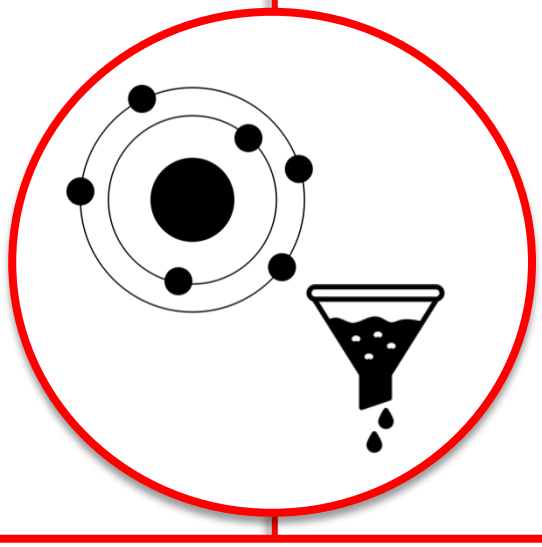
HIGHER
CHEMISTRY UNIT 1 – ATOMIC STRUCTURE AND THE PERIODIC TABLE



<u>In this topic you will learn about</u> the fundamentals of chemistry and how the periodic table and the model of the atom we use today were developed.
You will learn more about the structures of atoms, what isotopes are and what ions are and how they are formed. You will develop your knowledge of the periodic table and how to use the information it tells us. You will also learn more about the reactions of elements in groups 1 and 7 of the periodic table.

<u>This will build up on</u> the work you did in years 7 and 8 on elements and compounds. It will also build on the work you did in year 9 on atoms, bonding and the periodic table

<u>This will help you</u> in all of your future chemistry units as it will develop your knowledge of the periodic table and chemical formula and enable you to use the information you gain about elements, atoms and ions to help you when you are studying topic such as bonding, chemical calculations and chemical reactions.

Name:

Set:

Teacher:

Target:

The Periodic Table of Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[97] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[267] **Rf** rutherfordium 104	[270] **Db** dubnium 105	[269] **Sg** seaborgium 106	[270] **Bh** bohrium 107	[270] **Hs** hassium 108	[278] **Mt** meitnerium 109	[281] **Ds** darmstadtium 110	[281] **Rg** roentgenium 111	[285] **Cn** copernicium 112	[286] **Nh** nihonium 113	[289] **Fl** flerovium 114	[289] **Mc** moscovium 115	[293] **Lv** livermorium 116	[293] **Ts** tennessine 117	[294] **Og** oganesson 118

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted.

Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.

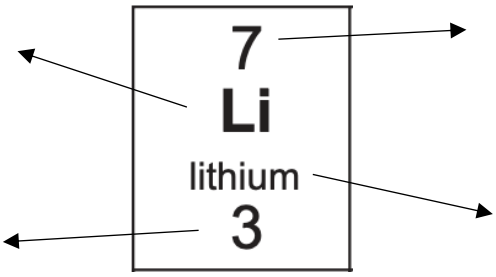
ACTIVATE KNOWLEDGE

This key is on your periodic table:

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

Use this key, and your knowledge from year nine, to label what we know about the element lithium from the information given to us on the periodic table:



What else does this tell us about an atom of the element lithium? Write down as much information as you can.

CONTENT

Elements are made up of one type of atom

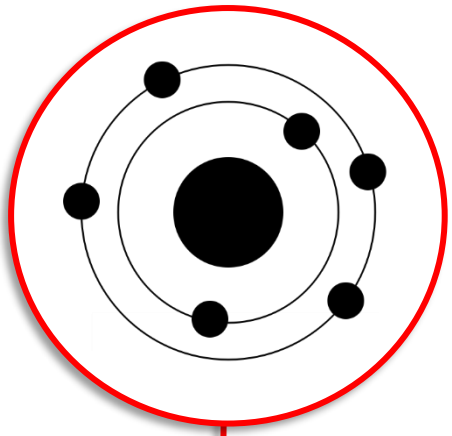
The element lithium is made up of _____ atoms only.

The element sodium is made up of sodium _____ only.

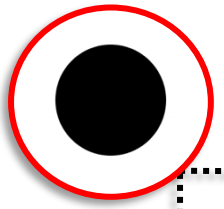
The element copper is made up of copper atoms _____.

The element silver is made up of _____.

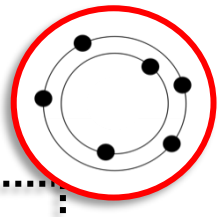
The element iron is made up of _____.



Elements are made up of one type of atom



Structure of an atom



Nucleus in the centre of the atom containing protons and neutrons

Energy Levels / Shells surrounding the nucleus where electrons are found

The three sub-atomic particles

Nucleus 

Energy Levels / Shells 

Protons

Protons are found in the _____ of the atom.

They have a _____ charge, so each proton has a charge of +1.

Protons have a relative _____ of 1.

All atoms of a particular element have the same number of protons.

Neutrons

Neutrons are found in the _____ of the atom.

They have _____ charge, so each neutron has a charge of 0.

Neutrons have a relative _____ of 1.

Electrons

Electrons are found in _____ levels or _____ surrounding the nucleus.

They have a _____ charge, so each electron has a charge of -1.

Electrons are the _____ sub-atomic particle and their relative _____ is so small we say it is negligible or zero.

Atoms have the same number of electrons as _____.

Elements on the Periodic Table

All of the elements can be found on the periodic table.

The periodic table tells us four pieces of information about each element.

1. The top number tell us the relative atomic mass of an atom of that element. This tells us how many protons plus neutrons there are in an atom of the element.

2. The letters in the centre tell us the symbol of the element.

3. The word below the symbol tells us the name of the element.

4. The bottom number tells us the atomic (proton) number. This tells us how many protons there are in an atom of the element.

The number of protons in an atom is the same as the number of electrons.

CONTENT

How electrons are arranged in an atom

We know the following facts about electrons

1. Electrons are located on shells around the nucleus of an atom.

2. Electrons have a tiny mass.

3. Electrons have a _____ charge of -1

4. The number of electrons is the same as the number of _____ in an atom

When you are drawing electrons on the shells of an atom you can use dots or crosses.

The first shell can hold a maximum of _____ electrons.

The second and third shell can hold a maximum of _____ electrons.

The innermost shell fills up first, then the second shell and then the third shell.

We can use this information to draw the atomic structure of the first 20 elements.

THE PERIODIC TABLE **Date: ……**

RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	What is made up of one type of atom?		
2	Where are protons found in an atom?		
3	Where are neutrons found in an atom?		
4	Where are electrons found in an atom?		
5	Do protons have a positive or negative or neutral charge?		
6	Do electrons have a positive, negative or neutral charge?		
7	How do the number of protons in atom compare to the number of electrons?		
8	An atom of an element has an atomic number of 7. How many protons will it have?		
9	An atom of an element has an atomic number of 7. How many electrons will it have?		
10	What will be the electronic structure of an element with an atomic number of 7.		
	Score:		

ACTIVATE KNOWLEDGE

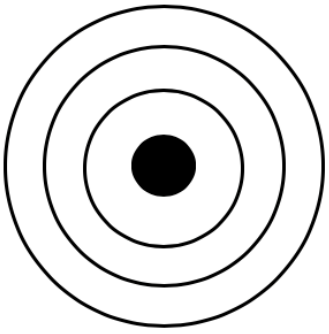
This key is on your periodic table:

relative atomic mass
atomic symbol
name
atomic (proton) number

Use this key and your own knowledge to complete the table and draw the electronic structure of aluminium.

27
Al
aluminium
13

Name of element	
Symbol of element	
Relative atomic mass	
Atomic number	
Number of protons	
Number of electrons	
Number of neutrons	
Electronic structure	



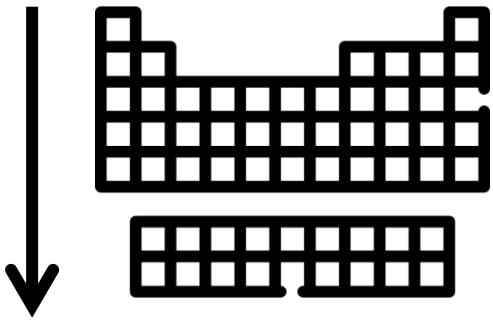
CONTENT

The Periodic Table

In the periodic table elements are arranged in order of _____ number (the number of _____).

All atoms of the same element have the same number of protons – the number of protons is unique to an atom of that particular element and _____ change.

