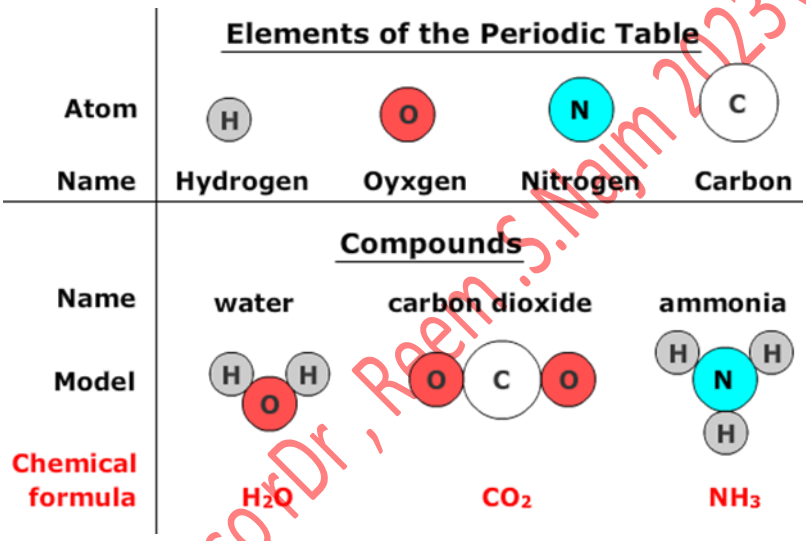
Lect.3.

3-Chemical formula.

A chemical formula is a way of expressing information about the proportions of atoms that constitute a particular chemical compound, using a single of chemical element symbols, numbers, and sometimes also other symbols.



A chemical formula :is not a chemical name, and it contains no words.

Although a chemical formula may imply certain simple chemical structures, it is not the same as a full chemical structural formula.

Chemical formulas can fully specify the structure of only the simplest of molecules and chemical substances, and are generally more limited in power than are chemical names and structural formulas.

Lect.3.

3-1 Types of chemical formula

1-The simplest types of chemical formulas are called **empirical formulas**, which use only letters and numbers indicating atomic proportional ratios (the numerical proportions of atoms of one type to those of other types).

2-Molecular formulas: indicate the simple numbers of each type of atom in a molecule of a molecular substance, and are thus sometimes the same as empirical formulas (for molecules that only have one atom of a particular type).

and at other times require larger numbers than do empirical formulas.

An example of the difference is the empirical formula for glucose, which is CH_2O, while its molecular formula requires all numbers to be increased by a factor of six, giving $C_6H_{12}O_6$.

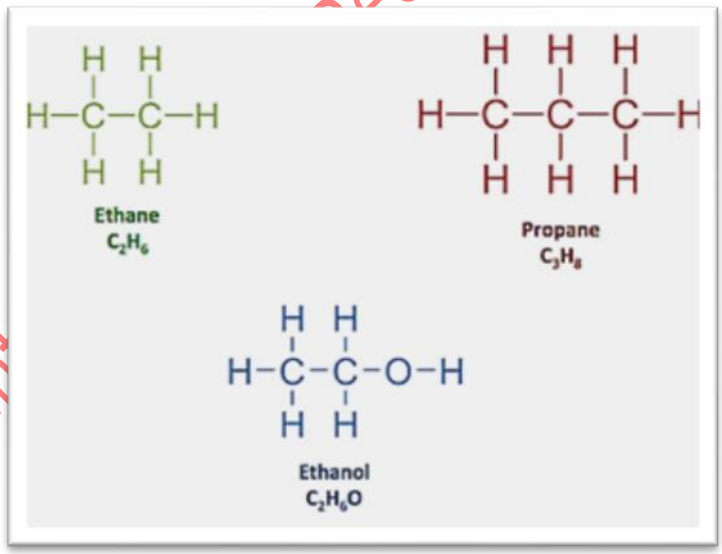
Lect.3.

3-2 Structural Formula: When we simply write the molecular formula, we do not know how the atoms are arranged or which atoms are bonded to each other.

The structural formula shows both the actual number of atoms of elements in a compound and also how the atoms are arranged as well as which atoms are bonded to one another.

Below are the structural formulas of ethane, propane and ethanol.

The molecular formulas of each are reflected below the structural formulas.



Let us look at ethane. It shows that the carbon (C) atom on the left is bonded to three hydrogen (H) atoms and the other carbon atom.

