CHEM 100 **Name**________________________________

Exam 3 **Summer 2011**

Due by 3:00 PM Tuesday, June 26
NO LATE PAPERS ACCEPTED!

Follow instructions on the attached exam. Clearly mark your answers. YOU MUST SHOW YOUR WORK TO RECEIVE CREDIT.

Instructions

- *This exam MUST be completed INDIVIDUALLY and in your own words.* Group work or plagiarism will result in a zero for the exam. You may not receive assistance from anyone else.
- Before opening the exam, prepare for it like you would for a traditional, in-class exam. Review concepts and examples from the text, as well as those discussed in class. This preparation will help to maximize your effort on the exam and allow you to complete it more efficiently. You should be able to complete the exam in 50 minutes or less.
- Once you have completed the exam, you may refer to your textbook or lecture notes for a maximum of 20 minutes to verify and/or correct your answers. You MAY NOT use the internet!! **All answers must be in your own words, verbatim copying from the text will result in a score of zero for the problem.**

"Open Book" Portion Time Restriction

You may spend no more than twenty (20) minutes using your book or notes to aid you on this exam. This must be in one continuous block of time. You are on your honor to adhere to this restriction and record the time spent in the chart below.

Date	Time Began	Time Finished	Total Time
Total Time Spent with Open Book			

Pledge

I pledge on my honor that I have completed the exam in accordance with the above instructions and that I have not provided or received unethical assistance. I realize that failure to comply with these instructions will result in a score of zero on the exam.

____ ________________

Signature Date

CHEM 100 **Name**________________________________

Exam 3 **Summer 2011**

Part I. Multiple choice. Circle the correct answer for each problem. 3 points each

1. A compound containing only carbon and hydrogen and which has no double bonds between atoms is classified as an

   a. alkene. b. alkyne. c. aromatic. d. alkane.

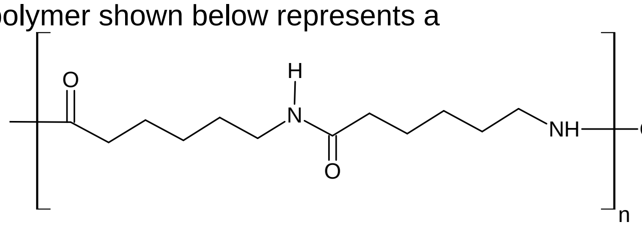
2. In organic chemistry, compounds are generally classified by

   a. state. b. color. c. functional group. d. odor.

3. Monomers are

   a. ethylene. b. small polymers.
   c. small building blocks of polymers. d. all of the above

4. The segment of a polymer shown below represents a



   a. polyester. b. polyamide. c. polyethylene. d. polystyrene.

5. H_3O^+ is called the

   a. hydroxide ion. b. hydrogen ion.
   c. hydrate ion. d. hydronium ion.

6. The compound CH_3NH_2 reacts with water to form $CH_3NH_3^+$ and OH^-. In this reaction, CH_3NH_2 is acting as a(n)

   a. salt. b. base. c. acid. d. solvent.

7. If the concentration of a dilute solution of nitric acid is 0.00010 M, what is the pH of that solution?

   a. 14.0 b. 7.0 c. 4.0 d. 5.0

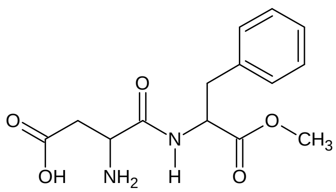
8. The primary structure of a protein is determined by

a. the intertwining of protein molecules to form a "functional" protein.
b. the order of amino acids in the protein.
c. the hydrogen bonding that gives the protein three dimensional shape.
d. the amino acid composition.

9. The most important feature that distinguishes one DNA molecule from another is (are)

a. the type of phosphate bonds.
b. the order of the bases attached to the sugar phosphate backbone.
c. the type of sugar in each molecule.
d .all of the above features

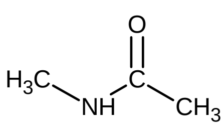
10. Aspartame, shown below, is the artificial sweetener in Equal and Nutrasweet. What is the molecular formula of aspartame?

