Chapter 1
A Review of General Chemistry:
Electrons, Bonds and Molecular Properties

Review of Concepts

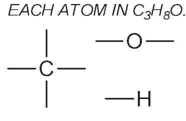
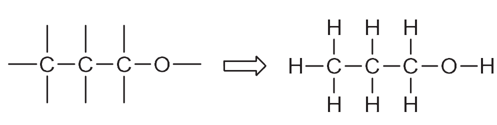
Fill in the blanks below. To verify that your answers are correct, look in your textbook at the end of Chapter 1. Each of the sentences below appears verbatim in the section entitled *Review of Concepts and Vocabulary*.

_____________ **isomers** share the same molecular formula but have different connectivity of atoms and different physical properties.
Second-row elements generally obey the _______ **rule**, bonding to achieve noble gas electron configuration.
A pair of unshared electrons is called a ______________.
A **formal charge** occurs when an atom does not exhibit the appropriate number of ___________________________.
An **atomic orbital** is a region of space associated with ____________________, while a **molecular orbital** is a region of space associated with _______________.
Methane's tetrahedral geometry can be explained using four degenerate _____**-hybridized orbitals** to achieve its four single bonds.
Ethylene's planar geometry can be explained using three degenerate _____**-hybridized orbitals**.
Acetylene's linear geometry is achieved via _____**-hybridized** carbon atoms.
The geometry of small compounds can be predicted using valence shell electron pair repulsion (**VSEPR**) theory, which focuses on the number of bonds and _______________ exhibited by each atom.
The physical properties of compounds are determined by __________________ forces, the attractive forces between molecules.
London dispersion forces result from the interaction between transient __________________ and are stronger for larger alkanes due to their larger surface area and ability to accommodate more interactions.

Review of Skills

Fill in the blanks and empty boxes below. To verify that your answers are correct, look in your textbook at the end of Chapter 1. The answers appear in the section entitled *SkillBuilder Review*.

SkillBuilder 1.1 Drawing Constitutional Isomers of Small Molecules

STEP 1 *DETERMINE THE VALENCY OF EACH ATOM IN C_3H_8O.* 	***STEP 2*** *CONNECT THE ATOMS OF HIGHEST VALENCY, AND PLACE THE MONOVALENT ATOMS AT THE PERIPHERY.* 	***STEP 3*** *CONSIDER OTHER WAYS TO CONNECT THE ATOMS.*

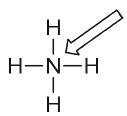
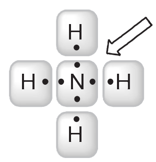
SkillBuilder 1.2 Drawing the Lewis Dot Structure of an Atom

STEP 1 - *DETERMINE THE NUMBER OF VALENCE ELECTRONS* Nitrogen is in Group ___ of the periodic table, and is expected to have ___ valence electrons.	***STEP 2 -*** *PLACE ONE ELECTRON BY ITSELF ON EACH SIDE OF THE ATOM*	***STEP 3 -*** *IF THE ATOM HAS MORE THAN FOUR VALENCE ELECTRONS, PAIR THE REMAINING ELECTRONS WITH THE ELECTRONS ALREADY DRAWN*

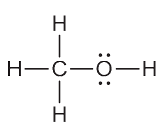
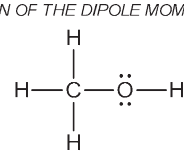
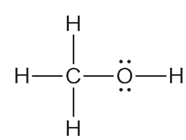
SkillBuilder 1.3 Drawing the Lewis Structure of a Small Molecule

STEP 1 - *DRAW THE LEWIS DOT STRUCTURE OF EACH ATOM IN* CH_2O	***STEP 2 -*** *FIRST CONNECT ATOMS THAT FORM MORE THAN ONE BOND*	***STEP 3 -*** *CONNECT THE HYDROGEN ATOMS*	***STEP 4 -*** *PAIR ANY UNPAIRED ELECTRONS, SO THAT EACH ATOM ACHIEVES AN OCTET*

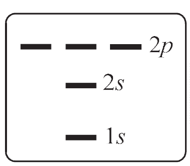
SkillBuilder 1.4 Calculating Formal Charge

STEP 1 - *DETERMINE THE APPROPRIATE NUMBER OF VALENCE ELECTRONS*  Nitrogen is in Group ___ of the periodic table, and is expected to have ___ valence electrons.	***STEP 2 -*** *DETERMINE THE NUMBER OF VALENCE ELECTRONS IN THIS CASE*  In this case, the nitrogen atom is using only ___ valence electrons.	***STEP 3 -*** *ASSIGN A FORMAL CHARGE TO THE NITROGEN ATOM IN THIS CASE*

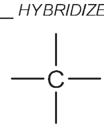
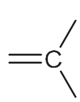
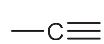
SkillBuilder 1.5 Locating Partial Charges Resulting from Induction