Groups



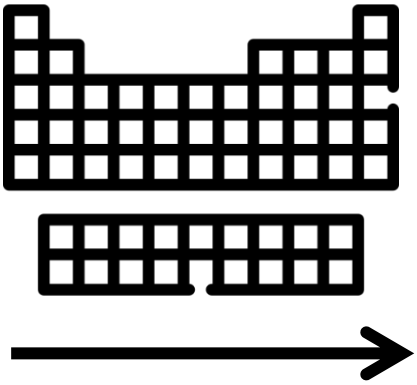
Groups are vertical _____ on the periodic table.

The groups are numbered on your periodic table – there are groups 1, 2, 3, 4, 5, 6, 7 and 0.

Elements in the same group have similar chemical _____.

The group an element is in will also tell you how many electrons an atom of that element has in its outer shell – so all elements in group 1 have _____ electrons in their outer shell, all elements in group 2 have _____ electrons in their outer shell.

Periods

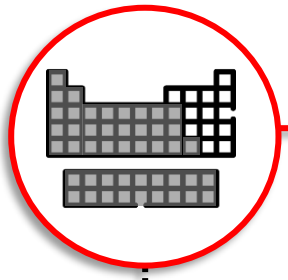


Periods are horizontal _____ on the periodic table.

The elements are in rows in order of their atomic number or their number of protons.

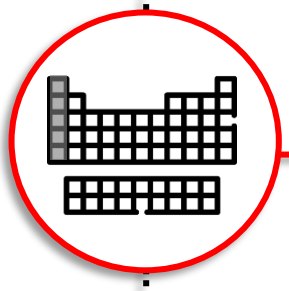
Elements in the same period have the same number of _____ surrounding their nucleus – so all the elements in period 2, such as lithium, carbon and oxygen have _____ shells surrounding their nucleus. All the elements in period 3, such as sodium, chlorine and argon have _____ shells surrounding their nucleus.

KEY FEATURES OF THE PERIODIC TABLE



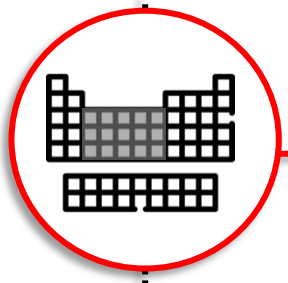
Metal and Non-Metals

Metals are found to the _____ and towards the bottom of the periodic table. Most elements are metals.
Non-metals are found to the _____ and towards the top of the periodic table.



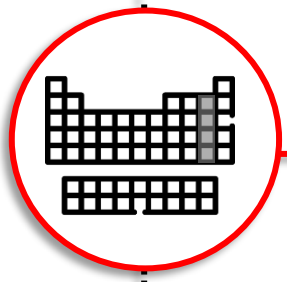
Group 1 Elements

The elements in group 1 are called the _____ metals.
They all have _____ electron in their _____ shell.



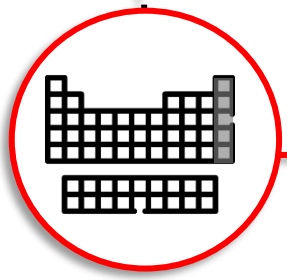
The Transition Metals

The elements in the centre of the periodic table, between _____ 2 and 3 are called the _____ metals.



Group 7 Elements

The elements in group 7 are called the _____.
They all have _____ electrons in their _____ shell.



Group 0 Elements

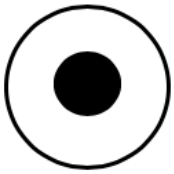
The elements in group 0 are called the _____ gases.
They all have a _____ outer shell of electrons.

Group Zero - The Noble Gases

Helium

1st row (period) of group 7.

4
He
helium
2

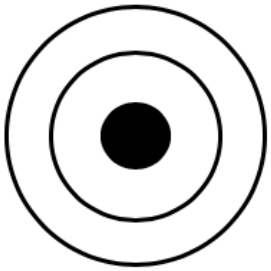


Helium has _____ electrons in its outer shell. It has a _____ outer shell of electrons making it unreactive.

Neon

2nd row (period) of group 7.

20
Ne
neon
10

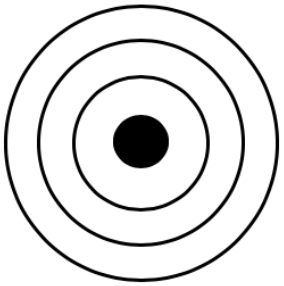


Neon has _____ electrons in its outer shell. It has a _____ outer shell of electrons making it unreactive.

Argon

3rd row (period) of group 7.

40
Ar
argon
18



Argon has _____ electrons in its outer shell. It has a _____ outer shell of electrons making it unreactive.

All of the atoms of group zero elements have a _____ outer shell of electrons. This gives them a _____ arrangement of electrons and makes them _____.

The elements in group zero are called the _____ gases.

As you go down group zero on the periodic table the relative atomic mass of the elements _____.

As you go down group zero the boiling points of the noble gases _____, so argon will have a _____ boiling point than helium.

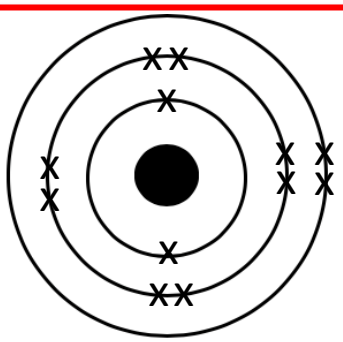
ATOMS, ISOTOPES AND IONS **Date: ……**

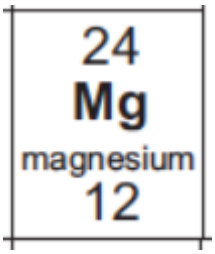
RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	Which two sub-atomic particles are found in the nucleus of an atom?		
2	Does the nucleus of an atom have a positive or negative charge?		
3	Do the electrons, found in the shells surrounding the nucleus, have a positive or negative charge?		
4	What is the charge of a proton?		
5	What is the charge of an electron?		
6	What is the name given to elements in group seven of the periodic table?		
7	How many electrons will atoms of group seven elements have in their outer shell?		
8	What is the name given to elements in group zero of the periodic table?		
9	Why are elements in group zero unreactive?		
10	Is the relative atomic mass of an element the top number or the bottom number on the periodic table?		
	Score:		

ACTIVATE KNOWLEDGE

What is this a diagram of? _____





Use this information and your own knowledge to answer the following questions

1. How many protons would it have? _____

2. What is the relative charge of a proton? _____

3. How many electrons would it have? _____

4. What is the relative charge of an electron? _____

5. How many neutrons would it have? _____

4. What is the relative charge of a neutron? _____

6. What group of the periodic table would this element be in? _____

7. How do you know? _____

_____

5. Why would it have no overall charge? _____

_____

CONTENT

Atoms

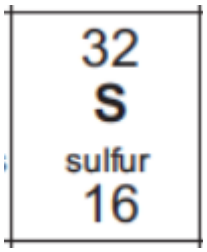
All atoms of the same element have the same number of _____.

Atoms are made up of a central _____ containing protons and neutrons.

Surrounding the nucleus there are energy levels or shells where the _____ are found, which orbit the nucleus.

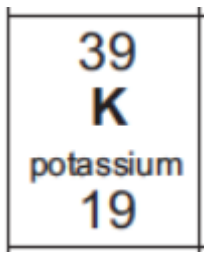
The number of protons in an atom cannot _____ – the number of protons determines what element the atom is.

The _____ number on the periodic table tells us how many protons an atom has.



An atom of sulfur has _____ protons.

All atoms of sulfur will have _____ protons in their nucleus, this is what makes it an atom of sulfur.



An atom of potassium has _____ protons.

All atoms of potassium will have _____ protons in their nucleus, this is what makes it an atom of potassium.

Atoms have no overall _____.

This is because they have the _____ number of protons as electrons.

Protons have a positive charge of _____. Electrons have a negative charge of _____.

Since the number of protons is the same as the number of electrons the positive charges cancel out the negative charges, so the atom has no _____ charge.

Isotopes

All atoms of the same element have the _____ number of protons.

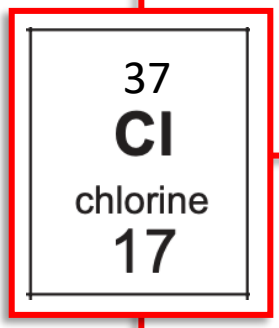
Isotopes are atoms of an element with a different number of _____.

Isotopes of an element have the _____ number of protons and the _____ number of electrons.

The element chlorine has two common isotopes.

This atom of chorine has 17 _____ – this is what makes it chlorine.

It has 17 electrons and _____ neutrons



This atom of chorine has 17 _____ – this is what makes it chlorine.

It has 17 electrons and _____ neutrons

These two atoms of chlorine have the same number of protons and electrons but a different number of _____.

