

GREETINGS SENIORS!

To prepare you for the curriculum during your senior year, I have prepared the following materials to help you gear up for what will be a rather unique experience as we cover organic chemistry, biochemistry, and environmental chemistry during your final year at the Governor's School. The fact that you are getting ready for another school year studying even more advanced topics in chemistry tells me that you thrive on challenges, and I will do my best to help you achieve success in your chemistry class for your senior year.

As you enjoy your well-deserved summer vacation, I have prepared an assignment that I would like you to complete before the start of the new school year. My recommendation is that you work on a small section of this assignment each day. If you work on this consistently, you can potentially complete this entire assignment in approximately 4 to 5 days! Keep in mind that these problems are at the introductory level and are general enough so that you can find whatever solutions you need to solve the problems on the internet and/or a chemistry study guide. Nevertheless, should you find yourself having a challenging time with any of the following questions and/or topics, please leave me a comment and/or question about them so that I may address them during class.

I look forward to seeing everyone on the first day of class! Do not forget to relax and have fun during your summer vacation. At the same time, do not lose your academic edge! Feel free to email me if you need help. I do check my work email periodically over the summer, so I will respond to your messages whenever I can.

In addition to your summer assignment, please continue brainstorming possible ideas for your mentorship project. If you have any questions as to whether select research project topics are allowed in a basic chemistry laboratory, please do not hesitate to email me about it. We will discuss the mentorship project at the start of the school year.

Good luck, have fun, and I will see everyone when classes resume.

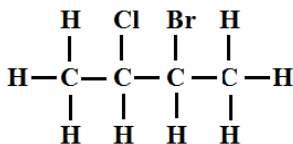
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Day 1 Topic: Introduction to Organic Chemistry

The addition of a few additional atoms to the organic molecule not only changes its properties, but also turn the molecule into a different type of molecule altogether. Please fill in the following information specified in the table below:

Organic families	Name of family's characteristic functional group	Draw the arrangement/structure of the atoms making up the characteristic functional group
Alcohols		
Aldehydes		
Ketones		
Ethers		
Esters		
Amines		
Amides		
Carboxylic acids		
Nitro		

1. The following molecule is named 2-bromo-3-chlorobutane. The name may be broken down into 4 parts: 2-bromo, 3-chloro, but, and -ane. Do some research and justify this four-part name.



- a. Explain why the molecule name is 2-bromo-3-chlorobutane and NOT 2-chloro-3-bromobutane.
2. Propane, propanol, and propanoic acid differ in their intermolecular forces due to the presence of different functional groups. Please answer the following questions and justify your answer with additional research.
- Which of the three compounds mentioned above have the highest boiling point?
 - Which of the compounds is the most polar?
 - Which of the compounds contains a carboxylic acid group?
 - Would the type of functional group present affect the reactivity of the compound in a chemical reaction? Why or why not? Which of the three compounds do you think will be the most reactive?

Day 2 Topic: Functional Group Priorities and Nomenclature

As you have observed during the organic chemistry bootcamp sequence during your junior year, organic molecules are classified into specific types of compounds based on the identity of the main functional group on the molecule. As we work with more complex molecules, there is a good possibility you will encounter a compound with multiple functional groups on its structure. To determine which of the functional groups will be the main functional group, the functional group priority rules need to be followed. The functional groups featured in this table refers to functional groups with carbon in the central atom position. A good rule of thumb to follow in terms of priority is to take the oxidation state of the central carbon into priority determination; the higher the oxidation state of the central carbon, the higher the priority of the functional group. This is why carboxylic acids have a higher priority than alcohols.

Table 1. Functional Group Priorities (please keep this for reference in your notebooks!)

Priority	Functional Group	Formula	Prefix	Suffix
1	Cations e.g. ammonium	-NH_4^+	-onio- -ammonio-	-onium -ammonium
2	Carboxylic acids	-COOH	Carboxy-	-oic acid
3	Carboxylic acid derivatives e.g. esters, amides	-COOR -CONH_2	R-oxycarbonyl- Carbamoyl-	-amide
4	Aldehydes	-CHO	Formyl-	-al
5	Ketones	>CO	Oxo-	-one
6	Alcohols Thiols	-OH -SH	Hydroxy- Sulfanyl-	-ol -thiol
7	Amines	-NH_2	Amino-	-amine
8	Ethers Thioethers	-O- -S-	-oxy- -thio-	
9	Peroxides Disulfides	-OO- -SS-	-peroxy- -disulfanyl-	
10	Alkenes Alkynes	C=C $\text{C}\equiv\text{C}$		-ene -yne

TIER 1 QUESTIONS

 **Question.** Let's test out your knowledge of functional group priorities!

- The molecule you will be analyzing is 3-bromo-2-pentanol.
 - Explain what each part of the name indicates about the structure of the molecule.
 - Why is the parent chain named pentanol instead of pentane?
 - Explain why the -OH group is assigned position 2 instead of position 4.
 - Why is the bromine substituent named as a prefix instead of as a suffix?
 - Would the name 2-bromo-3-pentanol be correct? Justify your answer using numbering rules.

 Question. Let's make this more interesting with additional substituents

2. The molecule you will be analyzing is 4-ethyl-2-methylhexane.
 - a. Identify the parent chain and explain why it is named hexane.
 - b. Explain how substituents are identified and located on the carbon chain.
 - c. Why is the compound named ethyl before methyl, even though methyl appears closer to the beginning of the chain?
 - d. Explain why numbering begins from the end closest to a substituent.
 - e. Would the name 3-ethyl-5-methylhexane be acceptable? Why or why not?

