JBA 2021 – Chemistry Exam 2

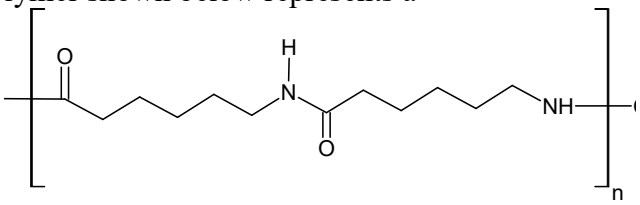
Name:_____ **Score:**_____**/100 =** _____**/80**

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____

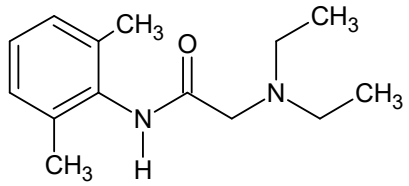
2. The segment of a polymer shown below represents a



   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

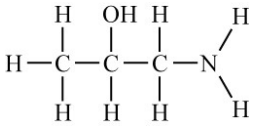
Answer __a____

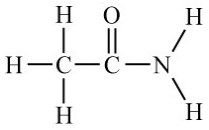
6. One can learn about the environments of hydrogens or carbons present in an organic compound by using the following technique.

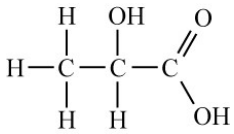
a. infrared spectroscopy
b. mass spectrometry
c. NMR spectroscopy
d. a really big magnifying glass.

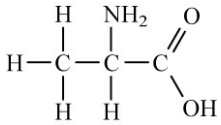
Answer __c____

7. Amino acids are compounds that contain **both** amine and carboxylic acid groups. Which compound is an amino acid? is:

a.


c.


b.


d.


Answer __d____

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

__G__alkene	A. a compound with substituents on the same side of a double bond
__I__stereoisomers	B. a collection of atoms in a molecule that has predictable properties and reactivity
__F__chiral carbon	C. a bond that ties two polymer chains together
__H__mole	D. species that determines the theoretical yield in a reaction
__E__radical	E. a reactive species with one unpaired electron
__C__crosslink	F. an atom bonded to 4 different groups
__D__limiting reactant	G. a compound of carbon and hydrogen containing at least one carbon-carbon double bond
__B__functional group	H. one Avogadro's number of anything
	I. compounds that have the same chemical formula and bonding but different arrangement in space
	J. a compound of carbon and hydrogen containing at least one carbon-carbon triple bond

9. Complete the following table. (6 points)

10. ___147_ g H_2O	=	8.14 mol H_2O	=	4.90 x 10^{24} molecules H_2O

In order to relate moles and mass, we need to use the molar mass, so we must calculate the molar mass of water:

$$\frac{2\ \cancel{\text{mol H}}}{1\ \text{mol } H_2O} \times \frac{1.01\ \text{g}}{1\ \cancel{\text{mol H}}} + \frac{1\ \cancel{\text{mol O}}}{1\ \text{mol } H_2O} \times \frac{16.00\ \text{g}}{1\ \cancel{\text{mol O}}} = \frac{18.02\ \text{g}}{1\ \text{mol } H_2O}$$

Therefore, the molar mass of H_2O is 18.02 g/mol

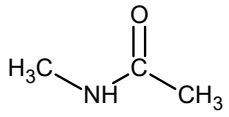
Now the conversion between moles and grams:

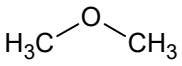
$$8.14\ \cancel{\text{mol } H_2O} \times \frac{18.02\ \text{g}}{1\ \cancel{\text{mol } H_2O}} = 146.68\ \text{g} = \mathbf{147\ g\ H_2O}$$

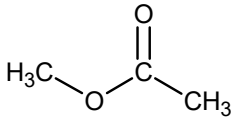
To convert between moles and molecules, we use Avogadro's number that tells us that 1 mol = 6.022 x 10^{23} molecules.

