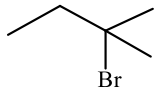
**Names of all students (please print)** _____

_____

**CHEM 243 Organic Chemistry I** **Points_____ (10 max)**

**Worksheet #19: November 6, 2024.** 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) SN1 Reactions – Predicting Reaction Products.** Complete the reactions shown below by drawing the structure of the substitution product. Do not balance these equations, and be sure to draw the proper product **stereochemistry**, if relevant.

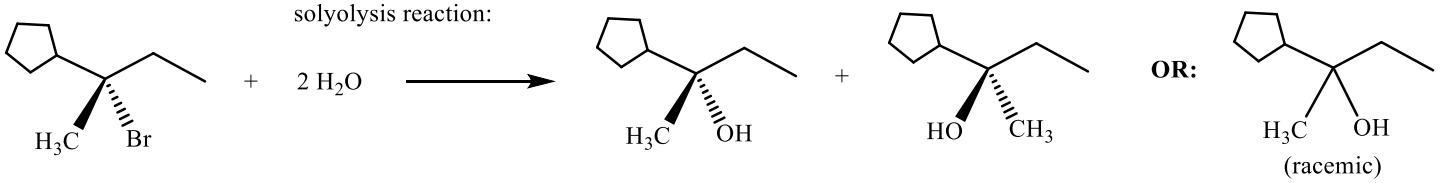
(a) 

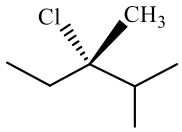
+ NaCl ⟶

**Background info for SN1 reactions b, c, d:**

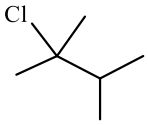
- These are solvolysis SN1 reactions, where the nucleophile is also the solvent.
- Note that: -if the solvent is water ($H_2O$), the substitution product is an alcohol (R-OH)
  -if the solvent is an alcohol (R'-OH), the product is an ether (R-O-R').
  -water and alcohols are both poor nucleophiles (weak bases), which are ideal SN1 nucleophiles.
- With these poor nucleophiles ($H_2O$ or R-OH), the oxygen forms the new bond to the positive carbon of the substrate. The oxygen always loses ONE H, and everything else bonded to the oxygen remains bonded in the product. Note that the correct stoichiometry is **TWO** molecules of $H_2O$ or R-OH. The 2nd molecule is used as a base to remove the $H_2O$ or R-OH proton (see mechanism in question 4).
- Stereochemistry: Remember, SN1 reactions are NOT stereospecific, so you get a Racemic Mixture of products (both the R and S enantiomers). See the example reaction below:

Example of an SN1 solyolysis reaction:

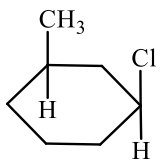



(b) 

+ 2 $H_2O$ ⟶

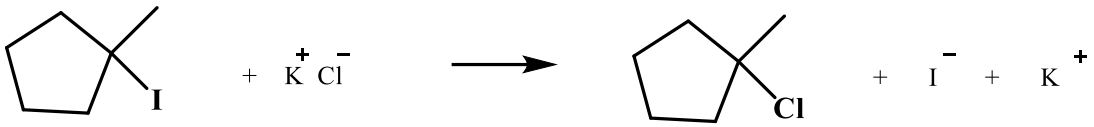
(c) 

+ 2 $CH_3OH$ ⟶

(d) 

+ 2 $H_2O$ ⟶

**(2) SN1 <u>Two-Step</u> Mechanism**. The mechanism for the following **balanced SN1 net reaction** requires TWO steps. In Step #1 the Lg leaves, forming a carbocation intermediate. In Step #2 the nucleophile adds to the carbocation forming the neutral organic product. If you add together your Step-1 and Step-2, you must get the balanced net reaction.

