JBA 2017 – Chemistry Exam 2

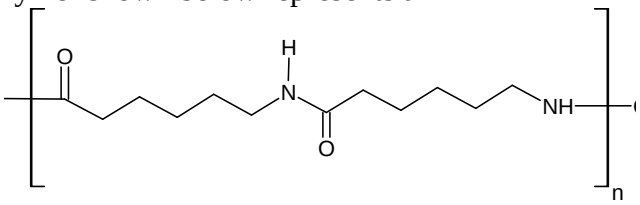
Name:_____ Score:_____/100 = _____/80

Multiple choice questions are worth two points each.

1. Constitutional isomers are compounds that have
   a. the same chemical formulas and molecular structures but different physical properties.
   b. the same chemical formulas but different molecular structures and physical properties.
   c. different chemical formulas and molecular structures but the same physical properties.
   d. the same chemical formulas, molecular structures and physical properties.

   Answer ___b____

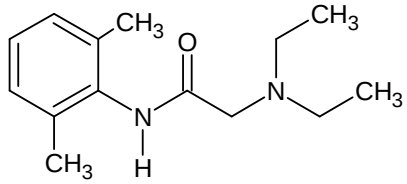
2. The segment of a polymer shown below represents a



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

   Answer __b_____

3. Lidocaine, shown below, is both a local anesthetic and an antiarrhythmic drug. In emergency medical situations, patients with irregular heartbeats frequently receive lidocaine injections or drips. What is the molecular formula of lidocaine?



   a. $C_{14}H_{20}N_2O$
   b. $C_{14}H_{17}N_2O$
   c. $C_{14}H_{13}N_2O$
   d. $C_{14}H_{22}N_2O$

   Answer __d____

4. Which of the following contains the greatest number of moles of O?
   a. 2.3 mol H_2O
   b. 1.2 mol H_2O_2
   c. 0.9 mol $NaNO_3$
   d. 0.5 mol $Ca(NO_3)_2$

   Answer___d____

5. Consider the reaction below. If 2.00 mol of A reacts with 3.00 mol B, what is the theoretical yield of C?

$$5A + 4B \rightarrow 3C$$

   a. 1.20 mol
   b. 2.25 mol
   c. 3.00 mol
   d. 3.45 mol

Answer __a_____

6. One can learn about the functional groups present in an organic compound by using the following technique.

   a. NMR spectroscopy
   b. mass spectrometry
   c. infrared spectroscopy
   d. a really big magnifying glass.

Answer __c_____

7. The fundamental law that energy cannot be created or destroyed is:

   a. The first law of thermodynamics
   b. The second law of thermodynamics
   c. The third law of thermodynamics
   d. The law of the jungle

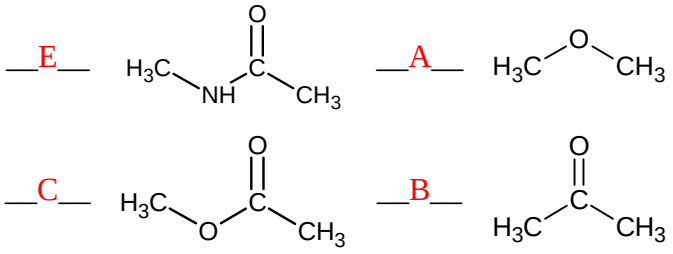
Answer __a_____

8. Match the term with its definition. (8 points)

__J__ thermodynamics	A. covalent bond formed by overlap of s orbitals
__I__stereoisomers	B. a measure of randomness or disorder
__F__chiral center	C. covalent bond formed by overlap of p-orbitals
__H__mole	D. species that determines the theoretical yield in a reaction
__E__radical	E. a reactive species with on unpaired electron
__C__ pi bond	F. an atom bonded to 4 different groups
__D__ limiting reactant	G. energy transferred as heat
__G__ enthalpy	H. one Avogadro's number of anything
	I. compounds that have the same chemical formula and bonding but different arrangement in space
	J. the study of energy and its changes

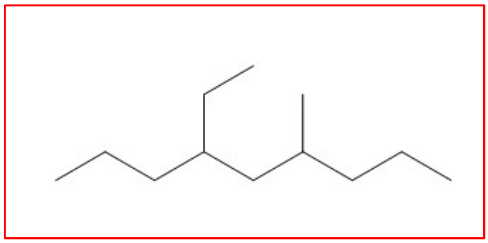
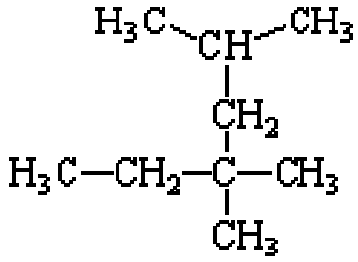
Please write legibly! If I can't read it, I can't grade it!

