What is Molecular Geometry?

Worksheet

Molecular geometry is determined by counting electron pairs (bonding and lone) around the central atom. Electron pairs repel and arrange themselves to minimize repulsion, creating distinct 3D shapes: tetrahedral, trigonal planar, linear, pyramidal, and bent.

Questions

1. What geometry does a molecule with 4 electron pairs adopt?

A) Linear
B) Trigonal planar
C) Tetrahedral
D) Octahedral

2. PH (phosphine) has 3 bonding pairs and 1 lone pair. Its molecular geometry is

A) Tetrahedral
B) Trigonal planar
C) Trigonal pyramidal
D) Linear

3. Which molecule is linear?

A) HO
B) CO
C) NH
D) CH

4. In water (HO), why is the bond angle 104.5 not 109.5?

A) Oxygen is smaller
B) Two lone pairs compress the angle
C) Hydrogen is too small
D) Water is polar

5. Predict the geometry of NH (ammonia).

6. What is the geometry of CO (carbon dioxide)?

7. Predict the shape of HO (water).

8. Define: What does VSEPR theory predict?

9. Define: What is the difference between electron geometry and molecular geometry?

10. Define: Why does NH have a different bond angle than CH?

Answer Key

1. C) Tetrahedral - Four electron pairs (bonding or lone) arrange in a tetrahedral geometry to minimize repulsion at 109.5 angles.

2. C) Trigonal pyramidal - 4 electron pairs = tetrahedral electron geometry; 3 bonded atoms + 1 lone pair = trigonal pyramidal molecular geometry.

3. B) CO - CO: 2 electron pairs (2 double bonds), 0 lone pairs on C, linear arrangement with 180 bond angle.

4. B) Two lone pairs compress the angle - Lone pairs repel more strongly than bonding pairs. The 2 lone pairs in water compress the H-O-H angle below the tetrahedral 109.5.

5. N has 5 valence electrons, each H has 1. Lewis: N with 3 H atoms bonded + 1 lone pair. Total electron pairs = 4 (3 bonding + 1 lone). Electron geometry = tetrahedral (4 pairs). Molecular geometry = trigonal pyramidal (3 bonded atoms, 1 lone pair). Bond angle 107 (less than 109.5 due to lone pair repulsion).

6. C has 4 valence electrons, each O has 6. Lewis: O=C=O (2 double bonds, 0 lone pairs on C). Total electron pairs = 2 (counting double bonds as one pair). Electron geometry = linear. Molecular geometry = linear. Bond angle = 180.

7. O has 6 valence electrons, each H has 1. Lewis: O with 2 H atoms bonded + 2 lone pairs. Total electron pairs = 4 (2 bonding + 2 lone). Electron geometry = tetrahedral (4 pairs). Molecular geometry = bent (2 bonded atoms, 2 lone pairs). Bond angle 104.5 (less than 109.5 due to two lone pairs).

8. Valence Shell Electron Pair Repulsion theory predicts molecular geometry by stating that electron pairs (bonding and lone) repel each other, minimizing repulsion to determine 3D shape.

9. Electron geometry includes all electron pairs (bonding + lone); molecular geometry includes only bonded atoms. Lone pairs affect electron geometry but not molecular geometry naming.

10. NH has 1 lone pair that repels bonding pairs more strongly than another bonding pair would, compressing the H-N-H angle to 107 (vs. 109.5 in CH).