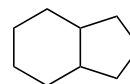
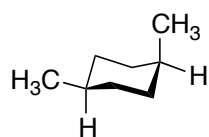


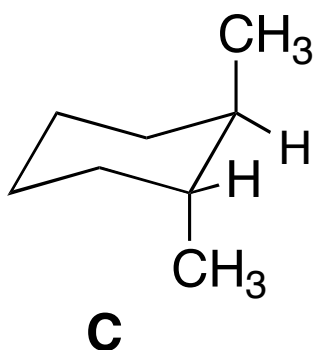
Organic Chemistry
CHM 223

Exam 2 Study Questions

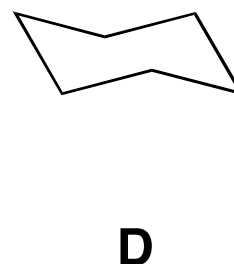
Provide IUPAC names for the following molecules:



Using the blank chair scaffold **D**, draw the alternative chair conformation (ring flip) of the *trans*-1,2-dimethylcyclohexane conformer **C**. Circle the most stable conformation (**C** or **D**).



ring flip

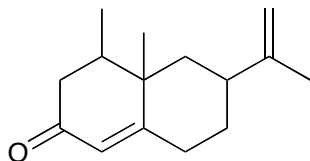


Using the following strain energy data, calculate the energy difference between the two chair conformations **C** and **D**.

H-CH₃ diaxial interaction - 3.8 kJ/mol

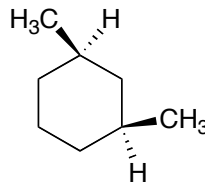
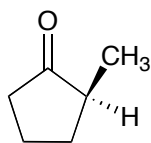
CH₃-CH₃ gauche interaction - 3.8 kJ/mol

Identify the chiral carbons (label them with a star or asterisk) in the following structure of nootkatone, isolated from grapefruit oil.

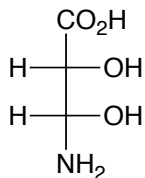


Nootkatone (grapefruit oil)

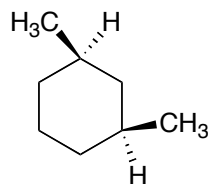
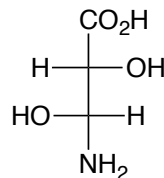
Designate the chiral carbons of the following two molecules as either R or S. Then indicate if each of the molecules would be predicted to be optically active (yes or no will suffice).



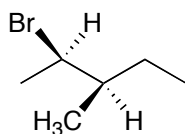
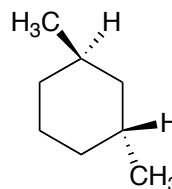
Which of the following pairs represent enantiomers (E) or diastereomers (D) or are the same (S).



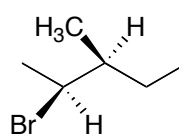
and



and



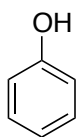
and



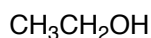
(2R,3R)-2,3-Dibromobutane is:

- a. optically active.
- b. racemic.
- c. dextrorotatory.
- d. a *meso* compound.

Explain why phenol is a stronger acid ($pK_a = 10$) than a simple alcohol such as ethanol ($pK_a = 16$).



phenol

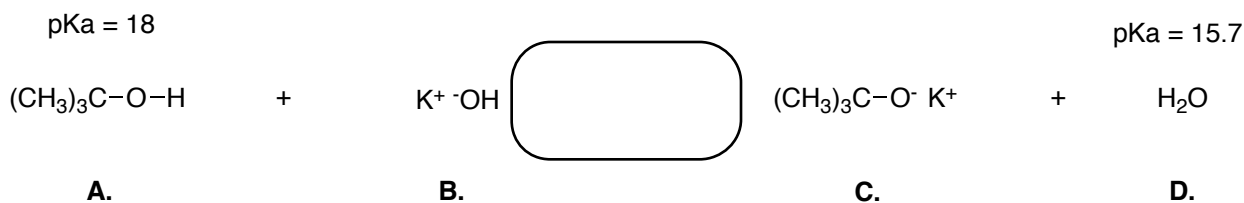


ethanol

An acid with a high pK_a :

- a. is a weak acid
- b. is a strong acid
- c. has a weak conjugate base
- d. both b and c

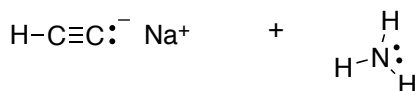
Refer to the following equation to answer questions 1 - 3, below. Place the letter corresponding to the correct answer in the blank.



