Names of all students (please print) Answer Key

CHEM 243 Organic Chemistry I **Points** _____ **(10 max)**

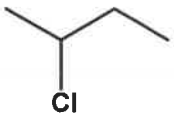
Worksheet #15: October 20, 2021. Complete the following worksheet by collaborating with a group of 3-4 students. You can use a text book or your lecture video notes. You must work together, with the names of all students included on **ONE** sheet and turned in for a group grade.

From now on you can expect to see **"think outside the box"** types of worksheet problems, that require you to use your problem-solving skills, and information from earlier in the course. **A course notebook will be essential!** Remember, my worksheets are designed with the assumption that you have: (1) watched the videos, (2) taken notes, and (3) have your notebook open on your bench.

(1) SN2 Reactions Background Information. Place an "X" next to each term that is associated with SN2 reactions.

____ not a stereospecific reaction	X substrate reactivity: methyl > 1° > 2° >>> 3°
X stereospecific reaction	____ substrate reactivity: methyl <<< 1° << 2° < 3°
X concerted mechanism	X nucleophile is best defined as a base
____ nucleophile "attacks" same side as Lg	____ nucleophile is best defined as a acid
X nucleophile "attacks" opposite side as Lg	____ leaving group forms a strong base
X crowded transition state	X leaving group forms a weak base

(2) SN2 Reactions – Substrate (alkyl halide) Reactivity. Rank the following substrates in order of their reactivity in an SN2 reaction, (1 = most reactive.....5 = least reactive).



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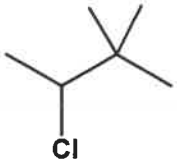

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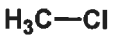

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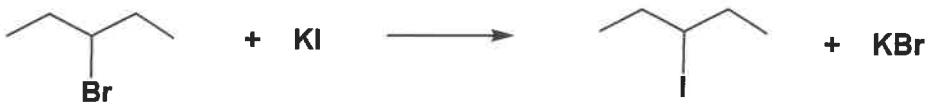
(3) SN2 Reaction Theory. Answer the following questions for the SN2 reaction drawn below:

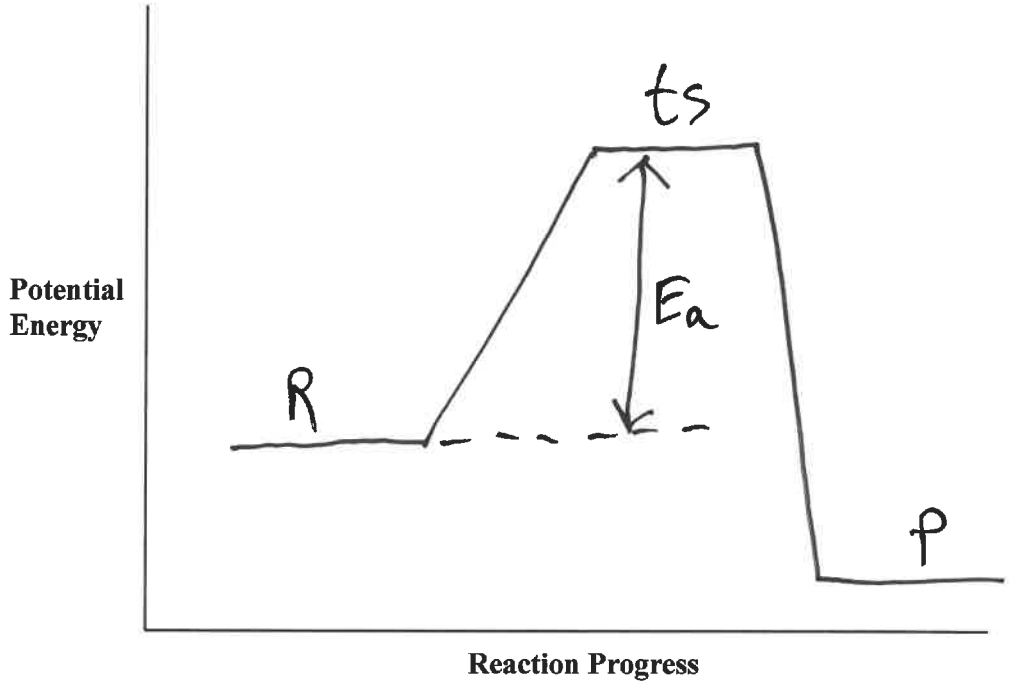
(a) What is the Nucleophile (write with correct charge if relevant) $I^{\ominus}$

(b) What is the Leaving Group (write with correct charge if relevant) $Br^{\ominus}$

(c) What is the role of the K^+ ion? spectator Ion

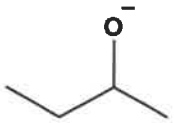
(4) SN2 Energy Diagram. For the **exothermic** SN2 reaction at the right, draw a **completely labeled** Energy Diagram. Be sure to label the position of the: reactant, product, transition state, and activation energy.