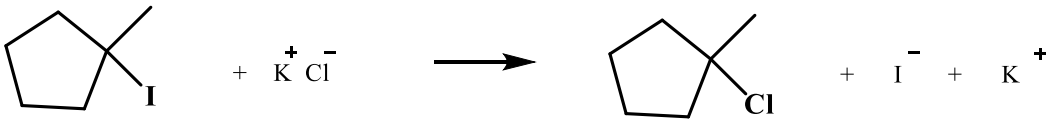



(a) What is the nucleophile _____

(b) What is the leaving group _____

(c) Why is this reaction classified as SN1 and not SN2?

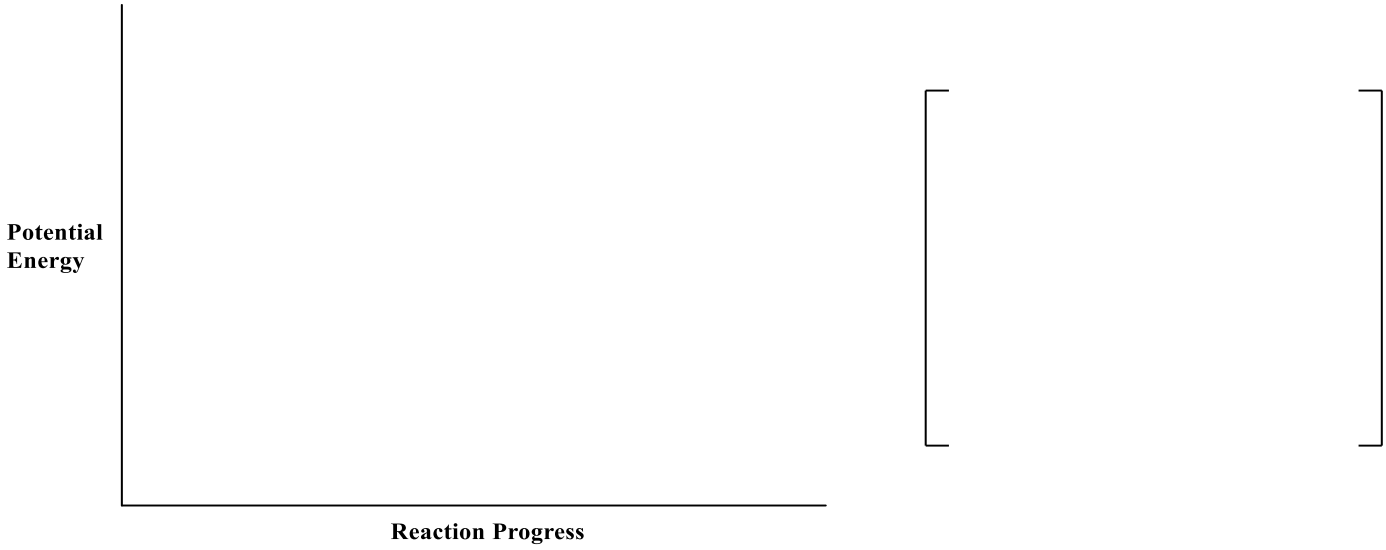
(d) Write a complete mechanism that explains the formation of all products in the balanced net SN1 reaction shown below. Your mechanism must consist of a series of balanced chemical equations, and curved arrows to show electron pair movement.




**Step #1 (leaving group leaves to form the carbocation intermediate):**

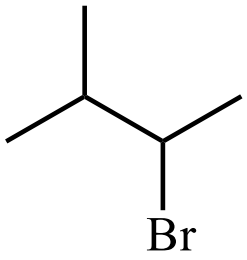
**Step #2 (nucleophile adds to the carbocation forming the neutral organic product):**

(e) Now, draw and label the **Energy Diagram** for this exothermic reaction (R, P, ts-1, ts-2, intermediate, activation energy), and also draw the structure for the **transition state** of the Rate-Limiting Step from your mechanism.




**(3) Inefficient Chemical Reactions: Substitution + Elimination Reactions.** 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).

(a) In the alkyl bromide at the right, label the α and β carbons.




(b) If you have more than one β-carbons, you can get more than one alkene products. Based on your α- and β-carbons, draw all possible elimination products.