Atoms of the same element can have different number of neutrons. These atoms are called _____.

Isotopes are atoms with the same number of protons and electrons but a different number of neutrons – so they have a different relative atomic _____.

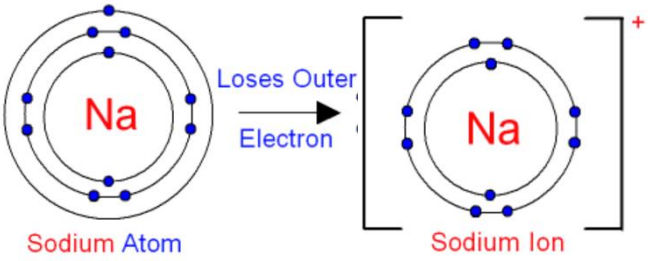
Ions

All atoms of the same element have the _____ number of protons.

Ions are atoms that have lost or gained _____.

Ions always have a _____.

Positive Ions



Metal atoms _____ the electrons in their outer shell when they become an ion.

This means they have more protons than electrons so they will have a _____ charge.

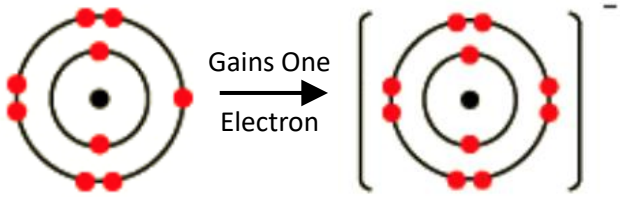
If it loses 1 electron it will have a charge of _____.

If it loses 2 electrons it will have a charge of _____.

If it loses 3 electrons it will have a charge of _____.

The only non-metal atom that forms a positive ion is hydrogen – it loses the 1 electron in tis outer shell to give it a charge of _____.

Negative Ions



Non-metal atoms _____ electrons to get a full outer shell when they become an ion.

This means they have more electrons than protons so they will have a _____ charge.

If it gains 1 electron it will have a charge of _____.

If it gains 2 electrons it will have a charge of _____.

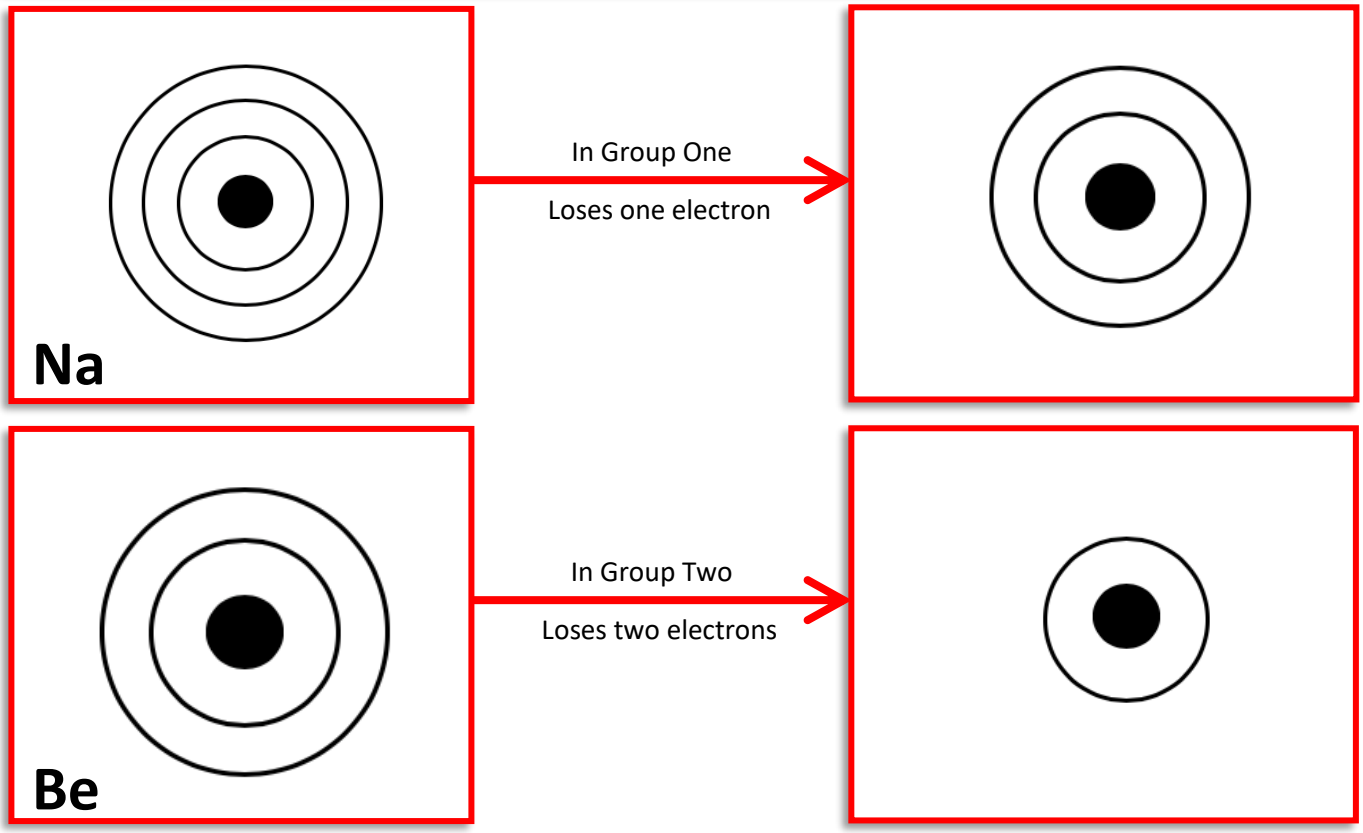
If it gains 3 electrons it will have a charge of _____.

When non-metal atoms gain electrons to form negative _____ their name changes to end in ide e.g. an oxygen atom gains 2 electrons to form a negative _____ ion with a charge of -2.

All ions have a _____ outer shell of electrons and all atoms have a charge. If an atom gains electrons it will have a _____ charge. If an atom loses electrons, it will have a _____ charge

