Polar and nonpolar molecules worksheet answers questions answer

(A greater difference in electronegativity suggests a more polar bond, which is described with a longer arrow.) Decide whether the arrangement of arrows is symmetrical or asymmetrical If the arrangement is symmetrical and the arrows are of equal length, the molecule is nonpolar. BF3 is a trigonal planar molecule and all three peripheral atoms are the same. A polar molecule is a molecule in which one end of the molecule is slightly positive, while the other end is slightly negative. The other side of the molecule, the H atom, adopts a partial positive charge, which is represented by δ+. No side of the molecule has more negative or positive charge than another side, and so the molecule is nonpolar: A water molecule is polar because (1) its O-H bonds are significantly polar, and (2) its bent geometry makes the distribution of those polar bonds asymmetrical. Figure \(\PageIndex{1}\) Some examples of nonpolar molecules based on molecular geometry (BF3 and CCl4). The \(\ce{-OH}\) side is different from the other 3 \(\ce{-H}\) sides. Another non polar molecule shown below is boron trifluoride, BF3. Steps to Identify Polar Molecules Draw the Lewis structure Figure out the geometry (using VSEPR theory) Visualize or draw the geometry Find the net dipole moment (you don't have to actually do calculations if you can visualize it) If the net dipole moment is zero, it is non-polar. The molecule is symmetric. NH3 Answer a non polar Answer b polar In order to continue enjoying our site, we ask that you confirm your identity as a human. Just like the water molecule, none of the bond moments cancel out. When there are no polar bonds in a molecule, there is no permanent charge difference between one part of the molecule and another, and the molecule is nonpolar. None of the bonds in hydrocarbon molecules, such as hexane, C6H14, are significantly polar, so hydrocarbons are nonpolar molecular substances. Hydrogen fluoride is a dipole. For molecules with more than two atoms, the molecular geometry must also be taken into account when determining if the molecule is polar or nonpolar. The figure below shows a comparison between carbon dioxide and water. Carbon dioxide \(\left(\ce{CO_2} \right)\) is a linear molecule. a. The Lewis structure for OF2 is The electronegativities of oxygen and fluorine, 3.44 and 3.98, respectively, produce a 0.54 difference that leads us to predict that the O-F bonds are polar. Any molecule with lone pairs of electrons around the central atom is polar. The 0.35 difference in electronegativity for the H-C bonds tells us that they are essentially nonpolar. Step 4: Draw a geometric sketch of the molecule. Move on to Step 4. Because of the shape, the dipoles do not cancel each other out and the water molecule is polar. Molecules with one polar bond are always polar. Step 3: If there is only one central atom, examine the electron groups around it. EXAMPLE – Predicting Molecular Polarity: Decide whether the molecules represented by the following formulas are polar or nonpolar. Learning Objective Determine if a molecule is polar or nonpolar. Describe the polar bonds with arrows pointing toward the more electronegative element. To know how the bonds are oriented in space, you have to have a strong grasp of Lewis structures and VSEPR theory. Example \(\PageIndex{1}\): Label each of the following as polar or nonpolar. (If the difference in electronegativity for the atoms in a bond is greater than 0.4, we consider the bond polar. The oxygen atoms are more electronegative than the carbon atom, so there are two individual dipoles pointing outward from the \(\ce{C}\) atom to each \(\ce{O}\) atom. This is not a symmetric molecule. For example, the three bonds in a molecule of BF3 are significantly polar, but they are symmetrically arranged around the central boron atom. This shows the symmetry of the bonds. d. The Lewis structure for CH2Cl2 is The electronegativities of hydrogen, carbon, and chlorine are 2.20, 2.55, and 3.16. Water is a bent molecule because of the two lone pairs on the central oxygen atom. CH2Cl2 e. The 0.49 difference in electronegativity for the C-N bond tells us that it is polar. In contrast, water is polar because the OH bond moments do not cancel out. The 0.35 difference in electronegativity for the H-C bond shows that it is essentially nonpolar. Figure \(\PageIndex{3}\) The molecular geometry of a molecule affects its polarity. Thank you very much for your cooperation. The molecular geometry of OF2 is bent. The side of the water molecule containing the more electronegative oxygen atom is partially negative, and the side of the molecule containing the less electronegative hydrogen atoms is partially positive. OF2 c. Assuming you do, you can look at the structure of each one and decide if it is polar or not - whether or not you know the individual atom electronegativity. To determine if a molecule is polar or nonpolar, it is frequently useful to look at Lewis structures. Sample Study Sheet: Predicting Molecular Polarity Tip-off – You are asked to predict whether a molecule is polar or nonpolar; or you are asked a question that cannot be answered unless you know whether a molecule is polar or nonpolar. CCl4 d. Keep in mind that Lewis structures often give a false impression of the geometry of the molecules they represent.) e. The Lewis structure and geometric sketch for HCN are the same: