**Problem Set 8: Substitution Reactions**

**Chemistry 260** **Organic Chemistry**

1. Which of the following species are nucleophiles?

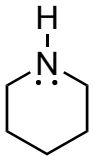
(1) $CN^-$ (2) $Na^+$ (3) $I^-$ (4) $Ca^{2+}$ (5) $NH_3$

2. For each of the compounds below, indicate whether it is a nucleophile, an electrophile, or neither.

(a)

(b)

(c)



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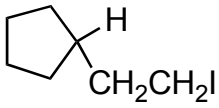

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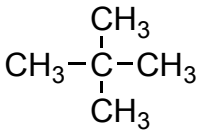

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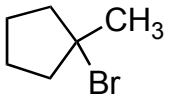
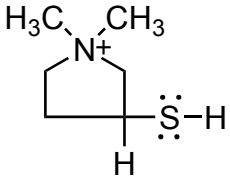


3. Circle the nucleophilic atom in the compounds below.

(a)



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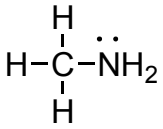

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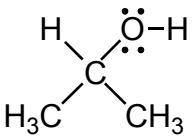
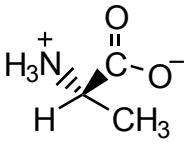


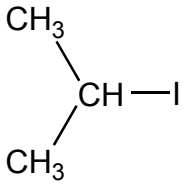
(d)



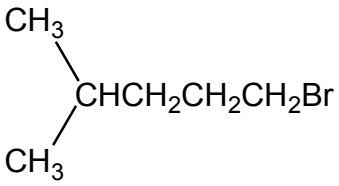
4-6. Which is the most reactive in an $S_N2$ reaction?

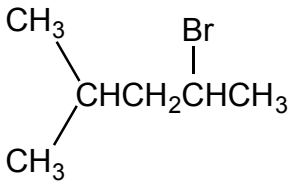
4. (1) $HS^-$ (2) $HO^-$

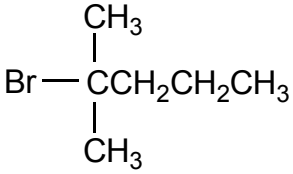
5. (1) $Cl^-$ (2) $Br^-$ (3) $I^-$

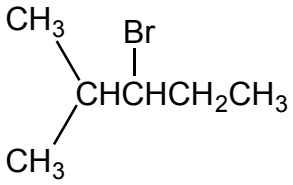
6. (1) $CH_3$-I (2) 

7. Which is the most reactive in an $S_N2$ reaction?

(1) 

(2) 

(3) 

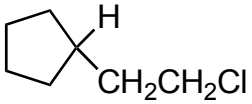
(4) 

8. Which of the following statements applies to the $S_N2$ reaction of optically pure (-)-2-bromooctane with dilute aqueous sodium hydroxide?

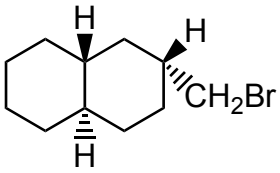
(1) the product will be racemic 2-octanol
(2) the product will be optically pure (+)-2-octanol
(3) the product will be optically pure (-)-2-octanol
(4) the product will be either optically pure (+) or (-)-2-octanol, but it is not possible to predict which
(5) none of the above

9-12. Identify each of the alkyl halides below as: (1) 1° (2) 2° (3) 3°.

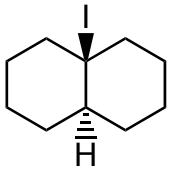
9.



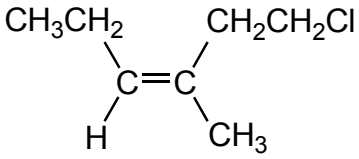

10.




11.

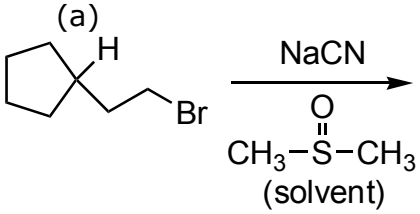



12.

