POTD ANSWERS, 11/20/09

8.38 We calculate the electronegativity differences for each pair of atoms:

DE: $3.8 - 3.3 = 0.5$ DG: $3.8 - 1.3 = 2.5$ EG: $3.3 - 1.3 = 2.0$ DF: $3.8 - 2.8 = 1.0$

The order of increasing covalent bond character is: **DG < EG < DF < DE**

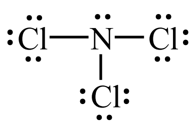
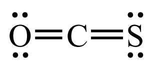
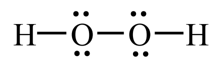
8.41 **(a)** The two silicon atoms are the same. The bond is **nonpolar**.

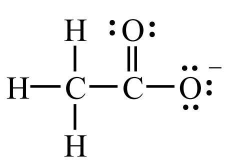
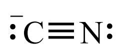
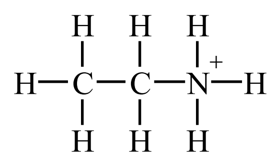
(b) The electronegativity difference between Cl and Si is $3.0 - 1.8 = 1.2$. The bond is **polar covalent**.

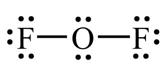
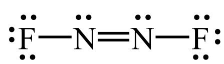
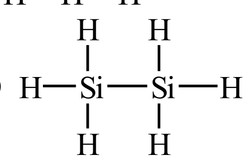
(c) The electronegativity difference between F and Ca is $4.0 - 1.0 = 3.0$. The bond is **ionic**.

(d) The electronegativity difference between N and H is $3.0 - 2.1 = 0.9$. The bond is **polar covalent**.

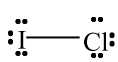
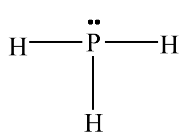
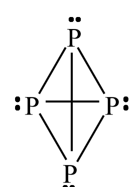
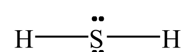
8.42 The Lewis structures are:

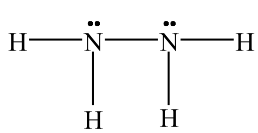
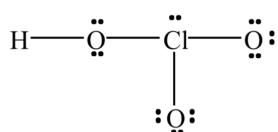
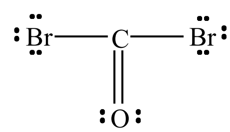
(a)  **(b)**  **(c)** 

(d)  **(e)**  **(f)** 

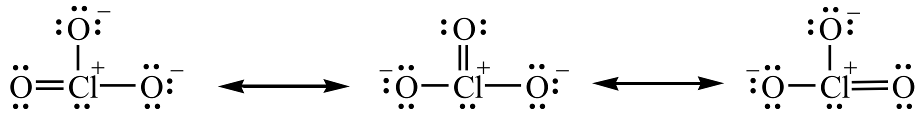
(a)  **(b)**  **(c)** 

8.44 The Lewis structures are:

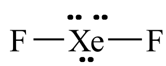
(a)  **(b)**  **(c)**  **(d)** 

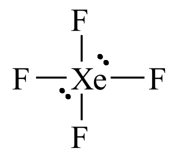
(e)  **(f)**  **(g)** 

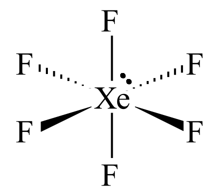
8.54 The resonance structures with formal charges are:

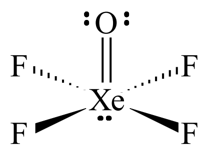


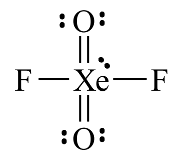
8.66 For simplicity, the three, nonbonding pairs of electrons around the fluorine atoms are omitted.

(a) 

(b) 

(c) 

(d) 

(e) 

The octet rule is exceeded in each case.

8.75 **(a)**

Bonds Broken	*Number Broken*	*Bond Enthalpy* (kJ/mol)	*Enthalpy Change* (kJ)
C – H	12	414	4968
C – C	2	347	694
O = O	7	498.7	3491

Bonds Formed	*Number Formed*	*Bond Enthalpy* (kJ/mol)	*Enthalpy Change* (kJ)
C = O	8	799	6392
O – H	12	460	5520

$\boldsymbol{\Delta H°}$ = total energy input – total energy released

= (4968 + 694 + 3491) – (6392 + 5520) = **–2759 kJ/mol**

(b) $\Delta H° = 4\Delta H_f^\circ(CO_2) + 6\Delta H_f^\circ(H_2O) - [2\Delta H_f^\circ(C_2H_6) + 7\Delta H_f^\circ(O_2)]$

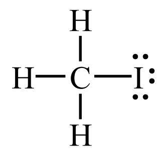
$\boldsymbol{\Delta H°}$ = (4)(–393.5 kJ/mol) + (6)(–241.8 kJ/mol) – [(2)(–84.7 kJ/mol) + (7)(0)] = **–2855.6 kJ/mol**

The answers for part (a) and (b) are different, because *average* bond enthalpies are used for part (a).

