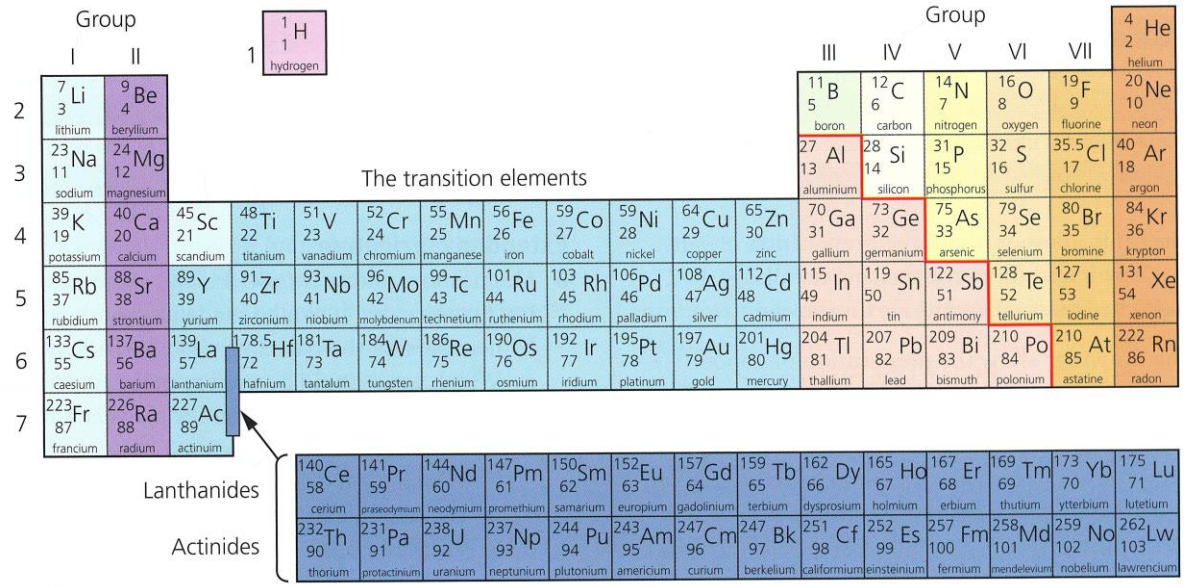
UNIT 5

PERIODIC TABLE and BONDING

1. The periodic table
2. Why do atoms bond
3. Types of substances
4. Atomic mass
5. Molecular mass
6. The mole

1.THE PERIODIC TABLE

In the periodic table the elements are arranged by increasing their atomic number so H is the first element because it has an atomic number of one, then on its right we have He which has an atomic number of two..



As the atomic number increases the number of electrons also increases. The important thing about the electrons is how they are placed around the nucleus. They are arranged in different energy levels and that is what determines their chemical behaviour.

The horizontal rows in the periodic table are called periods.

The vertical columns are called groups.

All the elements in the same group have similar properties and all the elements in the same period have electrons placed in similar energy levels.

We classify all the elements in two groups: metals and non-metals.

Metals are the elements on the left side of the red line.

In the picture you can see where they are placed.

The name of the groups are:

Alkali (alcalinos)

(Acalino térreos)
(Térreos)
(Carbonoideos)
(Nitrogenoideos)
(Anfígenos)

Halogens (Halógenos)
Noble gases (Gases nobles)
The noble gases are very stable, because they have eight electrons in the outer shell and this gives them a great stability.

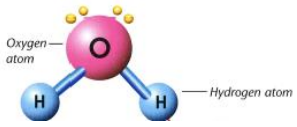
2.WHY DO ATOMS BOND

Atoms tend to join together to become more stable. For that reason, the majority of atoms, except those of the noble gases, are joined to other atoms forming chemical bonds.
Elements bond together to make substances (Both simple substances and compounds).
Atoms bond with each other in order to gain a stable arrangement of outer-shell electrons, like the noble gases group does.
This means that they bond to have 8 electrons in their outer shell. This is called the octet rule.
The three main types of bonding are:
Ionic bonding
Covalent bonding
Metallic bonding
Substances can form different structures:

- Molecules, are aggregates formed of a small, fixed number of atoms.
- Crystals, are aggregates formed of a large, variable number of atoms, ions or cations which are ordered in space.

