

# Chem 2213a Midterm Test

May 23, 2013 2 h 15 min



Section 001 Exam code 111

*Message from the Dean:* All answer sheets are subject to a common data analysis which identifies anomalies of statistical significance in the selection of right and wrong answers by pairs of students. The course instructor is required to report all statistically significant results which suggest that cheating may have occurred. All such incidents will be subject to further investigation. All proven cases of cheating will be subject to severe academic penalties. If you are currently seated near someone with whom you had studied, and you think you may choose many of the same answers as that person, please raise your hand now and ask a proctor to reseat you.

- Western has a reciprocal agreement with other institutions. If you are a visiting student, academic offences will be reported to your home institution.

This test contains 35 multiple-choice questions of equal value. Be sure you have a complete test paper. Scrap paper and a periodic table are attached, and they may be removed for use.

No electronic devices may be in your possession, even for timekeeping purposes. A molecular model kit is permitted, but the sharing of models or model pieces is strictly forbidden.

Proctors and instructors will not interpret, translate, clarify, or explain questions, nor will they confirm, verify, or assist you with your answers or your thinking. Therefore, you are not permitted to ask any questions related to the content of the test.

## **Please note:**

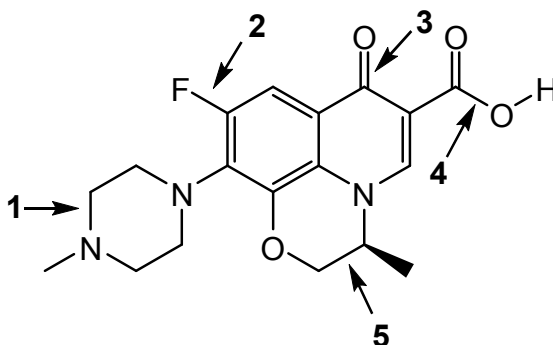
**The Scantron must be completed within the duration of the test.** At the end of the test, everyone must put their pencils down. Your Scantron, whether completed or not, will be collected. Under no circumstances will this booklet be used for marking purposes. The answers on your Scantron are considered to be your official answers, so please ensure that you complete your Scantron accurately. Answers that cannot be read by the Scantron computer will be marked as being incorrect.

If you do not leave before the last 15 minutes, stay in your seat until you are dismissed.



1. *Levofloxacin*, shown below, is an antibiotic that inhibits the enzyme *DNA gyrase* in bacteria. Which indicated bond is the *most polar* covalent bond?

- A) 2  
B) 5  
C) 3  
D) 4  
E) 1



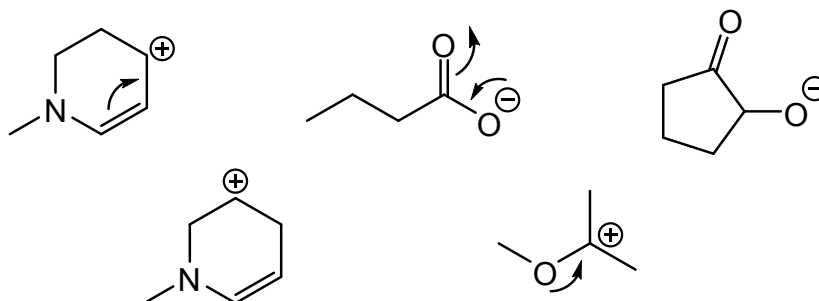
All of the indicated bonds involve *p*-block elements on the same row of the periodic table. The electronegativities of these elements increase from left to right. Elements C and F have the greatest difference in electronegativity.

2. Refer again to the structure of *levofloxacin*. Which functional group is not present in *levofloxacin*?

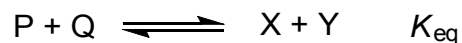
- A) Ketone  
B) Carboxyl group  
C) Amine  
D) Aromatic ring  
E) Alkyl halide (no  $sp^3$  carbon bonded to a halide)