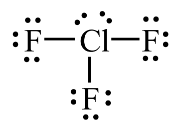
9.10 We determine the molecular geometry using the following sequence of steps:

draw Lewis structure ⟶ count electron-domains around the central atom ⟶ find electron-domain geometry ⟶ determine molecular geometry based on position of atoms

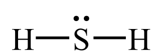
(a) Looking at the Lewis structure we find 4 electron domains around the central atom. The electron-domain geometry is tetrahedral. Since there are no lone pairs on the central atom, the molecular geometry is also **tetrahedral**.



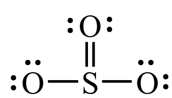
(b) Looking at the Lewis structure we find 5 electron domains around the central atom. The electron-domain geometry is trigonal bipyramidal. There are two lone pairs on the central atom, which occupy equatorial positions in the trigonal plane. The molecular geometry is **t-shaped**.



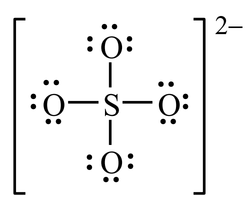
(c) Looking at the Lewis structure we find 4 electron domains around the central atom. The electron-domain geometry is tetrahedral. There are two lone pairs on the central atom. The molecular geometry is **bent**.



(d) Looking at the Lewis structure, there are 3 electron domains around the central atom. (Recall that a double bond counts as one electron domain.) The electron-domain geometry is trigonal planar. Since there are no lone pairs on the central atom, the molecular geometry is also **trigonal planar**.



(e) Looking at the Lewis structure, there are 4 electron domains around the central atom. The electron-domain geometry is tetrahedral. Since there are no lone pairs on the central atom, the molecular geometry is also **tetrahedral**.



9.12 **(a)** AB_4 (no lone pairs on the central atom) tetrahedral

(b) AB_2 (two lone pairs on the central atom) bent

(c) AB_3 (no lone pairs on the central atom) trigonal planar

(d) AB_2 (two lone pairs on the central atom) linear

(e) AB_4 (two lone pairs on the central atom) square planar

(f) AB_4 (no lone pairs on the central atom) tetrahedral

(g) AB_5 (no lone pairs on the central atom) trigonal bipyramidal

(h) AB_3 (one lone pair on the central atom) trigonal pyramidal

(i) AB_4 (no lone pairs on the central atom) tetrahedral

9.18 **(a)** linear, **polar** **(b)** square planar, **nonpolar**

9.32 **(a)** NH_3 is an AB_3 molecule with one lone pair (four electron domains on the central atom). Referring to Table 9.4 of the text, the nitrogen is sp^3 hybridized.

(b) N_2H_4 has two equivalent nitrogen atoms. Centering attention on just one nitrogen atom shows that it is an AB_3 molecule with one lone pair (four electron domains on the central atom), so the nitrogen atoms are sp^3 hybridized. From structural considerations, how can N_2H_4 be considered to be a derivative of NH_3?

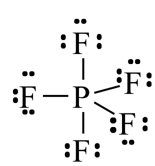
(c) The nitrate anion NO_3^- is isoelectronic and isostructural with the carbonate anion CO_3^{2-}. There are three resonance structures, and the ion is of type AB_3 with no lone pairs (three electron domains on the central atom) thus, the nitrogen is sp^2 hybridized.

9.33 **Strategy:** The steps for determining the hybridization of the central atom in a molecule are:

draw Lewis Structure of the molecule → count the number of electron-domains on the central atom → use Table 9.4 of the text to determine the hybridization state of the central atom

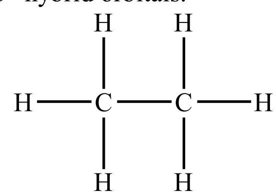
Solution:

Draw the Lewis structure of the molecule.

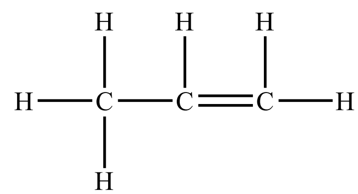


Count the number of electron domains around the central atom. Since there are five electron domains around P, the electron-domain geometry is trigonal bipyramidal (AB_5 w/no lone pairs) and we conclude that P is ***sp^3d* hybridized**.

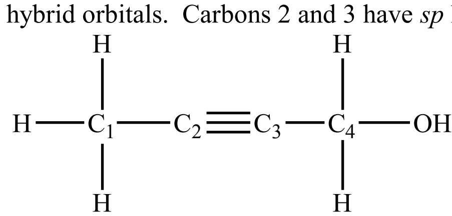
9.36 **(a)** Each carbon has four electron domains with no lone pairs and therefore has a tetrahedral electron-domain geometry. This implies *sp*^{3} hybrid orbitals.