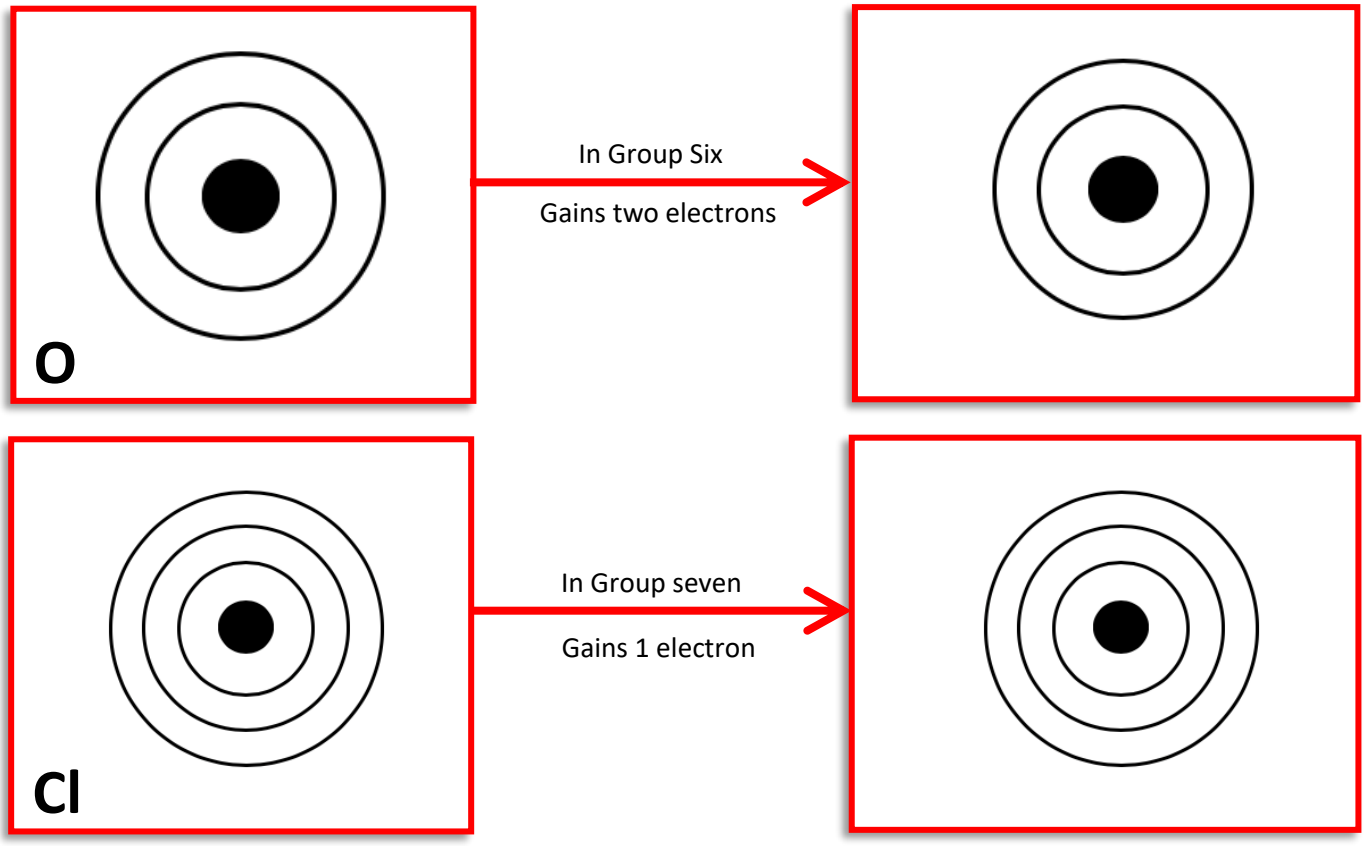
Positive Metal Ions

Metal atoms (and hydrogen) lose electrons to form positive ions



Negative non-metal Ions

Non-metal atoms (except hydrogen) gain electrons to form negative ions

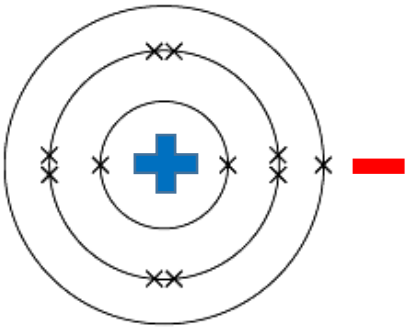


GROUP ONE ELEMENTS **Date: ……**

RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	Which sub-atomic particle has a positive charge?		
2	Which sub-atomic particle has a negative charge?		
3	How does the number of protons in an atom compare to the number of electrons?		
4	What is the name given to an atom with a different number of neutrons?		
5	What is the name given to an atom that has lost or gained electrons?		
6	Does the nucleus of an atom have a positive charge or a negative charge?		
7	What is the general name for elements in group 1?		
8	How many electrons will an atom of an element in group 1 have in its outer shell?		
9	Will an atom of a group 1 element gain or lose electrons when it forms an ion?		
10	What will the charge of a group 1 ion be?		
	Score:		

ACTIVATE KNOWLEDGE



The diagram above shows an atom of sodium in group 1. What do you think keeps the negative electrons in orbit around the positive nucleus? (What is the name of the forces of attraction between a positive charge and a negative charge?)

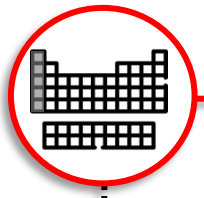
_____

_____

_____

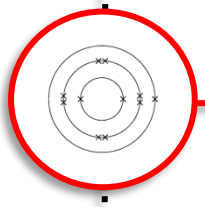
CONTENT

THE ALKALI METALS



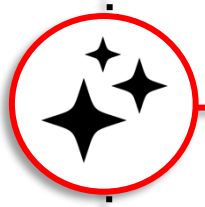
The alkali metals are in group _____ of the periodic table.

The alkali metals are :
_____
_____
_____



The atoms of alkali metals have _____ electron in their outer shell.

This makes them very reactive because the single outer shell electron can be _____ easily.

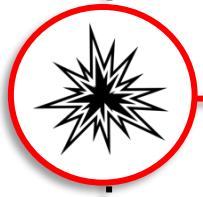


The alkali metals are _____, silvery solids.

This is because they are _____, and found on the _____ hand side of the periodic table.

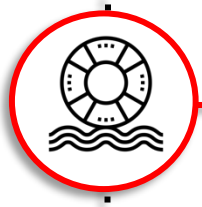
The alkali metals are _____.

The alkali metals can be _____ easily with a knife.



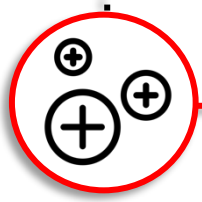
The alkali metals must be stored in _____.

This is because the alkali metals are so reactive – if they are not stored in oil they will react with the _____ in the air.



Have a _____ density.

Lithium, sodium and potassium are all less dense than water so they will _____ on the surface of water.



Form positive ions with a charge of _____ so form _____ compounds with non-metals

Group one metals form _____ ions when they lose their outer shell electron. They bond with _____ non-metals ions to form _____ compounds. These compounds are usually _____ solids, such as sodium chloride.

The Reactions of the Alkali Metals

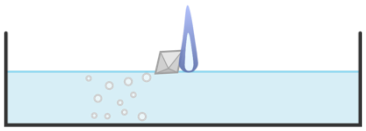
with water

The alkali metals react vigorously with water. They will float and move about on the surface of the water.

Hydrogen gas is produced so you will see _____.

A metal hydroxide is also produced. Metal hydroxides are alkali so if you add universal indicator it will turn _____. This is why the group 1 metals are called the alkali metals.

metal + water → metal hydroxide + hydrogen



Observations when the metal is added:

_____
_____
_____

Observations of the products:

_____
_____
_____

Observations when universal indicator is added and why:

_____
_____
_____

lithium + water → lithium hydroxide + hydrogen

$2Li + 2H_2O \rightarrow 2LiOH + H_2$

sodium + water → sodium hydroxide + hydrogen

$2Na + 2H_2O \rightarrow 2NaOH + H_2$

potassium + water → potassium hydroxide + hydrogen

$2K + 2H_2O \rightarrow 2KOH + H_2$

The Reactions of the Alkali Metals

with chlorine

The alkali metals are very reactive.

The alkali metals react _____ with chlorine gas.

The alkali metals are shiny silvery solids.

Chlorine is a _____ gas.

The product is a metal _____.

Metal chlorides are normally _____ solids.

Metal + Chlorine → Metal Chloride

lithium + chlorine → lithium chloride
2Li + Cl_2 → 2LiCl

sodium + chlorine → sodium chloride
2Na + Cl_2 → 2NaCl

potassium + chlorine → potassium chloride
2K + Cl_2 → 2KCl

with oxygen

The alkali metals are very reactive.

The alkali metals react rapidly with oxygen gas in the air.

A metal _____ is produced – the type of metal oxide depends on which group 1 element it is.

This is why when you cut a group one metal the surface becomes _____ – because it is reacting with oxygen in the _____ to form a dull metal oxide layer on the surface.

Metal + Oxygen → Metal Oxide

lithium + oxygen → lithium oxide
4Li + O_2 → $2Li_2O$

sodium + oxygen → sodium oxide
4Na + O_2 → $2Na_2O$

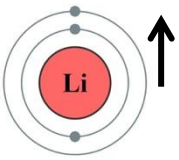
potassium + oxygen → potassium oxide
4K + O_2 → $2K_2O$

As you move down group one…

Lithium
Sodium
Potassium
Rubidium
Caesium
Francium

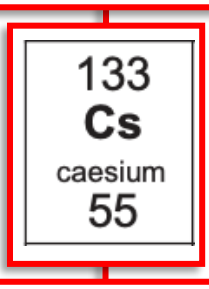
- The atoms have _____ shells.
- The size of the atom _____
- The elements become _____ reactive.

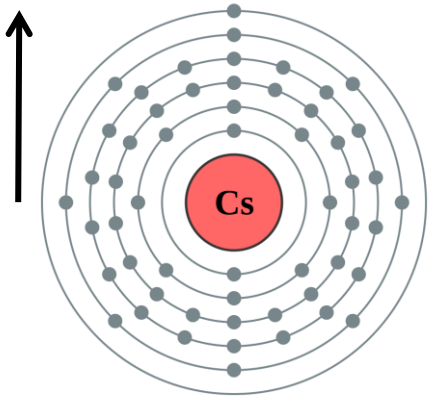
At the top of group 1



The _____ is smaller
The atom has fewer _____.
The outer electron shell is _____ to the nucleus.
There is less _____ between the positive nucleus and the negative electron on the outer shell.
This makes the _____ forces between the negative electron on the outer shell and positive nucleus stronger.
This means the electron on the outer shell is less easily _____.

At the bottom of group 1





The atom is _____.
The atom has _____ shells.
The outer electron shell is further from the _____.
There is _____ shielding between the positive nucleus and the negative electron on the outer shell.
This makes the electrostatic forces between the negative electron on the outer shell and positive nucleus _____.
This means the electron on the outer shell is _____ easily lost.

