

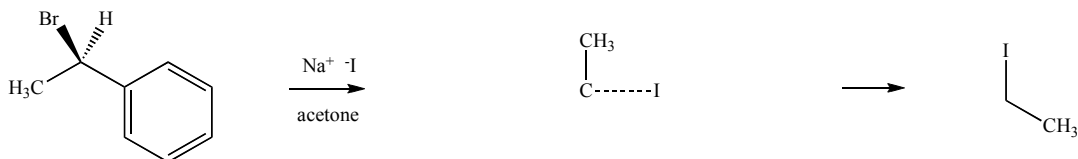
For any question on this exam worth three or more points, you have two choices: answer the question as written or you may write and circle the phrase "one point". If you write "one point" you will receive one point (and only one point) of credit for the question. "One point" overrides anything you have written for that question, regardless of its accuracy.

Example: (10) Briefly explain everything about organic chemistry.

One point

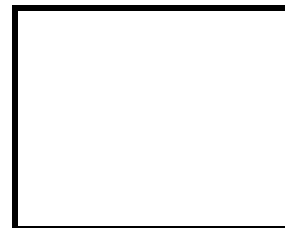
You may use "Ph" anywhere on this exam where appropriate.

The questions on this page refer to the following incomplete S_N2 reaction.



- (3) Draw the reaction mechanism by adding the missing curved arrows.
- (4) Complete the drawing of the transition state.
- (3) Complete the drawing of the product.
- (2) Complete the following rate expression for this reaction. *Be specific.* Rate = k

- (2) In the box draw the structure of acetone. Include all lone pairs and formal charges.



- (3) Fill in the blanks with atoms that make bonds. (Example: ...the Li-P bond...) *There may be more spaces than answers.* Within the molecular structure of acetone, the _____-_____ and _____-_____ bond(s) decrease(s) ϵ whereas the _____-_____ and _____-_____ bond(s) enhances(s) ϵ .

- (2) Instead of acetone, what other solvent might you pick to make the reaction occur as quickly as possible? Circle one:

CH₃OH DMF H₂O CH₂Cl₂

- (6) What happens to the rate of the reaction when the following changes are made? Circle one rate effect in each case. *The changes are not cumulative. For example, part (b) ignores the change made in part (a).*

- | | | | |
|---|----------------|----------------|----------------------------|
| (a) Br changed to I | Becomes faster | Becomes slower | No significant rate change |
| (b) H-C-Br changed to H ₃ C-C-Br | Becomes faster | Becomes slower | No significant rate change |
| (c) I changed to F | Becomes faster | Becomes slower | No significant rate change |

9. (6) Define the following terms using *no more than 20 words* in each case.

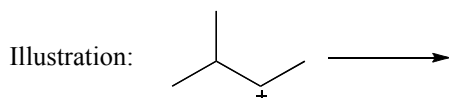
(a) Transition state:

(b) Rate-determining step:

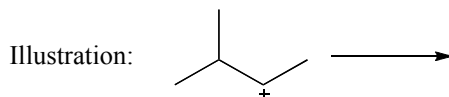
10. (2) On the course discussion board was written, "All primary alkyl halides undergo S_N2 reactions." If this statement is true write "true" in the box. Otherwise draw in the box the structure of a primary alkyl halide that violates this statement.

11. (9) Using the carbocation shown below and methanol as the only reactants in each case, name and illustrate the three common fates of a carbocation. Include appropriate curved arrows. If the fate can occur in more than one way, illustrate only the most likely result. If a particular fate is not likely to occur, write "not likely" in place of its illustration.

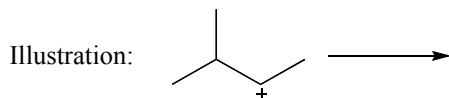
Name of carbocation fate: _____



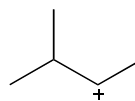
Name of carbocation fate: _____



Name of carbocation fate: _____

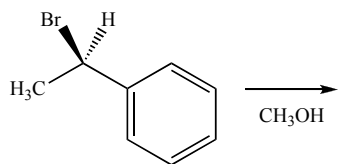


12. (2) By changing only one hydrogen atom into a fluorine atom, redraw the less stable carbocation shown here so that it is more stable. If this is not possible, write "not possible" in the box.



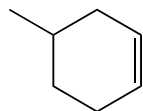
Less stable carbocation More stable carbocation

Questions 13 and 14 refer to this S_N1 reaction:

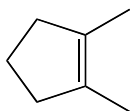


13. (7) In the space above write the S_N1 reaction product(s). If more than one product is formed, write “major” below the major product.
14. (7) Write the mechanism for the major product. Label the rate-determining step as ‘rds’. Do not include transition states.