 Question. Let's give you the chance to further apply your knowledge of functional group priorities.

3. The molecule is named 2-chloropropanoic acid.
 - a. Break down the name into its components and explain each part.
 - b. Why is the parent name based on propanoic acid instead of propanol or propane?
 - c. Explain why the carboxylic acid group determines the numbering of the chain.
 - d. Why is chlorine treated as a substituent rather than the main functional group?
 - e. Why can the compound NOT be named 1-chloro-2-propanoic acid?

TIER 2 QUESTIONS

 Question. Now try applying the priority rules when dealing with multiple functional groups!

1. The molecule you are analyzing for this question is 3-hydroxy-2-butanone.
 - a. Why is the suffix -one used instead of -ol, even though an -OH group is present?
 - b. Explain how functional group priority determines the suffix of the compound.
 - c. Why is the hydroxyl group written as a prefix (hydroxy-) instead of a suffix?
 - d. Would the name 2-hydroxy-3-butanone describe the same compound? Justify your answer.

 Question. Application time with complex substitutions and numbering strategies

2. The molecule that is the focus of this question is 2,3-dibromo-4-methylpentane.
 - a. Explain why the prefix di- is used and what it indicates.
 - b. Describe the rules used to assign numbering to the substituents.
 - c. Why are the bromine substituents listed before methyl in the name?
 - d. Would the name 3,4-dibromo-2-methylpentane be equivalent? Explain using the "lowest set of locants" rule

TIER 3 (CHALLENGE) QUESTIONS

 Challenge Problem. Intermediate Level

1. The molecule being analyzed is 4-chloro-2-methylpentanal.
 - a. Explain what each part of the name indicates about the structure of the molecule.
 - b. Why is the parent chain named pentanal instead of pentane or pentanol?
 - c. Explain why the carbonyl carbon in the aldehyde group must be assigned position 1.
 - d. Why are substituents numbered relative to the aldehyde group rather than minimizing all substituent positions simultaneously?
 - e. Would the name 2-chloro-4-methylpentanal represent the same compound? Use both numbering rules and alphabetical conventions to justify your answer.

 Challenge Problem. Advanced Level

2. The molecule that is the focus of this question is 5-bromo-3-hydroxy-2-hexanone.
- Explain the role of each component of the name in describing the molecule's structure.
 - Why is the suffix *-one* used instead of *-ol*, even though a hydroxyl group is present?
 - Explain how functional group priority rules determine which group becomes the suffix.
 - Why must the ketone group receive the lowest possible position number, even if this results in higher locants for other substituents?
 - Would the name 2-hydroxy-5-bromo-3-hexanone be a valid alternative? Justify your answer using:
 - The functional group priority
 - The lowest locant rule
 - Alphabetical ordering

 Challenge Problem. Expert Level

3. The molecule you are analyzing is called 3-ethyl-2,4-dimethylheptanoic acid.
- Explain how each part of the name contributes to identifying the full structure.
 - Why is heptanoic acid selected as the parent name instead of a shorter or different chain?
 - Explain why the carboxylic acid functional group must always be assigned carbon 1 and how this affects numbering of substituents.
 - Compare the naming possibilities:
 - 3-ethyl-2,4-dimethylheptanoic acid
 - 5-ethyl-4,6-dimethylheptanoic acidWhich is correct, and why? Use the lowest set of locants rule to justify.
 - Why is ethyl listed before methyl in the name, even though methyl appears twice? Include in your answer discussions including the following topics:
 - Alphabetical ordering
 - Ignoring multiplicative prefixes (di-, tri-)

Day 3 Topic: Introduction to Biochemistry

1. In your own words, please describe or explain what you think is Biochemistry.
2. Explain how an unsaturated fat is different from a saturated fat?
3. How are omega-3 fish oils different from omega-6 fish oils?
4. Compile information on the different macromolecules with the following information (I recommend organizing this in a table that you keep in your notebook for future reference later in the Fall semester course!):
 - a. The macromolecules to research on – carbohydrates, lipids, nucleic acids, proteins.
 - b. For each of the four macromolecules, include the following information:
 - i. A general description of the macromolecule
 - ii. General structure (a diagram is fine)
 - iii. General nomenclature
 - iv. Examples of macromolecules
 - v. Physical and chemical properties
 - vi. Biochemical role
 - vii. Interesting facts

Day 4 Topic: Environmental Chemistry

Directions: Try your best to find the following items for the scavenger hunt. It is alright if you do not locate all of them by the end of summer break, but try to find as many items as you possibly can. As you locate these items, check them off the list and make a little note beside each item detailing something significant about the item. You can also use the internet's resources (such as current event articles in the news) for your scavenger hunt as well.

1. An herbivore eating a producer
2. Growing crops
3. An organic food item in the grocery store
4. A genetically modified food item
5. 3 pieces of litter from a public place
6. Product made from recycled materials
7. Renewable energy
8. A source of freshwater
9. Nonpoint or point source of pollution
10. Decomposition
11. Reuse of potential waste
12. A tree you cannot put your arms more than halfway around
13. A mineral that came from a mine
14. An electric or hybrid vehicle in use (i.e. not merely at a dealership, but can be parked)
15. An environmentally positive sight (i.e. something that you think is helping the environment)
16. An LEED certified building
17. Source of air pollution that is NOT an automobile
18. Invasive species
19. Endangered species
20. A nonhuman thing in the environment that you find extraordinarily beautiful