

What is an element?

- A substance that is made up of one type of atoms
- Let us give some examples of elements that we know

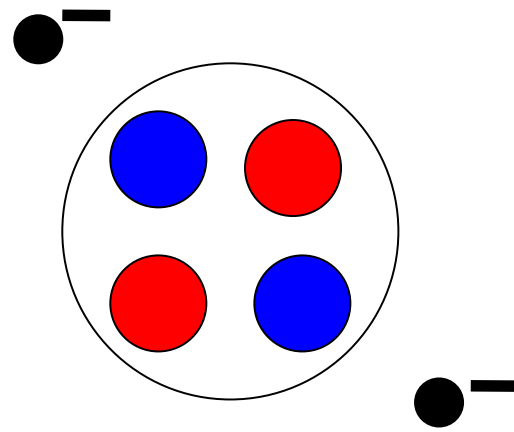
Atomic Structure

- Atoms are particles of elements
- Substances that cannot be broken down further
- They cannot be broken down further without changing their chemical nature

If you take an individual atom and break it down, then that will change its chemical property

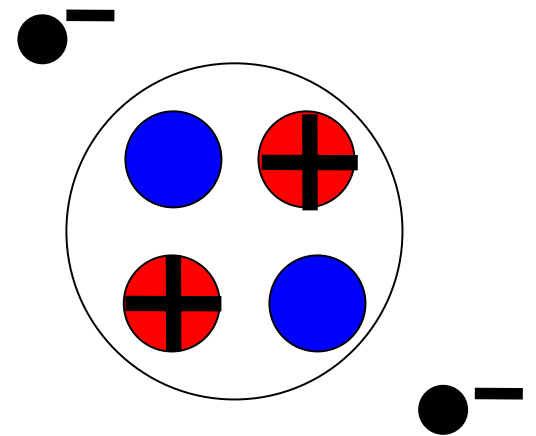
What are atoms made of?

- They are made up of 3 types of particles
 - Electrons
 - Protons
 - Neutrons

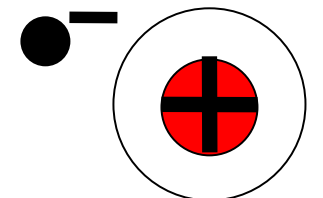


- These particles have different properties
- Electrons are tiny, very light and have a negative charge

- **Protons** are much larger and heavier than electrons
- They have a **positive charge**
- **Neutrons** are large and heavy
- They have no charge
- Each atom is made up of a combination of these particles – electrons, protons and neutrons