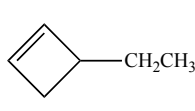
15. (4) Rank the stability of the following alkenes by circling one number beneath each. 1 = most stable and 4 = least stable.



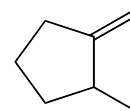
1 2 3 4



1 2 3 4



1 2 3 4



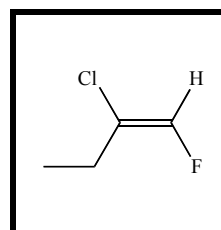
1 2 3 4

16. (3) Circle *one* choice in each set that best describes the alkene in the box.

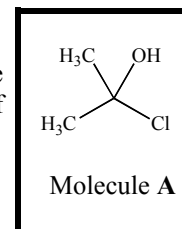
(a) Cis Trans Neither

(b) E Z Neither

(c) Terminal Internal Neither



17. (4) The following statement concerning molecule A may contain some errors. Correct these errors by circling the wrong word(s) and write the correct word(s) below the circled words. If no errors are present, write “no errors.”



Molecule A is a tertiary chloride because the carbon bonded to the chlorine atom is also bonded to one OH and two methyl molecules. Molecule A cannot undergo an S_N1 reaction because the carbon with the OH leaving group is too sterically hindered.

18. (3) Draw a molecule that has exactly five carbon atoms plus any number of atoms of any other elements that when reacted with a strong base follows Zaitsev’s Rule but gives only a terminal alkene product.

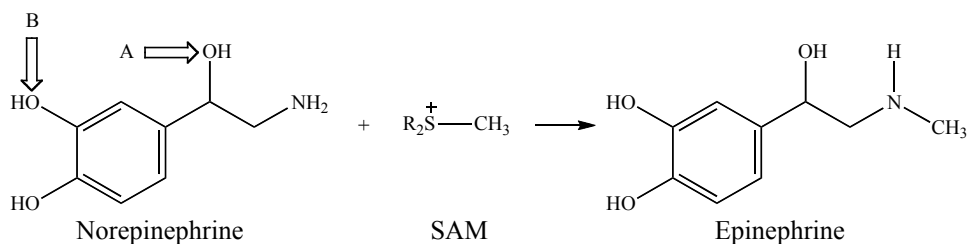
19. (4) For the reaction described in question 18, write the base you might use, and the structure of the major organic product formed.

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Base

Major reaction product

Questions 20 and 21 refer to the *N*-methylation of norepinephrine with *S*-adenosylmethionine (SAM) to give (after deprotonation) epinephrine (adrenaline), an S_N2 reaction discussed in lecture.



20. (6) Complete each sentence using **25 words or less**. Be specific, and do not use the same reason for both.

(a) Methylation occurs at the amine instead of at the OH labeled A because...

(b) Methylation occurs at the amine instead of at the OH labeled B because...

21. (8) In order to verify the norepinephrine/SAM reaction mechanism, the effect of solvent on the reaction rate was studied.

(a) Rank the order of polarity of the solvents shown below by writing “most” below the most polar and “least” below the least polar.



(b) Circle the solvent(s) that is/are polar *and* protic:



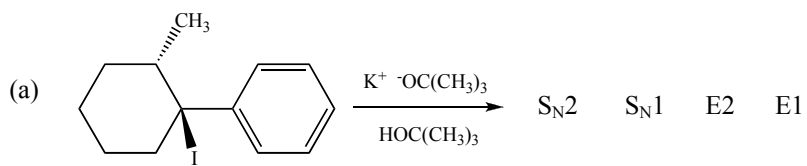
(c) In the norepinephrine/SAM reaction, circle the one species that receives the greatest increase in stabilization when the solvent polarity is increased:

Nucleophile Electrophile Transition state

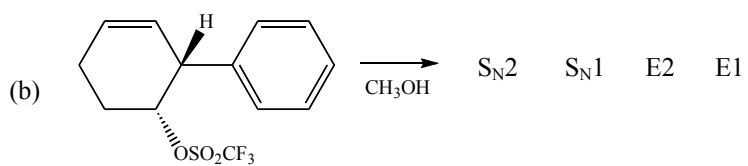
(d) In the norepinephrine/SAM reaction, which solvent makes the reaction slowest? Assume that everything present dissolves completely in any of the solvent choices.



22. (10) For each reaction shown below, circle the most likely mechanism(s), then draw the major product(s) in the space below the reaction.



Major product(s):



Major product(s):