3. How many of the ions shown below are stabilized by resonance?

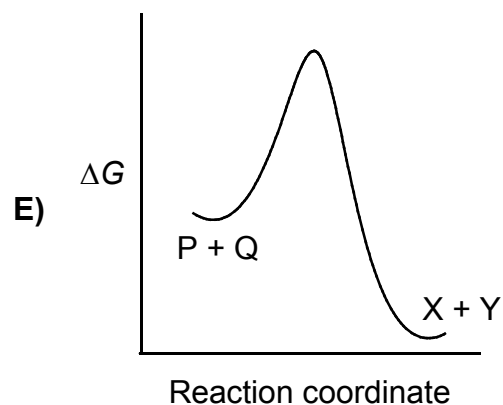
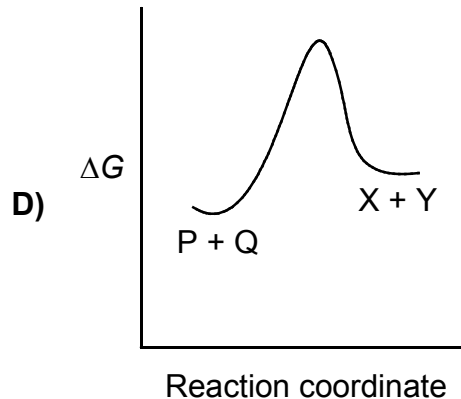
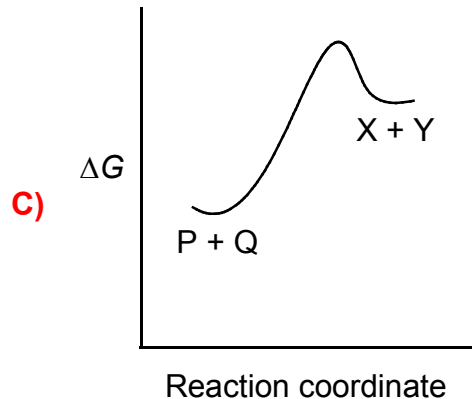
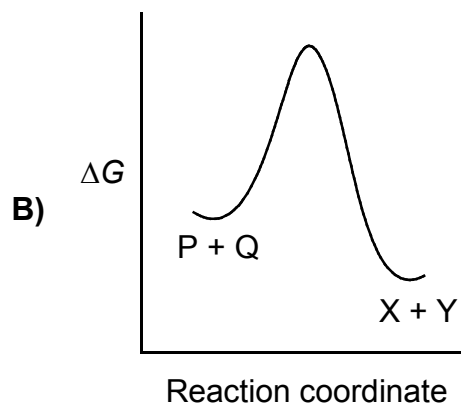
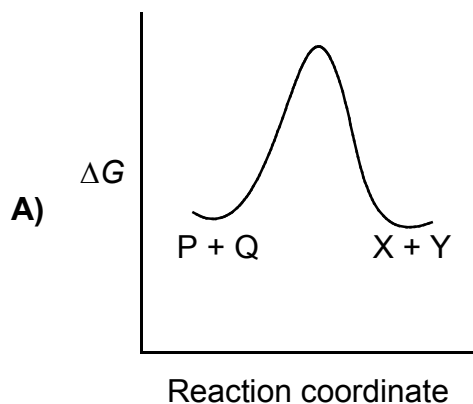
- A) 5  
B) 1  
C) 2  
D) 4  
E) 3



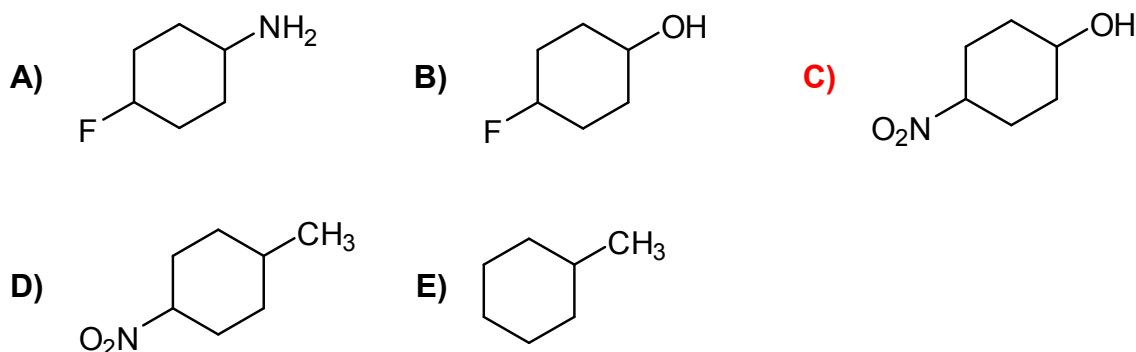
4. The equilibrium between the reactants P + Q and the products X + Y, as shown below, has an equilibrium constant of  $K_{eq}$ .



Shown in A – E are reaction coordinate plots that compare the free energies ( $\Delta G$ ) of the reactants and the products. Which one of these plots corresponds to the *smallest* value of  $K_{eq}$ ? **Smallest = the plot in which the products are least favoured = most positive  $\Delta G$ .**

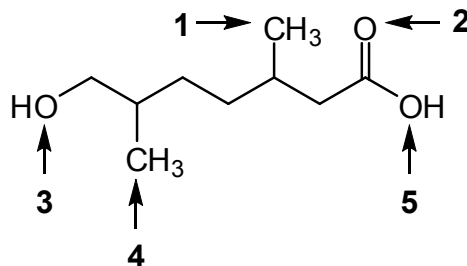


5. Which one of the following statements is correct?
- A) Weaker acids have  $K_a$  values that are higher than those of stronger acids.  
The other way around.
- B)  $H_2O$  is a stronger acid than  $NH_3$  is because the oxygen atom is larger than the nitrogen atom. Due to electronegativity.
- C) Ions that are negatively charged are more stable in hexane than in water.  
Ions are less stable in non-polar solvents.
- D) Trichloroacetic acid is a stronger acid than trifluoroacetic acid because of the larger atomic size of chlorine. This is the inductive effect, not a size effect.
- E) The conjugate bases of weaker acids are less stable than the conjugate bases of stronger acids.
6. Which one of the following compounds has the lowest  $pK_a$ ? i.e. Which compound gives the most stable conjugate base? Choice C gives an  $O^-$  that is stabilized by the inductively withdrawing nitro group.



7. When the compound shown below is treated with a strong acid, which atom is protonated first? From textbook problem 2.29 and past midterm. #2 is highly  $\delta^-$  due to resonance contribution from oxygen 5.