3.TYPES OF SUBSTANCES

MOLECULES
Atoms that form this type of strucure: Non metal with non metal, they can be the same atoms (Cl_2)or different atoms(H_2O)
How do atoms bond: They bond by the electrons shared among the atoms.
They share one or more pair of electrons
Structure:
As two or more specific atoms join, they form molecules



Properties of molecules:

- Low melting and boiling points, most of them are gases, many are liquids and a few are solids.
- They don´t conduct heat nor eletricity.
- The ones which are solids are soft.

Examples: Cl_2, CO_2, H_2O....

Language:

Most
Many
A few

COVALENT CRYSTALS

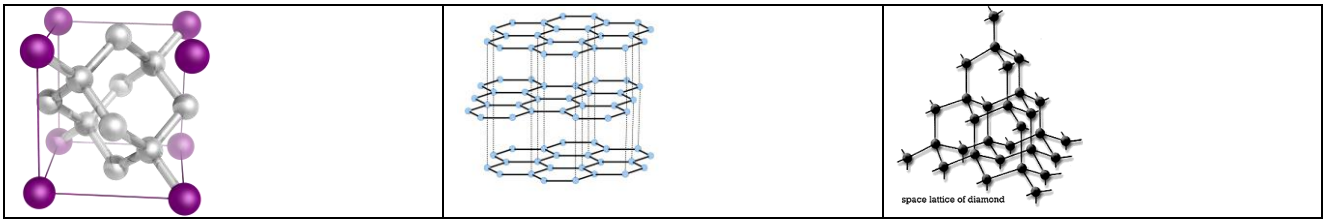
Atoms that form this type of structure: Non metal with non metal they can be the same atoms (Diamond C)or different atoms(Si O_2)

How do atoms bond: They bond by the electrons shared among the atoms.

They share one or more pair of electrons

Structure: Covalent lattice, with differents arrangements, depending on the substance.

A covalent lattice is a regular repeating arrangement of ATOMS in the solid



Properties of covalent crystals:

- All of them are in the solid state.

Examples: SiO2, C-graphite, C-diamond

IONIC CRYSTALS

Atoms that form this type of bond : Metal and non metal

How do atoms bond : This bond is made by the electron transfer between the metal and the non metal atoms.

The metal loses electrons, and becomes a cation.

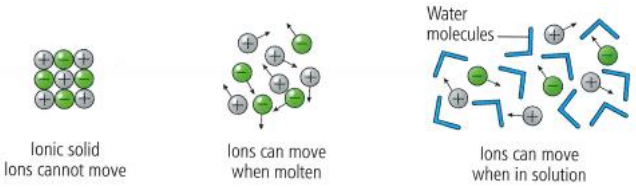
The non-metal gains the electrons that the metal loses and becomes an anion.

Ions stick together strongly because of electrostatic forces and they make an ionic substance.

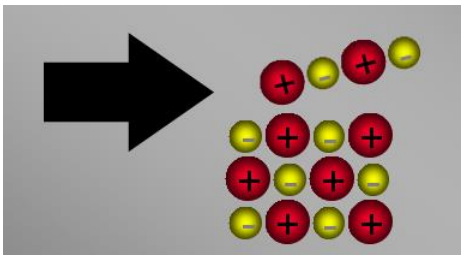
Structure: Ionic lattice, with differents arrangements, depending on the substance.
An ionic lattice is a regular repeating arrangement of IONS in the solid.

Properties of ionic compounds:

- They conduct electricity when they are melted or dissolved, because conducting allows the charges to move. When they are in the solid state the ions are locked in place. Ionic solids are insulators.

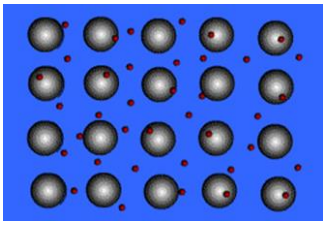


- They have high melting points because of the strong forces between ions.
- Ionic solids are brittle because, when we make a force in them strong repulsion breaks crystal apart.



