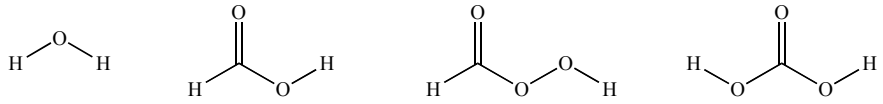
1. (8) Circle the strongest acid in each set.

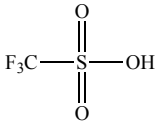
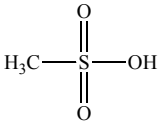
   (a) CH_3CH_2OH CF_3CH_2OH CH_3CH_2SH CF_3CH_2SH

   (b) CH_3OH CH_3F CH_3NH_2 CH_3CH_3 CF_4

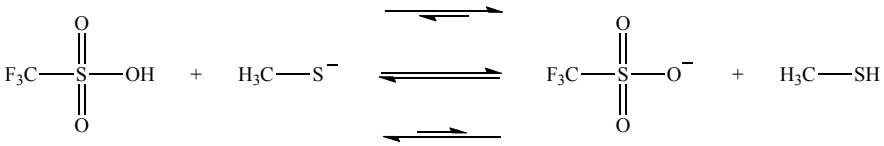
   (c) HOF HOCl HOBr HOI H_2O

   (d) 

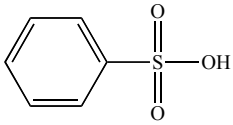
2. (2) Assign pK_a values by writing a number to the right of each molecule. pK_a choices: 10.7, -1.2, and -16.

    pK_a =  pK_a = pK_a =

3. (2) Circle the arrow set that best describes the position of the equilibrium shown.

4. (6) By changing ***only*** hydrogen atoms into ***only*** methyl groups, redraw in the box the structure of benzenesulfonic acid so that it is even more acidic. If this is not possible, write 'not possible.'

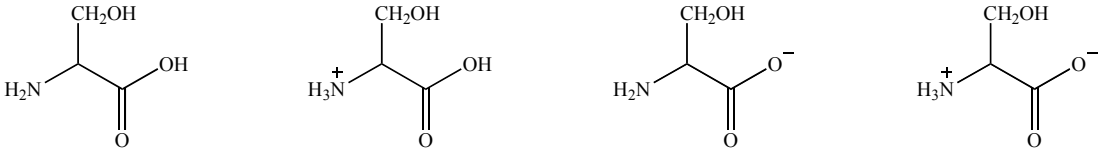
   

   Benzenesulfonic acid More acidic molecule

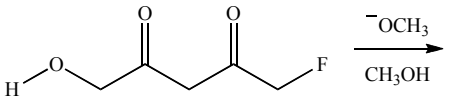
   Circle the start of one explanation then complete it by adding ***no more than thirty words***:

   The modified benzenesulfonic acid structure that I drew is more acidic because... ***Or*** This is not possible because...

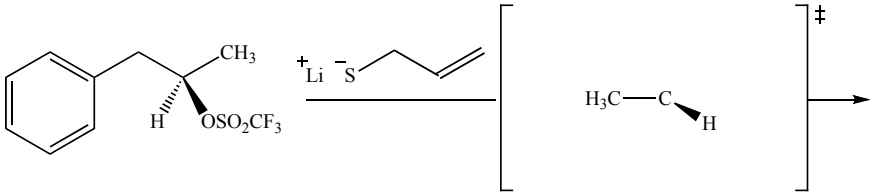
5. (2) Circle the structure that has the most acidic CH_2OH group.

6. (3) Write the most likely product of this proton transfer mechanism step. Include the corresponding curved arrows.



Questions 7–11 refer to the following S_N2 reaction:



7. (8) In the space above, finish the S_N2 reaction by adding the appropriate curved arrows and product, as well as completing the transition state drawing.

8. (2) The carbon undergoing inversion in this reaction is (circle one): Methyl 1^o 2^o 3^o None of these

9. (2) Circle the solvent in which this S_N2 reaction has the fastest reaction rate:

DMF acetone methanol ethanol

10. (6) Circle the change in S_N2 reaction rate when each of the following changes is made. *The changes are not cumulative. For example the change in part (a) is not carried on to part (b).*

(a) OSO_2CF_3 changed to OCH_3	Faster	About the same	Slower	Reaction stops
(b) H–C–OSO_2CF_3 changed to H_3C–C–OSO_2CF_3	Faster	About the same	Slower	Reaction stops
(c) $^{-}SCH_2CH{=}CH_2$ changed to $^{-}SCH_2CH_2CH_3$	Faster	About the same	Slower	Reaction stops

11. (3) Trifluoromethanesulfonate ($CF_3SO_3^{-}$; also called triflate) is an excellent leaving group. In the blank after each structural feature listed below, write 'enhances' if the given feature enhances triflate's ability to leave, or 'inhibits' if this feature makes it harder for triflate to leave.

Resonance: _____ Inductive effect: _____ Formal charge: _____

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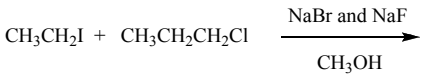
12. (2) Ethyl iodide, 1-chloropropane, NaBr, and NaF were mixed in methanol and allowed to react. Although several products were formed, one product was formed much faster than all the others. Complete the following reaction by drawing this product.