- A) 1  
B) 3  
C) 4  
D) 5  
E) 2



8. How many constitutional isomers of  $C_7H_{16}$  containing one quaternary carbon exist?

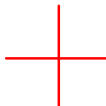
A) 1

**B) 3**

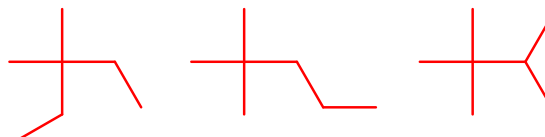
C) 2

D) 5

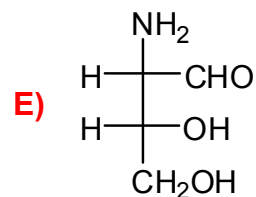
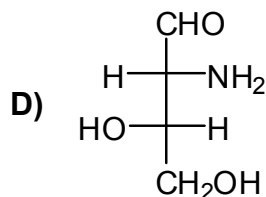
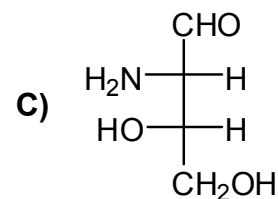
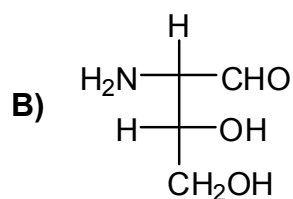
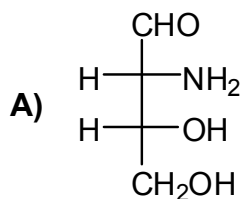
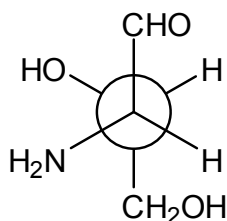
E) 4

quaternary carbon, so must have this core: 

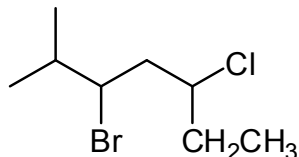
This takes care of 5 of the 7 carbons.  
Put the two methyl groups on the core.



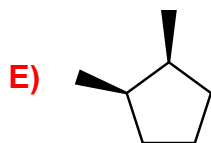
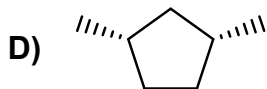
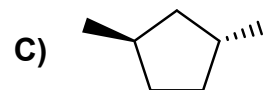
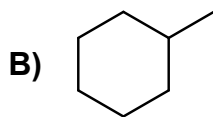
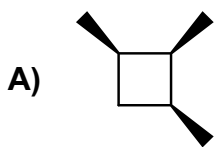
9. The compound represented by the Newman projection is the same as which compound shown in A – E? **The best strategy here is to build the Newman and see which Fischer corresponds to the same compound. Alternatively, you can do R and S.**



10. What is the IUPAC name for the following compound?

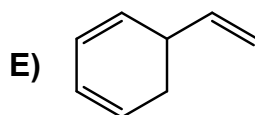
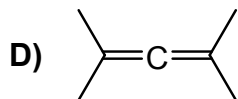
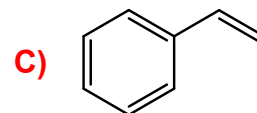
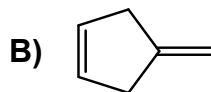
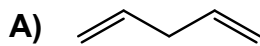


- A) 3-Bromo-5-chloro-2-methylheptane  
 B) 5-Bromo-3-chloro-6-methylheptane  
 C) 3-Bromo-1-chloro-1-ethyl-4-methylpentane  
 D) 1,1-Dimethyl-2-bromo-4-chlorohexane  
 E) 2-Bromo-4-chloro-1,1-dimethylhexane
11. Which one of A – E is not a constitutional isomer of *trans*-1,2-dimethylcyclopentane? **i.e. does not have a different bonding sequence**

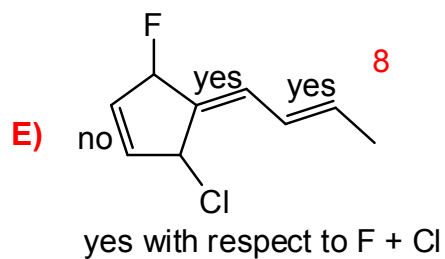
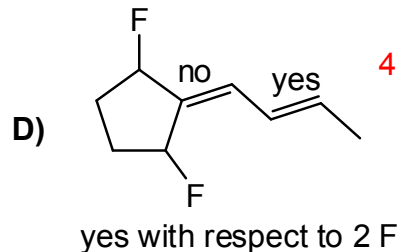
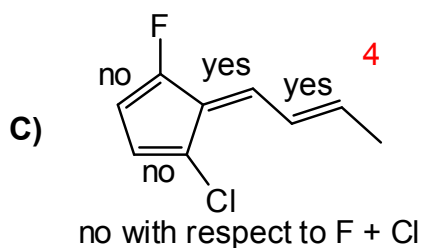
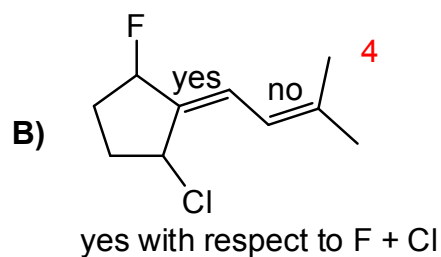
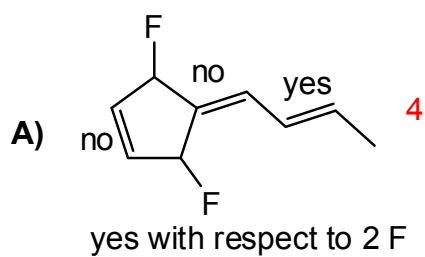