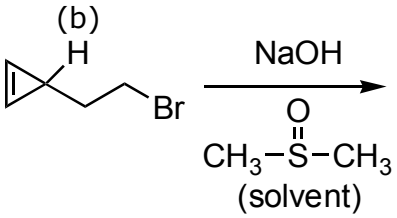



13. Predict the products of each of the reactions below.

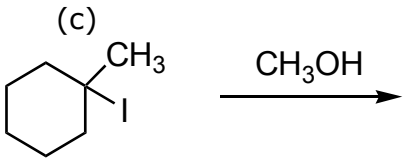
(a)



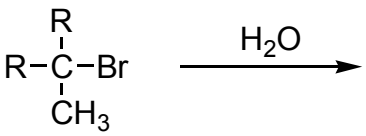

(b)




(c)

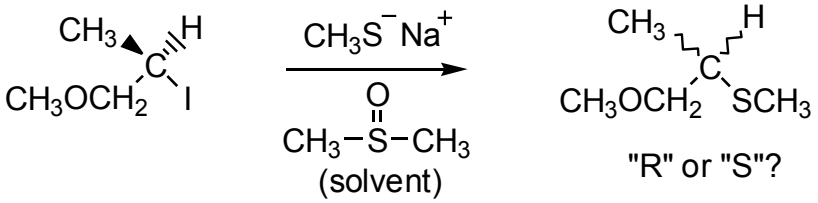



(d)

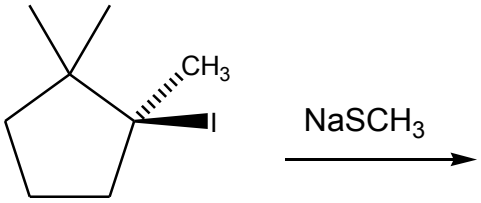



R = any alkyl

14. What is the R/S configuration of the product of the $S_N2$ reaction below? Base your answer on the structure of the reactant and the mechanism of the reaction, not on the way the product is drawn.



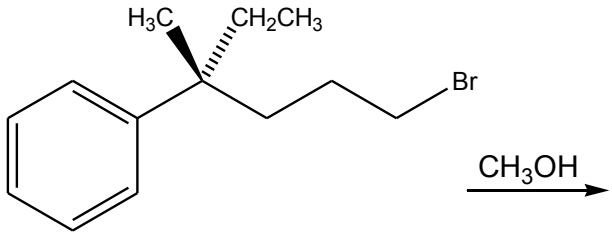

15. Choose the best statement regarding the reaction below.




Optically Pure

(a) The product will be optically pure.
(b) The product will have no optical activity.
(c) The product will have considerable optical activity, but will not be pure.
(d) The extent of optical activity cannot be predicted.

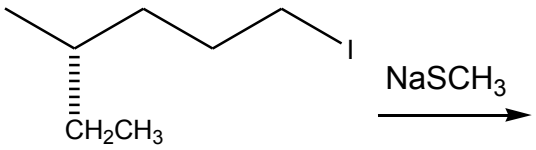
16. Choose the best statement regarding the reaction below.




Optically Pure

(a) The product will be optically pure.
(b) The product will have little or no optical activity.
(c) The product will have considerable optical activity, but will not be pure.
(d) The extent of optical activity cannot be predicted.

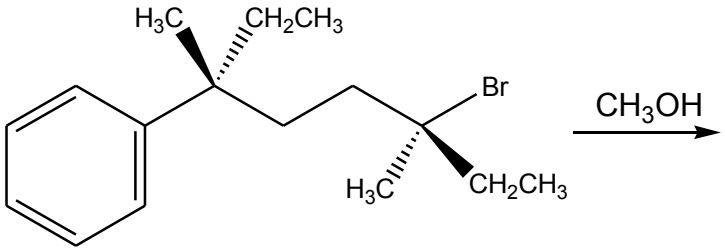
17. Choose the best statement regarding the reaction below.




(*S*)-4-methyl-1-iodohexane

(a) The product will have S configuration.
(b) The product will have R configuration.
(c) The product will be racemic.
(d) Cannot predict the configuration of the product.

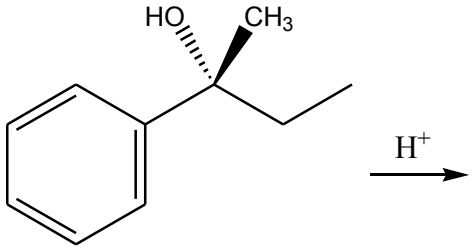
18. Choose the best statement regarding the reaction below.




Optically Pure

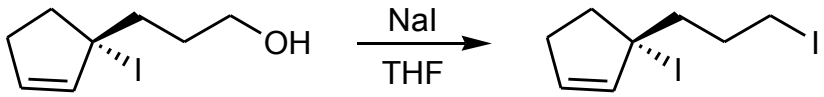
(a) The product will be optically pure.
(b) The product will have no optical activity.
(c) The product will have some optical activity, but will not be optically pure.