The carbon on the right is also bonded to three hydrogen atoms and the carbon on the left.

Lect.3.

3-3Lewis structures.

Lewis structures (also known as Lewis dot structures, and electron dot structures) are diagrams that show the bonding between atoms of a molecule and the lone pairs of electrons that may exist in the molecule.

A Lewis structure can be drawn for any bonded molecule, as well as coordination compounds. The Lewis structure was named after Gilbert N. Lewis, who introduced it in his 1916 article The Atom and the Molecule.

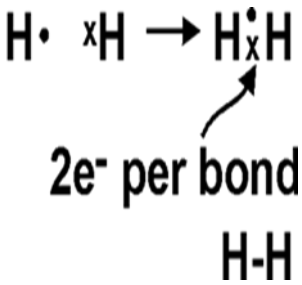
They are similar to electron dot diagrams in that the valence electrons in lone pairs are represented as dots, but they also contain lines to represent shared pairs in a chemical bond (single, double, triple, etc).

Lewis structures: show each atom and its position in the structure of the molecule using its chemical symbol. Lines are drawn between atoms that are bonded to one another (pairs of dots can be used instead of lines).

Excess electrons that form lone pairs are represented as pairs of dots, and are placed next to the atoms.

Examples:

^{4}C

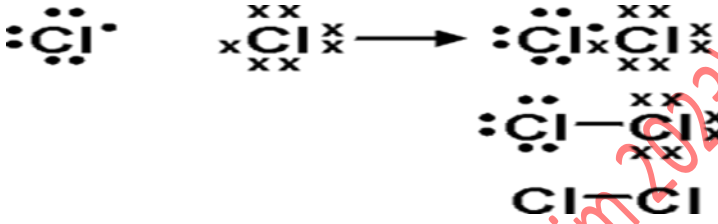


Lec.3.

Sometimes we use an x instead of a dot to represent an electron.

This allows us to track the electrons better.

Cl_2

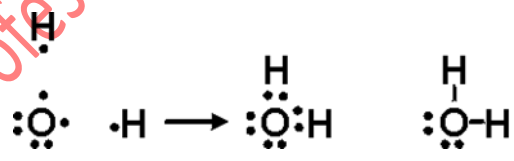


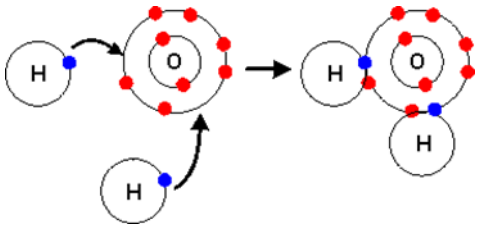
Octet rule (for s- and p-block elements) - atoms combine and form bonds either by transferring electrons to form ions or by sharing electrons in covalent bonds.

until each atoms is surround by 8 valence electrons.

Electrons in bonds are considering in counting the electrons in both atoms involved in the bond. H and He are the exception.

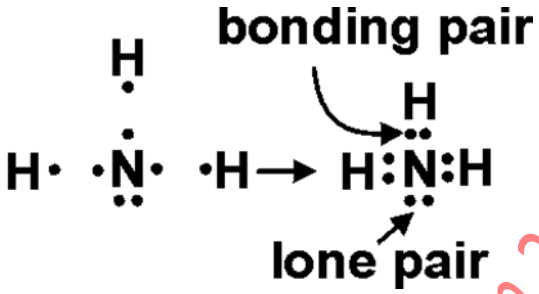
H_2O

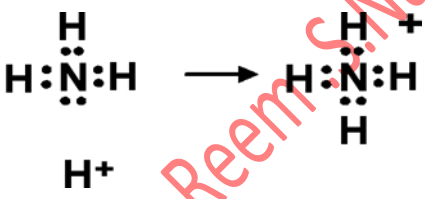




Lect.3.

How would you put together N and H to form a compound? (ammonia).





Lect.3.

3- 4The Chemical Bond.

The atoms of a compound are held together by chemical bonds formed by the interaction of electrons from each atom.

atoms bond together to form molecules in such a way that each atom participating in a chemical bond acquires an electron configuration resembling that of the noble gas nearest it in the periodic table.

Thus the outer shell of each bonded atom will contain eight electrons (or two electrons for hydrogen and lithium)

The simplest chemical bond is that formed between two hydrogen atoms. Each hydrogen atom has one electron.