The electronegativities of hydrogen, carbon, and nitrogen are 2.20, 2.55, and 3.04. Even though the C-Cl bonds are polar, their symmetrical arrangement makes the molecule nonpolar. The Lewis structure for CO2 is The electronegativities of carbon and oxygen are 2.55 and 3.44. Exercise \(\PageIndex{1}\) Label each of the following as polar or nonpolar. The molecular geometry of CCl4 is tetrahedral. The 0.89 difference in electronegativity indicates that the C-O bonds are polar, but the symmetrical arrangement of these bonds makes the molecule nonpolar. If there are no lone pairs on the central atom, and if all the bonds to the central atom are the same, the molecule is nonpolar. b. Each CO bond has a dipole moment, but they point in opposite directions so that the net CO2 molecule is nonpolar. Figure \(\PageIndex{4}\) Some examples of polar molecules based on molecular geometry (HCl, NH3 and CH3Cl). If the molecule has polar bonds, move on to Step 3. To summarize, to be polar, a molecule must: Contain at least one polar covalent bond. The molecule is not symmetric. For example, the Cl2 molecule has no polar bonds because the electron charge is identical on both atoms. If the arrangement is asymmetrical, the molecule is polar. c. SO3 b. Hydrogen cyanide is polar. Propane is nonpolar, because it is symmetric, with \(\ce{H}\) atoms bonded to every side around the central atoms and no unshared pairs of electrons. (Notice that the Lewis structure above incorrectly suggests that the bonds are symmetrically arranged. Have a molecular structure such that the sum of the vectors of each bond dipole moment does not cancel. If the polar bonds are evenly (or symmetrically) distributed, the bond dipoles cancel and do not create a molecular dipole. Methanol is polar. (This shortcut is described more fully in the Example that follows.) If the central atom has at least one polar bond and if the groups bonded to the central atom are not all identical, the molecule is probably polar. This works pretty well - as long as you can visualize the molecular geometry. The individual dipoles point from the \(\ce{H}\) atoms toward the \(\ce{O}\) atom. It is therefore a nonpolar molecule. Nonpolar compounds will be symmetric, meaning all of the sides around the central atom are identical - bonded to the same element with no unshared pairs of electrons. Oxygen is nonpolar. Water, H2O: Methanol, CH3OH: Hydrogen Cyanide, HCN: Oxygen, O2: Propane, C3H8: Solution Water is polar. Step 2: Identify each bond as either polar or nonpolar. A molecule with two poles is called a dipole (see figure below). (You may need to draw Lewis structures and geometric sketches to do so.) a. The 0.61 difference in electronegativity for the C-Cl bonds shows that they are polar. A diatomic molecule that consists of a polar covalent bond, such as \(\ce{HF}\), is a polar molecule. HCN Solution: a. Polar molecules are asymmetric, either containing lone pairs of electrons on a central atom or having atoms with different electronegativities bonded. (For example, you are asked to predict the type of attraction holding the particles together in a given liquid or solid.) General Steps - Step 1: Draw a reasonable Lewis structure for the substance. As mentioned in section 4.7, because the electrons in the bond are nearer to the F atom, this side of the molecule takes on a partial negative charge, which is represented by δ− (δ is the lowercase Greek letter delta). Such an asymmetrical distribution of polar bonds would produce a polar molecule. This is because you know that all bonds between dissimilar elements are polar, and in these particular examples, it doesn't matter which direction the dipole moment vectors are pointing (out or in). The following geometric sketches show that the polar bonds are asymmetrically arranged, so the molecule is polar. In the figure below, the net dipole is shown in blue and points upward. If we put arrows into the geometric sketch for CO2, we see that they exactly balance each other, in both direction and magnitude. Use the length of the arrow to show the relative polarities of the different bonds. CO2 b. Three other polar molecules are shown below with the arrows pointing to the more electron dense atoms. Otherwise, it is polar. Figure \(\PageIndex{2}\) A dipole is any molecule with a positive end and a negative end, resulting from unequal distribution of electron density throughout the molecule. The nitrogen and hydrogen have different electronegativities, creating an uneven pull on the electrons. A molecule can possess polar bonds and still be nonpolar. If the difference in electronegativity is less than 0.4, the bond is essentially nonpolar.) If there are no polar bonds, the molecule is nonpolar. If the arrows are of different lengths, and if they do not balance each other, the molecule is polar. Notice that a tetrahedral molecule such as \(\ce{CCl_4}\) is nonpolar Figure (\(\PageIndex{1}\). However, since the dipoles are of equal strength and are oriented this way, they cancel out and the overall molecular polarity of \(\ce{CO_2}\) is zero. Step 5: Determine the symmetry of the molecule using the following steps. That's the hard part. The two oxygen atoms pull on the electrons by exactly the same amount. The two electrically charged regions on either end of the molecule are called poles, similar to a magnet having a north and a south pole.

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