CHEMISTRY 1A
Spring 2008 Final Exam Key

YOU MIGHT FIND THE FOLLOWING USEFUL;

$$\Delta H^\circ = \Delta E^\circ + (\Delta n)RT \qquad R = \frac{0.008314\ \text{kJ}}{\text{K} \bullet \text{mol}}$$

$$q = -\left[C_{cal} + \frac{0.00418\ \text{kJ}}{\text{K} \bullet \text{mol}} m_w \right] \Delta T$$

$$\Delta H^\circ_{rxn} = \Sigma\, \Delta H_f^\circ\ (\text{products}) - \Sigma\, \Delta H_f^\circ\ (\text{reactants})$$

$$PV = nRT \qquad R = \frac{0.082058\ \text{L} \bullet \text{atm}}{\text{K} \bullet \text{mol}} \text{ or } \frac{8.3145\ \text{L} \bullet \text{kPa}}{\text{K} \bullet \text{mol}}$$

Electronegativities

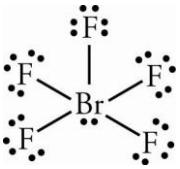
H 2.2							
Li 0.98	**Be** 1.57	**B** 2.04	**C** 2.55	**N** 3.04	**O** 3.44	**F** 3.98	
Na 0.93	**Mg** 1.31	**Al** 1.61	**Si** 1.9	**P** 2.19	**S** 2.58	**Cl** 3.16	
K 0.82	**Ca** 1.0	**Ga** 1.81	**Ge** 2.01	**As** 2.18	**Se** 2.55	**Br** 2.96	
Rb 0.82	**Sr** 0.95	**In** 1.78	**Sn** 1.96	**Sb** 2.05	**Te** 2.1	**I** 2.66	**Xe** 2.6
Cs 0.79	**Ba** 0.89	**Tl** 2.33	**Pb** 2.02	**Bi** 2.0	**Po** 2.2		

Answer the following by writing the word, words, letter, letters or number in each blank that best completes each sentence. (1 point each blank)

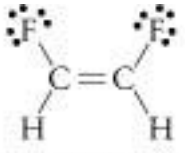
1. **Metalloids** or **semimetals** are elements that have some but not all of the characteristics of metals.
2. The elements in group 1 on the periodic table are called **alkali metals**.
3. **Transition metals** are the elements in groups 3 through 12 (the "B" groups) on the periodic table.
4. **Isotopes** are atoms that have the same number of protons but different numbers of neutrons. They have the same atomic number but different mass numbers.
5. A chemical formula that includes positive integers that describe the simplest ratio of the atoms of each element in a compound is a(n) **empirical formula**.
6. A(n) **polyatomic ion** is a charged collection of atoms held together by covalent bonds.
7. **Isomers** are compounds that have the same molecular formula but different molecular structures.
8. A(n) **mole** is the amount of substance that contains the same number of particles as there are atoms in 12 g of carbon-12.
9. A(n) **combustion** reaction is a rapid oxidation accompanied by heat and usually light.
10. **Reduction** is any chemical change in which at least one element gains electrons, either completely or partially.
11. A(n) **weak base** is a substance that produces fewer hydroxide ions in water solution than particles of the substance added.
12. **Potential** energy is a retrievable, stored form of energy an object possesses by virtue of its position or state.
13. A(n) **exothermic change** is a change that leads to *heat* energy being released from the system to the surroundings.
14. The heat involved in the formation of one mole of substance from its elements in their standard states at a constant pressure of 1 atm and a constant temperature of 298.15 K is called **heat of formation (ΔH_f)**.
15. **Excited state** is the condition of an atom that has at least one of its electrons in orbitals that do not represent the lowest possible potential energy.
16. A(n) **trans** isomer is a structure that has like groups on different carbons (which are linked by a double bond) and on different sides of the double bond.
17. **Hydrogenation** is a process by which hydrogen is added to an unsaturated triglyceride to convert double bonds to single bonds. This can be done by combining the unsaturated triglyceride with hydrogen gas and a platinum catalyst.

