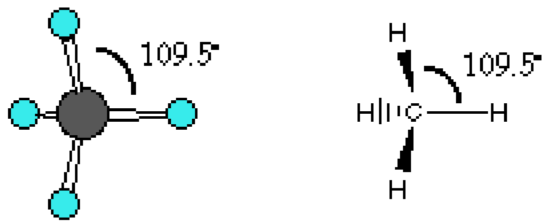
Chem 1515.001 - 006
Problem Set #3
Spring 2002

Name___________________________________
TA's Name ______________________________
Sec _____

ALL work must be shown to receive full credit. **PS3.1 - PS3.4 are due in lecture at 8:30 a.m. on Monday, February 4, 2002.**

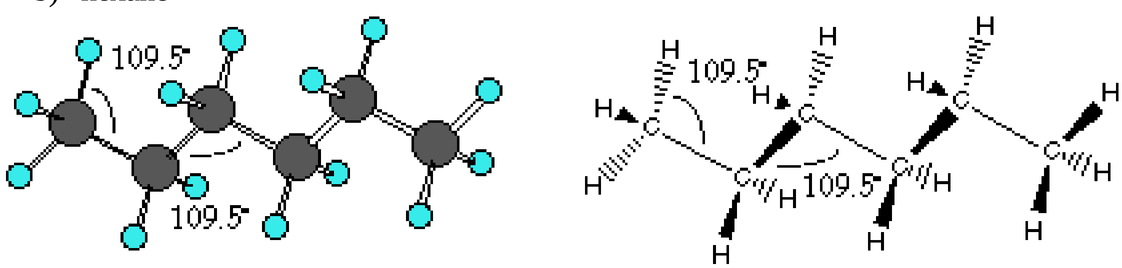
PS3.1. Draw the Lewis structure for, and indicate all of the bond angles for each of the following hydrocarbons;

a) methane



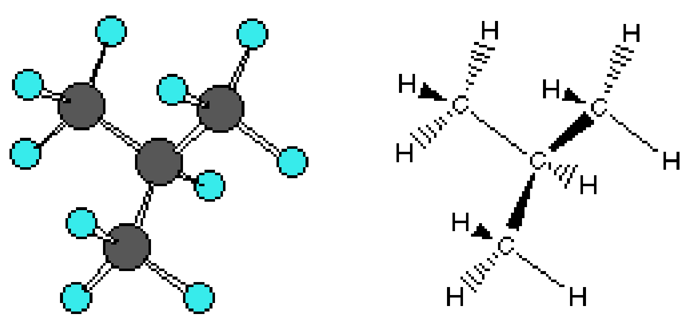
ball-and-stick model   Lewis structure
all H-C-H bond angles are 109.5°

b) hexane



ball-and-stick model   Lewis structure
all H-C-H , C-C-H and C-C-C bond angles are 109.5°

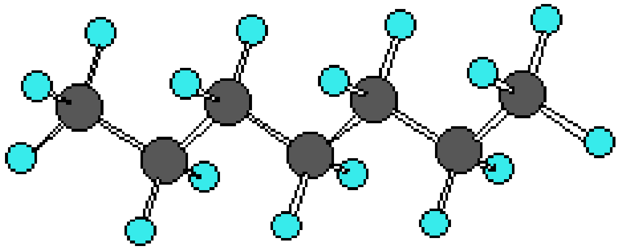
c) 2-methylpropane

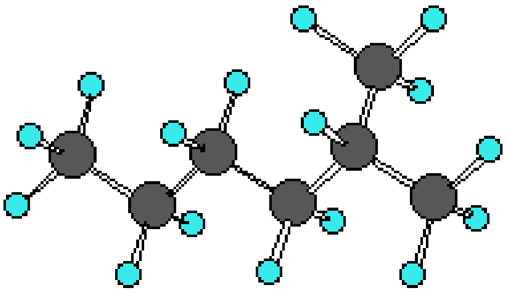


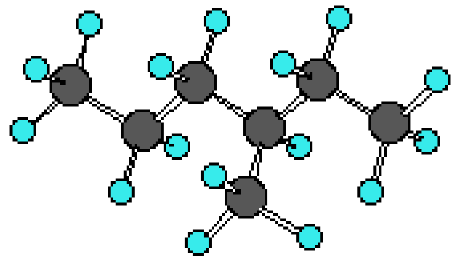
ball-and-stick model   Lewis structure
all H-C-H , C-C-H and C-C-C bond angles are 109.5°

