Sample Examinations

On the following pages you will find sample examinations that will help you prepare for your midterm examination (Examination 1) and your final examination (Examination 2). We have included such questions in this manual so that students may obtain a better idea of the length of a normal Athabasca University chemistry examination. Short answers for a majority of the questions are given at the end of the sample examinations.

Sample Midterm Examination

The midterm examination is two (2) hours long. In the actual examination you may not consult your books or notes; however, you may use a calculator or slide rule. You will also be provided with a periodic table and a set of ^{1}H NMR chemical shifts and infrared stretching frequencies.

Part A: Short Questions (3 marks each)

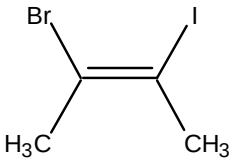
1. Draw the structure of each of the following compounds:

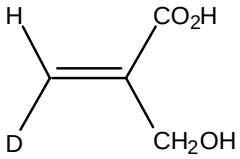
   a. 2-methyl-1,3,5-hexatriene

   b. 3,4-dimethyl-1-pentyne

   c. *trans*-1,2-dichloro-2-methylcyclobutane

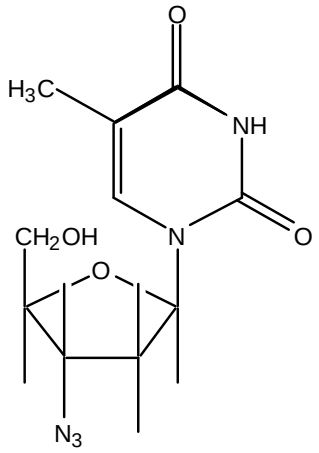
2. Determine whether each of the compounds shown below has *E* or *Z* configuration.

   a. 

   b. 

3. State Markovnikov's Rule and illustrate your answer with a suitable example.

4. Azidothymidine (AZT) is a drug that has been shown to delay the progress of Acquired Immune Deficiency Syndrome (AIDS) in certain victims of the disease. The structure of AZT is shown below. Use asterisks (*) to label each of the stereogenic (chiral) carbon atoms present in this compound.



5. Consider the activation energy ($\Delta G^{\ddagger}$) and net change in energy ($\Delta G°$) for two reactions (given in kJ/mol):

   Reaction *A*: $\Delta G^{\ddagger} = 44$ $\Delta G° = -5$

   Reaction *B*: $\Delta G^{\ddagger} = 135$ $\Delta G° = 27$

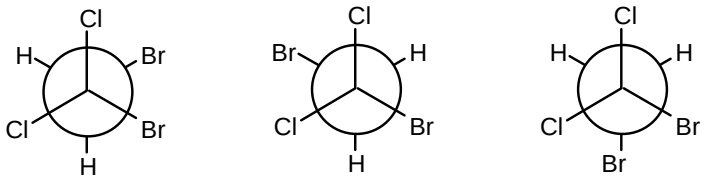
   a. Which reaction is endergonic?

   b. Which reaction is expected to be faster?

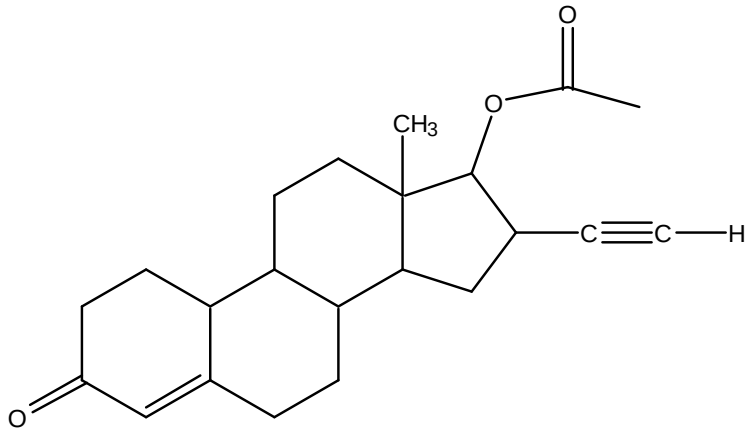
   c. Assuming that each reaction starts with the same compound or compounds, which would have the more stable intermediate (transition state)?

6. A certain sample of 2-butanol is found to have an observed rotation of $-3.5°$. If the specific rotation, $[\alpha]_D^{20}$ of pure liquid (+)-2-butanol is +13.90°, what percentage of each enantiomer is present in the sample?