18. A polar molecule or ion (or a portion of a molecule or polyatomic ion) that is attracted to water is called **hydrophilic**.
19. A(n) **catalyst** is a substance that speeds a chemical reaction without being permanently altered itself.
20. A(n) **peptide bond** is an amide functional group that forms when the carboxylic acid group on one amino acid reacts with the amine group of another amino acid.
21. A(n) **substrate** is molecule that an enzyme causes to react.
22. A(n) **active site** is a specific section of the protein structure of an enzyme in which the substrate fits and reacts.
23. **Hydrolysis** is a chemical reaction in which larger molecules are converted into smaller molecules by adding water to their structure.
24. A(n) **salt bridge** is an attraction between a negatively charged side chain and a positively charged side chain in a protein molecule.
25. Sucrose (white table sugar) is a disaccharide composed of the two monosaccharides **glucose** and **fructose**.
26. The digestion products of triglycerides are **glycerol** and **fatty acids**.

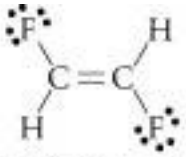
27. Draw Lewis structures for each of the following,
    a. BrF_5 (3 points)



    b. Cis and trans isomers of $C_2H_2F_2$ (4 points)

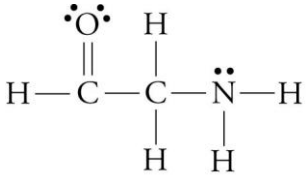


cis-1,2-difluoroethene

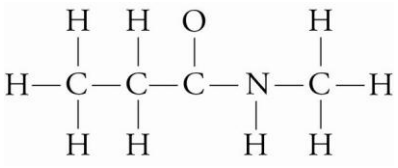


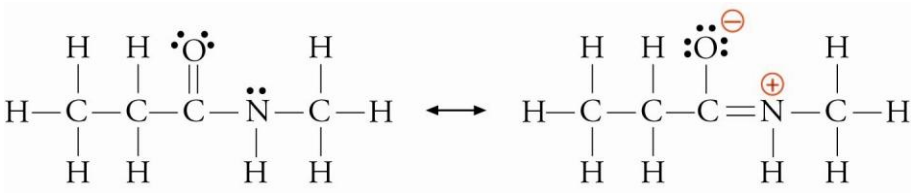
trans-1,2-difluoroethene

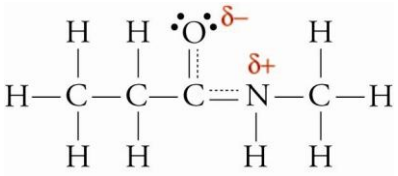
    c. NH_2CH_2CHO (3 points)



28. Draw all the resonance structures and the resonance hybrid for $CH_3CH_2CONHCH_3$. Use the following skeleton. Include formal charges. (6 points)







29. Identify each of the following as a binary covalent compound, a binary ionic compound, a binary acid, an ionic compound with a polyatomic ion, an oxyacid, an alcohol, or a sugar. Write the name for each. (7.5 points)

Chemical formula	**Type of substance**	**Name**
SF_4	**binary covalent**	**Sulfur tetrafluoride**
$MgSO_3$	**ionic with polyatomic ion**	**Magnesium sulfite**
$HClO_4$	**oxyacid**	**Perchloric acid**
$Fe(HSO_4)_2$	**ionic with polyatomic ion**	**Iron(II) hydrogen sulfate**
HCl(aq)	**binary acid**	**hydrochloric acid**

30. Identify each of the following as a binary covalent compound, a binary ionic compound, a binary acid, an ionic compound with a polyatomic ion, an oxyacid, an alcohol, or a sugar. Write the formula for each. (7.5 points)

Chemical name	**Type of substance**	**Formula**
hydrogen bromide	**binary covalent**	**HBr**
2-propanol (isopropyl alcohol)	**alcohol**	**$CH_3CHOHCH_3$**
potassium dihydrogen phosphate	**ionic with a polyatomic ion**	**KH_2PO_4**
sodium nitrite	**ionic with polyatomic ion**	**$NaNO_2$**
sulfurous acid	**oxyacid**	**HSO_3**

31. Write the complete equation, the complete ionic equation, **and** the net ionic equation for the neutralization reaction that takes place between the following reactants. (8 points)

$Na_2CO_3(aq) + 2HNO_3(aq) \rightarrow 2NaNO_3(aq) + H_2O(l) + CO_2(g)$

$2Na^+(aq) + CO_3^{2-}(aq) + 2H^+(aq) + 2NO_3^-(aq) \rightarrow 2Na^+(aq) + 2NO_3^-(aq) + H_2O(l) + CO_2(g)$

