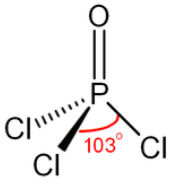
SL & HL Answers to Shapes & polarity questions

1. i. BCl_3 contains 3 bonding electron pairs around the central boron atom so the shape trigonal planar with angles of 120°.



ii. $POCl_3$ contains 4 bonding electron domains so tetrahedral with angles of approximately 109.5°. In fact the Cl-P-Cl bond angle is 103° (see right)

iii. PH_3 contains 3 bonding & 1 non-bonding electron pairs so trigonal pyramidal with bond angles of approximately 107° (the actual value is 93.5°)

iv. HCN contains two electron domains around the central carbon atom so linear with bond angles of 180°.

2. The sulfur atom in SO_2 contains three electron domains arranged to give a trigonal planar shape. The two bonding electron domains to the oxygen atoms give the molecule its bent shape with an angle of approximately 120°. In carbon dioxide there are only two electron domains (both bonding) around the central carbon atom so the molecule is linear.

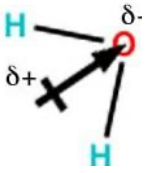
3. O is more electronegative than C so the C=O bond is polar. The two C=O bonds are at 180° to each other so the resultant polarity is zero.

4. Ammonia contains one non-bonding pair of electrons around the central nitrogen atom. This exerts a greater repulsion than the three bonding pairs so the H-N-H bond angle will be less than 109.5°. In the ammonium ion the four bonding pairs of electrons around the central nitrogen atom give the ion a regular tetrahedral shape with a bond angle of 109.5°.

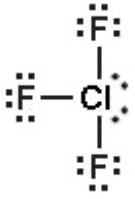
5. i. In benzene each carbon atom has three electron domains (all bonding) so the bond angles will all be approximately 120°.

ii. In cyclohexane each carbon atom has four electron domains (all bonding) so the bond angles will all be approximately 109.5°.

6. HF is polar as the molecule only contains two atoms with different electronegativity values. H_2O is polar as the molecule is bent and contains a dipole (see right). CF_4 is tetrahedral and CO_2 is linear; in both cases the bond polarities cancel out to give a zero resultant dipole.



HL only questions



7. i. XeF_4: 6 electron pairs (4 bonding + 2 non-bonding) so square planar

ii. ICl_4^- : 6 electron pairs (4 bonding + 2 non-bonding) so square planar

iii. ClF_3 : 5 electron pairs (3 bonding + 2 non-bonding) so T-shaped (right)
(the two non-bonding pairs go in the trigonal pyramid part of the trigonal bipyramid basic shape so that they are as far apart from each other as possible).

8. i. PF_5 (trigonal bipyramid shape so) 90°, 120° and 180°

ii. PF_6^- (octahedral shape so) 90° and 180°.