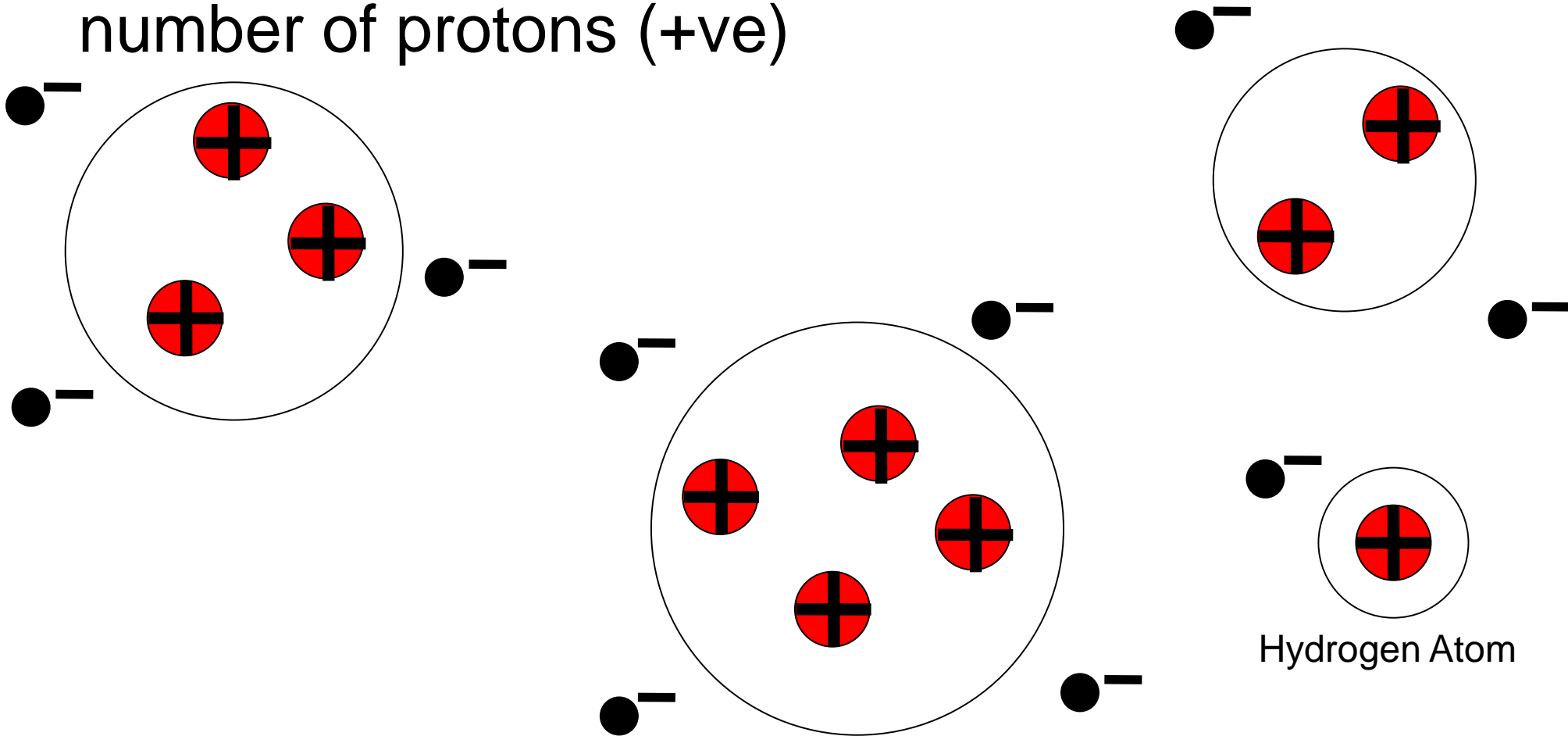
- Atoms are very small
- Take an example of a hydrogen atom
- It has one proton, one electron and no neutron
- A hydrogen atom is so small that in a dash like this one:
-
• if that dash is 1 mm long, there would be about 20 million hydrogen atoms to make that length