$CO_3^{2-}(aq) + 2H^+(aq) \rightarrow H_2O(l) + CO_2(g)$

32. For each of the following, write the name of the type of attraction holding these particles in the solid and liquid form. Indicate the formula in each pair that represents the substance that you would expect to have the higher melting point and boiling point. (3 points each)

a. Silicon dioxide, SiO_2

type of attraction **covalent bonds**

or ethane, C_2H_6

type of attraction **London forces**

higher m.p and b.p. **SiO_2**

b. Octanal, $CH_3(CH_2)_6CHO$

type of attraction **dipole-dipole attractions and London forces**

or ethanal, CH_3CHO

type of attraction **dipole-dipole attractions and London forces**

higher m.p and b.p. **$CH_3(CH_2)_6CHO$**

c. Magnesium chloride, $MgCl_2$

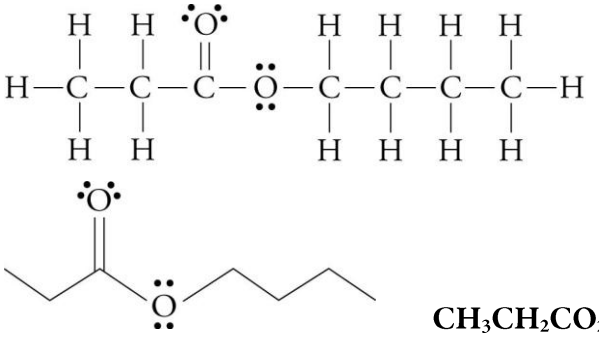
type of attraction **ionic bonds**

or methanol, CH_3OH

type of attraction **hydrogen bonds and London forces**

higher m.p and b.p. **$MgCl_2$**

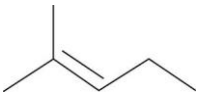
33. Draw the line drawing and condensed formula for the Lewis structure below. Classify it as an alkane, alkene, alkyne, arene (aromatic), alcohol, carboxylic acid, aldehyde, ketone, ether, ester, amine, or amide. (6 points)



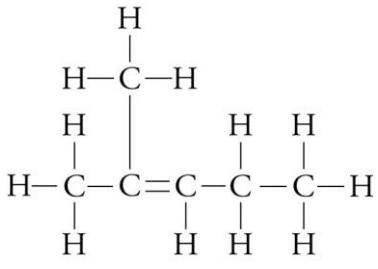
ester

$CH_3CH_2CO_2CH_2CH_2CH_2CH_3$

34. Draw the Lewis structure and condensed formula for the line drawing below. Classify it as an alkane, alkene, alkyne, arene (aromatic), alcohol, carboxylic acid, aldehyde, ketone, ether, ester, amine, or amide. (6 points)

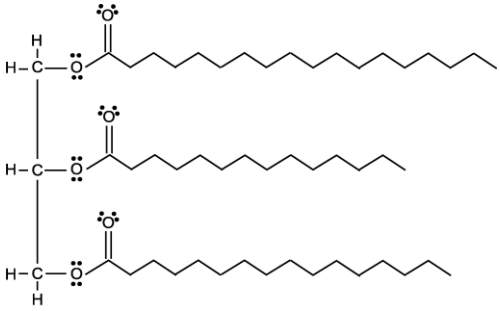


alkene

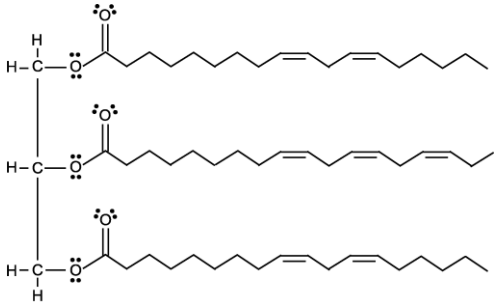


$CH_3C(CH_3)CHCH_2CH_3$

35. Identify each of the following triglycerides as saturated or unsaturated. Which is more likely to be a solid at room temperature, and which is more likely to be a liquid? (4 points)

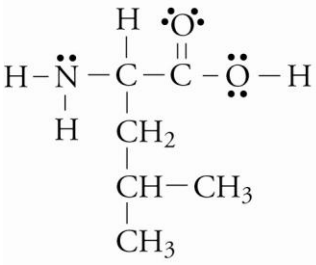


saturated – solid

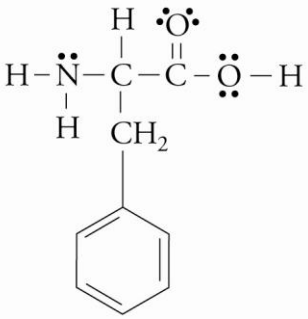


unsaturated – liquid

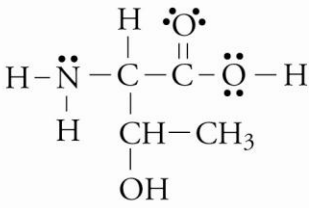
36. Draw the structure of the tripeptide that forms from linking the amino acids leucine, phenylalanine, and threonine. (4 points)