As the two atoms approach each other, the nucleus of one atom attracts the electron of the other.

Eventually the two orbitals overlap, becoming a single orbital containing two electrons.

Lect.3.

3-5Ionic Bond.

An ionic bond is formed by the attraction of oppositely charged atoms or groups of atoms. When an atom (or group of atoms) gains or loses one or more electrons, it forms an ion.

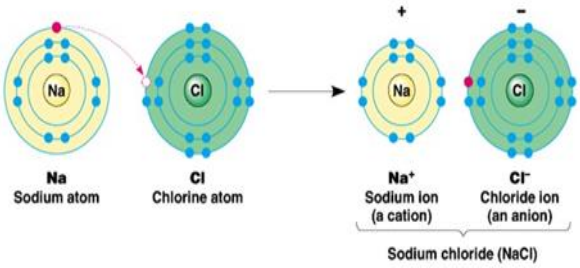
Ions have either a net positive or net negative charge. Positively charged ions are attracted to the negatively charged 'cathode' in an electric field and are called cations.

Anions are negatively charged ions named as a result of their attraction to the positive 'anode' in an electric field.

Every ionic chemical bond is made up of at least one cation and one anion.

Ionic bonding is typically described to students as being the outcome of the transfer of electron(s) between two dissimilar atoms.

The Lewis structure below illustrates this concept.



Sodium chloride (NaCl) is the classic example of ionic bonding. Ionic bonding is not isolated to simple binary systems, however.

An ionic bond can occur at the center of a large covalently bonded organic molecule such as an enzyme.

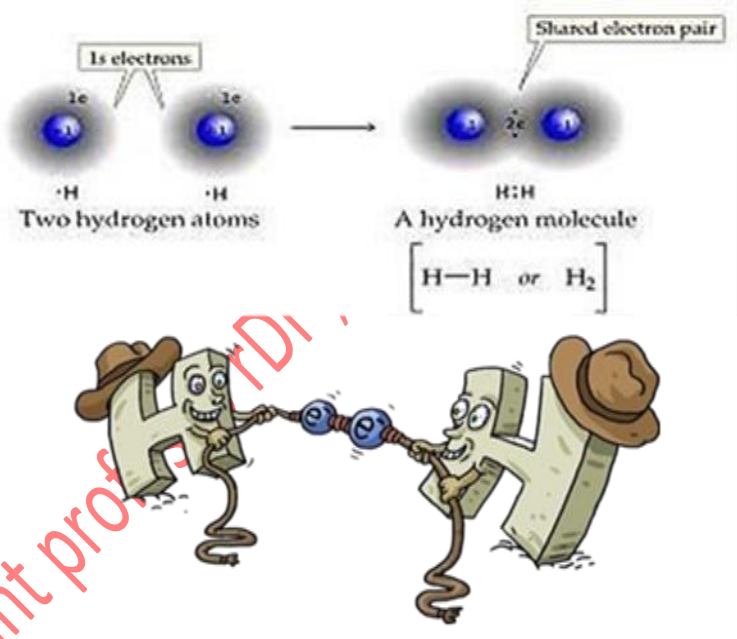
Lect.3.

3-6Covalent bond

A covalent chemical bond results from the sharing of electrons between .two atoms with similar electro negativities

Single covalent bonds represent the sharing of two valence electrons (usually from two different atoms).

The Lewis structure below represents the covalent bond between two hydrogen atoms in a H_2 molecule.



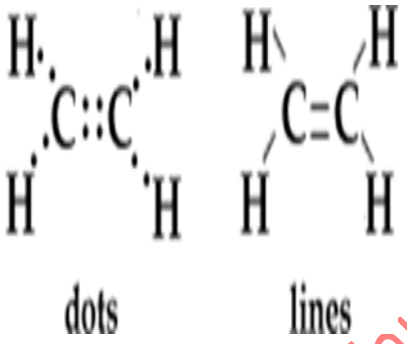
Multiple covalent bonds are common for certain atoms depending upon their valence.

For example, a double covalent bond, which occurs in ethylene (C_2H_4), results from the sharing of two sets of valence electrons.

