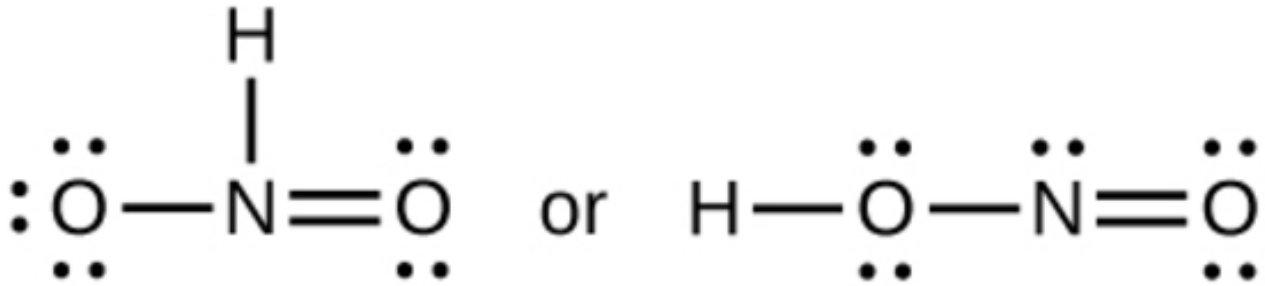
# General Chemistry

202-SN1-RE

*with Olivia Bibollet-Bahena*

Office: 5th floor

Which of the following structures would we expect for nitrous acid? Determine the formal charges:



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What are the geometry and shape of each central atom? What are the bond angles?

First molecule:
N: trigonal planar, trigonal planar, 120 degree angles

Second molecule:
O: tetrahedral, bent, less than 109.5 degree angles
N: trigonal planar, bent, less than 120 degree angles

# Exercise

Which of the following molecules has a dipole moment?

a) $CF_4$
b) $SF_4$
c) $XeF_4$
d) All of these have a dipole moment.
e) None of these has a dipole moment.

Draw the Lewis structure first.

Dipole moments result from differences in electronegativity and geometry. Both the **tetrahedral** ($CF_4$) and **square planar** ($XeF_4$) geometries result in dipole moments of zero. The **see-saw** geometry of $SF_4$ produces a dipole moment.

# Geometry and Dipoles

- Consider the chemical formula $\mathrm{Xe}I_2F_2$.

- Determine two possible stable geometries for this chemical formula, one which is polar and one which is not.

Draw the Lewis structures.

$XeI_2F_2$ has a square planar shape. When the two I atoms are opposite each other and the two F atoms are opposite each other, the molecule will be nonpolar. When I is across F, then a dipole moment is created.

# Exercise

True or false:

Lone pairs always make a molecule polar.

-If true, explain why.

-If false, provide a counter-example.

False, lone pairs do not always make a molecule polar. They might be arranged so that they are symmetrically distributed to minimize repulsions, such as $XeF_4$.

# Exercise

Which of the following statements best describes $BF_3$ and $NF_3$? (*Note:* Geometry refers to the electron pair arrangement, and shape refers to the atom arrangement.)

a) They have variable geometries and shapes due to their potential resonance structures.

b) They have the same geometry and different shapes.

c) They have the same geometry and the same shape.

d) They have different geometries and the same shape.

e) They have different geometries and different shapes.

# Exercise

Predict $\Delta H$ for the reaction of methane with chlorine and fluorine to give Freon-12 ($CF_2Cl_2$):

$$CH_4(g) + 2Cl_2(g) + 2F_2(g) \rightarrow CF_2Cl_2(g) + 2HF(g) + 2HCl(g)$$

$$\Delta H = [4(413) + 2(239) + 2(154)] - [2(485) + 2(339)] + 2(565) + 2(427)]$$

$$\Delta H = 2438 \text{ kJ} - 3632 \text{ kJ}$$

$$\Delta H = -1194 \text{ kJ}$$

| Single Bonds | | | | | | Multiple Bonds | |
|---|---|---|---|---|---|---|---|
| H—H | 432 | N—H | 391 | I—I | 149 | C═C | 614 |
| H—F | 565 | N—N | 160 | I—Cl | 208 | C≡C | 839 |
| H—Cl | 427 | N—F | 272 | I—Br | 175 | O═O | 495 |
| H—Br | 363 | N—Cl | 200 | | | C═O* | 745 |
| H—I | 295 | N—Br | 243 | S—H | 347 | C≡O | 1072 |
| | | N—O | 201 | S—F | 327 | N═O | 607 |
| C—H | 413 | O—H | 467 | S—Cl | 253 | N═N | 418 |
| C—C | 347 | O—O | 146 | S—Br | 218 | N≡N | 941 |
| C—N | 305 | O—F | 190 | S—S | 266 | C≡N | 891 |
| C—O | 358 | O—Cl | 203 | | | C═N | 615 |
| C—F | 485 | O—I | 234 | Si—Si | 340 | | |
| C—Cl | 339 | | | Si—H | 393 | | |
| C—Br | 276 | F—F | 154 | Si—C | 360 | | |
| C—I | 240 | F—Cl | 253 | Si—O | 452 | | |
| C—S | 259 | F—Br | 237 | | | | |
| | | Cl—Cl | 239 | | | | |
| | | Cl—Br | 218 | | | | |
| | | Br—Br | 193 | | | | |

*C═O($CO_2$) = 799

Using the bond energies on the previous slide, determine the approximate enthalpy change for each of the following reactions:

(a) $\mathrm{Cl_2}(g) + 3\mathrm{F_2}(g) \longrightarrow 2\mathrm{ClF_3}(g)$

(b) $\mathrm{H_2C{=}CH_2}(g) + \mathrm{H_2}(g) \longrightarrow \mathrm{H_3CCH_3}(g)$

(c) $2\mathrm{C_2H_6}(g) + 7\mathrm{O_2}(g) \longrightarrow 4\mathrm{CO_2}(g) + 6\mathrm{H_2O}\,(g)$

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