18. The bonds in beryllium hydride (BeH₂) molecules are polar, and yet the dipole moment of the molecule is zero. Explain why. Draw a 3D drawing of the molecule to support answer. BeH₂ has a net dipole moment of 0 because it is linear, and the dipole moments of the individual bonds, which have the same magnitude but opposite directions, cancel out.

19. The following four molecules all have the same molecular geometry. H₂O, H₂S, H₂Te, H₂Se.
   a) What is the molecular geometry that they all have? bent
   b) Draw the 3D structure of each of the molecules and arrange the drawings in order of increasing dipole moment.
   Since electronegativity decreases going down a column (group) in the periodic table, the electronegativity differences between hydrogen and the other Group 6 element will increase in the order Te < Se < S < O, and the electronegativity of H is equal to that of Te.

21. Draw the 3D structure of each of the following molecules and arrange the drawings in order of increasing dipole moment: H₂O, CBr₄, H₂S, HF, NH₃, CO₂. (2 of them are NP)
   CO₂ = CBr₄ (µ = 0 for both) < H₂S < NH₃ < H₂O < HF

23. Which of the following molecules has the higher dipole moment? b Why?
   In molecule (a), the trans arrangement cancels the bond dipoles and the molecule is nonpolar.
   Molecule (b) will have a higher dipole moment.

24. Draw in arrows on the following molecules to show any bond dipoles.
   Which two of the molecules are non-polar? b and d
   Which one is slightly polar? c Which one is the most polar? a

Most polar Nonpolar Slightly polar Nonpolar
(a) (b) (c) (d)
Use valence theory to explain the bonding in Cl₂ and HCl. For each, draw a diagram which shows the orbitals overlapping between the two atoms.

a) Cl₂: In Cl₂ there overlap between the 3p orbitals of the two chlorine atoms. This is a sigma bond because there is direct overlap.

b) HCl: In HCl there overlap between the 1s orbital of H and the 3p orbital of Cl. This is a sigma bond because it is direct overlap.

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Determine if the following molecules are polar or nonpolar by filling the this chart.

<table>
<thead>
<tr>
<th>Formula</th>
<th>Lewis Dot Structure</th>
<th>3D Drawing (Show arrows for all bond dipoles)</th>
<th>Electron domain geometry and Molecular Geometry</th>
<th>Polar or Nonpolar?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) SO₃</td>
<td>:O :|--|:O :O :O</td>
<td>3D Drawing</td>
<td>Trigonal planar Trigonal planar</td>
<td>nonpolar.</td>
</tr>
<tr>
<td>b) PF₃</td>
<td>:F --- F --- F --- F</td>
<td>3D Drawing</td>
<td>Tetrahedral trigonal pyramidal</td>
<td>polar.</td>
</tr>
<tr>
<td>c) SiF₃H</td>
<td>:F --- Si --- F --- F</td>
<td>3D Drawing</td>
<td>Tetrahedral</td>
<td>polar.</td>
</tr>
<tr>
<td>d) SiH₅⁻</td>
<td>H --- Si --- H --- H</td>
<td>3D Drawing</td>
<td>Tetrahedral</td>
<td>Neither polar or nonpolar. It is an ion.</td>
</tr>
<tr>
<td>e) CH₂Br₂</td>
<td>H --- C --- Br --- Br</td>
<td>3D Drawing</td>
<td>Tetrahedral</td>
<td>Polar</td>
</tr>
</tbody>
</table>