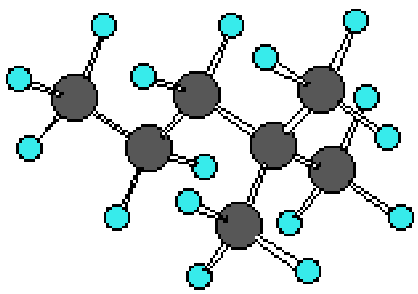
PS3.2. What are structural isomers? Draw and name all of the structural isomers for each of the following compounds;

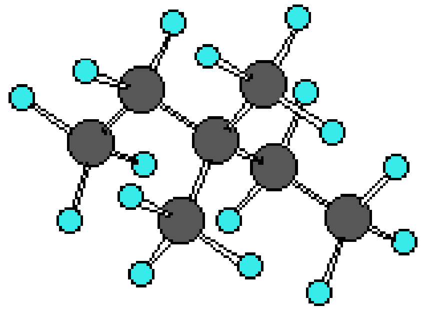
a) C_7H_{16}

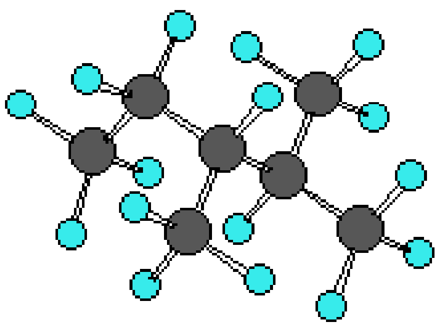

n-heptane

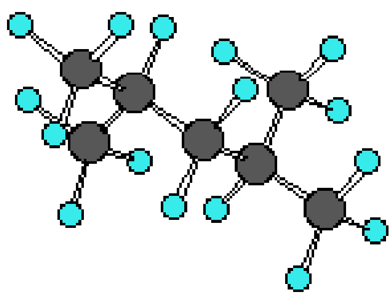

2-methylhexane

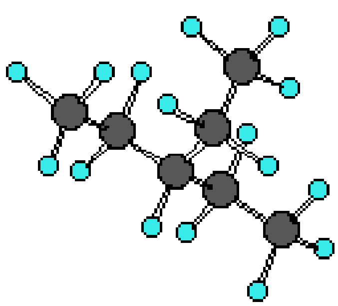

3-methylhexane

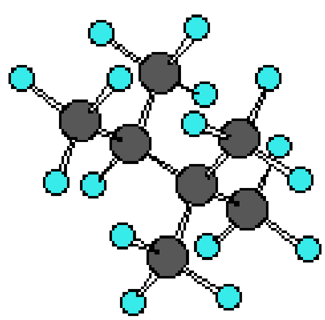

2,2-dimethylpentane


3,3-dimethylpentane


2,3-dimethylpentane

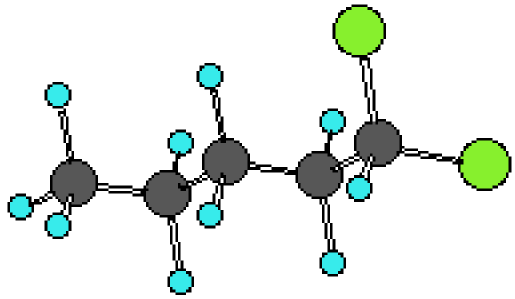

2,4-dimethylpentane


3-ethylpentane

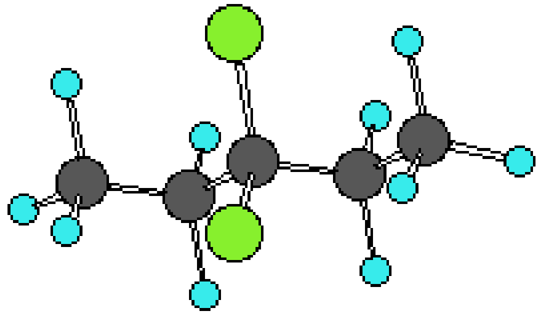

2,2,3-trimethylbutane

PS3.2. (Continued)