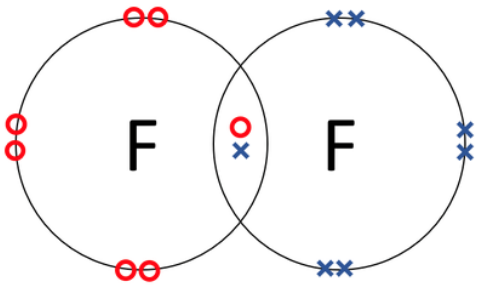
This means the alkali metals get more _____ as you go down the group.

GROUP SEVEN ELEMENTS **Date: ……**

RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	What is the general name for the elements in group 7?		
2	How many electrons will atoms of elements in group 7 have in their outer shell?		
3	How many more electrons do atoms of elements in group 7 need to have a full outer shell?		
4	Are elements in group 7 metals or non-metals?		
5	What is the name given to the sub-atomic particle with a positive charge?		
6	What is the name given to the sub-atomic particle with a negative charge?		
7	Will an atom of a group 7 element gain or lose electrons when it forms an ion?		
8	What will the charge of a group 7 ion be?		
9	What will be the name of the ion when a chlorine atom becomes an ion?		
10	What will be the formula of the ion when a chlorine atom becomes an ion?		
	Score:		

ACTIVATE KNOWLEDGE



A fluorine molecule (F_2)

What is a molecule and why do the elements of group seven exist as molecules?

_____

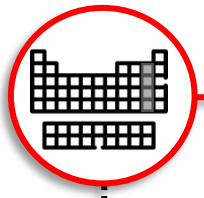
_____

_____

_____

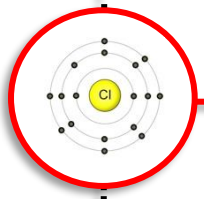
CONTENT

THE HALOGENS



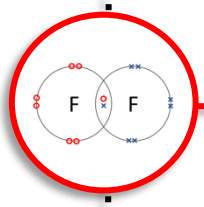
The halogens are in group _____ of the periodic table.

The halogens are:
_____
_____
_____



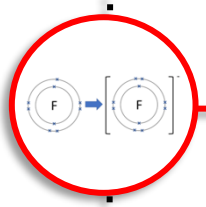
The atoms of halogens all have _____ electrons in their outer shell, so they have similar chemical properties.

To have a full outer shell they need to gain _____ electron. This is what happens when they react to form compounds.



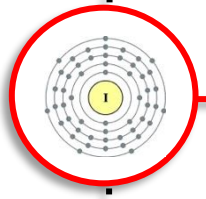
The halogens exist as diatomic _____. These are pairs of atoms covalently bonded together.

The halogens form molecules where they share _____ pair of electrons in a covalent bond. This gives them a full outer shell.



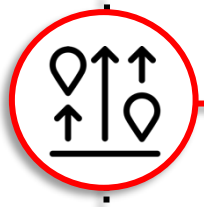
The halogens can form ionic compounds with _____

The halogens form ions called halides with a _____ charge of _____ when they gain an electron from a metal atom.



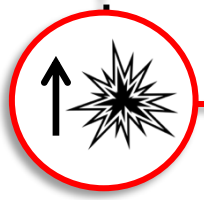
As you go down group 7 the atoms of elements _____ in size, as the atoms have more shells.

As you go down group 7 the mass of the molecules increase, because the atoms increase in size and have _____ protons and neutrons.



As you go down group 7 the melting point and boiling point of the elements _____.

At room temperature fluorine and chlorine are gases, bromine is a _____ and iodine and astatine are solids.



As you go down group 7 the elements become _____ reactive.

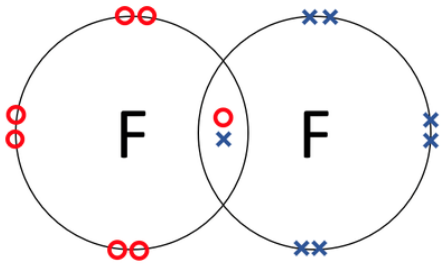
Fluorine is the most reactive group 7 element because it has fewer electron shells, so it is easier for it to gain an extra electron.

The halogens exist as pairs of atoms called molecules

The halogens do not exist as individual atoms, instead they exist as pairs of atoms.
For example, fluorine exists as F_2, chlorine exists as Cl_2, bromine exists as Br_2 and iodine exists as I_2.

These pairs of atoms are called diatomic molecules, because they are made up of two atoms covalently bonded together.

The atoms form a covalent bond with one another and share one pair of electrons. This gives them a full outer shell and a stable arrangement.



The Reactions of the Halogens

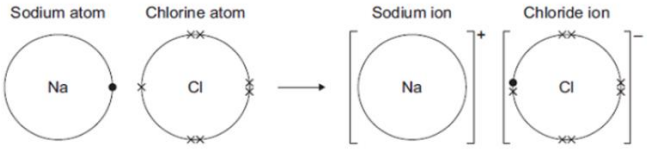
with metals

The halogens form ionic bonds with metals to form ionic compounds.

The halogens form ions with a negative charge of -1 called halides.

Examples of the halide ions are F^-, Cl^-, Br^- and I^-

For example, chlorine bonds with sodium to form sodium chloride:



The sodium atom transfers an electron to the chlorine atom.
The sodium atom becomes a positively charged sodium ion with a charge of +1.
The chlorine atom becomes a negatively charged chloride ion with a charge of -1
The atoms are oppositely charged and so are attracted to one another. The oppositely charged ions are held together with strong electrostatic forces of attraction, forming the ionic bond.
The ionic compound is a salt called sodium chloride.

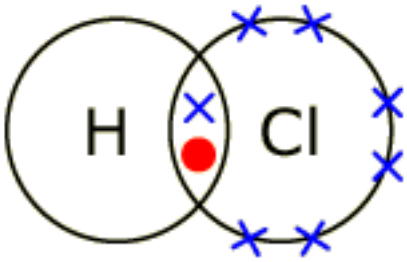
with non-metals

The halogens form covalent bonds with non-metals to form covalent compounds.

These covalent compounds are called molecules – because they are made up of two or more non-metal atoms covalently bonded together.

In a covalent bond the atoms share pairs of electrons to give them a full outer shell of electrons and a stable arrangement.

For example, chlorine bonds with hydrogen to form hydrogen chloride.



The hydrogen and chlorine atom share one pair of electrons, so that they will then both have a full outer shell of electrons. The chlorine atom now has 8 electrons in its outer shell, and the hydrogen atom now has 2 electrons in its outer shell – making them both full.

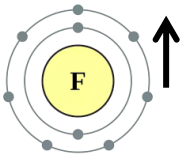
As you move down group seven…

Fluorine	Very reactive poisonous yellow gas
Chlorine	Fairly reactive poisonous dense green gas
Bromine	Dense, poisonous red-brown liquid
Iodine	Purple crystalline solid
Astatine	Nobody has ever seen astatine, but it is believed to be a black solid.

- The atoms have _____ shells.
- The size of the atom _____
- The mass of the atoms _____
- The melting point and boiling point of the elements _____
- The elements become _____ reactive.

At the top of group 7

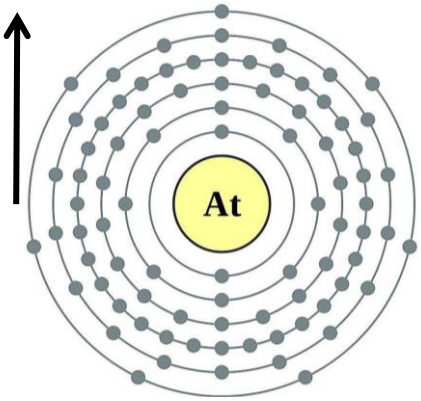
19
F
fluorine
9



The _____ is smaller
The atom has fewer _____.
The outer electron shell is _____ to the nucleus.
There is less _____ between the positive nucleus and the outer shell.
This makes the _____ forces between the outer shell and positive nucleus stronger.
This makes it easier for the positive nucleus to attract an extra _____

At the bottom of group 7

[210]
At
astatine
85



The atom is _____.
The atom has _____ shells.
The outer electron shell is further from the _____.
There is _____ shielding between the positive nucleus and the outer shell.
This makes the electrostatic forces between the outer shell and positive nucleus _____.
This makes it _____ for the positive nucleus to attract an extra electron.

This means the halogens get less _____ as you go down the group.

Displacement reactions involving the halogens.

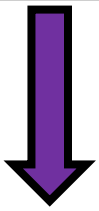
In a displacement reaction a more reactive element displaces a less reactive element.