19. Rationalize, in terms of a mechanism, the loss of optical activity of (*R*)-2-phenyl-2-butanol when dissolved in acidic solution.




(*R*)-2-phenyl-2-butanol

20. The following questions relate to the reaction shown below:



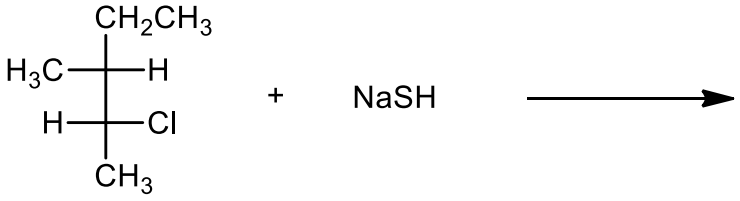

**A** **B**

(a) Why is little or no product **B** formed?

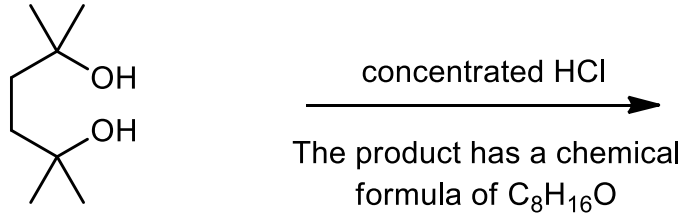
(b) Optical activity of **A** is lost. Why?

21. For each reaction shown below, draw the structure of the major organic product(s). Show stereochemistry where appropriate.

**(a)**

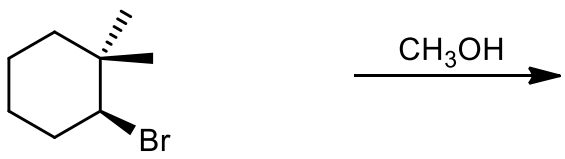



**(b)**

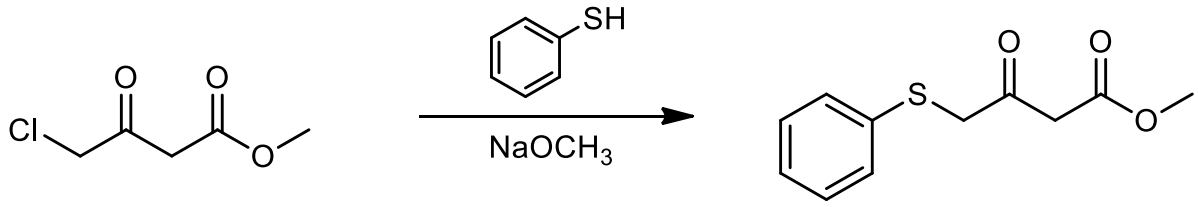



**(c)**


**(d)**

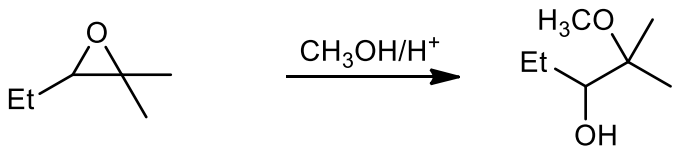


22. Propose a mechanism for the reaction below:

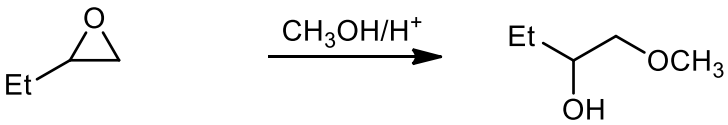



23. Propose a mechanism for each reaction below.

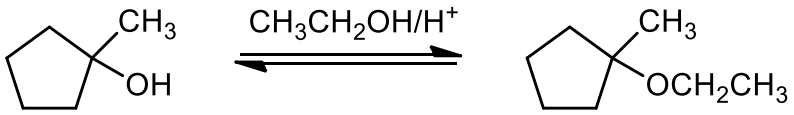
**(a)**




**(b)**



24. Answer the following questions with respect to the reaction below:




(a) Using the knowledge you have learned in Chem 123, how would you classify this reaction?

(b) When the concentration of the methylcyclopentanol is doubled, what would be the effect on the reaction rate?

(c) Assuming the reaction is reversible, if a dehydrating agent is added to the reaction mixture, which side of the equilibrium favour?

(d) If the temperature is increased, what will be the effect on the equilibrium constant?

(e) What would be the effect on the optical activity as this reaction proceeds?