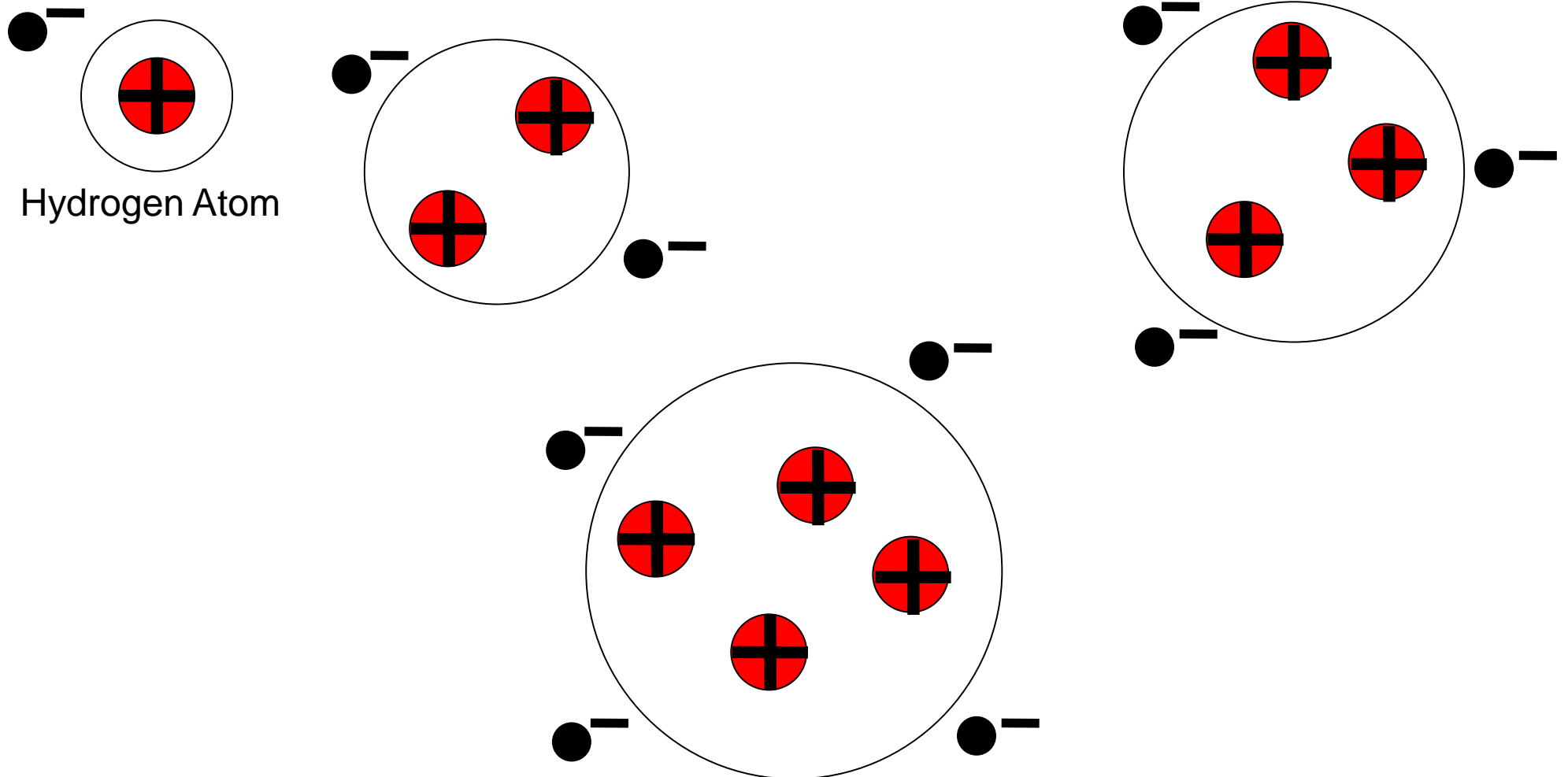
Hydrogen Atom

Neutral Atoms

- Naturally atoms have a neutral charge
- The number of electrons (-ve), is equal to the number of protons (+ve)



- You will realize that as you move from one element to another the number of protons increases

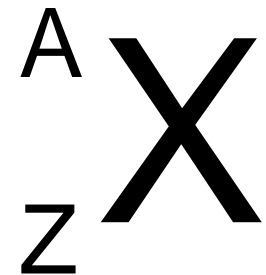


Atomic number

- The number of protons in an atom is known as the atomic number
- Atomic number also tells you no. of electrons
- The mass of an atom is made up by the number of protons and neutrons
- Electrons are so light that they contribute very little to the mass of an atom
- Mass of an atom = no. protons + no. neutrons is called mass number
- Atomic mass tells you no. of protons plus neutrons