The group seven elements can displace one another if they are more reactive e.g.

fluorine + sodium chloride → sodium fluoride + chlorine

The fluorine has displaced (pushed out) the chorine because fluorine is more reactive than chlorine.

The fluorine and chlorine swap places, and the fluorine becomes part of the compound with the sodium.

Group 7 Element	Can displace:	Reactivity
Fluorine	Chlorine, bromine, iodine and astatine	Most Reactive
Chlorine	bromine, iodine and astatine	
Bromine	iodine and astatine	
Iodine	astatine	
Astatine	-	Least Reactive

In the following examples consider whether a displacement reaction would take place.

If a reaction would take place give the product of the chemical reaction:

Reactants		Products if a reaction takes place
fluorine + sodium chloride	→	
chlorine + sodium fluoride	→	
bromine + sodium iodide	→	
bromine + sodium chloride	→	
fluorine + potassium chloride	→	
chlorine + potassium fluoride	→	
bromine + potassium iodide	→	
bromine + potassium chloride	→	
Fluorine + magnesium iodide	→	
Chlorine + magnesium bromide	→	
Bromine + magnesium fluoride	→	
Chlorine + magnesium fluoride	→	

A more reactive halogen can _____ a less reactive halogen.

The most reactive halogen is _____, which can displace all the other halogens.

DEVELOPMENT OF THE PERIODIC TABLE **Date: ……**

RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	Which two sub-atomic particles are found in the nucleus of an atom?		
2	Where are electrons found in an atom?		
3	What is the name given to an atom with a different number of neutrons?		
4	What does the bottom (atomic) number on the periodic table tell you about an atom?		
5	How does the number of protons compare to the number of electrons in an atom?		
6	What is the general name for elements in group 1 of the periodic table?		
7	Why do all of the elements in group 1 have similar chemical properties?		
8	What is the general name for elements in group 7 of the periodic table?		
9	What is the general name for elements in group 0 of the periodic table?		
10	Why are all of the elements in group 0 unreactive?		
	Score:		

ACTIVATE KNOWLEDGE

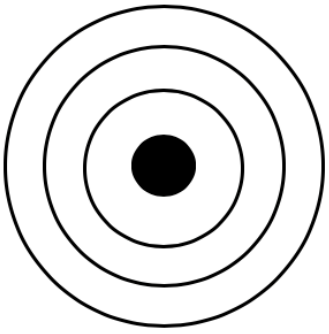
This key is on your periodic table:

relative atomic mass
atomic symbol
name
atomic (proton) number

Use this key and your own knowledge to complete the table and draw the electronic structure of phosphorus.

31
P
phosphorus
15

Name of element	
Symbol of element	
Relative atomic mass	
Atomic number	
Number of protons	
Number of electrons	
Number of neutrons	
Electronic structure	



CONTENT

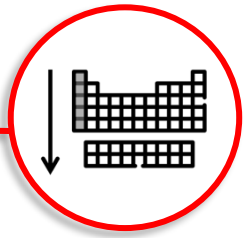
The Periodic Table Now

Scientists all over the world use the periodic table.

In the periodic table elements are in order of their atomic number (number of protons).

Elements with similar properties are found in the same group.

The table is called a periodic table because similar properties appear at regular intervals



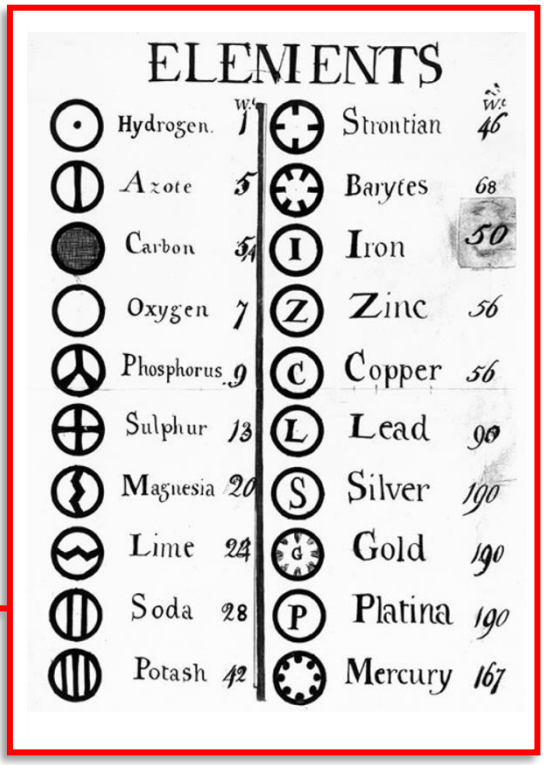
The Periodic Table Then

In 1789 a French chemist called Antoine Lavoisier defined an element as a substance that cannot be broken down into a simpler substance by a chemical reaction.

In the 1700's they had discovered elements such as oxygen, hydrogen, nitrogen, mercury, zinc and sulphur – but they did not know that sub-atomic particles existed. They knew nothing about protons, neutrons and electrons.

By 1789, 27 of the substances we now know as elements had been discovered. Though scientists at the time did not recognise them all as elements. Lavoisier attempted to put the elements he knew of into a list. He tried to group them by their properties, such as if they were metals or non-metals – but he also included light and a substance called caloric, because at that time they though heat was a fluid!

In 1808 John Dalton, a Manchester based scientist, assigned atomic weights to 20 of the elements he knew about at that time. He said that each element consisted of its own unique brand of indivisible atom; atoms of one element are all alike but they differ from atoms of other elements.



This led to many scientists trying to create periodic tables arranging elements in order of their atomic weight.

However, the early periodic tables were wrong and incomplete – because a number of elements had not been discovered yet - and some elements were placed into inappropriate groups when they used the atomic weights to order them. For example, non-metals were placed in groups with metals.

Dmitri Mendeleev, a Russian scientist, is known as the father of the modern periodic table. In 1869 he published his periodic table. He also ordered the elements by atomic weight, but he overcame some of the problems faced by other scientists by:

- leaving gaps for elements that hadn't been discovered yet.
- changing the order of some of the elements. (Rather than just basing it on atomic weight he swapped some of the elements around to make sure elements with similar properties were together.)

Evidence for Mendeleev's Periodic Table

Mendeleev left gaps for elements that hadn't been discovered yet.

As he made sure that elements with similar properties were placed together, it meant he was able to predict the properties of the elements he had left gaps for – that hadn't been discovered yet!

The element that really provided evidence to show Mendeleev was on the right lines was gallium. In 1871 he predicted the existence of an as yet unknown element, calling it eka-aluminium. He left a gap for it on his periodic table. Based on where it would fit he predicted its atomic weight, density and melting point.

In 1875 the element gallium was discovered – it matched with the properties Mendeleev had predicted pretty much perfectly!

Dmitri Mendeleev
1834 - 1907

Moving on from Mendeleev

In 1897 the first sub-atomic particle – the electron was discovered by a scientist called J.J. Thomson – who was born in Cheetham Hill in Manchester.

In 1911 a scientist called Ernest Rutherford discovered that atoms had a nucleus, where the mass of the atom was concentrated – and that the nucleus had a positive charge.

Henry Moseley was a scientist who worked with Ernest Rutherford in Manchester. He said that atomic numbers, not weights, determined how often similar chemical properties were repeated. In 1913 he proposed that the elements should be ordered by atomic number rather than atomic weight. He had discovered that the basic difference between elements is the number of positive charges they have and that this was equal to the atomic number. These positive charges were later discovered and called protons by Rutherford in 1919. Moseley realised that an element is ***defined*** by its number of positive charges. If an element has one positive charge it ***must*** be hydrogen; two positive charges ***must*** be helium, three positive charges ***must*** be lithium etc. Although this may seem obvious to us today, it was a huge discovery in 1913 – after years of searching, at last we had a periodic table that really worked.
In 1914 Moseley left Rutherford's Manchester laboratory planning on going to Oxford to carry on his physics research, but the outbreak of World War 1 put a stop to those plans. He volunteered for the Royal Engineers of the British Army. He served in Gallipoli, Turkey as a telecommunications officer. On the 10th August 1915, at the age of 27, he was shot and killed by a sniper. Given all that he had accomplished at such a young age, Isaac Asimov noted that Moseley's death "might well have been the most costly single death of the war to mankind generally." Indeed, because of it, the British government established a new policy barring the country's most prominent scientists from engaging in active combat duty. Experts have speculated that Moseley could have been awarded the Nobel Prize in Physics in 1916, if he had not been killed.