STEP 1 - *CIRCLE THE BONDS BELOW THAT ARE POLAR COVALENT* 	***STEP 2 -*** *FOR EACH POLAR COVALENT BOND, DRAW AN ARROW THAT SHOWS THE DIRECTION OF THE DIPOLE MOMENT* 	***STEP 3 -*** *INDICATE THE LOCATION OF ALL PARTIAL CHARGES (δ+ and δ-)* 

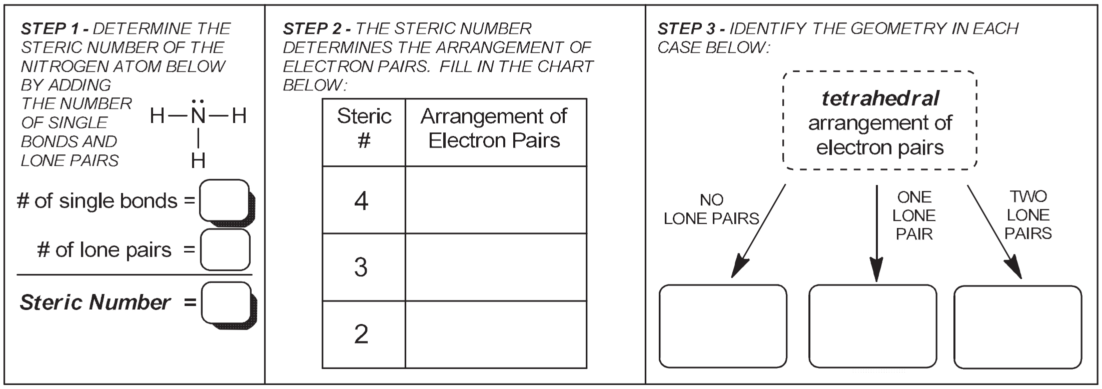
SkillBuilder 1.6 Identifying Electron Configurations

STEP 1 - *IN THE ENERGY DIAGRAM SHOWN HERE, DRAW THE ELECTRON CONFIGURATION OF NITROGEN (USING ARROWS TO REPRESENT ELECTRONS).*  Nitrogen	***STEP 2 -*** *FILL IN THE BOXES BELOW WITH THE NUMBERS THAT CORRECTLY DESCRIBE THE ELECTRON CONFIGURATION OF NITROGEN* $1s^{\square}\ 2s^{\square}\ 2p^{\square}$

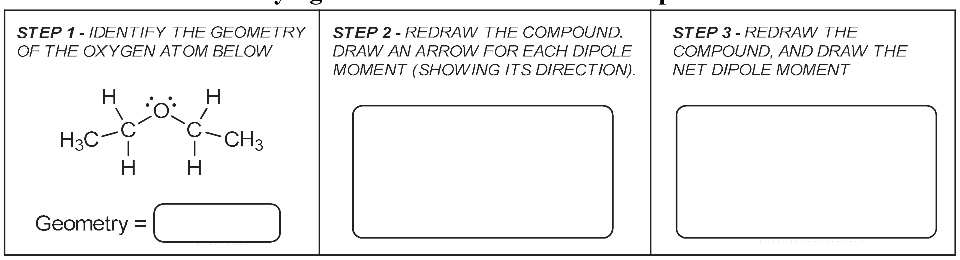
SkillBuilder 1.7 Identifying Hybridization States

A CARBON ATOM WITH FOUR SINGLE BONDS WILL BE _____ HYBRIDIZED 	*A CARBON ATOM WITH ONE DOUBLE BOND WILL BE _____ HYBRIDIZED* 	*A CARBON ATOM WITH A TRIPLE BOND WILL BE _____ HYBRIDIZED* 

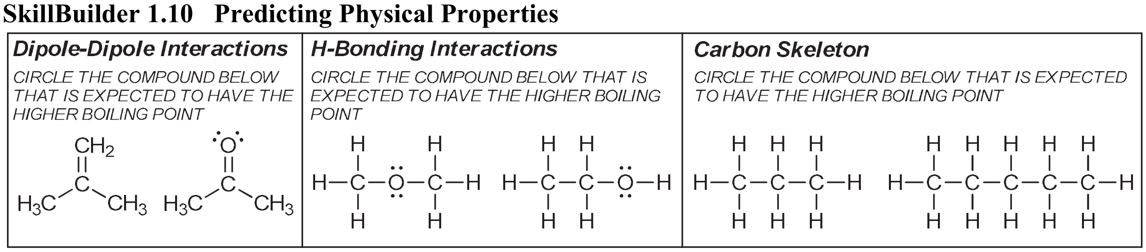
SkillBuilder 1.8 Predicting Geometry



SkillBuilder 1.9 Identifying the Presence of Molecular Dipole Moments



SkillBuilder 1.10 Predicting Physical Properties



A Common Mistake to Avoid

When drawing a structure, don't forget to draw formal charges, as forgetting to do so is a common error. If a formal charge is present, it MUST be drawn. For example, in the following case, the nitrogen atom bears a positive charge, so the charge must be drawn:

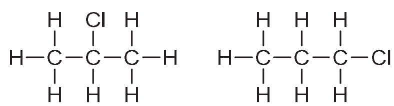
INCORRECT **CORRECT**

As we progress though the course, we will see structures of increasing complexity. If formal charges are present, failure to draw them constitutes an error, and must be scrupulously avoided. If you have trouble drawing formal charges, go back and master that skill. You can't go on without it. Don't make the mistake of underestimating the importance of being able to draw formal charges with confidence.