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

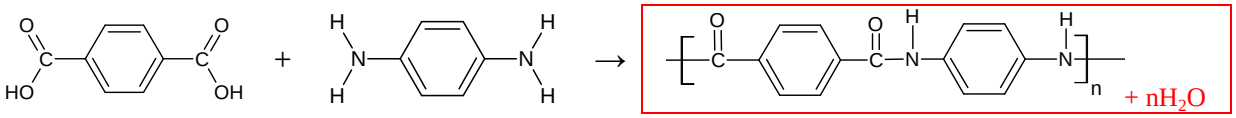


A. ether
B. ketone
C. ester
D. carboxylic acid
E. amide
F. amine

10. Complete the table for the alkanes below. (12 points)

Structure ***(Line angle or Lewis structures are acceptable)***	***Name***
	4-ethyl-6-metyl nonane
	2,4,4-trimethyhexane

11. Kevlar, a poly**amide** used to make bulletproof vests, is made from terephthalic acid and para-phenylenediamine. Write the polymerization reaction for the formation of Kevlar, indicating the repeating structure for the polymer. (4 points)

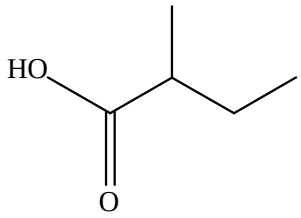
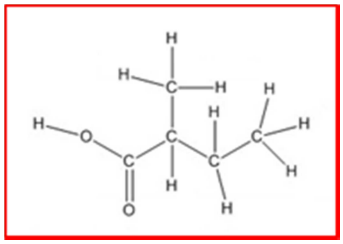
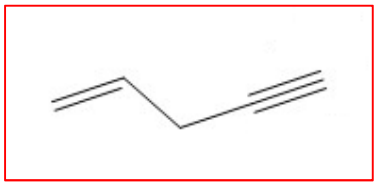
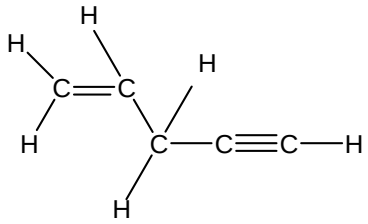
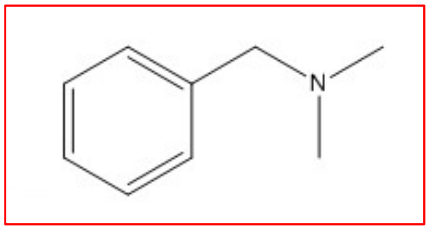
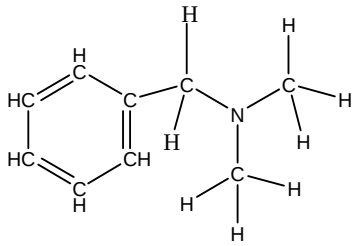
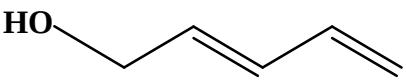
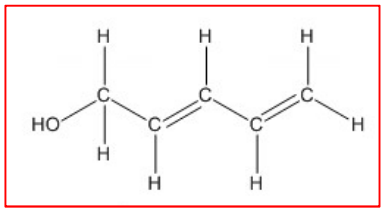


terephthalic acid

para-phenylene diamine

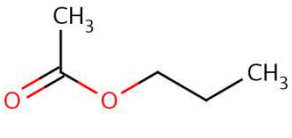
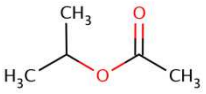
=

12. Complete the following table (12 points)

Line angle	*Lewis Structure*	*Molecular Formula*
		$C_5H_{10}O_2$
		C_5H_6
		$C_9H_{13}N$
		C_5H_8O

13. Draw organic compounds that fit the following criteria (there may be more than one structure that fits the criteria, <u>you only need to draw one example for each</u>):

a. A compound that contains an ester and has the formula $C_5H_{10}O_2$. (4 points)

Here are examples of possible structures:

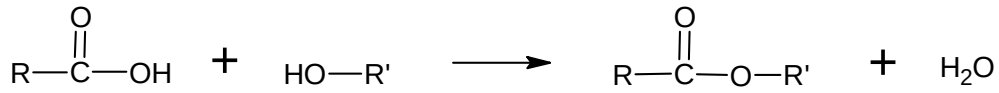
b. A compound that contains and amine and an ether and has the formula $C_4H_{11}NO$. (4 points)

Here's an example of one possible structure:

14. 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. (6 points)

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.)