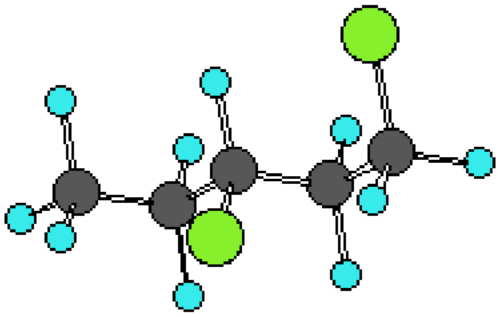
b) $C_5H_{10}Cl_2$ (draw and name at least 7 different isomers, do a few chloropentanes, a few chlorobutanes and a few chloropropanes)



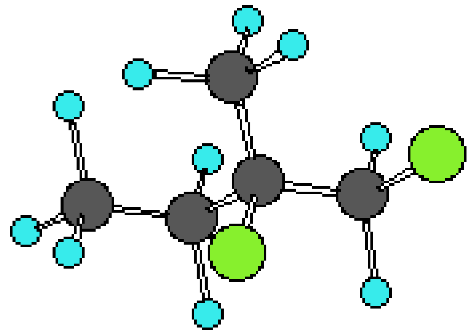
1,1-dichloropentane



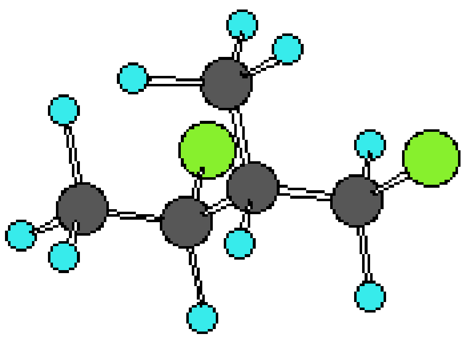
3,3-dichloropentane



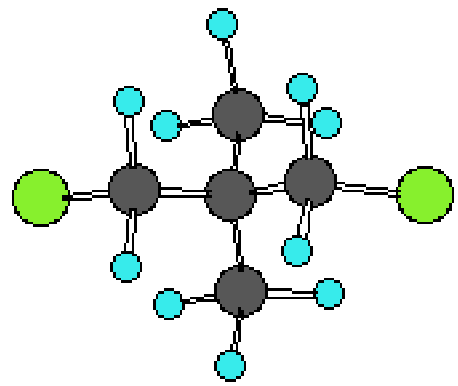
1,3-dichloropentane



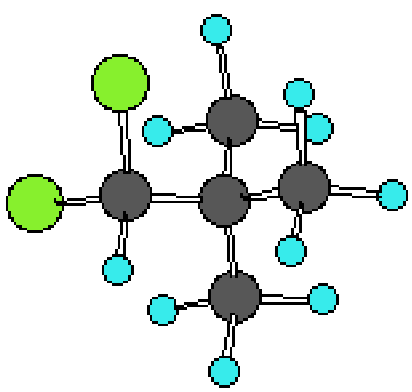
1,2-dichloro-2-methylbutane



1,3-dichloro-2-methylbutane

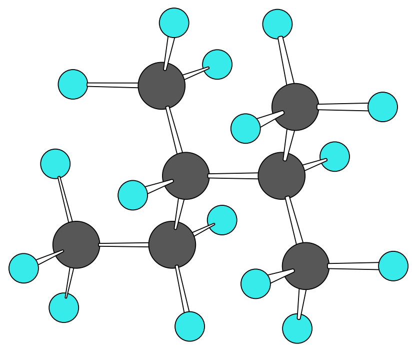
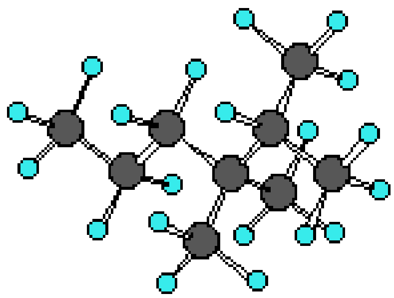


