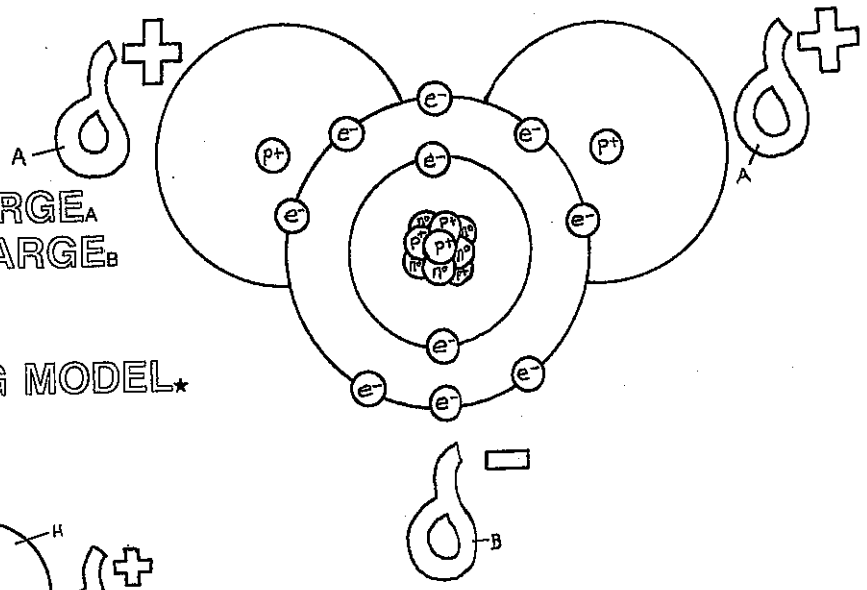
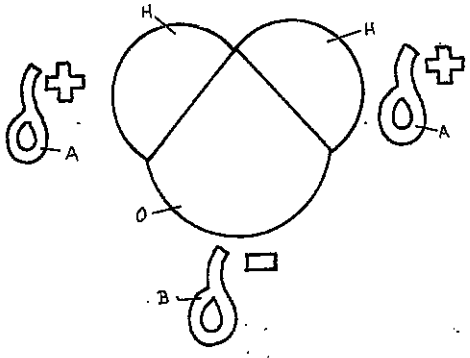
# WATER MOLECULES.

ELECTRON DIAGRAM★
PROTON$_{p+}$
NEUTRON$_{n^0}$
ELECTRON$_{e-}$
DELTA POSITIVE CHARGE$_A$
DELTA NEGATIVE CHARGE$_B$



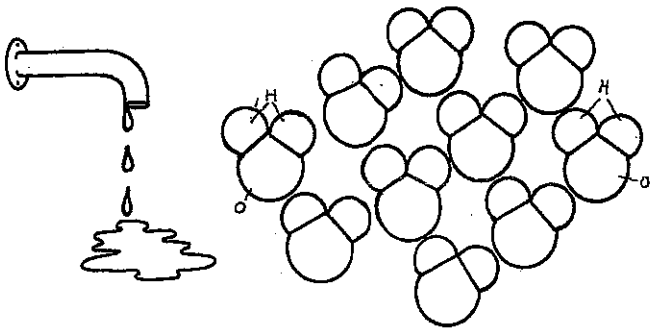

SPACE-FILLING MODEL★
HYDROGEN$_H$
OXYGEN$_O$




EMPIRICAL FORMULA$_{H_2O}$

$H_2O$


HYDROGEN BONDING OF WATER MOLECULES★



# WATER MOLECULES

DIRECTIONS: Read the text about water molecules.

1) On the back of this sheet, make a list of 5 new science words you read. Then find the definition (in the reading or you may use a dictionary) of the word and write it next to the word.
2) On the back of this sheet, color all the oxygens one color (up to you) and all the hydrogens another color.

We have just seen that a carbon atom can contribute to the formation of a molecule of methane by sharing electrons with four hydrogen atoms. That sharing is nearly equal, and no part of the surface of the molecule has an electric charge that is any different from any other part. Such a molecule is said to be "nonpolar"; that is, it lacks distinctive poles with opposite electrical charges. When oxygen shares electrons with hydrogen, the result is somewhat different. Oxygen has six electrons in its outermost shell and it needs only two more to fill that shell. Therefore, it will form covalent bonds with only two hydrogen atoms instead of four, producing a compound with the empirical formula $H_2O$, familiar to us as water. Because of the peculiar orbitals that electrons "like" to occupy, the water molecule is not symmetrical. The two hydrogen atoms are more toward one side than the other.

Since the oxygen atom has two more *protons* in its nucleus than carbon, it has a stronger attraction for *electrons* than the hydrogen atoms. As a result, the electrons that the oxygen is sharing with the hydrogen are not shared equally. They spend more time around the oxygen atom than around the hydrogen atom—enough more that they overbalance the positive charges of the oxygen nucleus. This gives the oxygen atom a distinct, but weak, *negative charge,* indicated by the Greek letter delta and a minus sign ($\delta^-$). The electrons spend enough less time around the hydrogen atom that they don't quite neutralize the positive charge of hydrogen's protons, so the hydrogen atoms acquire a distinct, but weak, positive charge, designated as *delta positive* ($\delta^+$). These delta charges are only about one-fifth as strong as the full unit of charge we saw on sodium and chloride ions, but that is strong enough to have a profound influence on the behavior of water and similar molecules. Such molecules are called "polar" because they have distinctive regions, or "poles," with opposite electric charges.

Carbon dioxide is an example of another molecule that is about the same size as water but is nonpolar. Since they have no surface electrical charges, carbon dioxide molecules do not have a strong attraction for one another. If they are released from the pressure bottle in which they are stored, they separate and expand into the atmosphere as a gas. Water molecules, however, are rather strongly held together by the attraction between the delta positive charges on the hydrogen atoms of one water molecule and the delta negative charges on the oxygen atoms of other water molecules. As a consequence of this attractive force, or bond, water remains as a liquid and does not rapidly become a gas, as carbon dioxide does, unless additional heat energy is put into it.

Such bonds between hydrogen atoms in a polar molecule and a negatively charged atom in some other molecule are called "hydrogen bonds." They are of great importance in determining the behavior of water and in the structure and functioning of proteins and the nucleic acids that determine our own heredity.

Since water molecules are polar, they are able to dissolve ionic compounds readily. A sodium chloride crystal, for example will quickly dissolve in water because four or five water molecules can fit around one *sodium* or *chloride ion* and the sum of their collective weak charges is enough to attract the ion away from the other ions in the crystal.