1996

Explain each of the following in terms of the electronic structure and/or bonding of the compounds involved.

(a) At ordinary conditions, HF (normal boiling point = 20°C) is a liquid, whereas HCl (normal boiling point = -114°C) is a gas.

(b) Molecules of AsF_3 are polar, whereas molecules of AsF_5 are nonpolar.

(c) The N-O bonds in the NO_2^- ion are equal in length, whereas they are unequal in HNO_2.

(d) For sulfur, the fluorides SF_2, SF_4, and SF_6 are known to exist, whereas for oxygen only OF_2 is known to exist.

1999

Answer the following questions using principles of chemical bonding and molecular structure.

(a) Consider the carbon dioxide molecule, CO_2 , and the carbonate ion, CO_3^{2-}.

(i) Draw the complete Lewis electron-dot structure for each species.

(ii) Account for the fact that the carbon-oxygen bond length in CO_3^{2-} is greater than the carbon-oxygen bond length in CO_2.

(b) Consider the molecules CF_4 and SF_4.

(i) Draw the complete Lewis electron-dot structure for each molecule.

(ii) In terms of molecular geometry, account for the fact that the CF_4 molecule is nonpolar, whereas the SF_4 molecule is polar.

2002B

Using principles of chemical bonding and molecular geometry, explain each of the following observations. Lewis electron-dot diagrams and sketches of molecules may be helpful as part of your explanations. For each observation, your answer must include references to both substances.

(a) The bonds in nitrite ion, NO_2^-, are shorter than the bonds in nitrate ion, NO_3^-.
(b) The CH_2F_2 molecule is polar, whereas the CF_4 molecule is not.
(c) The atoms in a C_2H_4 molecule are located in a single plane, whereas those in a C_2H_6 molecule are not.
(d) The shape of a PF_5 molecule differs from that of an IF5 molecule.
(e) $HClO_3$ is a stronger acid than HClO.

2003

Compound Name	Compound Formula	$\Delta H°_{vap}$ (kJ mol^{-1})
Propane	$CH_3CH_2CH_3$	19.0
Propanone	CH_3COCH_3	32.0
1-propanol	$CH_3CH_2CH_2OH$	47.3

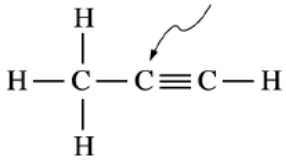
Using the information in the table above, answer the following questions about organic compounds.

(a) For propanone,
  (i) draw the complete structural formula (showing all atoms and bonds);
  (ii) predict the approximate carbon-to-carbon-to-carbon bond angle.

(b) For each pair of compounds below, explain why they do not have the same value for their standard heat of vaporization, $\Delta H°_{vap}$. (You must include specific information about both compounds in each pair.)
  (i) Propane and propanone
  (ii) Propanone and 1-propanol

(c) Draw the complete structural formula for an isomer of the molecule you drew in part (a) (i).

(d) Given the structural formula for propyne below,



  (i) indicate the hybridization of the carbon atom indicated by the arrow in the structure above;
  (ii) indicate the total number of sigma (σ) bonds and the total number of pi (π) bonds in the molecule.