E is a stereoisomer, not a constitutional isomer

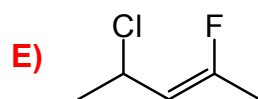
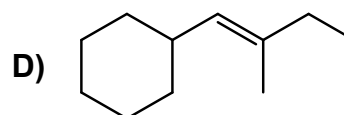
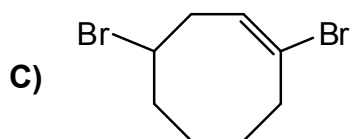
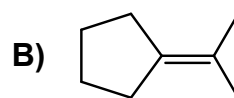
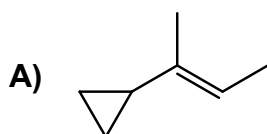
12. In which one of A – E are all of the carbon-carbon double bonds conjugated?



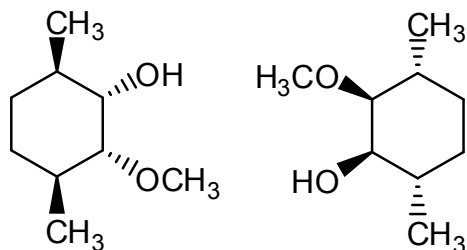
13. Which compound has different number of *cis-trans* isomers than the other four compounds?



14. Which one of the following contains an alkene in the Z configuration?



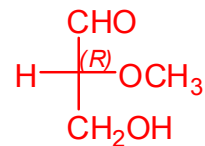
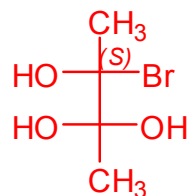
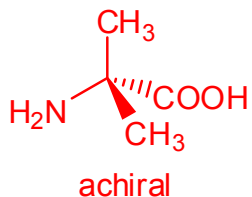
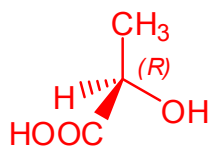
15. What is the relationship between these two compounds?



Rotate the right structure 180 deg in the plane of the page, and the configurations of all stereocentres will be the opposite. Or, flip the right structure along a horizontal axis, and it'll be a mirror image of the left structure.

- A) They are identical
- B) They are diastereomers
- C) They are constitutional isomers
- D) They are enantiomers
- E) They are *meso* compounds

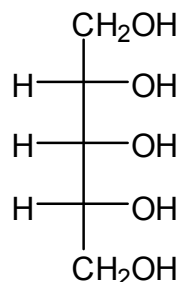
16. How many of the following have an *S* configuration?



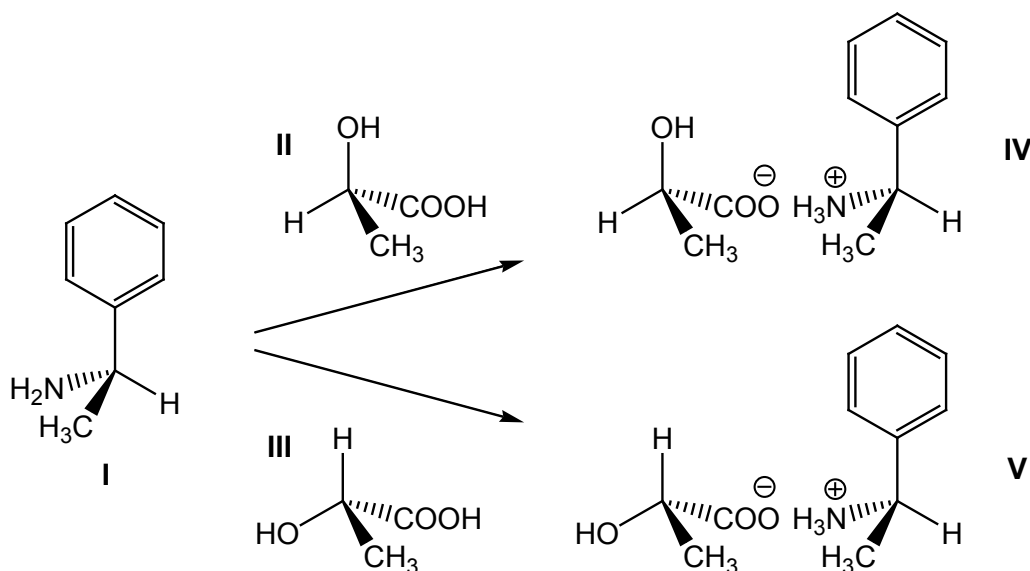
- A) 1
- B) 3
- C) 2
- D) 0
- E) 4

17. Shown below is a type of sugar known as a *sugar alcohol*. Similar compounds are used in “sugar free” chewing gum or candy. How many stereoisomers are possible for this sugar? **There are two stereocentres (carbons 2 and 4), so there are 4 possible stereoisomers.**

- A) 4  
B) 3  
C) 2  
D) 6  
E) 8



18. Compound **I** was separately combined with **II** and **III** to give the salts **IV** and **V**, respectively, as shown below. Which one of statements A – E is not correct?