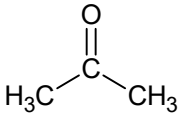
$$8.14\ \cancel{\text{mol}}\ \cancel{H_2O} \times \frac{6.022 \times 10^{23}\ \text{molecules}}{1\ \cancel{\text{mol } H_2O}} = 4.9019 \times 10^{24}\ \text{molecules} = \mathbf{4.90 \times 10^{24}\ molecules\ H_2O}$$

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

__E__ 

__A__ 

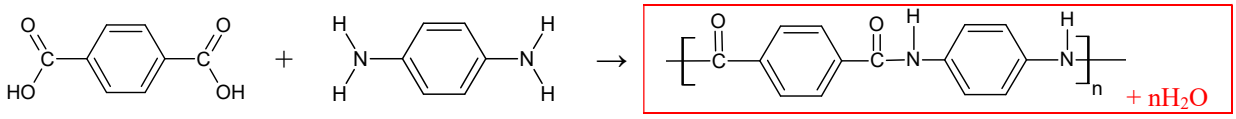
__C__ 

__B__ 

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

11. Kevlar, a poly**amide** used to make bulletproof vests, is made from terephthalic acid and para-phenylenediamine.

a. Write the polymerization reaction for the formation of Kevlar, indicating the repeating structure for the polymer. (4 points)



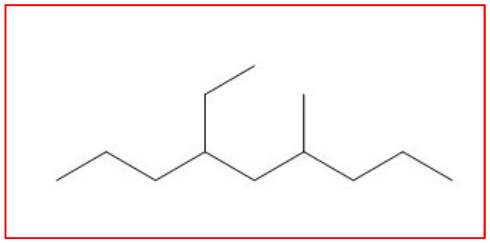
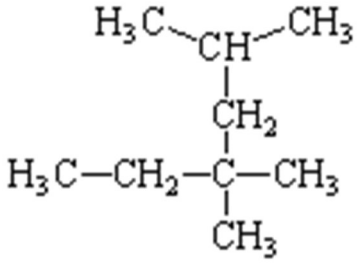
terephthalic acid

para-phenylene diamine

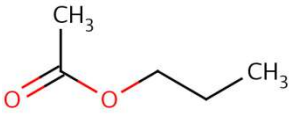
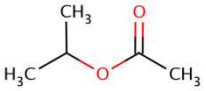
b. What type of polymerization reaction is this? Circle the correct answer. (2 points)

addition **condensation**

12. Complete the table for the alkanes below. (8 points)

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

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

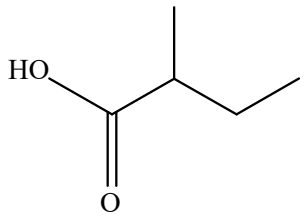
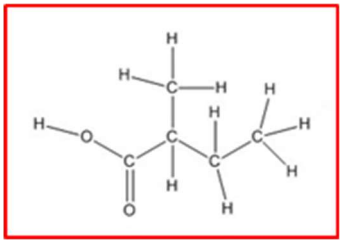
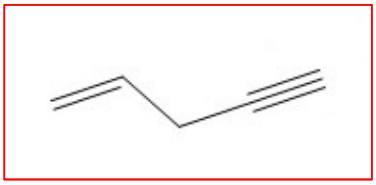
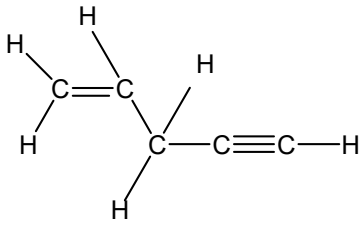
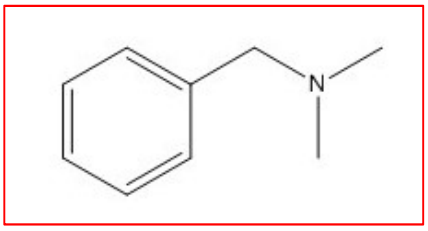
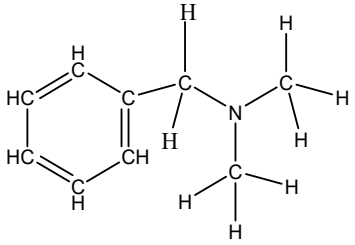
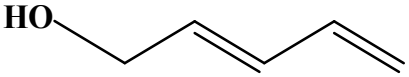
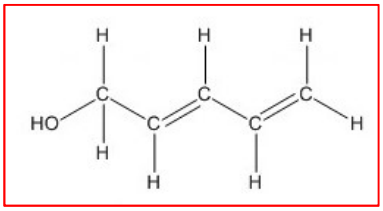
Here's an example of one possible structure:

14. Compounds that can serve as monomers for polymerization reactions must have one key property. What property is this? Show how this property appears 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.)

