Names of all students (please print) Answer Key

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

Worksheet #18: October 27, 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.

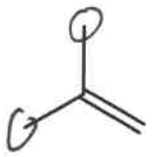
(1) E2 Reactions depend on Nucleophile (Base) Strength. Rank the following substances in order of their ability to produce increasing amounts of **E2 elimination** product from 2-bromobutane:

(weak base) 1 = least E2 product to 3 = most E2 product (strong base)

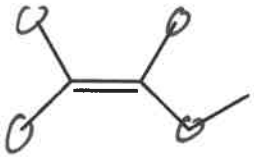
KF	**NaOH**	**$NaNH_2$**
(weakest base / least E2) 1	2	3 (strongest base = most E2)

(2) Stability of E2 Alkene Products based on the number of sp2 substituents. Rank the following alkenes in order of **increasing** stability:

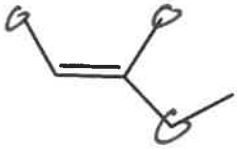
(fewest sp2 substituents) 1 = least stable to 4 = most stable (most sp2 substituents)



2



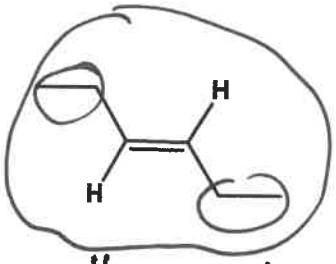
4



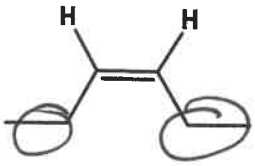
3

1

(3) Stability of E2 Alkene Products (cis & trans). Which alkene at the right is the **most** stable (circle): (least sp2 steric hindrance)



further apart



close together

PLEASE READ: Inefficient Chemical Reactions: Substitution + Elimination Reactions. In the previous worksheet you learned that many chemical reactions are not very efficient. The yield may be low (<75%), and you can have **two or more reactions occurring at the same time, in the same beaker**. Many substitution reactions are also accompanied by Elimination reactions. In an elimination reaction, the leaving group and an H are "eliminated" from the substrate to form alkenes as products. The C=C double bond of alkenes is formed between the carbon containing the Lg (α-carbon) and the adjacent carbons that have H's (β-carbons).

Substitution and Elimination reactions may produce ONE product, or a mixture of TWO organic products:

SN1 + E1 mixture **SN2 + E2 mixture** **SN2 only** **E2 only**

How will you keep track of all of this information? This is all about developing confidence through a logical approach to problem solving, which is a key learning outcome to this course. To help you out with this problem solving technique, I've provided you with a Flow Chart for Substitution and Elimination Reactions (see handout).

You must know the **key points** for **each** of those four reactions! As you read each of the following bullets, follow the logic in your **Flow Chart**. Learn how to use the **Flow Chart** as a guide and make sure you add it to your course notebook as you can use it for exams. In answering these problems, you will use the following strategy:

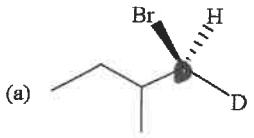
- Is the reactant alkyl halide 1°, 2° or 3°? If 1°, the reaction is SN2 and/or E2. If 3°, the reaction is SN1 and E1 (maybe E2). If 2°, more info needed.
- Is the nucleophile poor or good? H_2O and ROH are poor nucleophiles, and everything else is a good nucleophile. Poor nucleophiles give a mixture of both SN1 and E1 products.
- If a good nucleophile, is it a weak or strong base:
  - ALMOST everything with a negative charge is a Strong Base.
  - Everything else is a Weak Base, **plus** X^- (halide ions), ^-CN (cyanide ion) and carboxylate ions.
  - If a weak base, then you only get SN2 product.
  - If a strong base you get SN2 and E2 products.
- All E1 and E2 reactions give the most stable alkene product. The exception is for a large, bulky strong base that will give the least stable alkene product.
- In some of the reaction problems below the problem-solving logic has been done for you. See how this logic follows the Flow Chart. On the exam the logic will not be spelled out for you.