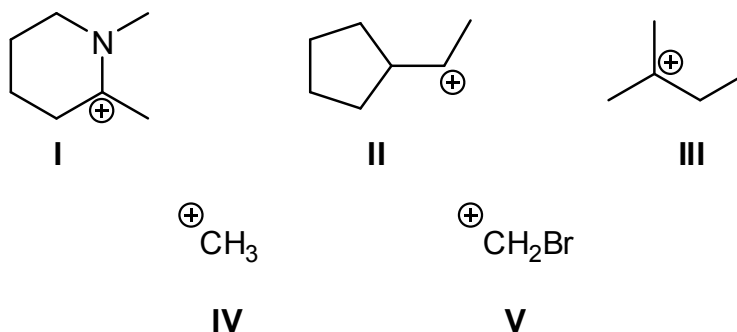


- A) Compounds **II** and **III** have identical  $pK_a$  values.  
B) Compound **I** is an *R* enantiomer.  
**C) The salt formed from **III** and the enantiomer of **I** will have a different melting point than compound **IV**. This would give two pairs of enantiomers, which have identical physical properties. Recall the separation of methamphetamine. (Diastereomers have different physical properties)**  
D) Compounds **IV** and **V** have different solubilities in water.  
E) Compounds **II** and **III** have identical solubilities in water.

19. Which one of A – E is correct in describing the addition of  $\text{Cl}_2$  to an alkene?

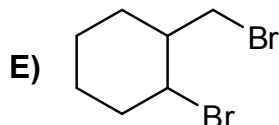
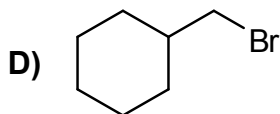
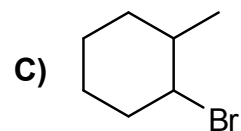
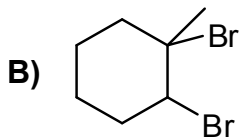
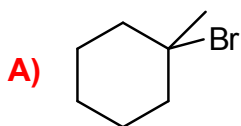
- A) The reaction is not stereoselective.  
 B) The reaction is known as a nucleophilic addition reaction.  
 C) The slow step of the reaction involves the attack of the chloride nucleophile.  
 D) The reaction is known as an electrophilic addition reaction.  
 E)  $\text{Cl}_2$  adds to the alkene in a *syn* manner.

20. Rank the following carbocations from the most stable to the least stable. See similar example in the notes. N is an excellent resonance donor, and Br is highly destabilizing.

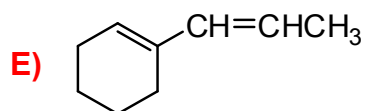
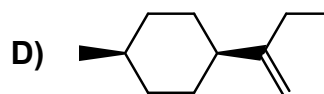
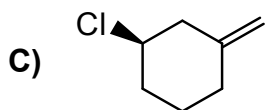
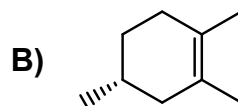
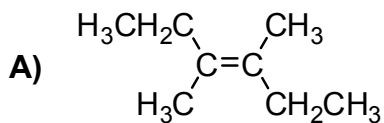


	most stable	$\xrightarrow{\hspace{10em}}$		least stable
A)	I	III	II	V
B)	V	IV	I	II
C)	III	I	V	IV
D)	I	III	II	IV
E)	III	II	I	V

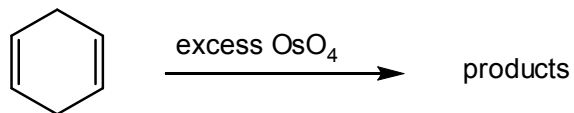
21. What is the major product formed upon the addition of HBr to 1-methylcyclohexene?



22. Which one of the following gives only one compound upon complete reaction with excess  $\text{H}_2/\text{Pt}$ ? Addition can occur from the top face and the bottom face of the alkene. If stereocentres are formed, then stereoisomers will be formed. E gives the same achiral product no matter which faces the  $\text{H}_2$  adds to.