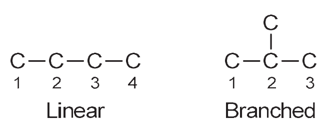
Solutions

1.1.

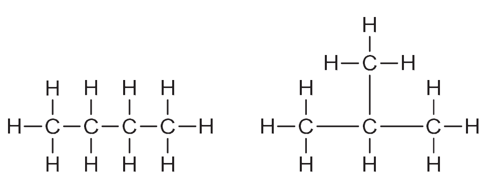
(a) Begin by determining the valency of each atom that appears in the molecular formula. The carbon atoms are tetravalent, while the chlorine atom and hydrogen atoms are all monovalent. The atoms with more than one bond (in this case, the three carbon atoms) should be drawn in the center of the compound. Then, the chlorine atom can be placed in either of two locations: i) connected to the central carbon atom, or ii) connected to one of the other two (equivalent) carbon atoms. The hydrogen atoms are then placed at the periphery.



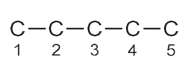
(b) Begin by determining the valency of each atom that appears in the molecular formula. The carbon atoms are tetravalent, while the hydrogen atoms are all monovalent. The atoms with more than one bond (in this case, the four carbon atoms) should be drawn in the center of the compound. There are two different ways to connect four carbon atoms. They can either be arranged in a linear fashion or in a branched fashion:



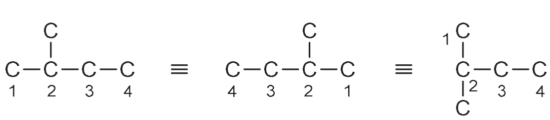
We then place the hydrogen atoms at the periphery, giving the following two constitutional isomers:



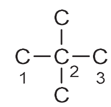
(c) Begin by determining the valency of each atom that appears in the molecular formula. The carbon atoms are tetravalent, while the hydrogen atoms are all monovalent. The atoms with more than one bond (in this case, the five carbon atoms) should be drawn in the center of the compound. So we must explore all of the different ways to connect five carbon atoms. First, we can connect all five carbon atoms in a linear fashion:



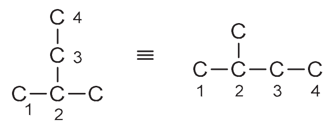
Alternatively, we can draw four carbon atoms in a linear fashion, and then draw the fifth carbon atom on a branch. There are many ways to draw this possibility:



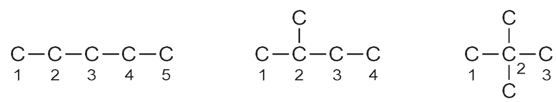
Finally, we can draw three carbon atoms in a linear fashion, and then draw the remaining two carbon atoms on separate branches.



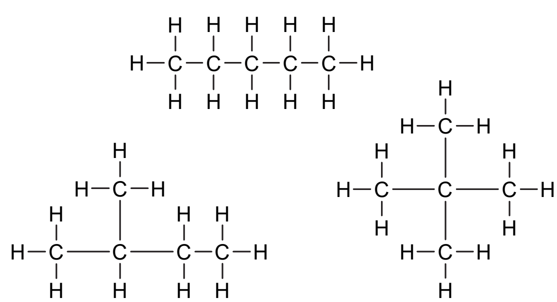
Note that we cannot place the last two carbon atoms together as one branch, because that possibility has already been drawn earlier (a linear chain of four carbon atoms with a single branch):



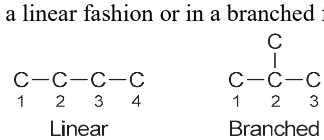
In summary, there are three different ways to connect five carbon atoms:



We then place the hydrogen atoms at the periphery, giving the following three constitutional isomers:



(d) Begin by determining the valency of each atom that appears in the molecular formula. The carbon atoms are tetravalent, the oxygen atom is divalent, and the hydrogen atoms are all monovalent. Any atoms with more than one bond (in this case, the four carbon atoms and the one oxygen atom) should be drawn in the center of the compound, with the hydrogen atoms at the periphery. There are several different ways to connect four carbon atoms and one oxygen atom. Let's begin with the four carbon atoms. There are two different ways to connect four carbon atoms. They can either be arranged in a linear fashion or in a branched fashion.



Next, the oxygen atom must be inserted. For each of the two skeletons above (linear or branched), there are