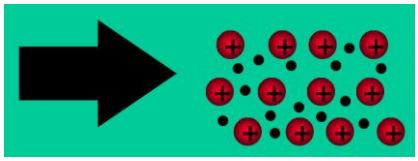
Examples: NaI, BaS, KCl, $BaCl_2$…

METALLIC CRYSTALS
Atoms that form this type of bond: Metals with themselves.
How do atoms bond: This bond is formed by the collective electron sharing among all the atoms.
Structure: Metallic lattice. A metallic lattice is a regular repeating arrangement of CATIONS in a "sea" of electrons shared between all the cations and they are free to move.



Properties of metallic crystals:

High melting points
Malleable and ductile: It means that they can be pressed and moulded into sheets and into wires respectively, because the electrons allow atoms to slide by.



Good conductors of heat and electricity, because they have free electrons in the lattice.
Typically they are shiny. (They shine)
When they mix with other metals they don´t bond they became a mixture called an alloy (aleación).

Examples: Mg, Cu, Fe...

4.ATOMIC MASS

It has the same value as the relative atomic mass but stated in uma.
Atomic mass is the average of all the isotopes of an element. The unit to express this magnitude is uma.
It is approximately equal to the mass of a single proton or neutron.
Chemists have defined the carbon-12 atom as having a mass of 12 atomic mass units.
So 1 uma = 1/12 the mass of a Carbon-12 atom.

5.MOLECULAR MASS

It is the mass of a molecule.
It is calculated by adding the atomic masses of all the atoms that build the molecule stated in uma.

6.AVOGADRO´S NUMBER, the mole

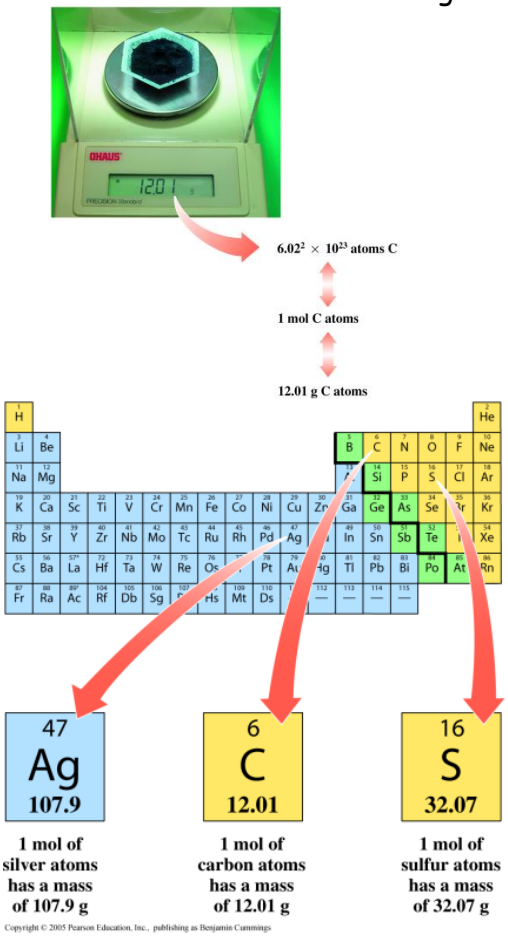
A mole of any substance contains 6,022.10 ^{23} particles. This number is called Avogrado´s number.
These particles can be molecules or atoms (or ions), it depends on what substance we are dealing with. If it is an element the particles are atoms, whereas if it is a compound the particles are molecules.
In both cases we represent the number of particles with the letter N.
Avogadro´s number is represented with the letter N_A