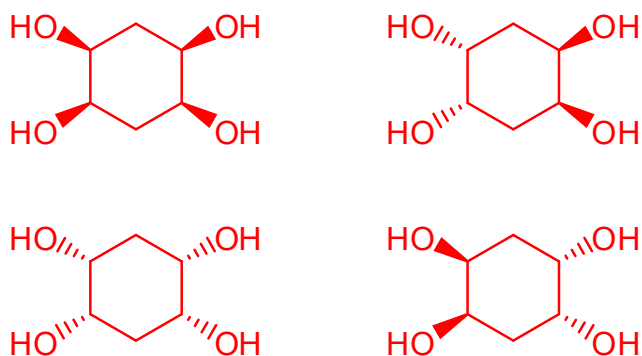


23. How many stereoisomers are formed in the following reaction?



- A) 2  
 B) 5  
 C) 4  
 D) 3  
 E) 6 or more

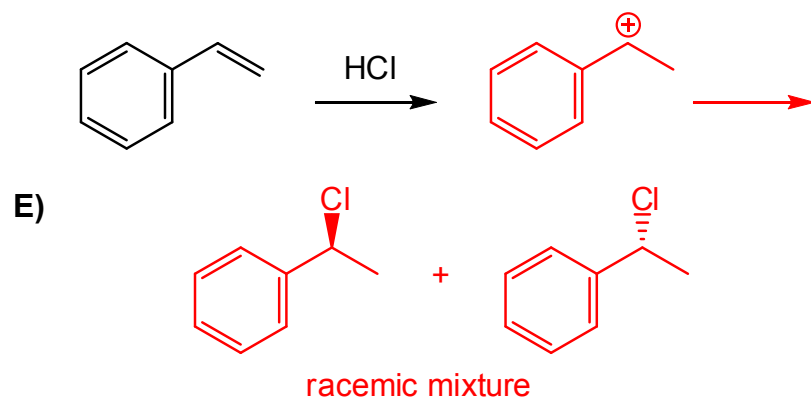
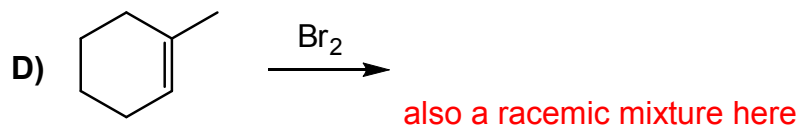
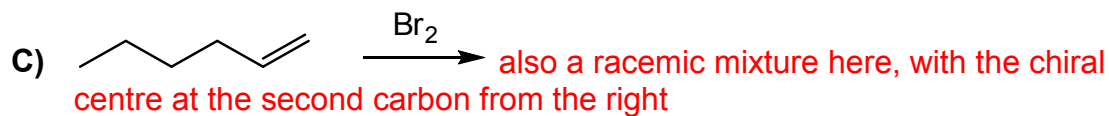
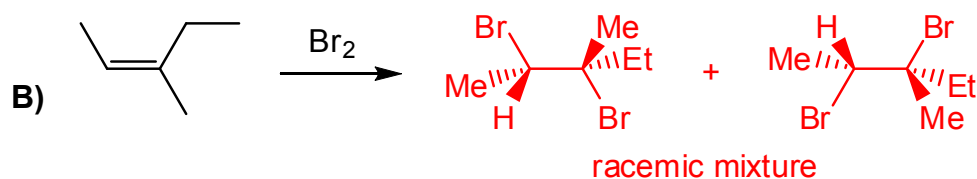
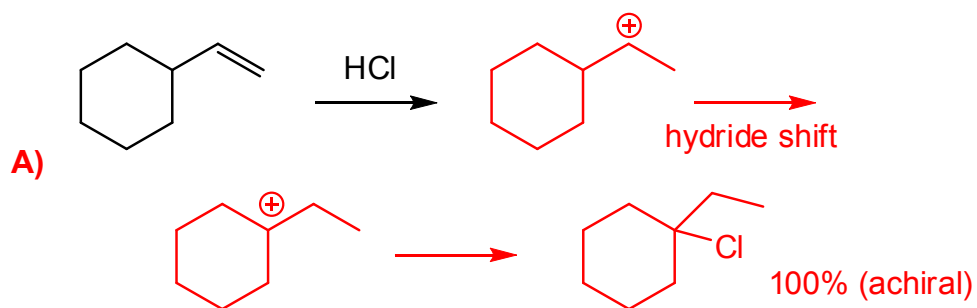
The two OH groups are added to each double bond in a *syn* manner and from either face of the alkene. The possible combinations are:



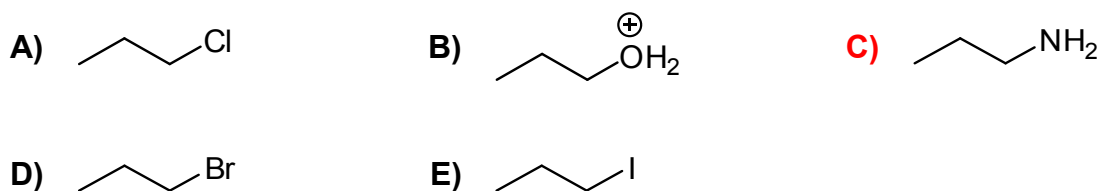
There are only two unique compounds.

24. 0.15 mole of an unknown compound with formula  $\text{C}_{20}\text{H}_{30}$  decolourizes exactly 0.60 mole of bromine dissolved in dichloromethane. How many rings are present in the compound? The stoichiometry of 0.15 and 0.60 tells us that the compound has 4  $\pi$  bonds. The formula indicates that the compound has 6 units of unsaturation. Therefore, the compound has 2 rings.
- A) 3  
 B) 2  
 C) 4  
 D) 1  
 E) 5

25. Which reaction forms only one major product?



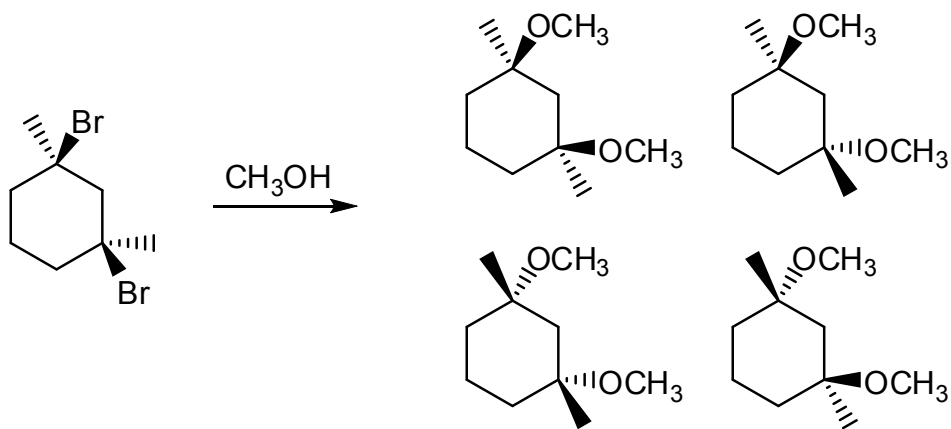
26. Which one of the following compounds contains the *worst* leaving group? **The amino group in C would leave as a highly unstable  $\text{H}_2\text{N}^-$ .**