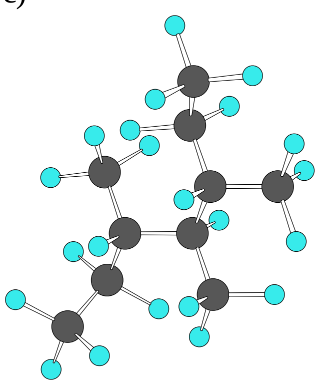
1,3-dichloro-2,2-dimethylpropane



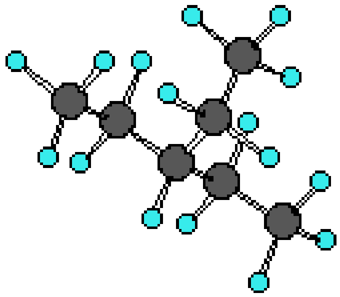
1,1-dichloro-2,2-dimethylpropane

PS3.3. Name the following compounds;

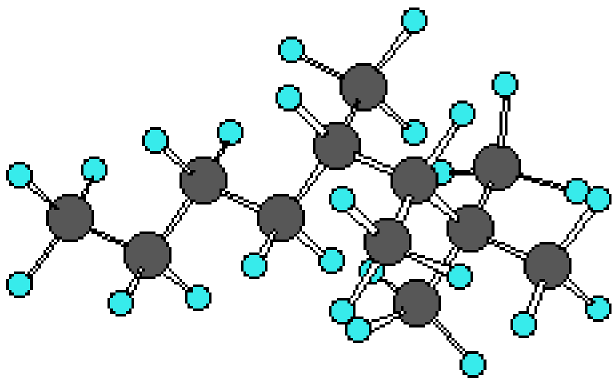
a) 	Name: **2,3-dimethylpentane**
b) $H_3CCH(CH_3)C(CH_3)_2CH_2CH_2CH_3$ 	Name: **2,3,3-trimethylhexane** Draw the Lewis structure

c) 	Name: **3,4,5-trimethylheptane**

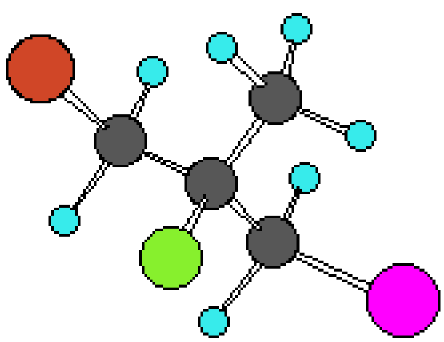
PS3.4. Draw the complete Lewis structure that corresponds to each of the following names. (Complete mean all hydrogens must be shown.)



3-ethylpentane



2,2,3,4-tetramethyloctane



1-bromo-2-chloro-3-iodo-2-methylpropane

Chem 1515.001 - 006
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Spring 2002

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ALL work must be shown to receive full credit. **PS3.5 - PS3.10 are due in lecture at 8:30 a.m. on Friday, February 8, 2002.**

PS3.5. Answer each of the following questions with a brief explanation.

a) Is NH_3 polar or nonpolar?

NH_3 is polar. The molecular geometry is pyramidal. There is a lone pair of electrons on the central nitrogen atom. Anytime there is a single lone pair of electrons on a central atom the molecule is polar.

b) Is SO_3 polar or nonpolar?

SO_3 is nonpolar. The molecular geometry is trigonal planar. The Lewis structure of SO_3 has a central sulfur atom with no lone pairs of electrons and three idential terminal oxygen atoms.

c) How do polar and nonpolar compounds differ?

The term polar or nonpolar as applied to compounds is used only when we discuss covalent compounds.

Polar compounds have at least one lone pair of electrons on the central atom. If there are no lone pair(s) of electron(s) on the central atom, a polar compound will have non-identical terminal atoms bonded to the central atoms.

Nonpolar compounds have no lone pairs of electrons on the central atom and identical terminal atoms. There are two exceptions to this statement. A molecule with three lone pairs of electrons on the central atom with identical terminal atoms is nonpolar, and a molecule with two lone pairs of electrons and four identical terminal atoms is nonpolar.