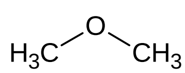


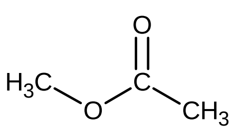
a. $C_{13}H_{16}N_2O_5$ b. $C_{14}H_{18}N_2O_5$ c. $C_{14}H_{16}N_2O_5$ d. $C_{14}H_{16}N_2O_3$

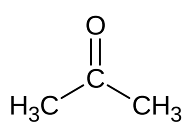
Part II. Complete each of the following. Point values are noted by each question.

11. Identify the functional group shown in each structure: (8 points)

__E__ 

__A__ 

__C__ 

__B__ 

A. ether
B. ketone
C. ester
D. carboxylic acid
E. amide
F. amine

12. Briefly describe the similarities and differences between addition polymerization and condensation polymerization. (8 points)

    Similarities: Both build larger molecules from small, bifunctional molecules called monomers.

    Differences: In condensation polymerization, all of the atoms in the monomer appear in the polymer. In addition polymerization, a small molecule like water is produced each time monomers combine. Therefore not all of the atoms in the monomers appear in the polymer.

13. Define the following terms in a sentence or two each: (8 points)
    a. active site: The location in a molecule (like an enzyme) at which the reaction occurs. Often shape and intermolecular force specific.

    b. base pair: Specific nitrogen bases in DNA that couple with one another by hydrogen bonding in the DNA structure.

    c. peptide bond: The amide linkage that connects amino acids in a protein.

    d. secondary protein structure: Specific geometric shape of the protein caused by inter- and intramolecular hydrogen bonding.

14. Calculate the hydroxide ion concentration ($[OH^-]$, in moles OH^- per liter) and pH for a solution made by diluting 3.50 g of NaOH (molar mass = 40.00 g/mol) to 250 mL with water. (8 points)

First to determine the concentration of OH^-:

$$3.5\ \text{g NaOH} \times \frac{1\ \text{mol NaOH}}{40.00\ \text{g NaOH}} \times \frac{1\ \text{mol OH}^-}{1\ \text{mol NaOH}} = 0.0875\ \text{mol OH}^-$$

So, the concentration of OH^- = (0.0875 mol OH^-/0.250 L) = **<u>0.350 M OH^-</u>**

We need H^+ concentration to determine pH. We know that $[H^+][OH^-] = 1.00 \times 10^{-14}$, so,

$$[H^+] = 1.00 \times 10^{-14}/[OH^-]$$
$$[H^+] = 1.00 \times 10^{-14}/0.350\text{M}$$
$$[H^+] = 2.86 \times 10^{-14}$$

Then, **<u>pH = $-\log(2.86 \times 10^{-14})$ = 13.54</u>**, which is basic, as we would expect for a solution of NaOH.

Part III. Complete the following 4 problems. **YOU MUST DO ALL FOUR PROBLEMS!** Each problem is worth ten (10) points. You must show you work on calculations to receive partial credit. Report numerical results to the correct number of significant figures and with the appropriate units.

15. Hydrochloric acid (HCl) is classified as a strong acid, while acetic acid (CH_3COOH) is classified as a weak acid. Explain what these terms mean. If you could examine a 0.10 M solution of HCl and a separate solution 0.10 M of acetic acid on a molecular level, what would you expect to see in each? How would the pH of each solution compare?

Key points to include:

- Strong acids dissociate completely. So, for a solution of HCl, an molecular-scale investigation would find essentially no intact HCl in solution, but instead 0.10 M H_3O^+ and 0.10 M Cl^-
- Weak acids do not dissociate completely. So, for a solution of CH_3COOH, an molecular-scale investigation would find a significant amount of intact CH_3COOH in solution, and only small amounts of H_3O^+ and 0.10 M CH_3COO^-.
- Since the 0.10 MHCl solution is expected to have a larger concentration of H_3O^+ than the CH_3COOH solution, the HCl solution should be more acidic and have a <u>lower</u> pH than the acetic acid solution.

16. Compounds that can serve as monomers for polymerization reactions must have one key property. What property is this? Show how this property manifests itself in both addition and condensation polymerization.

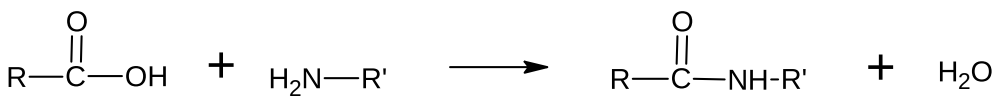
Monomers must be able to react in two locations in order for the polymer to continue to grow. For addition polymerization, the alkene produces a di-radical that can react in two locations and continue to grow. For condensation polymerization, the monomers must have two functional groups that can react independently. (Example structures would be useful here.)