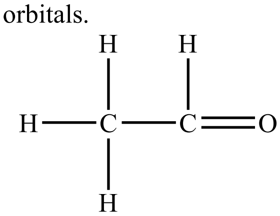
(b) The left-most carbon is tetrahedral and therefore has *sp*^{3} hybrid orbitals. The two carbon atoms connected by the double bond are trigonal planar with *sp*^{2} hybrid orbitals.



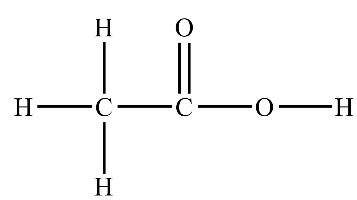
(c) Carbons 1 and 4 have *sp*^{3} hybrid orbitals. Carbons 2 and 3 have *sp* hybrid orbitals.



(d) The left-most carbon is tetrahedral (*sp*^{3} hybrid orbitals). The carbon connected to oxygen is trigonal planar (why?) and has *sp*^{2} hybrid orbitals.



(e) The left-most carbon is tetrahedral (*sp*^{3} hybrid orbitals). The other carbon is trigonal planar with *sp*^{2} hybridized orbitals.



9.41 A single bond is usually a sigma bond, a double bond is usually a sigma bond and a pi bond, and a triple bond is always a sigma bond and two pi bonds. Therefore, there are **nine σ bonds** and **nine π bonds** in the molecule.

11.13 **Strategy:** We use the conversion factors provided in Table 11.2 in the text to convert a pressure in mmHg to atm, bar, torr, and Pa.

Solution: Converting to atm:

$$\textbf{?atm} = 375\text{ mmHg} \times \frac{133.322\text{ Pa}}{1\text{ mmHg}} \times \frac{1\text{ atm}}{101{,}325\text{ Pa}} = \mathbf{0.493\ atm}$$

We could also have solved this by remembering that 760 mmHg = 1 atm.

$$\textbf{?atm} = 375\text{ mmHg} \times \frac{1\text{ atm}}{760\text{ mmHg}} = \mathbf{0.493\ atm}$$

Converting to bar:

$$\textbf{?bar} = 375\text{ mmHg} \times \frac{133.322\text{ Pa}}{1\text{ mmHg}} \times \frac{1\text{ torr}}{133.322\text{ Pa}} = \mathbf{0.500\ bar}$$

Converting to torr:

$$\textbf{?torr} = 375\text{ mmHg} \times \frac{133.322\text{ Pa}}{1\text{ mmHg}} \times \frac{1\text{ bar}}{1\times 10^{5}\text{ Pa}} = \mathbf{375\ torr}$$

Note that because 1 mmHg and 1 torr are both equal to 133.322 Pa, this could be simplified by recognizing that 1 torr = 1 mmHg.

$$375\text{ mmHg} \times \frac{1\text{ torr}}{1\text{ mmHg}} = \mathbf{375\ torr}$$

Converting to Pa:

$$375\text{ mmHg} \times \frac{1\text{ atm}}{760\text{ mmHg}} \times \frac{101{,}325\text{ Pa}}{1\text{ atm}} = \mathbf{5.00 \times 10^{4}\ Pa}$$

11.23 **Strategy:** This is a Boyle's law problem. Temperature and the amount of gas are both constant. Therefore, we can use Equation 11.2 to solve for the final volume.

$$P_1V_1 = P_2V_2$$

Solution:

Initial Conditions	Final Conditions
$P_1 = 0.970$ atm	$P_2 = 0.541$ atm
$V_1 = 25.6$ mL	$\boldsymbol{V_2 = ?}$

$$\boldsymbol{V_2} = \frac{P_1V_1}{P_2} = \frac{(0.970\text{ atm})(25.6\text{ mL})}{0.541\text{ atm}} = \mathbf{45.9\ mL}$$

Check: Make sure that Boyle's law is obeyed. If the pressure decreases at constant temperature, the volume must increase.

11.27 **Strategy:** Pressure is held constant in this problem. Only volume and temperature change. This is a Charles's law problem. We use Equation 11.4 to solve for the unknown volume.

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Solution:

Initial Conditions	Final Conditions
$T_1 = 35°C + 273 = 308\ K$	$T_2 = 72° + 273 = 345\ K$
$V_1 = 28.4\ L$	$\boldsymbol{V_2 = ?}$

$$\boldsymbol{V_2} = \frac{V_1 T_2}{T_1} = \frac{(28.4\ \mathrm{L})(345\ \mathrm{K})}{308\ \mathrm{K}} = \mathbf{31.8\ L}$$

Check: Make sure you express temperatures in kelvins and that Charles's law is obeyed. At constant pressure, when temperature increases, volume should also increase.