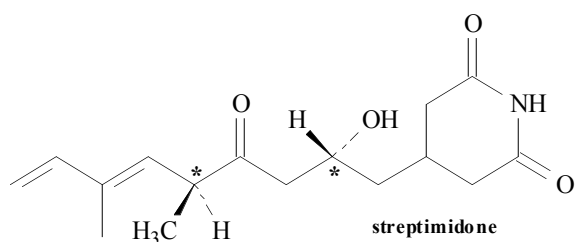
1. The strongest Brønsted-Lowry acid in the equation is _____ .
2. The strongest Brønsted-Lowry base in the equation is _____ .
3. The equilibrium reaction arrows above are missing. In which direction will the equilibrium be favored (circle the correct set of equilibrium arrows or draw them in the space above)?



Draw the products of the following reaction and provide an arrow pushing mechanism that accounts for their formation, label the acid (A), conjugate acid (CA), base (B) and conjugate base (CB), give an approximate pKa value for the acid and conjugate acid (based on the chart at the end of the exam) and predict the direction of the equilibrium by drawing the appropriate reaction arrows.



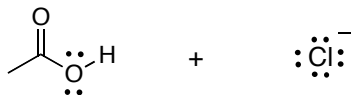
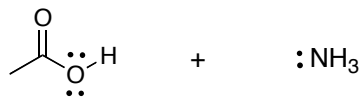
Consider the structure of streptimidone to answer the following two questions:



Assign *R* or *S* configuration to each chiral centers indicated in streptimidone and indicate these designations on the structure above.

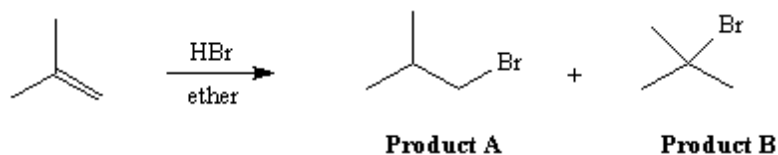
Based on the number of chiral centers, how many stereoisomers of streptimidone are possible?

Write an equation for the equilibrium reaction of acetic acid with each base below. Show all products formed and electron flow with arrows. Determine the pKa of each acid and conjugate acid (from the chart below) and indicate which equilibria lie toward the left and which lie toward the right by drawing the appropriate equilibrium arrows.



The reaction of isobutene with HBr in ether gives one of the two products below as the major product.

Answer the following question(s) about this reaction.



Which would be the major product?

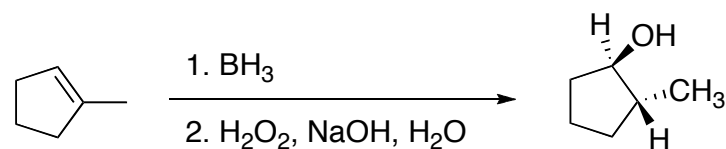
Which product would be formed via a primary carbocation intermediate?

Which product would have a higher energy transition state for the formation of the intermediate leading to it?

Which product is the anti-Markovnikov product?

Which product would be formed by a carbocation intermediate experiencing the greatest degree of hyperconjugative stabilization?