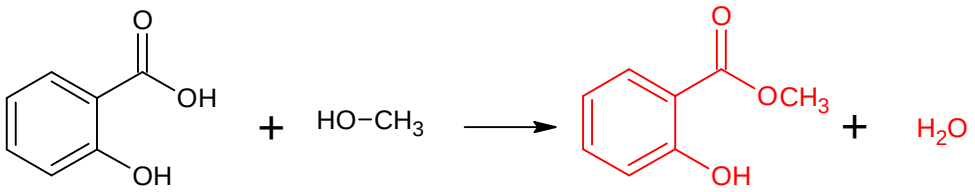
15. Alcohols and carboxylic acids react to form compounds by the process shown below.



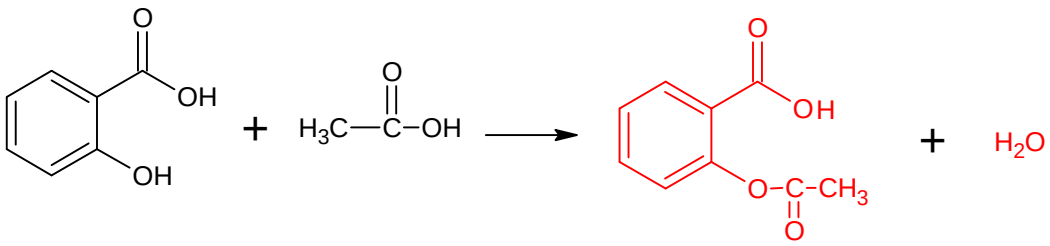
a. What type of functional group is formed when alcohols and carboxylic acids react? (2 points)

An ester group forms

b. Complete the reaction of salicylic acid with methanol to form methyl salicylate (oil of wintergreen). (3 points)



c. Complete the reaction of salicylic acid with acetic acid to form acetylsalicylic acid (aspirin). (3 points)



16. For the reaction below, what is the limiting reactant when 0.253 g aluminum reacts with 0.482 g Cl_2? You must justify your answer with a calculation. (8 pts)

$$2Al(s) + 3Cl_2(g) \rightarrow 2AlCl_3(s)$$

If aluminum is the L.R. how much $AlCl_3$ could be made?.

$$0.253\ \cancel{g\ Al} \times \frac{1\ \cancel{mol\ Al}}{26.98\ \cancel{g\ Al}} \times \frac{2\ \cancel{mol\ AlCl_3}}{2\ \cancel{mol\ Al}} = \mathbf{0.00938\ mol\ AlCl_3} \times \frac{133.34\ g\ AlCl_3}{1\ mol\ AlCl_3} = \mathbf{1.25g\ AlCl_3}$$

If chlorine is the L.R. how much $AlCl_3$ could be made?

$$0.482\ \cancel{g\ Cl_2} \times \frac{1\ \cancel{mol\ Cl_2}}{70.90\ \cancel{g\ Cl_2}} \times \frac{2\ \cancel{mol\ AlCl_3}}{3\ \cancel{mol\ Cl_2}} = \mathbf{0.00453\ mol\ AlCl_3} \times \frac{133.34\ g\ AlCl_3}{1\ mol\ AlCl_3} = \mathbf{0.604g\ AlCl_3}$$

Since less $AlCl_3$ is produced when all of the Cl_2 is consumed, Cl_2 must be the limiting reagent.

17. Urea (CH_4N_2O), is a common fertilizer that can be synthesized by the reaction of ammonia (NH_3) with carbon dioxide to produce urea and water. In an industrial synthesis of urea, 136.6 g of ammonia is combined with 211.4 g of carbon dioxide, producing 168.4 g of urea. What is the percent yield for the reaction? (*Hint: Start with a balanced reaction)* (12 points)

$$2NH_3 + CO_2 \rightarrow CH_4N_2O + H_2O$$

$$136.6\ g\ NH_3 \times \frac{1\ mol\ NH_3}{17.03\ g\ NH_3} \times \frac{1\ mol\ CH_4N_2O}{2\ mol\ NH_3} \times \frac{60.06\ g\ CH_4N_2O}{1\ mol\ CH_4N_2O} = 240.9\ g\ CH_4N_2O$$

$$211.4\ g\ CO_2 \times \frac{1\ mol\ CO_2}{44.01\ g\ CO_2} \times \frac{1\ mol\ CH_4N_2O}{1\ mol\ CO_2} \times \frac{60.06\ g\ CH_4N_2O}{1\ mol\ CH_4N_2O} = 288.5\ g\ CH_4N_2O$$

Therefore, NH_3 must be the limiting reactant and the percent yield is:

$$\frac{168.4\ g\ CH_4N_2O\ actual}{240.9\ g\ CH_4N_2O\ theoretical} \times 100\% = \mathbf{69.90\ \%\ yield}$$