Answer on Question #64489, Chemistry / General Chemistry

The question is which of the following acid is polar?

a) HF b) HCl c) HNO3 d) H2SO4

The sir drawn Lewis structure of these molecules and showed formal charges on HNO3 and told that it is the only polar acid in isolated state. I guess he do not know what is polar and non-polar. All above molecules have net-dipole moment associated with them so all should be polar in nature. Even my teacher told one controversial statement - “"water is non-polar in isolated state” he believes - “formal charges are real charges due to electrons. Formal charge is the criterion to detect polar and non-polar molecules. “When I said - dipole moment is the only criterion to detect polarity and formal charges are not real but hypothetical charges to keep track of electrons, he disagree. What you people think about answer by my chemistry teacher?

Answer:

Molecules that are formed by the atoms of different elements can be polar and non-polar. This depends on the geometrical shape. If the form is symmetric, non-polar molecule (CO_2). If asymmetrical (due to the presence of unpaired or unshared pair of electrons), the molecule is polar (HNO_3).
The polarity of the asymmetric shape of the molecule derived from the polarity of covalent bonds between the atoms of elements with different electronegativity.
There is a partial shift of the electron density along the axis due to the atom more electronegative element, such as:

$$H^{\delta+} \rightarrow Cl^{\delta-}$$

Here δ - partial electrical charge on the atoms.
The greater the difference in electronegativity of elements, the higher the absolute value of the charge, and δ is the more polar bond.
Consequently, the molecules formed in asymmetric electric dipole - spaced some distance into the space unlike charges.
Therefore, the dipole moment of the molecule determines the polarity.

HF
Between hydrogen and fluorine atoms form a covalent bond dipole moment. HF molecule becomes dipole (particle with two electrical poles), it acquires a certain positive electrical charge at one end (where the hydrogen atom) and some negative - on the other (wherein fluorine atom). HF, Hydrogen has an Electronegativity (EN) of 2.1 and Fluorine an EN of 4.0 (highest EN of any element). So do: 4.0-2.1 = 1.9.4.0-2.1 = 1.9.This value means that Fluorine in the molecule pulls on hydrogens electrons way more than hydrogen pulls on Fluorine's electrons. Meaning the molecule is considered polar.

HCl is a polar molecule. Let's start the explaination with Octet's rule: all atoms try to get 8 electrons in its outter shell (8 valance electrons) besides hydrogen and helium.
Cl has 7 valance electrons and wants to get 8 meaning it has to aquire one more electron. Hydrogen has 1 electron and doesn't apply to Octet's rule but rather wants to have a full outter first shell meaning it too needs one more electron. So what happens here is that the Cl and H share two electrons.

HNO_3 we can see that it is not a symmetrical molecule. We have Oxygen atoms on one side and a Hydrogen atom on the other. Because of the difference in electronegativities there will be two poles and HNO_3 is therefore a polar molecule.

H_2SO_4 is considered a type of polar compound. It is polar because its ions can have dipole moments due to uneven charges.