$$N = n \cdot N_A$$

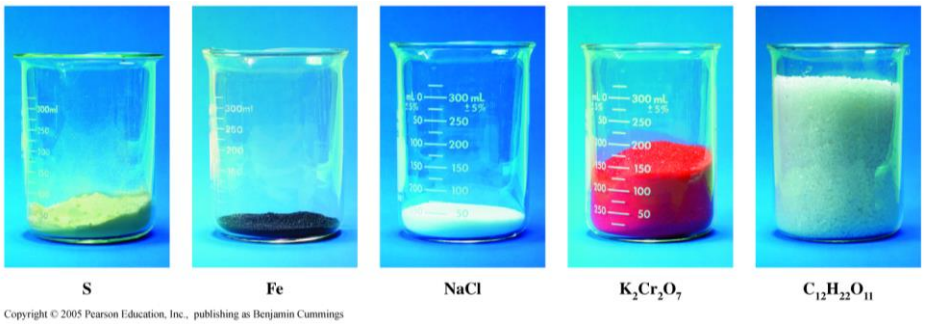
7.MOLAR MASS

It is the mass of one mole of an element or compound. It is represented by **M**

It has the same value as the atomic mass or molecular mass but stated in grams.
The molar mass of an atomic substance is the atomic mass stated in grams.
The molar mass of a compound is the molecular mass stated in grams.



As you can see one moles of different substances have different volumes and different mass. The only thing that all of them have in common is the number of particles, N_A. In all cases this number is $6{,}022.10^{23}$.



The molar mass of a compound is the sum of the molar masses of the atoms in the formula.

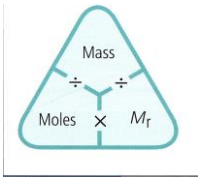
Example: Calculate the molar mass of $CaCl_2$.

Atom	Number of Moles	Atomic Mass	Total Mass
Ca	1	40.1 g/mole	40.1 g
Cl	2	35.5 g/mole	71.0 g
$CaCl_2$			111.1 g

Amount of substance

You can convert mass into moles, or moles into mass using the formula:

$$n = m/M$$



The magnitude **amount of substance** is represented with the letter **n** and its unit is **mole**.

A molar mass factor and Avogadro's number convert

- mass to particles.

molar mass *Avogadro's number*

mass ⟹ mole ⟹ particles

$n = m/M$ $N = n.N_A$

Mass (m) ⟹ ⟸ Mole (n) ⟹ ⟸ Particles (N)

$m = n.M$ $n = N/N_A$

Atoms
Molecules
Ions

GLOSSARY

bonding	/ˈbɒndɪŋ/
brittle	/ˈbrɪtl/
column	/ˈkɒləm/
ductile	/ˈdʌktaɪl/
group	/ˈgruːp/
halogens	/ˈheɪlə͡ʊdʒənz/
lattice	/ˈlætɪs/
malleable	/ˈmælɪəbl/
mole	/ˈməʊl/
molecule	/ˈmɒlɪkjuːl/
noble gases	/ˈnə͡ʊbl ˈgæsɪz/
period	/ˈpɪərɪəd/
periodic table	/ˌpɪərɪˈɒdɪk ˈteɪbl/
row	/ˈrə͡ʊ/
crystalline	/ˈkrɪstəˌlaɪn/

UNIT 5
ACTIVITIES

A1- ABC dictation. (act 1.13 Teaching others subjects through English, Deller & Price, Oxford)
Take an A-4 sheet of paper and cut it into four rectangular pieces .
Write on the top one letter A, B , C or D. The teacher will tell you which one.
Put a number on the left from one to four.
The teacher will read a text and you have to write it when she says your letter.
.....
Sit with three students (groups of four) that have different letters but the same number and exchange your information .
What do you find in common? What is the name of the topic?
Let´s listen to the whole texts and check your writings.

A2-Using the periodic table data, write :

a) The relative atomic mass of a He atom

b) The atomic mass of a Be atom

c) The relative molecular mass of a molecule of CO2

d) The molecular mass of a molecule of water

e) The atomic mass of a C atom

f) The relative molecular mass of a NH3 molecule.

A3- Questions to answers (5.10 Teaching other subjects through English, Deller&Price, Oxford).
There you have several answers. You have to write the question for each answer.

It is 12 u

It is 14

It is 16 g

Arranged in molecules.

Doesn´t conduct electricity when solid but it does when liquid.

They are formed by metal and non-metal atoms.

They conduct electricity because in their lattice there are free electrons

A4- How many moles are made of $5{,}4.10^{20}$ molecules?