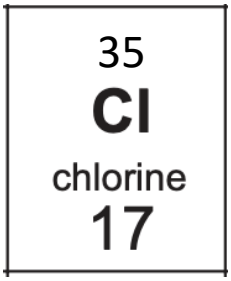
The term isotope was first used in 1913, by Scottish doctor Margaret Todd in a conversation with her cousin Frederick Soddy. He had discovered that atoms of the same element could have different atomic masses. This provided more evidence that elements should not be ordered by their atomic weight. The term isotope is a combination of the Greek word Isos, which means equal, and topos, the word for place. Todd suggested he call them isotopes, because they occupied the 'same place' in the periodic table.

James Chadwick was a scientist born in Cheshire, he was the son of a cotton spinner and domestic servant. At the age of 16 he sat an exam and won a scholarship to attend the University of Manchester. He walked the 4 miles to the university and back each day and studied under Ernest Rutherford. He would go on to discover the neutron in 1932. Chadwick was then able to explain the existence of isotopes through this discovery– because isotopes are atoms that have the same number of protons and electrons but a different number of neutrons, making the mass different.

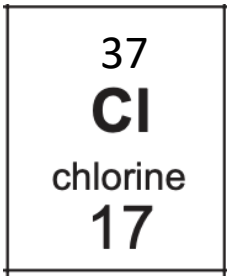
Isotopes and the Periodic Table

Isotopes are naturally occurring atoms of the same element with a different number of neutrons – this gives the atoms a different atomic mass.
(Atomic mass = the mass of an individual atom = protons + neutrons)

The element chlorine has two common isotopes:



75% of all chlorine atoms have an atomic mass of 35



25% of all chlorine atoms have an atomic mass of 37

We can use this information to find the relative atomic mass of chlorine.
(Relative atomic mass = the average mass of atoms of that element, based on how abundant the atoms are.

$$\text{Relative Atomic Mass} = \frac{(\text{Mass of isotope 1} \times \text{percentage}) + (\text{Mass of isotope 2} \times \text{percentage})}{100}$$

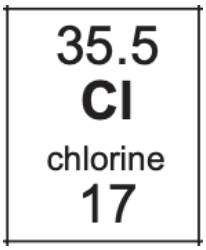
$$\text{Relative atomic mass of chlorine} = \frac{(35 \times 75) + (37 \times 25)}{100}$$

$$\text{Relative atomic mass of chlorine} = \frac{2625 + 925}{100}$$

$$\text{Relative atomic mass of chlorine} = \frac{3550}{100}$$

Relative atomic mass of chlorine = **35.5**

This is why in the periodic table the relative atomic mass is given as 35.5

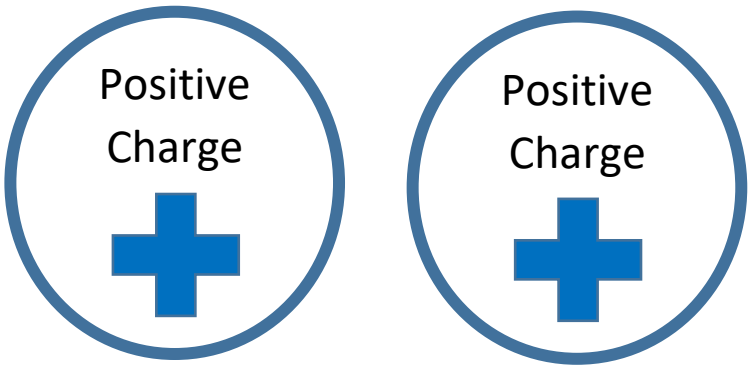


DEVELOPMENT OF THE MODEL OF THE ATOM **Date: ……**

RETRIEVAL ACTIVITY

	Question	Answer	Mark
1	Which sub-atomic particles are found in the nucleus of an atom?		
2	Which sub-atomic particles are found in shells surrounding the nucleus?		
3	What is the relative charge of a proton?		
4	What is the relative charge of a neutron?		
5	What is the relative charge of an electron?		
6	What is the relative mass of a proton?		
7	What is the relative mass of a neutron?		
8	What is the relative mass of an electron?		
9	Is the nucleus of an atom positively or negatively charged?		
10	Is the mass of an atom concentrated in the nucleus or the shells surrounding the nucleus?		
	Score:		

ACTIVATE KNOWLEDGE



If you have two positively charged particles near to one another what do you think will happen and why?

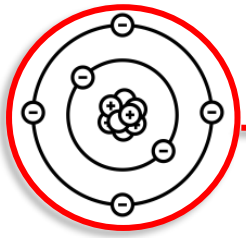
_____

_____

_____

CONTENT

The Atom Now



We now know that all substances are made up of atoms, and atoms are made up of protons, neutron and electrons.
We know that protons and neutrons are found in the nucleus and electrons are found in shells surrounding the nucleus.
We know the first shell can hold 2 electrons and the second and third shell can both hold 8 electrons each.

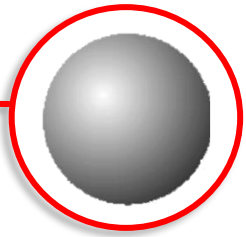
We know that protons have a positive charge, neutrons have no charge and electrons have a negative charge – so the nucleus of an atom is positively charged.

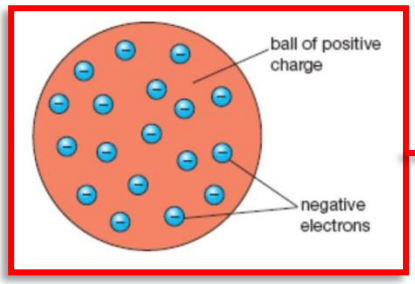
We know that protons and neutrons have a relative mass of 1 and the relative mass of an electron is very small – so the mass of an atom is concentrated in the nucleus.

But we didn't always know this. Over time there have been lots of theories about what an atom looks like and what it is made up of. The development of ideas about the atom is an excellent example of a model changing over time – as more evidence was gathered the current model was changed and replaced – until we get to the model of the atom we have today.

The Atom Then

Over 2000 years ago ancient Greek philosopher Democritus named atoms – calling them atomos, which means indivisible. He said that atoms were solid spheres which could not be divided into anything smaller.
John Dalton expanded on this model in 1803 with his billiard ball model – he said atoms of the same element are alike and atoms of different elements are different, and he agreed with Democritus that atoms were tiny solid spheres and it was impossible to divide an atom into anything smaller.





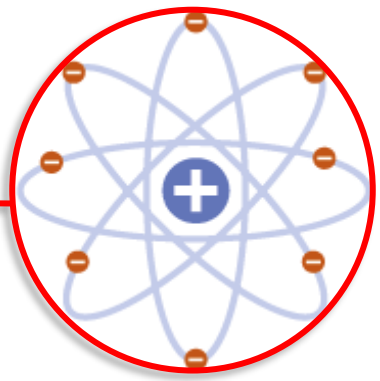
In 1897 the Manchester born scientist J.J. Thomson discovered the electron. This suggested an atom was not indivisible – but made up of smaller particles.
Thomson suggested the plum pudding model to represent what he thought an atom looked like.
The plum pudding model suggested that the atom is a ball of positive charge with negative electrons embedded in it.

In 1911 Ernest Rutherford put forward the nuclear model of the atom.

This model suggested that:

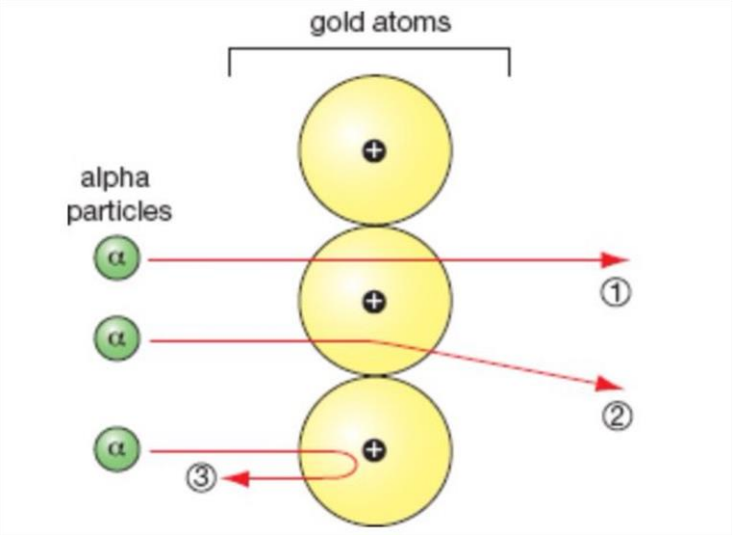
- The mass of an atom is concentrated in a central nucleus.
- The central nucleus of an atom is positively charged.
- The central nucleus of an atom is very small.
- Most of an atom is made up of empty space.

How did Rutherford develop these ideas? Through experimentation…



In 1911 Ernest Rutherford wanted to investigate what gold atoms were made up of so he took a very thin piece of gold foil – just 0.00004cm thick.