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

15. 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

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?

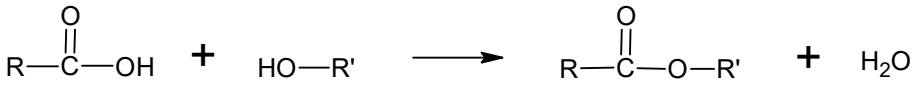
$$0.253\ \cancel{g\ Al} \times \frac{1\ \cancel{mol\ Al}}{26.98\ \cancel{g\ Al}} \times \frac{2\ \cancel{mol\ AlCl_3}}{2\ \cancel{mol\ Al}} = \mathbf{0.00938\ mol\ AlCl_3} \times \frac{133.34\ g\ AlCl_3}{1\ mol\ AlCl_3} = \mathbf{1.25g\ AlCl_3}$$

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

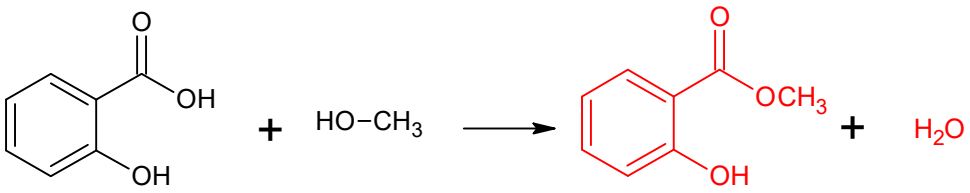
$$0.482\ \cancel{g\ Cl_2} \times \frac{1\ \cancel{mol\ Cl_2}}{70.90\ \cancel{g\ Cl_2}} \times \frac{2\ \cancel{mol\ AlCl_3}}{3\ \cancel{mol\ Cl_2}} = \mathbf{0.00453\ mol\ AlCl_3} \times \frac{133.34\ g\ AlCl_3}{1\ mol\ AlCl_3} = \mathbf{0.604g\ AlCl_3}$$

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

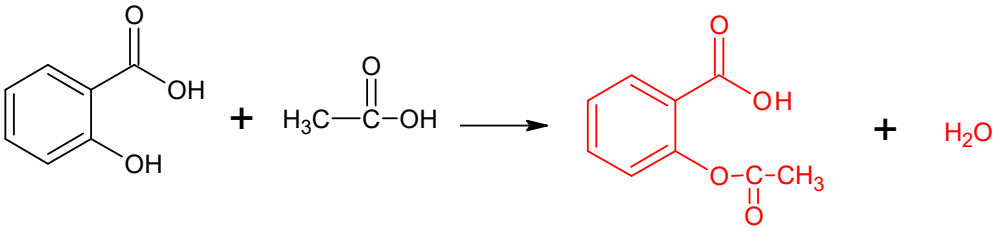
17. Alcohols and carboxylic acids react to form esters by the process shown below.



a. Complete the reaction of salicylic acid with methanol to form methyl salicylate (oil of wintergreen). (4 points)



b. Complete the reaction of salicylic acid with acetic acid to form acetylsalicylic acid (aspirin). (4 points)



18. You need to determine the identity of an unknown acid, represented by HA. You have two proposed formulas, $C_7H_6O_2$ and $C_5H_{10}O_2$. To determine the molar mass of the acid, you titrate the acid with 0.110 M NaOH. If 0.250 grams of the acid requires 22.25 mL of NaOH.

Balanced reaction: HA + NaOH → NaA + H_2O

a. How many moles of the acid must have reacted? (5 points)

$$0.02225 \cancel{\text{ L NaOH}} \times \frac{0.110 \cancel{\text{ mol NaOH}}}{1 \cancel{\text{L NaOH}}} \times \frac{1 \text{ mol HA}}{1 \cancel{\text{ mol NaOH}}} = \mathbf{0.0024475 \text{ mol HA}}$$

b. Calculate the molar mass of the acid and determine which of the two formulas is the correct formula for the acid. (5 points)

From our experimental results, the molar mass must be:

$$\frac{0.250 \text{ g HA}}{0.0024475 \text{ mol HA}} = \mathbf{102.1 \text{ g/mol}}$$

If $C_7H_6O_2$ is the correct formula, the molar mass would be 122.12 g/mol and if $C_5H_{10}O_2$ is the correct formula, the molar mass would be102.1 g/mol, therefore, the correct formula is **$C_5H_{10}O_2$**.