

<b>INTRODUCTORY ORGANIC CHEMISTRY I --- PROBLEM SET #1</b>
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INSTRUCTIONS: HAND IN STAPLED, COMPLETED ASSIGNMENT AT THE BEGINNING OF CLASS on Tuesday Sept. 30. LATE SUBMISSIONS WILL NOT BE ACCEPTED.

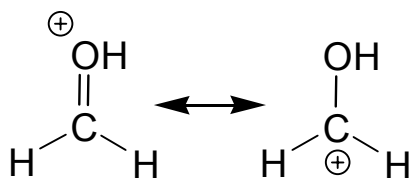
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# 1. Complete the following table about the structures of some common organic compounds.

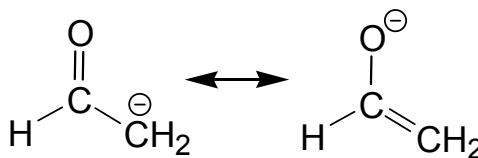
Common name	IUPAC name	Structural formula	Lewis structure	Line structure	Label bond polarities ( $\delta^+$ , $\delta^-$ )	Molecule polar OR nonpolar?
methyl alcohol						
acetic acid						
benzene						
acetylene						
carbon tetrachloride						

# 2. For each pair, circle the resonance structure that should contribute more:

(a)



(b)



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**# 3.** Electrostatic interactions between opposite charges, including only partial charges, cause molecules to interact with one another. Types of interactions include: ionic interactions, dipole-dipole interactions, hydrogen bonding, and van der Waals interactions.

(a) Draw the structures of the following molecules, and describe the intermolecular interactions in these compounds, using as many descriptors as apply.

n-butane

n-propanol

dimethyl ether

(b) Rank the above compounds by boiling point, according to the relative strengths of their intermolecular interactions: (note: the masses of the three are similar...)

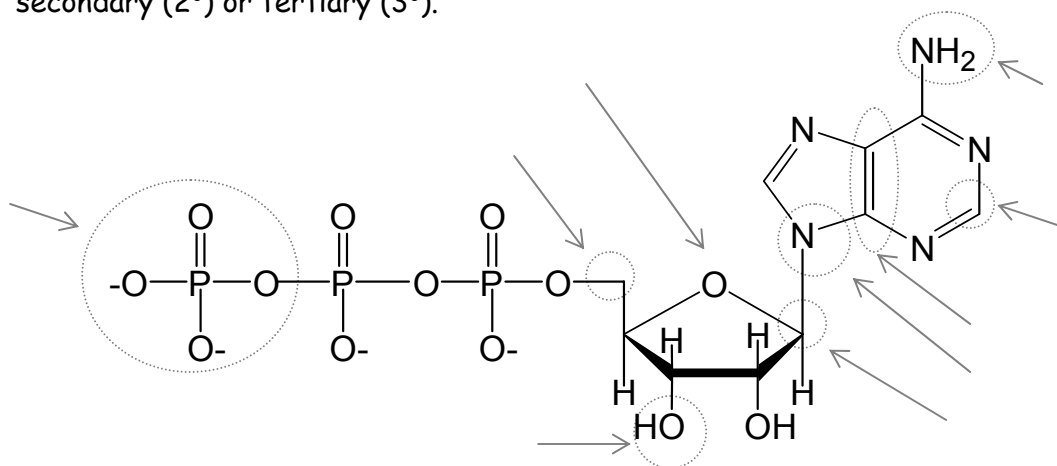
LOWEST BP \_\_\_\_\_ < \_\_\_\_\_ < \_\_\_\_\_ HIGHEST BP

(c) You are trying to remove a stain from bicycle chain grease (a long chain alkane) from the upholstery on your car's back seat. Which solvent would be the most useful? (choose 1)

1. rubbing alcohol (2-propanol, "isopropanol")
2. paint thinner (a mixture of hydrocarbons)
3. nail polish remover (ethyl ethanoate, "ethyl acetate")

**# 4.** Adenosine 5'-triphosphate (ATP), shown below, is a molecule used as an energy "currency" in cells. Energy is harnessed by the cellular machinery when phosphates are cleaved from ATP.

(a) Name the circled functional groups; when carbon atoms are circled, label their hybridization ( $sp^3$ ,  $sp^2$ ,  $sp$ ). Whenever appropriate, use the descriptors primary ( $1^\circ$ ), secondary ( $2^\circ$ ) or tertiary ( $3^\circ$ ).



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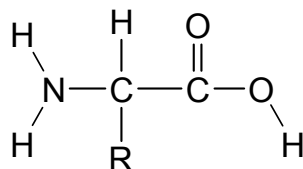
**# 5.** Constitutional isomers have the same elemental composition but different connectivity. Even seemingly subtle differences can have a huge impact on physical and chemical properties....

(a) Draw the Lewis structures and structural formulas for all the compounds with the molecular formula:  $C_4H_{10}O$  (there are 7 isomers).

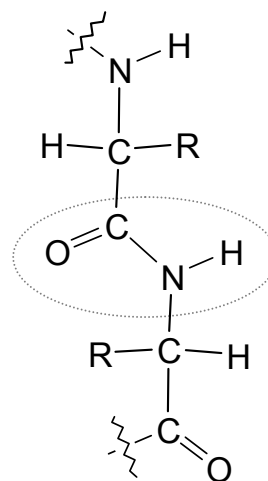
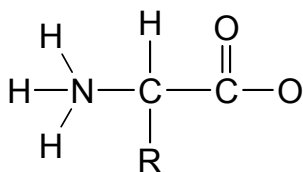
(b) The IUPAC name of one of the isomers is: 2-methyl-2-propanol. Circle your drawing of this isomer.

**# 6.** Proteins are biological macromolecules that consist of chains of amino acids linked together. The bonds that link the individual amino acid units together as amides are known as peptide linkages (circled). Each amino acid has an "R" group, called the side-chain, that gives it a specific character (e.g., polarity, ability to participate in H-bonding, etc.) --- thus, each amino acid influences a protein's structure and function.

General  
structure of  
an amino acid



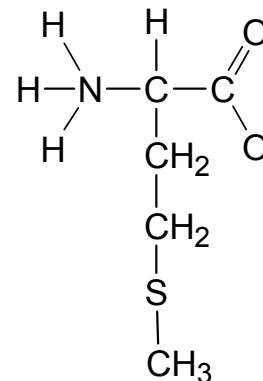
Connectivity under  
physiological conditions



A short bit of a  
polypeptide

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The amino acid methionine, shown here, is essential for the biosynthesis of proteins --- it is always incorporated as the first amino acid in growing polypeptide chains. The side-chain of methionine contains a thioether moiety.



(a) Complete the Lewis structure of methionine, showing all non-bonding electrons and formal charges where applicable.

(b) Another important amino acid has the following IUPAC name: 2-amino-4-methylpentanoic acid. Draw the structure of this amino acid in its non-ionized (as the name suggests) form, **and** provide its common name.

(c) Amino acids contain at least one carbon-oxygen double bond. Sketch the orbital descriptions of the  $\sigma$ - and  $\pi$ - bonds of a  $C=O$  double bond.

(d) Consider the peptide linkage circled in the polypeptide. Experimental evidence shows that the O-C-N-H linkage of the amide group all lie in the same plane. Use the concept of resonance and your understanding of orbitals to explain this observation.