(4) Reactions. Complete the reactions shown below by drawing the structure of the **major, neutral organic products.** Draw the proper stereochemistry, if relevant. It is **NOT** necessary to balance these reactions or write the mechanism.

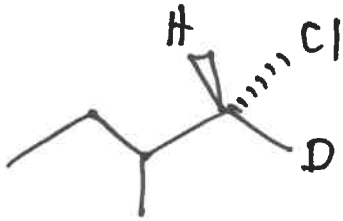
EXAMPLE:

Type of alkyl halide: 1° Nucleophile: good, weak base Type of Reaction(s): SN2 only

(a)



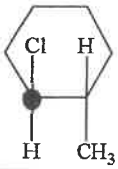
+ NaCl



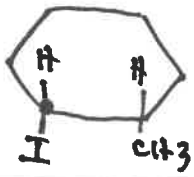
(inversion)

Type of alkyl halide: 1° Nucleophile: good, weak base Type of Reaction(s): SN2 only

(b)



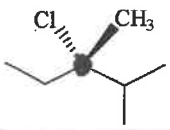
+ NaI



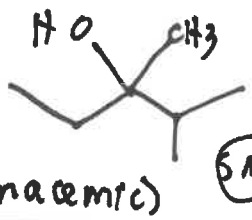
(inversion)

Type of alkyl halide: 2° Nucleophile: good, wh. base Type of Reaction(s): SN2 only

(c)

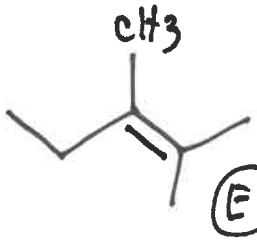


+ 2 H_2O



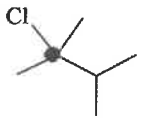
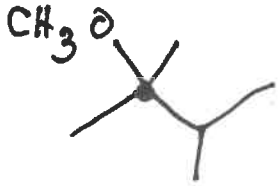
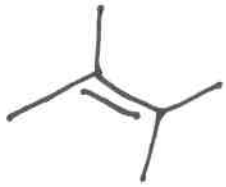
(racemic) SN1

+

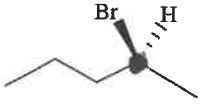


E1

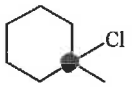
Type of alkyl halide: 3° Nucleophile: poor nucleophile Type of Reaction(s): SN1 & E1

(d)  + 2 CH_3OH ⟶  + 

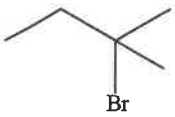
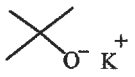
Type of alkyl halide: 3° Nucleophile: poor Type of Reaction(s): SN1 + E1

(e)  + NaCN ⟶ 

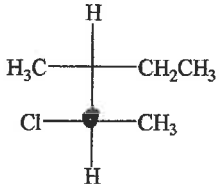
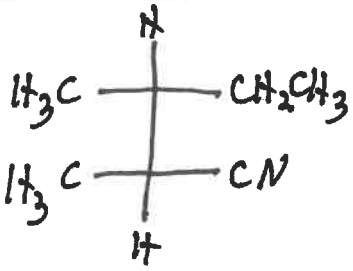
Type of alkyl halide: 2° Nucleophile: good, wk base Type of Reaction(s): SN2

(f)  + 2 H_2O ⟶  + 

Type of alkyl halide: 3° Nucleophile: poor Type of Reaction(s): SN1 + E1

(g)  +  ⟶ 

Type of alkyl halide: 3° Nucleophile: good, strong base, bulky Type of Reaction(s): E2 only forming least stable alkene

(h)  + NaCN ⟶ 

Type of alkyl halide: 2° Nucleophile: good, wk base Type of Reaction(s): SN2 only