7. The figure below shows the Newman projection formulas for three possible conformers of 1,2-dibromo-1,1-dichloroethane. Which of these three conformers is the most stable? Briefly justify your answer.



8. Norethindrone acetate is an active ingredient in a number of oral contraceptive pills and has the structure shown below.



   a. Circle an ester group in the structure above.

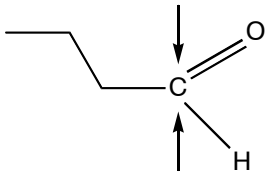
   b. Label an *sp*-hybridized carbon atom.

   c. Label an sp^2-hybridized carbon atom.

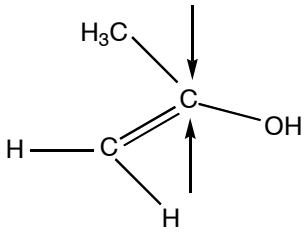
9. Arrange the alkanes hexane, pentane, and 2,2-dimethylpropane in order of increasing boiling point. Briefly justify your answer.

10. In each of the molecules below, label the indicated faces as *re* or *si*.

a.

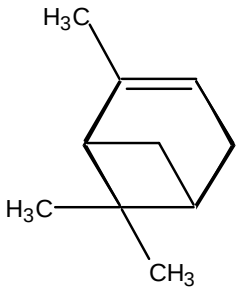


b.



Part B: Longer Questions (marks indicated)

11. The major component of turpentine is α-pinene, shown below.



Draw the structure of the product formed when α-pinene reacts with

a. hydrogen in the presence of a palladium catalyst.

b. bromine in carbon tetrachloride.

c. hydrogen bromide in ether.

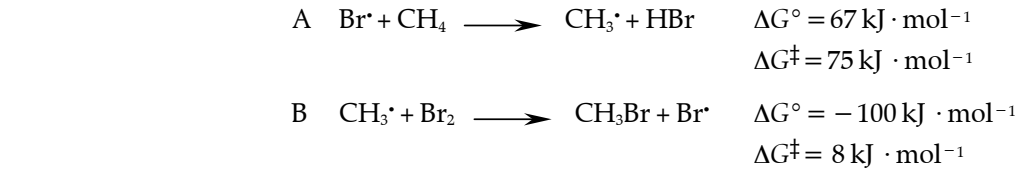
d. borane in THF followed by alkaline peroxides.

e. mercury(II) acetate in aqueous THF, followed by sodium borohydride.

[10 marks]

12. Draw a diagram to show the changes in potential energy that occur from the rotation around C2—C3 bond of pentane. Draw a Newman projection formula to correspond with each maximum and minimum in your diagram. **[10 marks]**

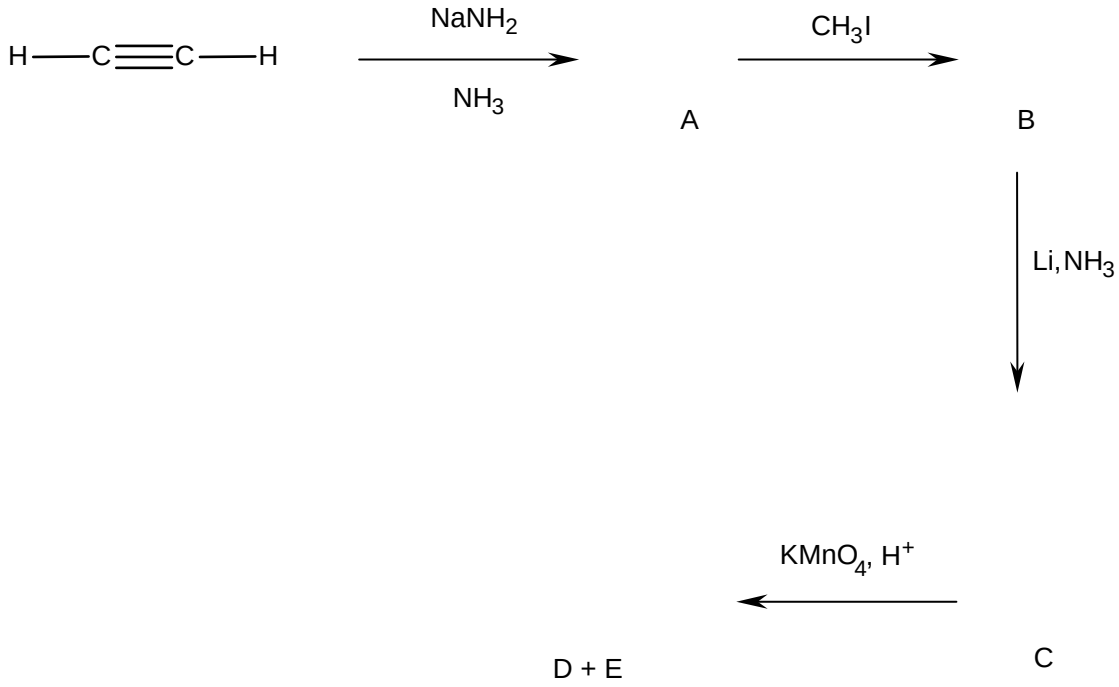
13. Draw a fully labelled reaction energy diagram (i.e., a diagram of energy versus progress of reaction) for the two-stage propagation step of the bromination of methane:



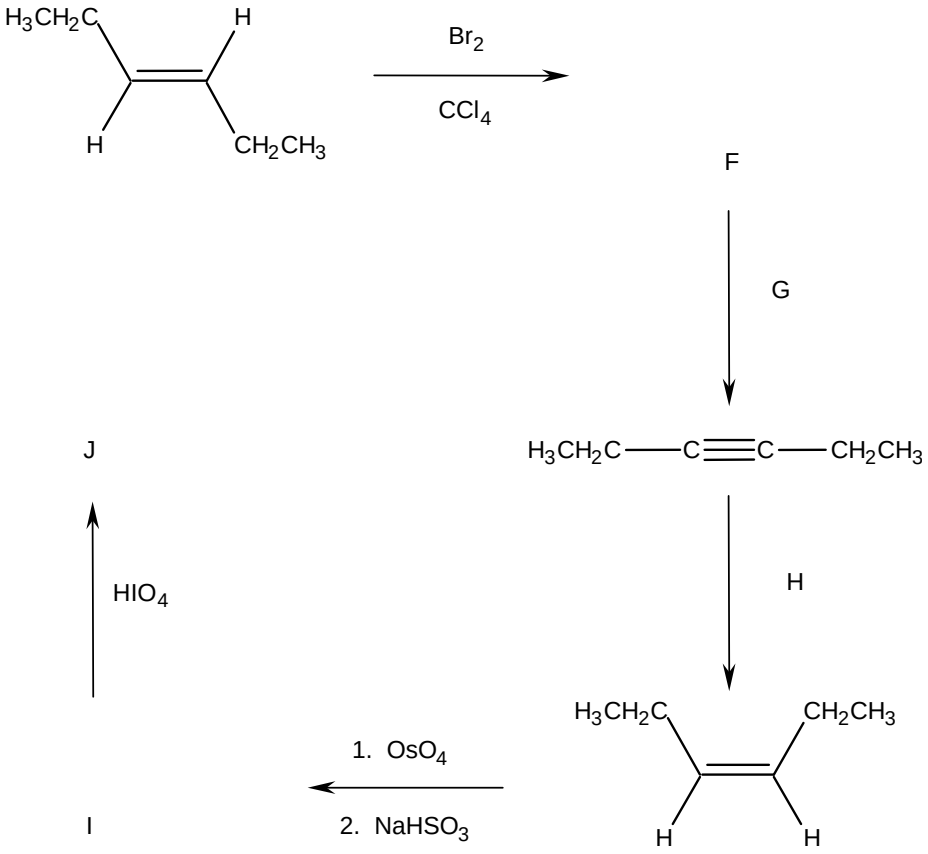
Be sure to indicate the position of all reactants, products, intermediates and transition states on your diagram. Identify which of the two steps is rate determining. **[8 marks]**

14. Identify the missing reactants, reagents and products represented by the letters A through J in the following two reaction schemes. Pay particular attention to changes in stereochemistry that may occur. **[10 marks]**

a.



b.



15. When the optically active compound V ($C_5H_{11}Br$) is heated with an ethanolic solution of potassium hydroxide, the major product is the alkene W and the minor product is another alkene, X. Reduction of the mixture of W and X using hydrogen gas and a palladium catalyst yields compound Y. Identify compounds V through Y, clearly showing how you reached your conclusions. **[12 marks]**

—END OF EXAMINATION—