

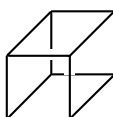
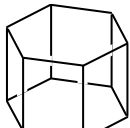


Quiz 1
CHEM 325
Spring 2009

Name: _____

1. (5 Points) Assign the following objects to the proper point group.

	(square pyramid)	<u> C_{4v} </u>
	(trigonal prism)	<u> D_{3h} </u>
	(rectangular prism)	<u> D_{4h} </u>
	(hexagonal prism)	<u> D_{6h} </u>

2. (6 Points) Cesium was discovered in mineral water in 1860 by Bunsen and Kirchoff. The name comes from the Latin *caesius*, which means “sky blue,” describing the blue line they observed for this element at 455.5 nm. Calculate the energy of this line in eV (electron volts). You are given $\lambda \cdot \nu = c$, $E = h \cdot \nu$, $c = 2.9978 \times 10^8 \text{ m} \cdot \text{s}^{-1}$, $h = 6.62608 \times 10^{-34} \text{ J} \cdot \text{s}$ and $1 \text{ eV} = 1.6022 \times 10^{-19} \text{ J}$.

Combine $\lambda \cdot \nu = c$ ($\nu = \frac{c}{\lambda}$) and $E = h \cdot \nu$ to give $E = \frac{h \cdot c}{\lambda}$.

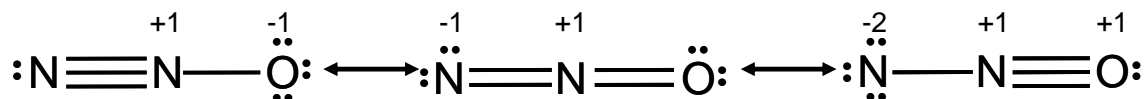
$$E = \frac{h \cdot c}{\lambda} = \frac{(6.62608 \times 10^{-34} \text{ J} \cdot \text{s})(2.9978 \times 10^8 \text{ m} \cdot \text{s}^{-1})}{455.5 \times 10^{-9} \text{ m}} \left(\frac{1 \text{ eV}}{1.6022 \times 10^{-19} \text{ J}} \right) = 2.722 \text{ eV}$$

This transition has an energy of 2.722 eV.

3a. (10 Points) Nitrous oxide (N_2O) has three possible resonance structures. Draw them and indicate any non-zero formal charges on the atoms in each resonance structure. You are given that the electronic configuration of N is $1s^2 2s^2 2p^3$ and that of O is $1s^2 2s^2 2p^4$.

Calculate the total number of valence electrons.

$$\begin{array}{r} 2 \text{ N} \quad 2 \times 5 = 10 \\ \text{O} \quad 6 \\ \hline \text{Total} \quad 16 \end{array}$$



Calculation of the formal charges.

$$\text{Central N: } FC = 5 - 0 - \frac{1}{2}(8) = +1$$

$$\text{Left N, triple bonded structure: } FC = 5 - 2 - \frac{1}{2}(6) = 0$$

$$\text{Left N, double bonded structure: } FC = 5 - 4 - \frac{1}{2}(4) = -1$$

$$\text{Left N, single bonded structure: } FC = 5 - 6 - \frac{1}{2}(2) = -2$$

$$\text{Oxygen, single bond: } FC = 6 - 6 - \frac{1}{2}(2) = -1$$

$$\text{Oxygen, double bond: } FC = 6 - 4 - \frac{1}{2}(4) = 0$$

$$\text{Oxygen, triple bond: } FC = 6 - 2 - \frac{1}{2}(6) = +1$$

b. (4 Points) Given the following bond lengths ($1 \text{ \AA} = 10^{-10} \text{ m}$), rationalize the observations that the N–N bond length in N_2O is 1.12 \AA and that the N–O bond length is 1.19 \AA .

N–N	1.67 \AA	N=O	1.15 \AA
N=N	1.20 \AA	N–O	1.47 \AA
N≡N	1.10 \AA		

The Electroneutrality Principle (based on minimizing formal charge and the placement of negative formal charges on more electronegative atoms) predicts that the structure with a N–N triple bond and an N–O single bond should be the most favorable structure. However, the data indicate that the bond character in the N–N bond is between that of a typical double and a typical triple N–N bond and that the N–O bond is between that of a typical double and typical single N–O bond. This suggests that the bonding in N_2O is better described by a resonance hybrid that includes both of the structures shown on the left above. In other words, both the first and second resonance structures shown above contribute to the resonance hybrid description of N_2O .

c. (2 Points) What is the hybridization of the central N?

The central N in N_2O has a linear electron pair geometry and is sp hybridized.