(5) SN2 Reactions: Nucleophile Reactivity.

(a) Rank the following nucleophiles in order of their reactivity in an SN2 reaction (1 = most reactive.....4 = least reactive). **HINT:** Usually, the stronger base = the more reactive nucleophile, but all of these nucleophiles have about the same base strength!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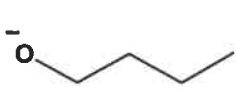
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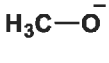
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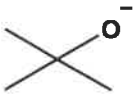
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(b) EXPLAIN the basis to your answer in 5(a) above.

Since each nucleophile is $R-O^{\ominus}$, they have about the same base strength. Due to the crowded SN2 transition state, the smallest nucleophile will be the most reactive.

(c) Which nucleophile in each pair will react faster in SN2 reactions? Circle one choice in each pair.
HINT: The stronger base = more reactive nucleophile. **EXCEPTION:** When comparing neutral species in the same column of the periodic table, the LARGER species is the most reactive (more polarizable).

AsH_3 or NH_3 — Larger, Neutral = better Nucleophile

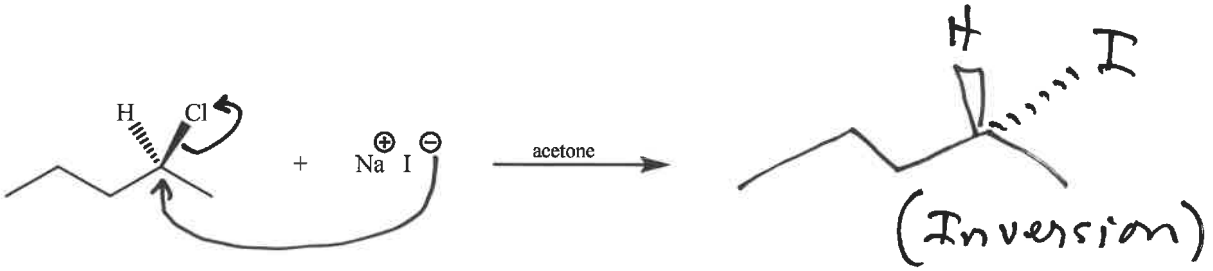
HO^- or HS^- — stronger base

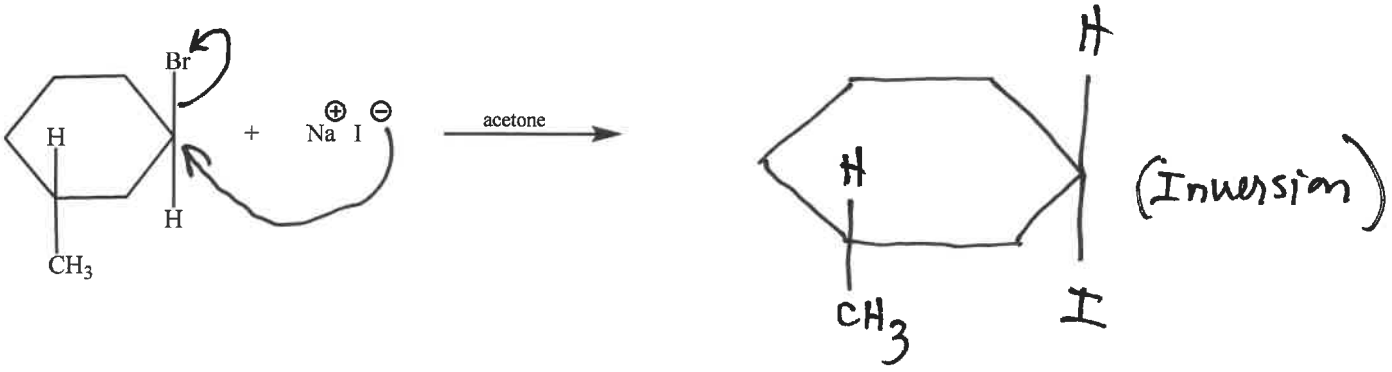
Cl^- or PH_2^- — stronger base

NH_3 or $Na^+ {}^-NH_2$ — stronger base

(6) SN2 Reactions: Predicting the Products, Stereochemistry, and the One-Step Mechanism.

(a) Complete the following two SN2 reactions by drawing **only the substitution product** with the correct stereochemistry. You do not need to balance these reactions. **HINT: Inversion of configuration!**





(b) Now, for EACH reaction draw above in curved arrows to the reactant side that explains the formation of all products. In a mechanism we use curved arrows to show electron pair movement as covalent bonds are being made and broken. You do not need to re-draw the reactions, just add the curved arrows above.