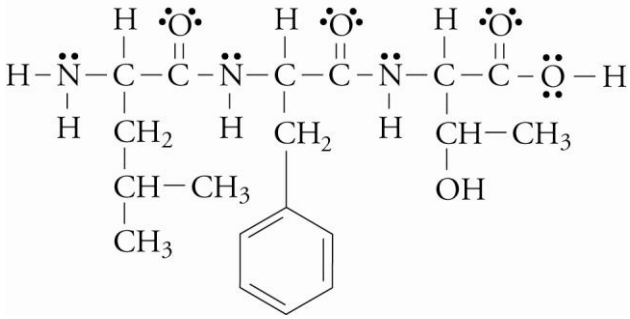
leucine



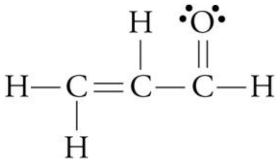
phenylalanine



threonine



37. Consider the following Lewis structure for propenal. (10 points)



What is the hybridization for carbon atoms? **sp^2**

What is the hybridization for the oxygen atom? **sp^2**

Write a description of the bonding, stating whether each bond is sigma, pi, or part of a delocalized pi system and by stating which atomic orbitals overlap to form the bonds.

4 σ H-C bonds due to 1s-sp^2 overlap

1 σ C-C bonds due to sp^2-sp^2 overlap

1 π C-C bond due to p-p parallel overlap

1 σ C-C bonds due to sp^2-sp^2 overlap

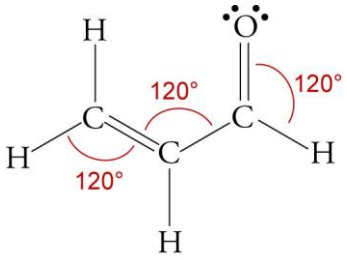
1 σ C-O bonds due to sp^2-sp^2 overlap

1 π C-O bond due to p-p parallel overlap

What is the name of the electron group geometry around each carbon atom?

trigonal planar

Draw a sketch with bond angles.

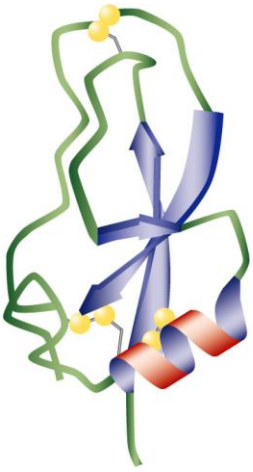


38. Explain why each enzyme only acts on a specific molecule of a specific type of reaction. (6 points)

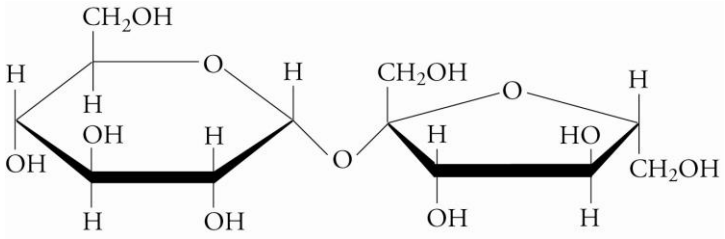
- **The active site of each enzyme has a physical shape that only allows certain substrates to fit into it.**
- **Binding groups attract specific substrates to the active site, which is the portion of the enzyme where the reaction occurs. The orientation of these groups fit certain groups on certain substrates so that the substrates are placed in the correct orientation to react.**
- **Catalytic groups stabilize the intermediates and therefore speed reactions. The orientation of these groups also fit certain groups on certain substrates.**