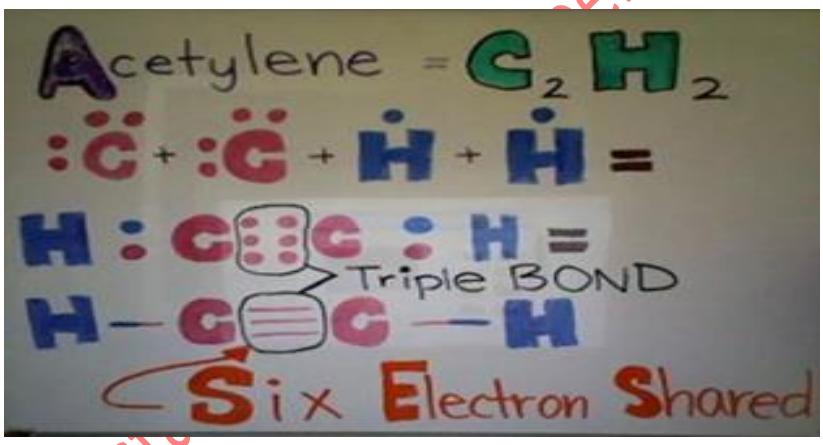
Atomic nitrogen (N_2) is an example of a triple covalent bond.

Lect.3.

Double Covalent Bond



Triple Covalent Bond



Lect.3.

3-7Polar covalent bond

The polarity of a covalent bond is defined by any difference in electronegativity the two atoms participating.

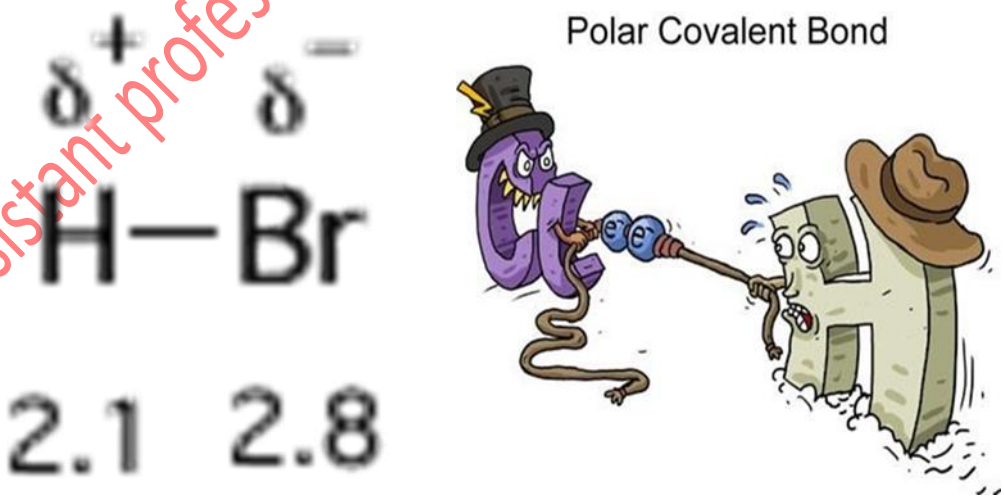
Bond polarity describes the distribution of electron density around two bonded atoms.

For two bonded atoms with similar electro negativities, the electron density of the bond is equally distributed between the two atom is This is nonpolar covalent bond.

The electron density of a covalent bond is shifted towards the atom with the largest electronegativity.

This results in a net negative charge within the bond favoring the more electronegative atom and a net positive charge for the least electronegative atom.

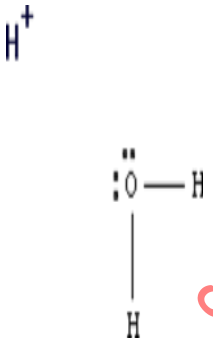
This is a polar covalent bond.



Lect.3.

3-8Coordinate Covalent bond

A coordinate covalent bond (also called a dative bond) is formed when one atom donates both of the electrons to form a single covalent bond. These electrons originate from the donor atom as an unshared pair.

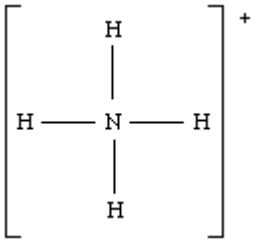
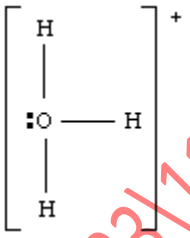


Both the ammonium ion and hydronium ion contain one coordinate covalent bond each.

A lone pair on the oxygen atom in water contributes two electrons to form a coordinate covalent bond with a hydrogen ion to form the hydronium ion.