13. (2) Draw the molecular structure of DMF.

14. (6) Circle the molecule with the indicated property in each set.

(a) Best leaving group: $CH_3CO_2^-$ $CH_3CH_2O^-$ $CF_3CO_2^-$ $CF_3CH_2O^-$

(c) Best nucleophile in aprotic solvent: $CH_3CO_2^-$ $CH_3CH_2O^-$ $CF_3CO_2^-$ $CF_3CH_2O^-$

(b) Most polar solvent: H_2O acetone DMF CH_3CH_2OH

15. (4) Circle the letter of the S_N2 reaction that occurs fastest in water. Complete the reaction you selected by writing its products in the products box.

(a) $CH_3S^- + CH_3I \xrightarrow[H_2O]{}$

(b) $(CH_3)_2S + CH_3I \xrightarrow[H_2O]{}$

(c) $CH_3S^- + CH_3OH_2^+ \xrightarrow[H_2O]{}$

(d) $(CH_3)_2S + CH_3OH_2^+ \xrightarrow[H_2O]{}$

S_N2 reaction products:

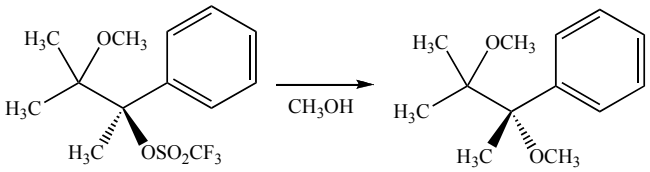
16. (8) Complete each explanation by adding ***no more than twenty words*** in each case.

(a) In an S_N2 reaction, the nucleophile attacks the electrophile from the backside of the carbon-leaving group bond because...

(b) In every S_N2 reaction, the transition state has higher energy than the reactants for that mechanism step because...

17. (4) Complete this sentence by writing ***up to three words (no more)*** in each blank. The S_N2 reaction of 2-iodopropane has a lower reaction rate than the same S_N2 reaction of 1-iodopropane because 1-iodopropane has the lowest _____ and therefore the lowest _____.

The questions on this page refer to this S_N1 reaction. Not all of the products are shown here.



18. (7) Write the mechanism for the formation of the product shown. Label the step that has the ***largest*** $\Delta G^{\ddagger}$ with a star (*). OK to use 'Ph'.

19. (3) Draw in the box an additional reaction product that has at least two carbons, and is likely to be produced in a significant amount.

20. (6) Circle the change in S_N1 reaction rate when each of the following changes is made. *The changes are not cumulative. For example the change in part (a) is not carried on to part (b).*

(a) CH_3OH changed to $(CH_3)_3COH$:	Faster	About the same	Slower	Reaction stops
(b) Benzene ring changed to methyl group:	Faster	About the same	Slower	Reaction stops
(c) R–OSO_2CF_3 changed to R–I:	Faster	About the same	Slower	Reaction stops

21. (4) Complete each statement concerning the reaction mechanism of question 18 by adding ***no more than fifteen words*** in each case.

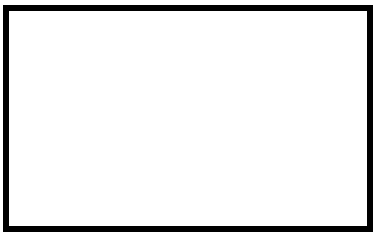
(a) An important factor that ***favors S_N1*** and at the same time ***disfavors S_N2*** is...

(b) An important factor that ***favors S_N1*** and at the same time ***does not disfavor S_N2*** is...

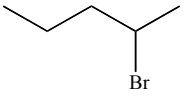
22. (2) Write 'most stable' in the blank below the most stable carbocation, and 'least stable' in the blank below the least stable carbocation.

$^{+}CH_2CH_3$	$^{+}CH_2NH_2$	$^{+}CH_2OH$	$^{+}CH_2F$
_____	_____	_____	_____

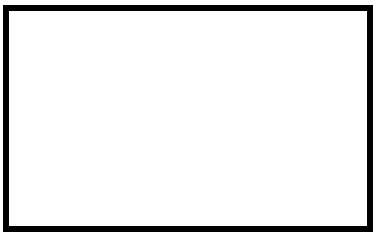
23. (2) In the box labeled 'slower ionization,' draw an isomer of 2-bromopentane that ionizes more slowly than 2-bromopentane itself. In the box labeled 'faster ionization' draw an isomer of 2-bromopentane that ionizes faster than 2-bromopentane itself.



Faster ionization

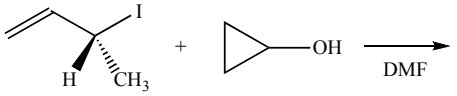


2-Bromopentane $C_5H_{11}Br$

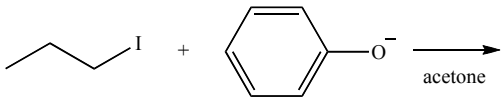


Slower ionization

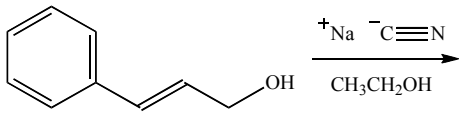
24. (6) For each set of reactants, circle the most likely mechanism pathway.

(a) 

S_N2 S_N1 Neither

(b) 

S_N2 S_N1 Neither

(c) 

S_N2 S_N1 Neither