He fired alpha particles at the gold foil. Alpha particles are the nucleus of a helium atom – so are tiny positively charged particles. This is what happened when he fired the positive alpha articles at the gold foil:

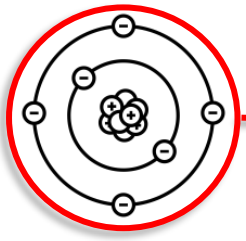


What was observed	What this showed about the atom
1. **Most** of the alpha particles passed straight through the gold foil.	These alpha particles had passed through the space surrounding the nucleus. This showed that most of the atom is made up of empty space.
2. **Some** alpha particles passed though the gold foil, but changed their direction as they moved through it.	These alpha particles had travelled near to the nucleus of the gold atoms. This showed that the nucleus of an atom is positively charged, because the positively charged alpha particles were repelled by the positively charged gold nucleus.
3. **A few** alpha particles bounced off the gold fold and then went backwards.	These alpha particles had hit the nucleus of the gold atoms. This showed that the mass of the atom was concentrated at the central nucleus, and that the nucleus was very small.

In 1913 Niels Bohr a Danish scientist, developed this model of the atom even further. He suggested the model of the atom called the energy level model.
He agreed with Rutherford that the mass of the atom was concentrated at the nucleus and the nucleus was positively charged.

He was the first to realise that electrons travel in separate orbits around the nucleus. He developed Rutherford's model by suggesting that electrons orbit the nucleus at specific distances in energy levels or shells.

Later experiments led to the idea that the positively charged nucleus was actually made up of smaller positively charged particles called protons. Protons were discovered by Ernest Rutherford in 1919. Each proton has the same amount of positive charge giving it a relative charge of +1.



In 1932, about 20 years after the nucleus was first discovered James Chadwick provided experimental evidence to prove the existence of neutrons within the nucleus.

This led to the atomic model we use today. We now know that a single atom has a radius of about 0.1nm (1×10^{-10}m) and the radius of a nucleus is less than 1/10,000 of the atom (about 1×10^{-14}m)

Scientific theories and models develop over time as new evidence is discovered which disproves old theories. New theories are made to explain the new evidence.

Development of the Atom

Dalton - 1803
Theorized that everything is made of atoms, which are tiny solid spheres that cannot be broken down.

Billiard Ball Model.

JJ Thompson - 1897
Discovered electrons. Theorized that atoms are balls of positive charge with negative electrons embedded in them.

Plum Pudding Model

Ernest Rutherford – 1911
Theorized atoms are mostly empty space with a small positive nucleus where the mass is concentrated.

Nuclear Model

Niels Bohr – 1913
Theorized electrons orbit the positive nucleus of the atom at specific distances in energy levels or shells.

Energy Level Nuclear Model

Ernest Rutherford – 1919
Discovered protons.

James Chadwick – 1932
Discovered neutrons.

Modern Nuclear Model

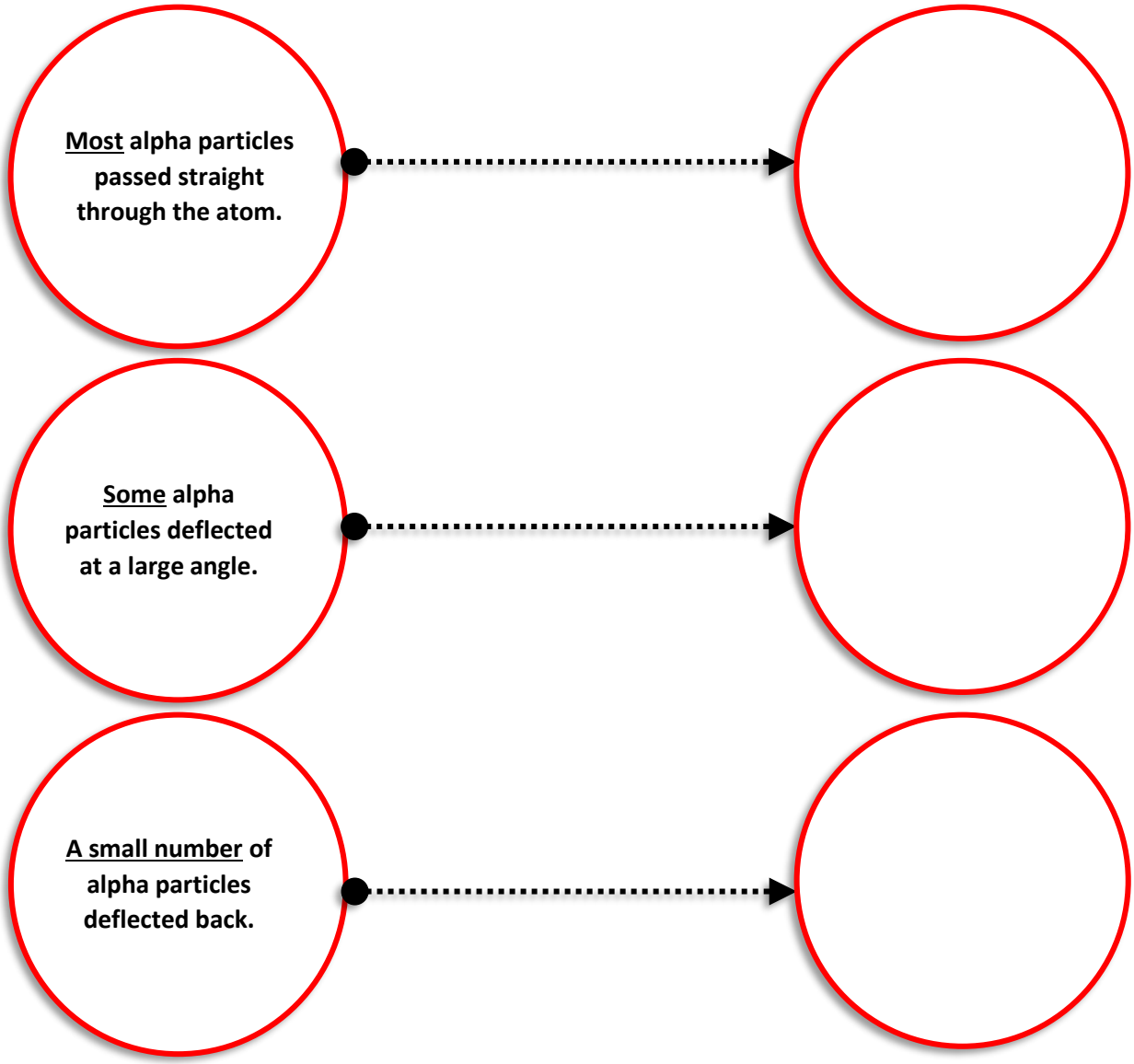
All scientific theories undergo peer review. This is where other scientists check theories to see if the evidence is correct. Peer review is important to avoid bias and improve validity.

The Alpha Scattering Experiment

Rutherford fired positive alpha particles at a thin sheet of gold foil.

Diagram:

Rutherford evidence led him to make three main conclusions about the atom.



RETRIEVAL ACTIVITIES

	Question	Answer	Mark
1	What was used to order atoms in the first periodic table?		
2	What is used to order atoms in the modern periodic table?		
3	Which scientist developed the modern periodic table?		
4	How did Mendeleev ensure that as yet undiscovered would fit in his periodic table?		
5	What did Mendeleev do so that elements with similar properties would be together in his periodic table?		
6	The discovery of which type of atom, with a different number of neutrons, showed that the early periodic tables were wrong?		
7	How did Mendeleev's predicted properties of undiscovered elements compare to their actual properties when they were discovered?		
8	What does the atomic number of an atom tell us about the atom?		
9	What does the atomic number of an atom tell us about the atom?		
10	What does the mass number of an atom tell us about the atom?		
	Score:		

	Question	Answer	Mark
1	What is the name of the early atomic model describing a ball of positive charge with negative electrons embedded in it?		
2	Which scientist discovered neutrons?		
3	Which scientist discovered electrons orbit the nucleus?		
4	Which scientist discovered protons?		
5	Which scientist discovered electrons and suggested the plum pudding model?		
6	In the alpha scattering experiment most alpha particles passed through the gold foil. What did this tell us about atoms?		
7	In the alpha scattering experiment some alpha particles changed angle as they passed through the gold foil. What did this tell us about atoms?		
8	In the alpha scattering experiment a few alpha particles bounced back off the gold foil. Name one thing this told us about atoms?		
9	Which of the three sub-atomic particles was discovered first?		
10	Which of the three sub-atomic particles was discovered most recently?		
	Score:		