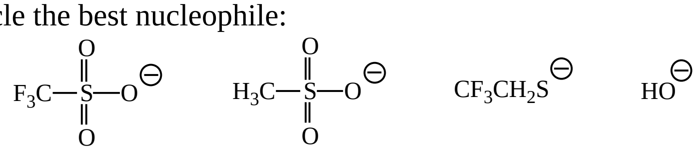
1. (6 points) Draw an energy profile for a typical exothermic S_N2 reaction. Label all important parts of your energy profile.

2. (3 points) Define: Transition state.

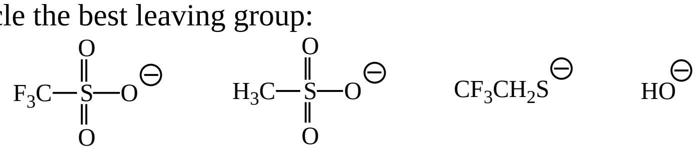
3. (2 points) Write the mathematical equation that shows the relationship between energy of activation and reaction rate.

4. (7 points) Briefly explain how the structure of a transition state influences the rate of a reaction.

5. (2 points) Circle the best nucleophile:



6. (2 points) Circle the best leaving group:



7. (2 points) Circle the molecule that reacts fastest in an S_N2 reaction:

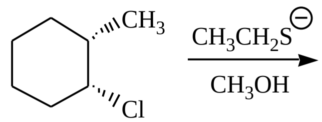
CH_3OH $(CH_3CH_2)_3CI$ CH_3CH_2F None of these will undergo S_N2

8. (1 point) Draw the structure of DMF.

9. (2 points) Circle the least polar solvent: DMF CH_3OH acetone $CH_3(CH_2)_4CH_3$

10. (2 points): Circle the protic solvent(s): DMF CH_3OH acetone $CH_3(CH_2)_4CH_3$

11. Consider this S_N2 reaction:



(a) (6 points) Write the major product and mechanism including all transition states.

(b) (1 point) Is this reaction concerted (circle one)?

Yes No Don't ask me; I didn't study

(c) (2 points) If $CH_3CH_2S^-$ is replaced with $CF_3CH_2S^-$ the reaction (circle one):

Becomes faster Becomes slower Rate does not change

(d) (2 points) If CH_3OH is replaced with DMF the reaction becomes (circle one):

Faster Slower Rate does not change

(e) (3 points) By adding, subtracting or otherwise changing at most four atoms of the electrophile rewrite the reaction so that it is ***obviously slower***.

12. (7 points) Briefly explain this observation: When (S)-2-iodobutane is allowed to react with a solution of NaI in acetone for a long period of time (i.e., the reaction has reached equilibrium), the product is racemic 2-iodobutane.

13. Consider these carbocations:

$H\overset{\oplus}{C}(CH_3)_2$ $HO\overset{\oplus}{C}(CH_3)_2$ $H_2N\overset{\oplus}{C}(CH_3)_2$ $H_2N\overset{\oplus}{C}(CF_3)_2$

(a) (1 point) Circle the most stable carbocation.

(b) (2 point) The most stable carbocation is (circle all that apply):

Methyl   1°   2°   3°   Resonance-stabilized

14. (2 points) Draw the structure of a primary carbocation that has ***exactly*** four carbons, ***exactly*** one ring and ***exactly*** one lone pair.

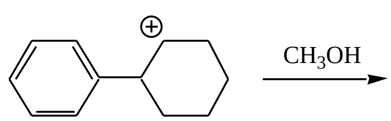
15. In lecture it was mentioned that regardless of the origin of a carbocation, it only reacts in a three ways, which we call the three carbocation fates.

(a) (2 points) In one sentence of less describe fundamental driving force lies behind all three of these carbocation fates.

(b) (9 points) Using the carbocation shown below and CH_3OH as the only reactants in each case, name and illustrate the three carbocation fates. Use curved arrows and show the products of each carbocation fate. If the fate can proceed by more than one pathway, write only the most favorable pathway.

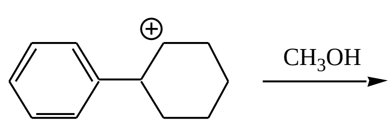
Fate #1: ______________________________

Illustration:



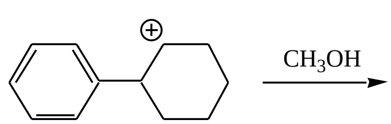
Fate #2: ______________________________

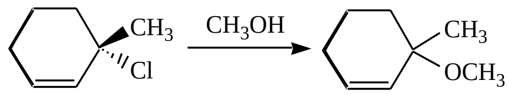
Illustration:



Fate #3: ______________________________

Illustration:



16. Consider this reaction: 

(a) (9 points) Circle the most probable mechanism for this reaction, then briefly explain your answer. Mechanism choices: S_N2 S_N1 Neither of these

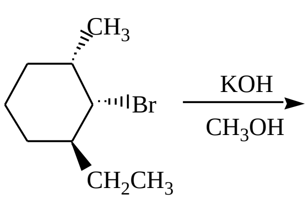
Explanation:

(b) (7 points) Write a complete mechanism for the reaction. Do not include any transition states. Label the rate-determining step as “rds”.

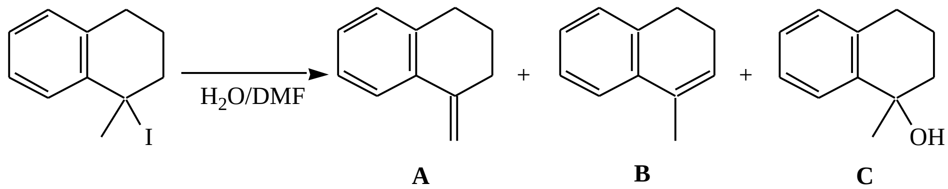
(c) (1 point) The reaction product is (circle one):

(R) (S) (R)/(S) mixture None of these

17. (4 points) Write the major product and mechanism for this ***E2*** reaction. Do not include any transition states.



18. Reaction of the iodide shown below with water and DMF produces three products:



(a) (1 point) Circle the product predicted by Zaitsev's rule: **A B C**

(b) (2 points) Circle the mechanism(s) that best account for the products:

S_N2 S_N1 E2 E1

(c) (10 points) Explain your choice of reaction mechanism(s).