Shape Sets Polarity

Use Lewis structures and electronegativity to explain molecular behavior.

CHE.2 "Construct explanations of the formation of intramolecular and intermolecular forces and their effects on atomic and molecular interactions. a. Develop and use Lewis dot diagrams to model the formation of covalent and ionic bonds. b..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the rules that connect electron domains to molecular shape. Circle the clues that help you decide whether bond dipoles cancel.

Why Shape Matters

1. Methane gas contains molecules with a predictable shape. Electron pairs around a central atom help set the shape. In a Lewis dot diagram, a line stands for a shared electron pair, while dots can show unshared pairs. Methane, CH_4, has carbon at the center with four single bonds to hydrogen atoms. The bonds point toward the corners of a tetrahedron.

2. Count electron domains. Each bond, even a double or triple bond, is one domain; each lone pair is another. Domains repel and spread apart. Two domains give a linear shape, three give a trigonal planar shape, and four give a tetrahedral arrangement. With four domains, one lone pair leaves a trigonal pyramidal shape; two leave a bent shape.

VALENCE ELECTRONS AND ELECTRONEGATIVITY

Element	Valence electrons	Electronegativity
H	1	2.20
C	4	2.55
N	5	3.04
O	6	3.44

3. The electronegativity table shows how strongly each element attracts shared electrons. A larger difference between bonded atoms makes a more polar bond. Molecular polarity also depends on shape: bond dipoles can cancel in a symmetric arrangement. Methane's four identical carbon-hydrogen bonds point symmetrically, so their dipoles cancel. Lone pairs or unlike atoms can prevent that cancellation.

2 ANSWER WITH EVIDENCE

Use the passage

1. Use the table and domain rules to predict the shape and polarity of H_2O. How many lone pairs are on oxygen?

2. For NH_3, how many electron domains and lone pairs surround nitrogen? What shape do the atoms form?

3. In CO_2, carbon forms a double bond to each oxygen. Explain why its polar bonds do not make the whole molecule polar.

4. In HCN, hydrogen bonds to carbon, and carbon has a triple bond to nitrogen. Predict the shape around carbon and whether the molecule is polar. Use the table to explain.

3 YOUR TURN

Your own words

Draw a Lewis dot diagram for CH_2O, with both hydrogen atoms bonded to carbon and oxygen bonded to carbon. Show all lone pairs, then write two sentences predicting the shape around carbon and explaining whether the molecule is polar.

Shape Sets Polarity

PART 1 · READ AND MARK

Underline the rules that connect electron domains to molecular shape. Circle the clues that help you decide whether bond dipoles cancel. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Use the table and domain rules to predict the shape and polarity of H_2O. How many lone pairs are on oxygen?	**Oxygen has two bonds and two lone pairs, giving it four domains. H_2O is bent and polar because its O-H bond dipoles do not cancel.**
2	For NH_3, how many electron domains and lone pairs surround nitrogen? What shape do the atoms form?	**Nitrogen has four domains: three bonds and one lone pair. The atoms form a trigonal pyramidal shape.**
3	In CO_2, carbon forms a double bond to each oxygen. Explain why its polar bonds do not make the whole molecule polar.	**The two double bonds count as two domains, making CO_2 linear. Its identical C-O bond dipoles point in opposite directions and cancel.**
4	In HCN, hydrogen bonds to carbon, and carbon has a triple bond to nitrogen. Predict the shape around carbon and whether the molecule is polar. Use the table to explain.	**Carbon has two bonding domains, so HCN is linear. It is polar: nitrogen attracts shared electrons more strongly than carbon or hydrogen, and the dipoles do not cancel.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Diagram: two C-H single bonds, one C=O double bond, and two lone pairs on O
Carbon has three bonding domains, so the atoms around it form a trigonal planar shape. Oxygen attracts electrons more strongly than carbon, and the bond dipoles do not cancel, so CH_2O is polar.

Accept equivalent Lewis dot diagrams that show carbon with two C-H single bonds and one C=O double bond, plus two lone pairs on oxygen. Polarity explanations should connect bond dipoles to molecular geometry, not rely on electronegativity alone.