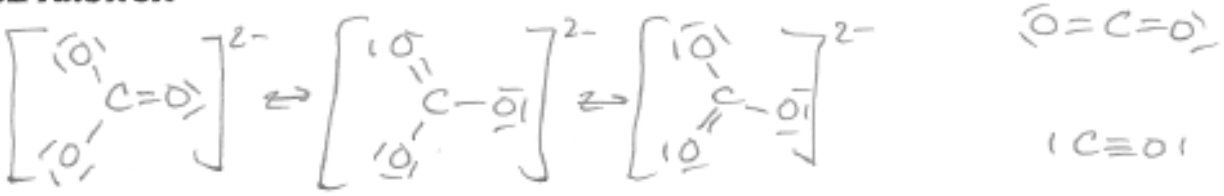
1982 Answer:

(a) 

(b) CO has the shortest bond because there is a triple bond. **OR** because there is the greatest number of electrons between C and O in CO.

(c) CO_3^{2-} trigonal planar (planar and triangular). C bonding is sp^2 hybrid - or - C has three bonding pairs and no lone pair.

CO_2 linear. C bonding is *sp* hybrid - or - C has two bonding pairs and no lone pairs - or - CO_2 is nonpolar and must be linear.

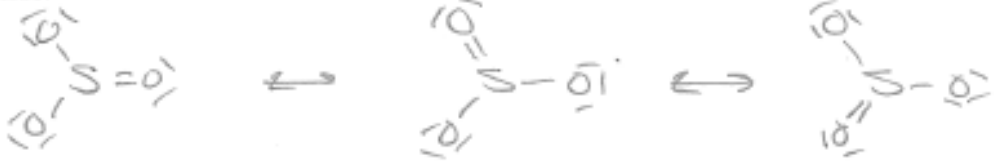
CO linear. Two atoms determine a straight line.

1990 Answer:

(a) C_2H_4 has a multiple bond; C_2H_6 has a single bond. Multiple bonds are stronger and, therefore, shorter than single bonds.

(b) NH_3 has 3 bonding pairs of electrons and 1 lone pair. Bonding pairs are forced together because repulsion between lone pair and bonding pairs is greater than between bonding pairs.

(c) The bonding in SO_3 can be described as a combination of 3 resonance forms of 1 double and 2 single bonds.

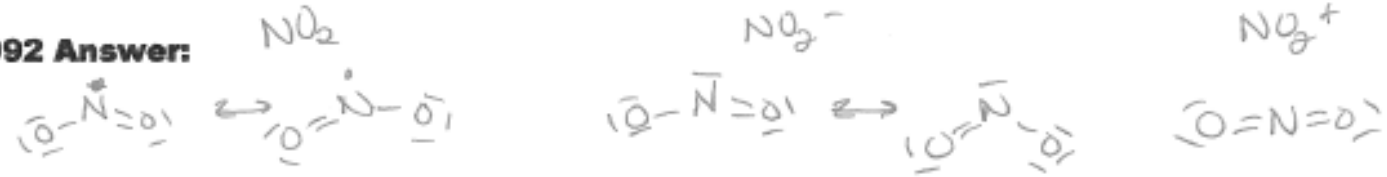


The actual structure is intermediate among the 3 resonance forms, having 3 bonds that are equal and stronger (therefore, shorter) than an S-O single bond.

(d) The central I atom has 3 lone pairs and 2 bonding pairs around it.

To minimize repulsion, the 3 lone pairs on the central atom are arranged as a triangle in a plane at right angles to the I-I-I- axis.

1992 Answer:

(a) 

(b) $NO_2^- < NO_2 < NO_2^+$

NO_2^- - 3 charge centers around N; lone pair of electrons on N

NO_2 - 3 charge centers around N; single electron on N

NO_2^+ - 2 charge centers on N

(c) NO_2^+ is linear, has sp hybridization - or - NO_2/NO_2^- have sp^2 hybridization

(d) NO_2 will dimerize, because it contains an odd electron that will pair readily with another, forming N_2O_4.

1996 Answer:

(a) hydrogen bonding (dipole-dipole attraction) is much larger in HF than in HCl.

(b) AsF_3 forms a pyramidal shaped molecule with a lone pair of electrons creating an asymmetrical region opposite the three highly electron-affinitive fluorine in the base. The AsF_5 molecule has a highly symmetrical trigonal bipyramidal shape with no lone electron pairs.

(c) The N-O bonds in the nitrite ion are stabilized by resonance and are of equal length, but in HNO_2, with a hydrogen attached to an oxygen, resonance is no longer possible.

$$[:\bar{\underline{O}}::\underline{\underline{N}}:\ddot{\underline{O}}:]^- \quad \times \quad [:\bar{\underline{O}}:\underline{\underline{N}}::\ddot{\underline{O}}:]^-$$

(d) There are only four orbitals in the valence shell of oxygen, one *s* and three *p*'s. As a result, oxygen can hold no more than eight valence electrons, which it gets when it forms OF_2. The valence orbitals of sulfur are in the $n = 3$ shell and includes empty *d* orbitals that can be used to expand its valence shell. Sulfur has 10 valence electrons in forming SF_4 and 12 valence electrons to form SF_6 (sp^3d^2 hybrid orbitals).