How many molecules are there in 3 mole?

A5- What is the proper unit to calculate the mass of one mole?

Calculate the mass of 2 mole of H2

What is the proper unit to calculate the mass of one molecule?

Calculate the mass of 3 molecules of Cl2

What do we have to do to calculate the mass of a number of molecules in grams?

Calculate the mass in grams of $4,7.10^{21}$ molecules of water

A6- If we have 45 g of O2. How many moles of oxygen do we have?

If we have 45 g of oxygen. How many molecules of oxygen do we have?

A7-If the odor of $C_6H_{10}S$ can be detected from 2×10^{-13} g in one litre of air, how many molecules of $C_6H_{10}S$ are there?

A.8-How many H_2O molecules are in 24.0 g H_2O?

A.9-Look up in the periodic table the relative atomic masses that you need, and repeat out loud (DON´T WRITE) the following sentences with the substances:

Li	BeCl2
C	K(OH)
Mg	Cl2
Al	HF

1 atom	of		has a mass of		uma
1 molecule	of		has a mass of		uma
6,022 x 10^{23}	atoms of		have a mass of		g
6,022 x 10^{23}	Molecules of		Have a mass of		g
1 mole	of		has a mass of		g

A10- Answer the following five questions:

Calculate the number of moles are made of 8 x 10^{23} particles.

Calculate the number of particles that are in 2 moles.

Calculate the number of moles that are made of 64 g of O_2 (A_rO = 16)

Calculate the mass of four moles of H_2 (A_rH=1)

Calculate the number of moles that are made of 12 g of H_2 (A_rH=1)

UNIT 5
EXERCISES

1

Copy and complete the paragraph using these words:

electrostatic energy forces high ionic negative

In giant _____ structures the _____ attractive _____ between the positive and _____ ions are very strong. Ionic compounds have very _____ melting points and boiling points because it takes a lot of _____ to overcome these forces.

2

Copy and complete using the words below:

attraction delocalised energy high melting mobile positive

In metallic bonding the _____ metal ions are held together by a sea of _____ electrons. The strong electrostatic _____ between the ions and the _____ electrons gives many metals their strength. Because it takes a lot of _____ to overcome these strong electrostatic forces the _____ and boiling points of most metals is _____.

3

State whether the following pairs of elements form ionic or covalent compounds when they combine:

(a) sodium and chlorine
(b) hydrogen and oxygen
(c) hydrogen and chlorine
(d) lithium and chlorine
(e) sodium and iodine

4

The table shows some properties of different substances.

substance	melting point/°C	conductivity of solid	conductivity of liquid	solubility in water
A	–56	does not conduct	does not conduct	insoluble
B	610	does not conduct	conducts	soluble
C	–70	does not conduct	does not conduct	insoluble
D	2310	conducts	conducts	insoluble
E	680	does not conduct	conducts	soluble

Classify each of these substances as metals, giant ionic structures or simple molecular structures.

5

Which one of these statements about the covalent compound carbon monoxide is true?

A It dissolves in water.
B It has a low boiling point.
C It conducts electricity.
D It has a high melting point.

6	Potassium chloride, KCl, has a giant ionic structure but methane, CH_4, is a simple molecule. **(a)** State three differences between the physical properties of potassium chloride and methane.
7	Match each type of structure and bonding with the description: Covalent — the solid conducts electricity Ionic — has a high melting point and conducts electricity when it dissolves in water Metallic — has a low melting point and does not conduct electricity
8	How many moles of atoms are there in 72 g of magnesium? (Ar= 24) What is the mass of 0.1 moles of carbon atoms? (Ar=12)
9	How many moles are there in 27 g of water, formula H_2O? (Ar H- 1; Ar O- 16)
10	How many atoms are there in 3 mole of Cu?
11	How many moles are there in $7,5 \times 10^{24}$ atoms of Mg?
12	What is the mass of 2 mole of Fe atoms ?

13	How many moles of K are there in 145 g of K?
14	How many molecules are there in 2,5 mole of BeI_2 ?
15	How many moles are there in 6×10^{24} molecules of MgO?
16	What is the mass of 3 mole of H_2S?