17. DNA and proteins are both polymers. Outline the similarities and differences in the two materials. How do inter- and intramolecular forces lead to interesting shapes of each polymer?

Similarities: Both form by combining a limited number of types of monomers. The order of monomers determines the "identity" of the DNA or protein.

Differences: Proteins are formed by amino acids, of which there are 20. DNA is formed by phosphate sugars that have nitrogen bases attached. There are only 4 nitrogen bases in DNA. Functional DNA consist of two polymer strands associated with one another in a double helix. Proteins can assume a much greater variety of structure.

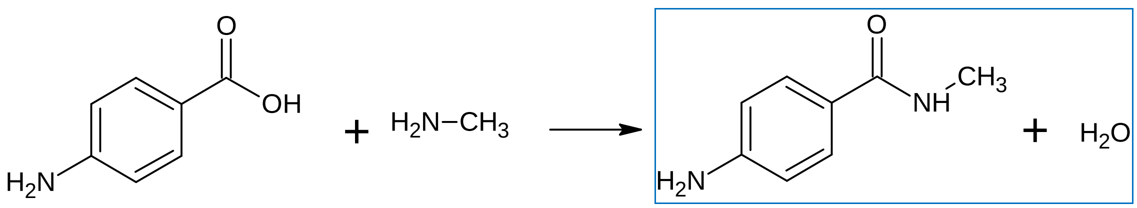
18. Alcohols and carboxylic acids react to form compounds by the process shown below.



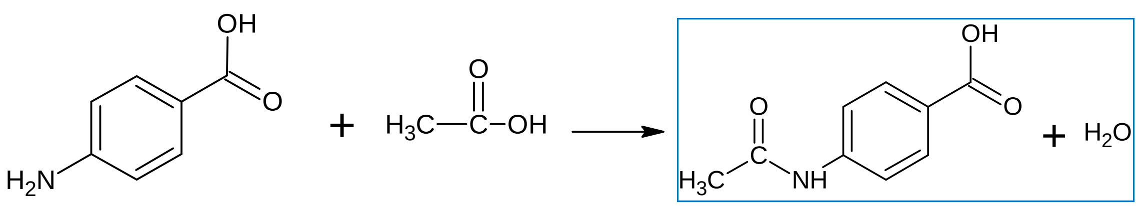
a. What type of functional group is formed when alcohols and carboxylic acids react?

   An amide is formed.

b. The compound para-aminobenzoic acid (PABA) has seen significant use as a component of sunscreens. Complete the reaction of PABA with methyl amine.



c. Complete the reaction of PABA with acetic acid.



Bonus (4 points)

What is the molecular formula of PABA? (The structure of PABA is shown in above.) $C_7H_7O_2N$

Possibly Useful Information

pH = $-\log[H^+]$	$[H^+] = 10^{-pH}$
$[H^+][OH^-] = 1.0 \times 10^{-14}$	$N_A = 6.02 \times 10^{23}\ mol^{-1}$

PERIODIC CHART OF THE ELEMENTS

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	INERT GASES
1 H 1.00797																1 H 1.00797	2 He 4.0026
3 Li 6.939	4 Be 9.0122											5 B 10.811	6 C 12.0112	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.183
11 Na 22.9898	12 Mg 24.312											13 Al 26.9815	14 Si 28.086	15 P 30.9738	16 S 32.064	17 Cl 35.453	18 Ar 39.948
19 K 39.102	20 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.942	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.909	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.905	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.905	46 Pd 106.4	47 Ag 107.870	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.904	54 Xe 131.30
55 Cs 132.905	56 Ba 137.34	*57 La 138.91	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.980	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	†89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 ? (271)	111 ? (272)	112 ? (277)						

Numbers in parenthesis are mass numbers of most stable or most common isotope.

Atomic weights corrected to conform to the 1963 values of the Commission on Atomic Weights.

The group designations used here are the former Chemical Abstract Service numbers.

* Lanthanide Series

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
140.12	140.907	144.24	(147)	150.35	151.96	157.25	158.924	162.50	164.930	167.26	168.934	173.04	174.97

† Actinide Series

90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
232.038	(231)	238.03	(237)	(242)	(243)	(247)	(247)	(249)	(254)	(253)	(256)	(256)	(257)