27. Which one of the following is the *worst* nucleophile? **D doesn't have any nonbonding electrons.**

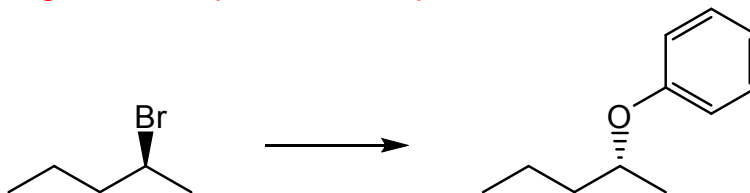
- A)  $\text{CH}_2\text{CH}_2\text{OH}$
- B)  $\text{H}_2\text{O}$
- C)  $\text{CN}^-$
- D)  $\text{CH}_4$**
- E)  $\text{NH}_3$

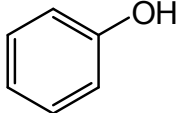
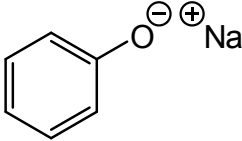
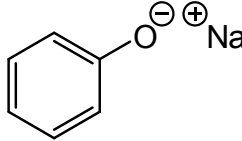
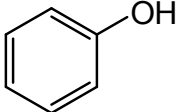
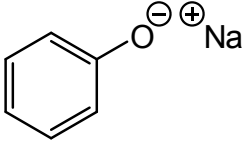
28. How many stereoisomers are formed in the following substitution reaction? Assume that both Br groups are replaced in the reaction. **Methanol is a weak nucleophile, and the alkyl halides are tertiary, so the reaction proceeds  $\text{S}_{\text{N}}1$ . Because a carbocation intermediate is involved, and the reacting carbons become chiral, stereoisomers are formed.**



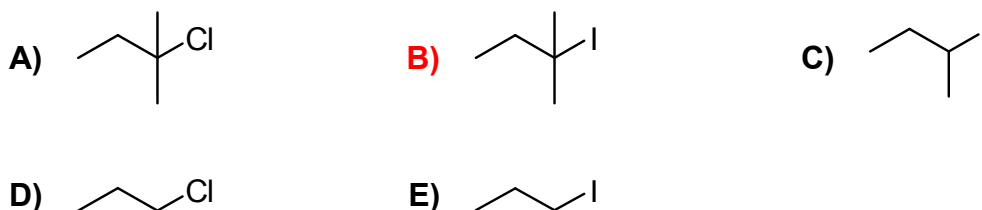
**there are 3 unique compounds**

29. Which of A – E should be added to the starting material shown in the reaction below to produce the highest yield of product and the fastest rate of reaction? Assume that the same experimental conditions are used for all five choices. **The reaction shows that inversion at the stereocentre has occurred. To ensure the best yield, an  $S_N2$  reaction should be done ( $S_N1$  would give a racemate). Choice E contains a good nucleophile and an aprotic solvent.**

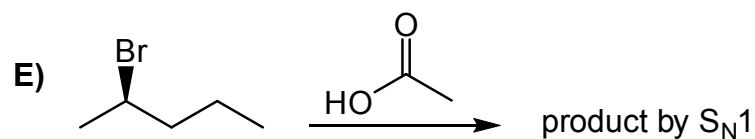
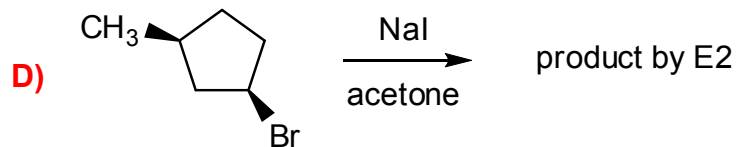
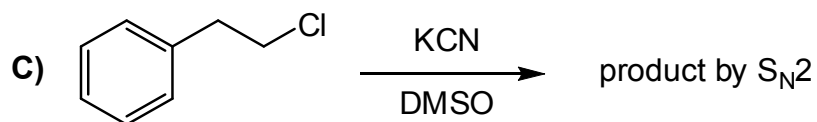
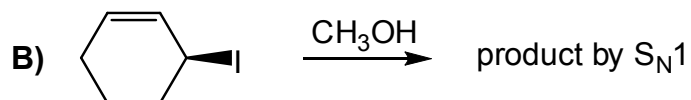
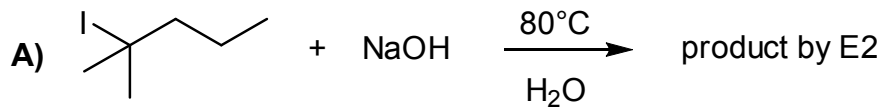


- A)  and ethanol
- B)  and ethanol
- C)  and water
- D)  and acetone
- E)  and acetone