Similarly, a lone pair on nitrogen contributes 2 electrons to form the ammonium ion. All of the bonds in these ions are indistinguishable once formed.

Lect.3.

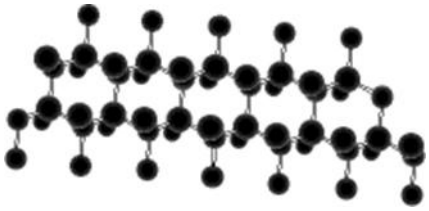
	
Ammonium (NH_4^+)	Hydronium (H_3O^+)

However Some elements form very large molecules by forming covalent bonds.

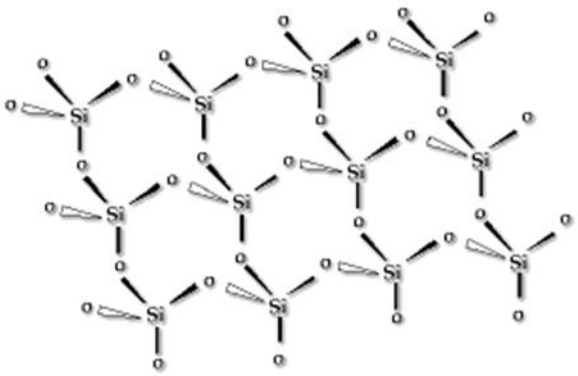
When these molecules repeat the same structure over and over in the entire piece of material, the bonding of the substance is called network covalent.

Diamond is an example of carbon bonded to itself. Each carbon forms 4 covalent bonds to 4 other carbon atoms forming one large molecule the size of each crystal of diamond.

Lect.3.



Silicates, $[SiO_2]x$ also form these network covalent bonds. Silicates are found in sand, quartz, and many minerals.



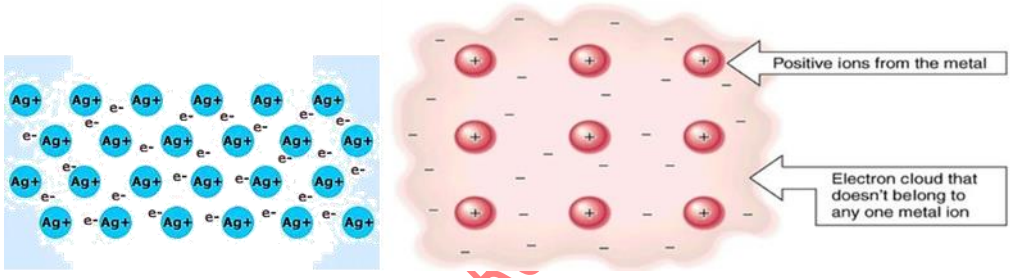
Lect.3

Metallic bond

The valence electrons of pure metals are not strongly associated with particular atoms.

This is a function of their low ionization energy.

Electrons in metals are said to be delocalized (not found in one specific region, such as between two particular atoms).



Since they are not confined to a specific area, electrons act like a flowing "sea", moving about the positively charged cores of the metal atoms.

Delocalization can be used to explain conductivity, malleability, and ductility.

Because no one atom in a metal sample has a strong hold on its electrons .and shares them with its neighbors, we say that they are bonded.

In general, the greater the number of electrons per atom that participate in metallic bonding, the stronger the metallic bond.

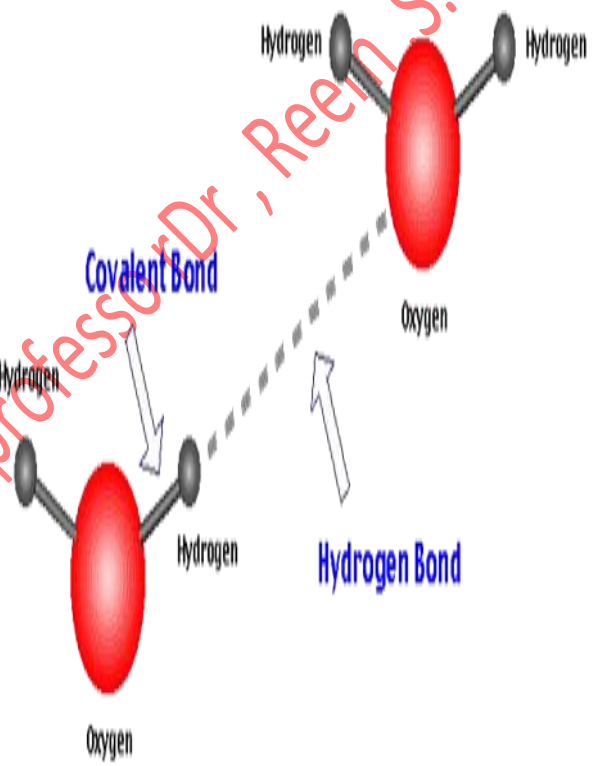
Lect.3.