PS3.6. Indicate the most important type of intermolecular attractive forces that operate in each of the following:

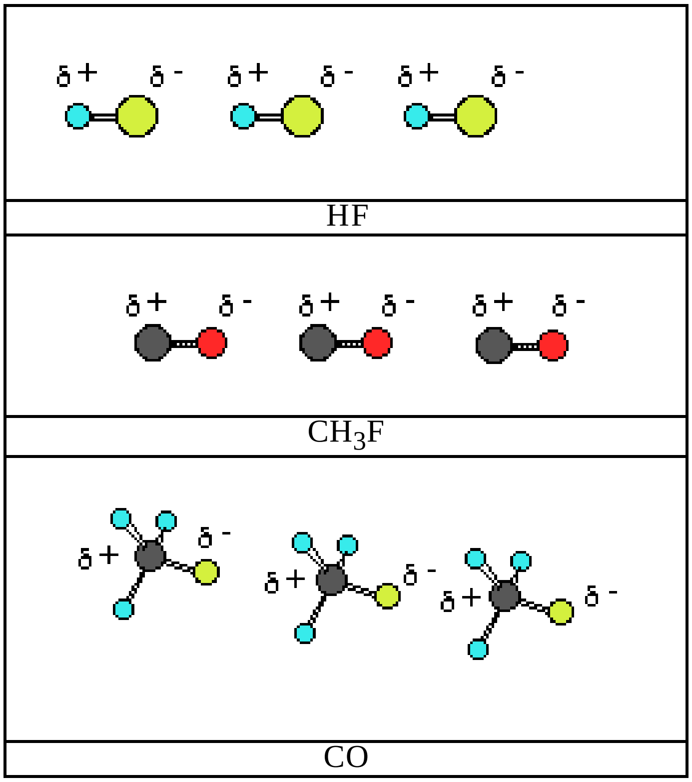
a) HF*(l)* **hydrogen bonding (MI) and dispersion forces**

b) CH_3F*(l)* **dipole-dipole forces (MI) and dispersion forces**

c) CO*(l)* **dipole-dipole forces (MI) and dispersion forces**

d) CO_2*(l)* **dispersion forces only (MI)**

e) In the boxes below draw a picture showing two or three molecules of HF, CH_3F and CO and label the intermolecular attraction that occurs between adjacent molecules.



PS3.7. What are the required structural features for a substantial hydrogen-bonding contribution to be the primary intermolecular attractive forces between two identical or two different substances?

X–H·····:Y where X can be oxygen, nitrogen or fluorine and :Y is oxygen, nitrogen, fluorine, sulfur or chlorine.

PS3.8. List all of the intermolecular attraction force, or bond, for each of the following substances. Indicate the strongest attractive force that must be overcome when each of the following substances is melted?

a) dinitrogen monoxide

Dipole-dipole and London dispersions forces : since nitrogen and oxygen are both second period we'll assume the dipole-dipole is more important than the dispersion forces.

b) carbon tetrachloride

London dispersion forces is the only force in this case so it is the most important by default.

c) hydrogen cyanide

Dipole-dipole and London dispersions forces : since nitrogen and oxygen are both second period we'll assume the dipole-dipole is more important than the dispersion forces.

d) magnesium chloride

Ionic interaction and London dispersion forces : but LDF are extremely small compared to ionic bonds.

e) Butane

London dispersion forces are the only forces

PS3.9. For each of the following pairs of substances predict which will have the higher boiling point and indicate why:

a) CO_2 and CS_2 **CS_2 will have the higher boiling point; both CO_2 and CS_2 are nonpolar and the only intermoelcular attractive forces are dispersion. Since S will have a higher polarizability compared to O we would expect CS_2 to have the greater boiling point.**	b) CH_3CH_2OH and $HOCH_2CH_2OH$ **Both ethanol and ethylene glycol are polar and hydrogen bonding and disperison are occuring. Ethylene glycol will have the higher boiling point compared to ethanol, because it has one more OH functional group than ethanol. The additional OH means more hydrogen bonding is possible.**
c) HBr and KBr **HBr is polar covalent and dipole-dipole and dispersion forces occur. For HBr the dispersion forces are more important than the dipole-dipole forces. KBr is ionic. KBr will have the higher boiling point because it is an ionic compound and the interparticle attractive forces are among the strongest-ionic bonds. HBr has dipole-dipole and dispersion forces that are very weak compared to the ionic bond in KBr.**	d) C_3H_8 and C_8H_{18} **C_3H_8 and C_8H_{18} are both nonpolar and dispersion forces occur. C_8H_{18} is much larger, has more electrons and is more polarizable compared to C_3H_8. Therefore C_8H_{18} has the higher boiling point.**

PS3.10. The compound $HOCH_2CH_2CH_2OH$ exhibits intermolecular hydrogen bonding and intramolecular hydrogen bonding. Use Lewis structure drawings to depict each type of hydrogen bonding.