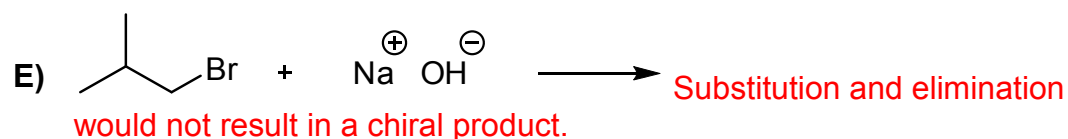
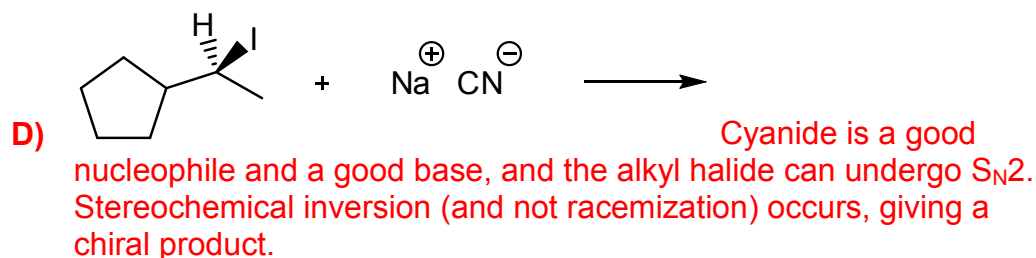
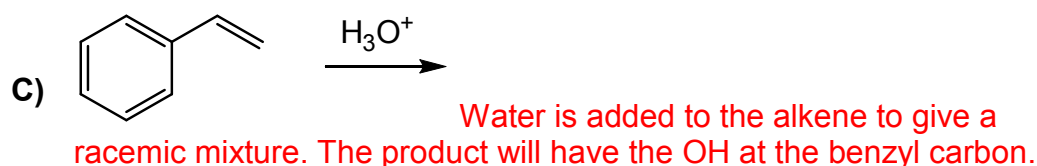
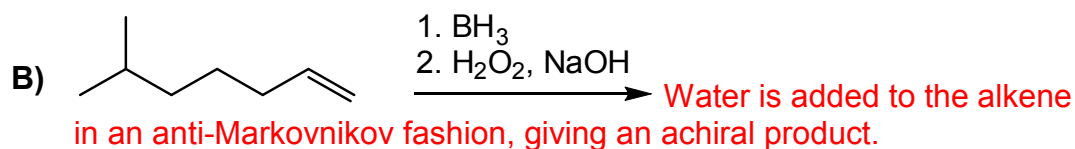
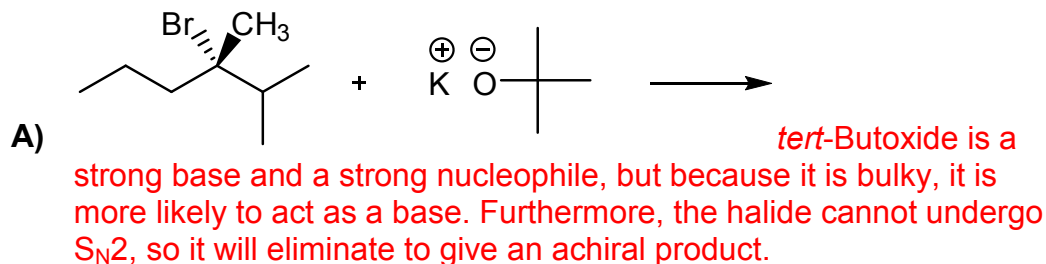
30. In the presence of a strong base, which one of the following compounds would eliminate the fastest to form an alkene? **Choices A and B give the most stable alkene, but B has a better leaving group.**

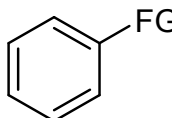


31. Which reaction is least likely to proceed by the mechanism indicated? [see assigned text problem 7.43](#)



32. Which reaction gives an optically active product or product mixture upon complete reaction? **Optically active = cannot be achiral, or there must be more of one enantiomer than the other (i.e. cannot be a racemic mixture)**



33. What is the purpose of adding charcoal during a recrystallization procedure?
- A) It is an inert material with small pores that induce even boiling
  - B) It is to determine how effective is the filter paper is at removing solids
  - C) It is a visual aid that makes the clear solution more visible
  - D) It helps to dissolve solid impurities
  - E) It absorbs some of the impurities in the solution
34. Which one of the following statements regarding recrystallization is correct?
- A) The amount of compound recovered in recrystallization is always 100%.
  - B) The recrystallization solution should be cooled quickly in order to obtain crystals of high quality.
  - C) The crystals should be collected while the recrystallization solution is still hot.
  - D) In any given solvent, organic compounds are usually more soluble at a higher temperature than at a lower temperature.
  - E) Recrystallization is not a useful nor practical technique for the purification of an organic compound.
35. Consider the compound on the right, where FG corresponds to a functional group. Which one of the statements A – E is correct?
- 
- A) If FG = CH<sub>3</sub>, the compound would be very soluble in aqueous HCl. The methyl group is neither acidic nor basic, so the compound would not dissolve in acid.
- B) If FG = NH<sub>2</sub>, the compound would be very soluble in aqueous NaOH. The amino group is basic, so the compound would dissolve in acid, not base.
- C) If FG = CH<sub>2</sub>COOH, the compound would be very soluble in aqueous HCl. The carboxyl group is acidic, so the compound would dissolve in base, not acid.
- D) If FG = NO<sub>2</sub>, the compound would be very soluble in aqueous NaOH. The methyl group is neither acidic nor basic, so the compound would not dissolve in base.
- E) None of the above are correct