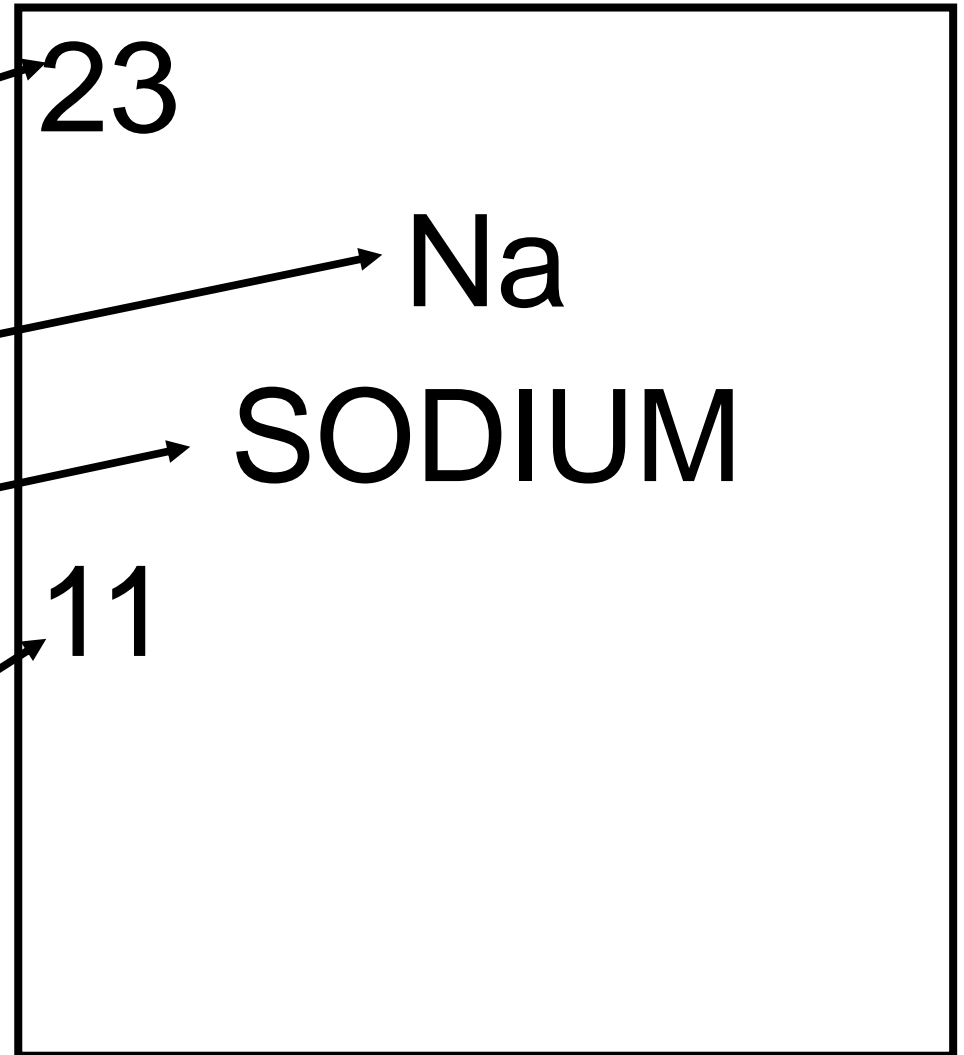
Elemental Notation

- It is a short way of writing information about the atom of a particular element
- The big X represents where you will find the symbol of the element
- “A” stands for mass number
- “Z” stands for the atomic number



What does it all mean?

- Each element has a mass number (the bigger one)
- Each element has a symbol (short way of writing it)
- Each element has a name
- Each element has an atomic number (the smaller one)



- Carbon – 6 protons, 6 neutrons
- Calcium – 20 protons, 20 neutrons
- Lithium – 3 protons, 4 neutrons
- Hydrogen – 1 proton, 2 neutrons
- Fluorine – 9 protons, 10 neutrons
- Hydrogen – 1 proton, 1 neutron
- Oxygen – 8 protons, 8 neutrons
- Hydrogen – 1 proton, 0 neutrons
- Barium – 56 protons, 80 neutrons

¹²C
6

⁴⁰Ca
20

⁷Li
3

³H
1

¹⁹F
9

²H
1

¹⁶O
8

¹H
1

¹³⁶Ba
56

To recap

- Elements are made from **atoms**
- Elements are found on the **Periodic table.**
- Each element has only one type of **atom.**
- Elements are arranged in columns called groups and rows called **periods.**

Isotopes

- Atomic number is unique to atoms of every element
 - If any two atoms have the same atomic number i.e. the same no. of protons, they are atoms of the same element
- It is possible to have atoms of the same element with different numbers of neutrons
- What determines the type of an atom is the atomic number – no. of protons
- Atoms which have same number of protons but different numbers of neutrons will have different mass numbers

- Atoms of the same element will always have the same number of protons
- But the number of neutrons can be different
- Atoms of the same element that have different numbers of neutrons are called Isotopes
- Isotopes are always identified by mass number
- For example, carbon 12 would be a carbon atom with mass number of 12 – 6 protons and 6 neutrons

- Carbon 14 has the mass number of 14 – 6 protons and 8 neutrons

Isotopes

• Atom	Protons	+ Neutrons	= Mass number
• Hydrogen1	1	0	1
• Hydrogen2	1	1	2
• Oxygen16	8		
• Oxygen17	8		
• Chlorine35	17		
• Chlorine37	17		

