Atomic Structure – Summary

Summarise the atomic structure topic. You may make a flow chart, mind-map, bullet-points, outlines, or brief statements.

Extension questions:
Chemcord purple books (N5): page 18 – 20
Hodder and Gibson (N5): page 11 – 16
SCHOLAR

Topic	2015	2016	2017	2018	2019
Rate of reaction	MC – 1,2,3,7 S2 –	MC – 3 S2 – 1(a), 1(b)	MC – 2 S2 – 1	MC – 2,5 S2 – 6	MC – 3,4,5,7 S2 – 1(b)

MC = multiple choice section, S2 = section 2, the written section.