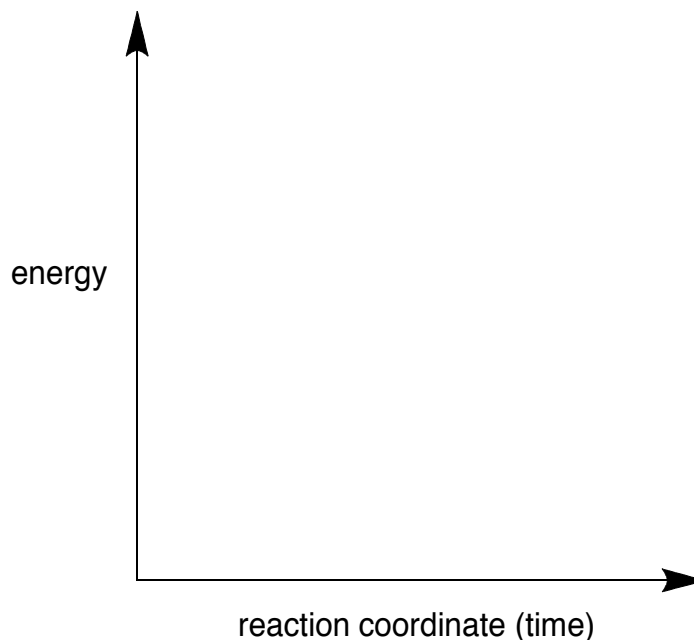
Alkenes may be hydrated by the hydroboration/oxidation procedure shown.



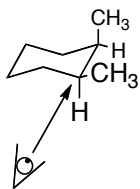
Overall, hydroboration of alkenes is an example of:

- a rearrangement reaction.
- a substitution reaction.
- an elimination reaction.
- an addition reaction.

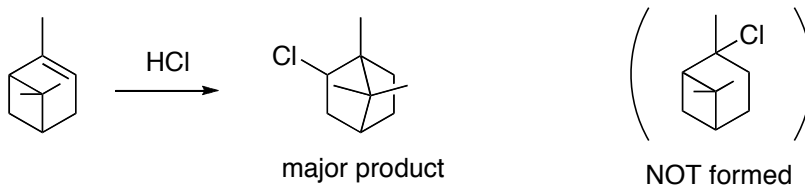
The S_N1 reaction, a reaction we will soon discuss, is a two-step reaction. For this example, assuming the reaction is exergonic/exothermic reaction, draw a reaction energy diagram for the conversion of reactant (**R**) to product (**P**). Make sure to label **R** and **P** on the diagram as well as the activation energy (ΔG^\ddagger), reaction energy (ΔG) and any intermediates (I) and/or transition states (\ddagger).





Draw a Newman projection that represents the C-C bond indicated in the structure below. You may abbreviate the ring structure with "R" or with a squiggly line as I often do in class.



Treatment of α -pinene with hydrochloric acid yields the major product shown below, NOT the direct Markovnikov addition product. Draw a stepwise, arrow pushing mechanism that supports the formation of the major product identified below.



	Acid	Formula	pK_a	Conjugate Base	
Weaker acid  Stronger acid	Ethane	CH ₃ CH ₃	51	CH ₃ CH ₂ ⁻	Stronger conjugate base  Weaker conjugate base
	Ethylene	CH ₂ =CH ₂	44	CH ₂ =CH ⁻	
	Ammonia	NH ₃	38	NH ₂ ⁻	
	Hydrogen	H ₂	35	H ⁻	
	Acetylene	HC≡CH	25	HC≡C ⁻	
	Ethanol	CH ₃ CH ₂ OH	15.9	CH ₃ CH ₂ O ⁻	
	Water	H ₂ O	15.7	HO ⁻	
	Methylammonium ion	CH ₃ NH ₃ ⁺	10.64	CH ₃ NH ₂	
	Bicarbonate ion	HCO ₃ ⁻	10.33	CO ₃ ²⁻	
	Phenol	C ₆ H ₅ OH	9.95	C ₆ H ₅ O ⁻	
	Ammonium ion	NH ₄ ⁺	9.24	NH ₃	
	Hydrogen sulfide	H ₂ S	7.04	HS ⁻	
	Carbonic acid	H ₂ CO ₃	6.36	HCO ₃ ⁻	
	Acetic acid	CH ₃ COOH	4.76	CH ₃ COO ⁻	
	Benzoic acid	C ₆ H ₅ COOH	4.19	C ₆ H ₅ COO ⁻	
	Phosphoric acid	H ₃ PO ₄	2.1	H ₂ PO ₄ ⁻	
	Hydronium ion	H ₃ O ⁺	-1.74	H ₂ O	
	Sulfuric acid	H ₂ SO ₄	-5.2	HSO ₄ ⁻	
	Hydrogen chloride	HCl	-7	Cl ⁻	
	Hydrogen bromide	HBr	-8	Br ⁻	
Hydrogen iodide	HI	-9	I ⁻		