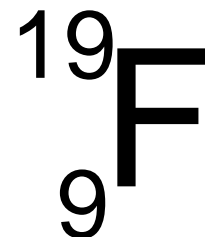
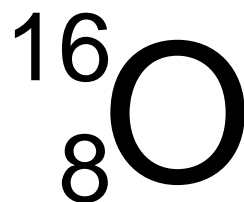
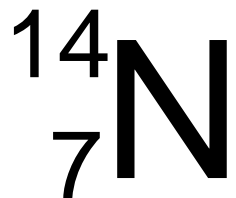
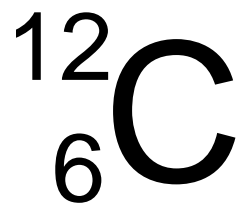
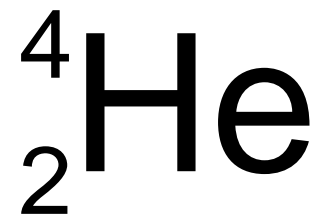
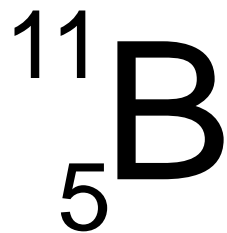
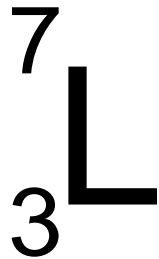
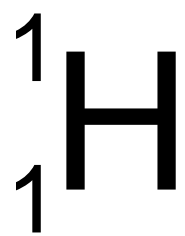
Electron Shells

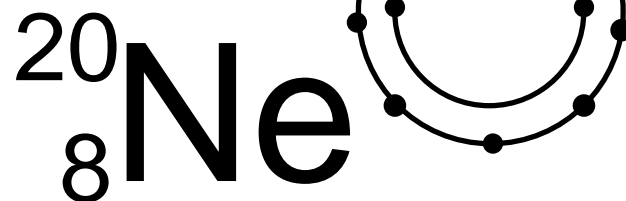
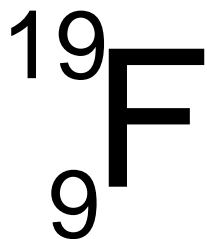
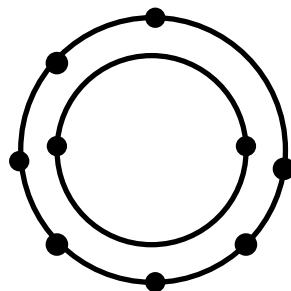
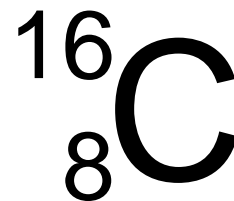
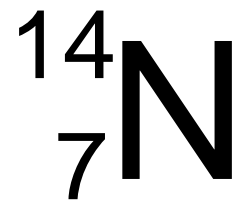
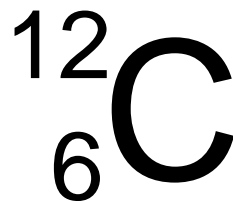
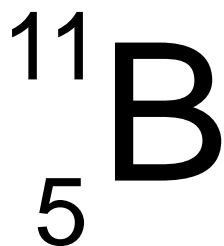
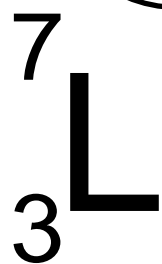
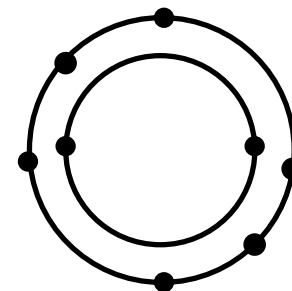
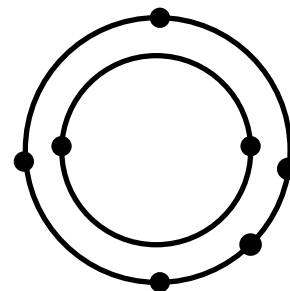
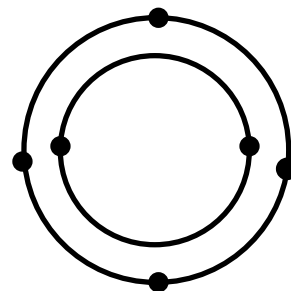
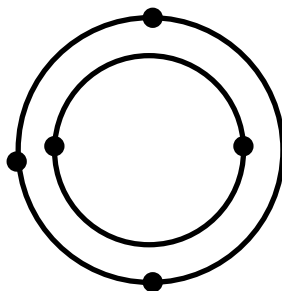
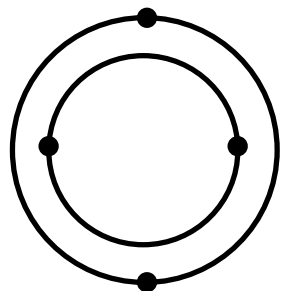
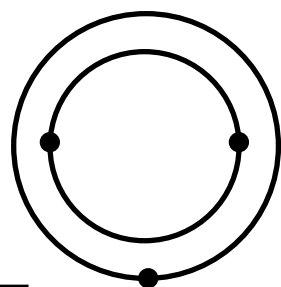
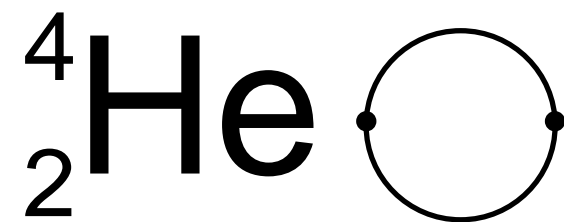
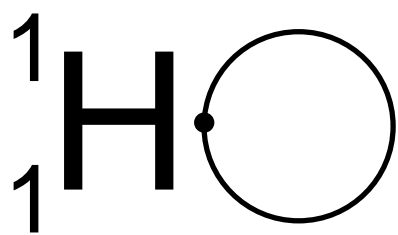
- Electrons are arranged around the nucleus in shells
- The Shells are numbered outward from the nucleus
- There is a definite arrangement of electrons in shells
- Maximum number of electrons found in a shell can be found by $2n^2$ where n is the shell no.