Hydrogen bond

A hydrogen bond is the electrostatic attraction between polar molecules that occurs when hydrogen (H), atom bound to a highly electronegative atom such as nitrogen (N), oxygen (O), or fluorine (F), experiences attraction to some other nearby highly.

electronegative atom.

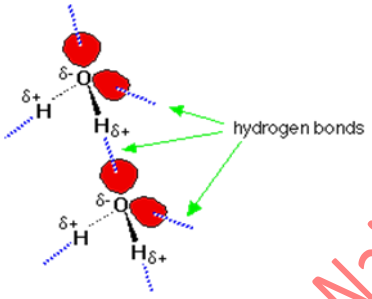
The name hydrogen bond is something of a misnomer, as it is not a true bond but a particularly strong dipole-dipole attraction, and should not be confused with a covalent bond.



Lect.3.

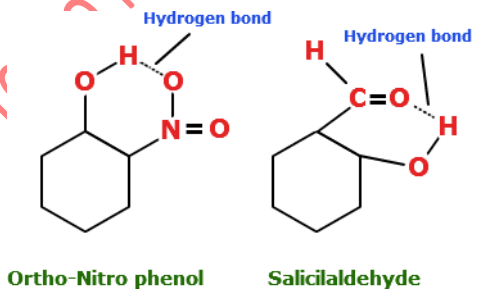
Types of hydrogen bonds:

1-**Intermolecular hydrogen bond**: These hydrogen-bond attractions can occur between molecules.



2-Intermolecular hydrogen bond:

These hydrogen-bond attractions can occur within different parts of a single molecule.



Note:- The hydrogen bond (5 to 30 kJ/mole) is stronger than a van der Waals interaction, but weaker than covalent or ionic bonds. This type of bond can occur in inorganic molecules such as water and in organic molecules like DNA and proteins.

Questions for Lec.3.

Q1\ Full the blanks…

1-Types of chemical formula are **empirical formulas**, and Molecular formulas.

2- **Chemical formulas** can fully specify the structure of only the simplest of molecules and chemical substances.

3-Types of hydrogen bonds is **Intermolecular hydrogen bond**, and **Inteamolecular hydrogen bond.**

4-Lewis structures **(also known as Lewis dot structures, and electron dot structures are diagrams that show the bonding between atoms of a molecule and the lone pairs of electrons that may exist in the molecule).**

5-**The Chemical Bond,** The atoms of a compound are held together by chemical bonds formed by the interaction of electrons from each atom.

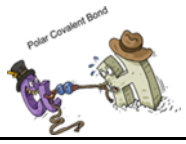
6-Every ionic chemical bond is made up of at least one **cation** and one anion.

7-A covalent chemical bond results from the **sharing of electrons** between two atoms with **similar electro negativities.**

8-The polarity of a covalent bond is defined **by any difference in electronegativity the two atoms participating.**

9-A coordinate covalent bond (also **called a dative bond)** is formed when one atom donates both of the **electrons to form a single covalent bond.**

10- **A hydrogen bond** is the electrostatic attraction between polar molecules.



Q2\ Answer

1-what are the types of Chemical bond? And discuss one of them.

2-what the different between Molecular formulas& Structural Formula.

3-what the different between Intermolecular hydrogen bond& Inteamolecular hydrogen bond.

Q3\\ choose the correct answer

1-can fully specify the structure of only the simplest of …… molecules and chemical substances,. a) Chemical formulas, b) name , c) generally.

2-The atoms of a compound are held together by chemical bonds formed ……. by the interaction of electrons from each atom a) molecules , b) Chemical Bond. c) substances.

3-.....is the electrostatic attraction between polar molecule

a), atoms, b) structure c) A hydrogen bond

4-Every ionic chemical bond is made up of at least one…….. and one anion.

a) cation , b) simplest c) interaction