39. Look at the front screen in the lecture hall and answer the following questions. (1 point each)
    a. Does this image represent an alkane, alkene, alkyne, arene (aromatic), alcohol, carboxylic acid, aldehyde, ketone, ether, ester, amine, or amide? **ether**
    b. Does this image represent an alkane, alkene, alkyne, arene (aromatic), alcohol, carboxylic acid, aldehyde, ketone, ether, ester, amine, or amide? **ester**
    c. Does this image represent an alkane, alkene, alkyne, arene (aromatic), alcohol, carboxylic acid, aldehyde, ketone, ether, ester, amine, or amide? **alkene**
    d. Does this image represent an alkane, alkene, alkyne, arene (aromatic), alcohol, carboxylic acid, aldehyde, ketone, ether, ester, amine, or amide? **ketone**
    e. Does this image represent an alkane, alkene, alkyne, arene (aromatic), alcohol, carboxylic acid, aldehyde, ketone, ether, ester, amine, or amide? **arene**
    f. Does this image represent an alkane, alkene, alkyne, arene (aromatic), alcohol, carboxylic acid, aldehyde, ketone, ether, ester, amine, or amide? **amine**
    g. Does this image represent an alkane, alkene, alkyne, arene (aromatic), alcohol, carboxylic acid, aldehyde, ketone, ether, ester, amine, or amide? **aldehyde**
    h. Does this image represent an alkane, alkene, alkyne, arene (aromatic), alcohol, carboxylic acid, aldehyde, ketone, ether, ester, amine, or amide? **amide**
    i. Does this image represent a carbohydrate, a triglyceride, an amino acid, a protein, or a steroid? **steroid**
    j. Does this image represent a carbohydrate, a triglyceride, an amino acid, a protein, or a steroid? **triglyceride**
    k. Does this image represent a carbohydrate, a triglyceride, an amino acid, a protein, or a steroid? **protein**
    l. Does this image represent a carbohydrate, a triglyceride, an amino acid, a protein, or a steroid? **amino acid**
    m. Does this image represent a carbohydrate, a triglyceride, an amino acid, a protein, or a steroid? **carbohydrate**
    n. Does this image represent glucose or fructose? **glucose**
    o. Does this image represent α-glucose or β-glucose? **α–glucose**
    p. Is the linkage shown in this structure an □α(1→4) linkage or a□ β(1→4) linkage? **α(1→4)**

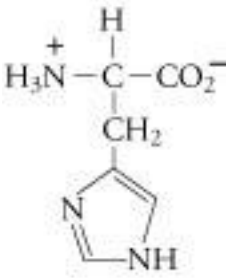
40. Identify each of the following structures as representing a carbohydrate, amino acid, protein (and peptide), triglyceride, or steroid. (8 points)

a. 

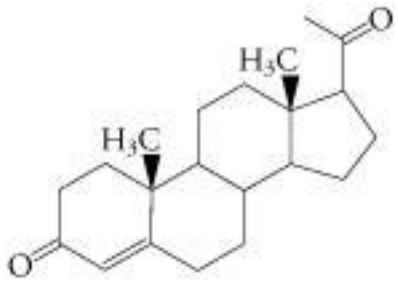
protein

b. 

carbohydrate

c. 

amino acid

d. 

steroid

For the following calculations, be sure to show your work and round your final answer off correctly. NOTE: Remember that there is part credit for each problem. Even if you cannot do all of a problem, be sure to set up as much of it as you can. (6 points each)

41. What is the minimum volume of 6.14 M HCl necessary to react completely with 2.53 kg of solid cobalt(II) hydroxide, $Co(OH)_2$?

$$?\ \text{L HCl soln} = 2.53\ \text{kg } Co(OH)_2 \left(\frac{10^3\ \text{g}}{1\ \text{kg}}\right)\left(\frac{1\ \text{mol } Co(OH)_2}{92.9479\ \text{g } Co(OH)_2}\right)\left(\frac{2\ \text{mol HCl}}{1\ \text{mol } Co(OH)_2}\right)\left(\frac{1\ \text{L HCl soln}}{6.14\ \text{mol HCl}}\right)$$

= 8.87 L HCl soln

42. Ethylene oxide is produced from the reaction of ethylene and oxygen at 270-290 °C and 8-20 atm. In order to prevent potentially dangerous pressure buildups, the container in which this reaction takes place has a safety valve set to release gas when the pressure reaches 25 atm. If a 15-m^3 reaction vessel contains 7.8×10^3 moles of gas, at what temperature will the pressure reach 25 atm?

$$PV = nRT \qquad T = \frac{PV}{nR} = \frac{25\ \text{atm}\left(15\ \text{m}^3\right)}{7.8 \times 10^3\ \text{mol}\left(\frac{0.082058\ \text{L} \bullet \text{atm}}{\text{K} \bullet \text{mol}}\right)}\left(\frac{10^3\ \text{L}}{1\ \text{m}^3}\right)$$

= 5.9×10^2 K or 3.1×10^2 °C