Electron Shells

Shell No. (n)	n^2	$2 \times n^2$
1	1	2
2	4	8
3	9	18
4	16	32
5	25	50

- In shell 1, the maximum number of electrons is 2
- The first shell is most stable when it is full – i.e. when it has 2 electrons
- After the first shell is filled, the second shell starts to fill
- The maximum number of electrons in the second shell is 8 – it is more stable when full
- Then the third starts to fill





The Octet Rule

- Atoms are most stable when they have 8 electrons in their outermost shells
- The exception is 1st shell which becomes stable with 2 electrons
- After the second shell is filled, things begin to get complicated
 - Third shell fills up to 8
 - Then the fourth shell begins to fill
 - Third shell fills up to 18

Valence Electrons

- Electrons in the outermost shell of an atom
- Valence electrons increase in number as you go across the period
- When you start the period, the number drops back to one and starts increasing again
- e.g. going from C, N to O, the valence electrons increase from 4 to 5 to 6
- Within a group in the periodic table, the valence number stays the same

- All elements in Group I have one valence electron
- You only need to know the group number to know the valence electrons
- But be careful of He in group VIII
- The pattern does not quite hold for the transition elements

Importance of Valence Electrons

- They are electrons in the highest energy level
- They are exposed
- They are electrons that get most involved in chemical reaction
- Electron dot diagrams are used to show valence electrons
- Drawn around the symbol of the atom as if there is a square around it – with up to two dots per side

- Use Lewis dot diagram to show the valence electrons of the following atoms:
- K, Al, As, F



- Elements in the periodic table are arranged according to atomic number
- Remember: atomic number determines the identity of the element
- The horizontal rows of the elements on the periodic table are called periods
- The columns are called groups
- The group number tells the valence electrons

- The table is set up such that it indicates the number of electron shells in each atom
- The number of valence electrons
- As you go down the rows, the number of shells increases
- As you move from left to right in any row, the number of valence electrons increases
- So you can predict the structure of the next atom

- The number of elements in a period increases as you move down the periodic table
- Elements within a group share a number of properties:
 - Valence electrons
 - Chemical properties

Categories of Elements

- Elements of the periodic table belong to 3 basic categories
 - Metals
 - Non-metals
 - Semi-metals or metalloids
- Majority of elements in the periodic table are considered metals
- These metals in the periodic table are divided into groups

Groups of Metals

- Alkali metals
 - Group I
 - Form salts and many other compounds
 - Highly reactive
- Alkaline Earth metals
 - Group II
- Transition metals
 - Very hard
 - High melting and boiling points

- Using the periodic table rows and groups one can predict a number of properties of atoms
- This is true for metals, non-metals and semi-metals
- In transition metals this simplified explanation of the properties of elements does not work