Name: Key

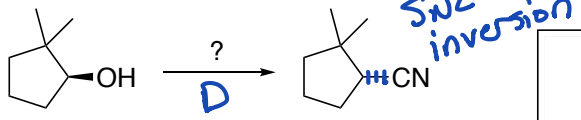
Last First MI

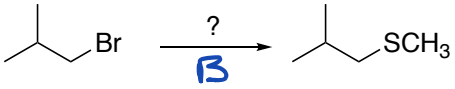
# Chemistry 233
## Final Exam – New Material Practice

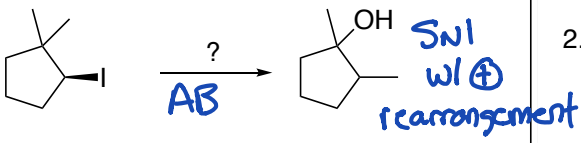
| 1 IA | | | | | | | | | | | | | | | | | 18 VIIIA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 H 1.01 | 2 IIA | | | | | | | | | | | 13 IIIA | 14 IVA | 15 VA | 16 VIA | 17 VIIA | 2 He 4.00 |
| 3 Li 6.94 | 4 Be 9.01 | | | | | | | | | | | 5 B 10.81 | 6 C 12.01 | 7 N 14.01 | 8 O 16.00 | 9 F 19.00 | 10 Ne 20.18 |
| 11 Na 22.99 | 12 Mg 24.31 | 3 IIIB | 4 IVB | 5 VB | 6 VIB | 7 VIIB | 8 | 9 VIIIB | 10 | 11 IB | 12 IIB | 13 Al 26.98 | 14 Si 28.09 | 15 P 30.97 | 16 S 32.07 | 17 Cl 35.45 | 18 Ar 39.95 |
| 19 K 39.1 | 20 Ca 40.08 | 21 Sc 44.96 | 22 Ti 47.88 | 23 V 50.94 | 24 Cr 52.00 | 25 Mn 54.94 | 26 Fe 55.85 | 27 Co 58.93 | 28 Ni 58.69 | 29 Cu 63.55 | 30 Zn 65.39 | 31 Ga 69.72 | 32 Ge 72.61 | 33 As 74.92 | 34 Se 78.96 | 35 Br 79.90 | 36 Kr 83.80 |
| 37 Rb 85.47 | 38 Sr 87.62 | 39 Y 88.91 | 40 Zr 91.22 | 41 Nb 92.91 | 42 Mo 95.94 | 43 Tc (98) | 44 Ru 101.07 | 45 Rh 102.91 | 46 Pd 106.42 | 47 Ag 107.87 | 48 Cd 112.41 | 49 In 114.82 | 50 Sn 118.71 | 51 Sb 121.76 | 52 Te 127.6 | 53 I 126.9 | 54 Xe 131.29 |
| 55 Cs 132.9 | 56 Ba 137.3 | 57 La* 138.9 | 72 Hf 178.5 | 73 Ta 180.9 | 74 W 183.9 | 75 Re 186.2 | 76 Os 190.2 | 77 Ir 192.2 | 78 Pt 195.1 | 79 Au 197.0 | 80 Hg 200.6 | 81 Tl 204.4 | 82 Pb 207.2 | 83 Bi 209 | 84 Po (209) | 85 At (210) | 86 Rn (222) |
| 87 Fr (223) | 88 Ra (226) | 89 Ac^ (227) | 104 Rf (261) | 105 Db (262) | 106 Sg (263) | 107 Bh (264) | 108 Hs (265) | 109 Mt (268) | 110 Ds (271) | 111 Rg (272) | | | | | | | |

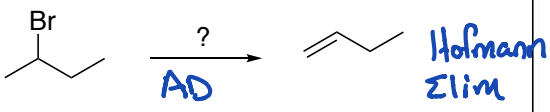
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * | 58 Ce 140.1 | 59 Pr 140.9 | 60 Nd 144.2 | 61 Pm (145) | 62 Sm 150.4 | 63 Eu 152.0 | 64 Gd 157.3 | 65 Tb 158.9 | 66 Dy 162.5 | 67 Ho 164.9 | 68 Er 167.3 | 69 Tm 168.9 | 70 Yb 173.0 | 71 Lu 175.0 |
| ^ | 90 Th 232.0 | 91 Pa (231) | 92 U 238.0 | 93 Np (237) | 94 Pu (244) | 95 Am (243) | 96 Cm (247) | 97 Bk (247) | 98 Cf (251) | 99 Es (252) | 100 Fm (257) | 101 Md (258) | 102 No (259) | 103 Lr (260) |

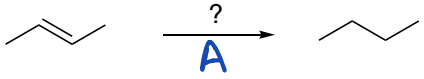
Using the reagent bank provided, select the appropriate reagent to carry out each of the following reactions.

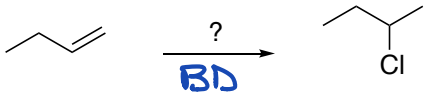
1. 

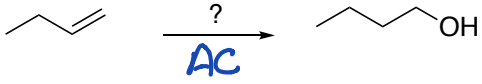

2. 

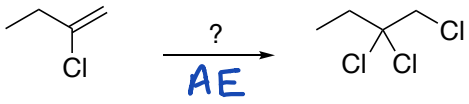

3. 


4. 


5. 


6. 

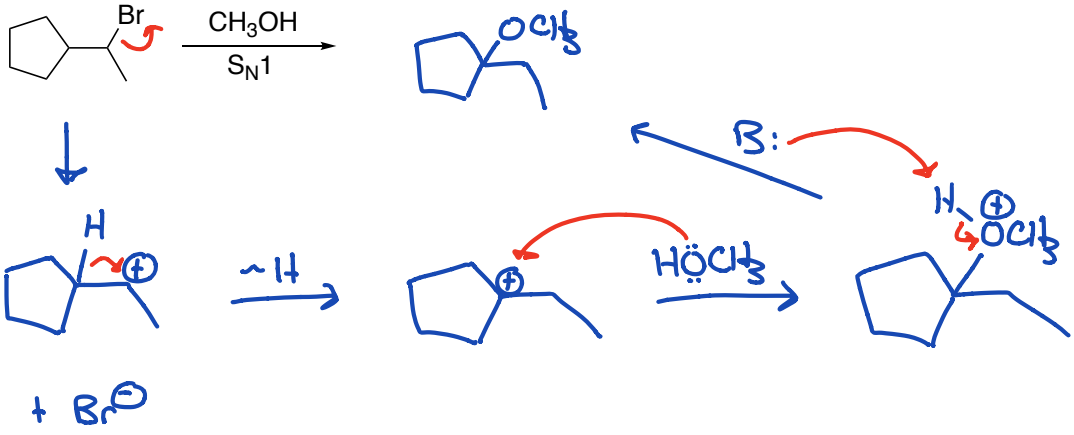

7. 


8. 

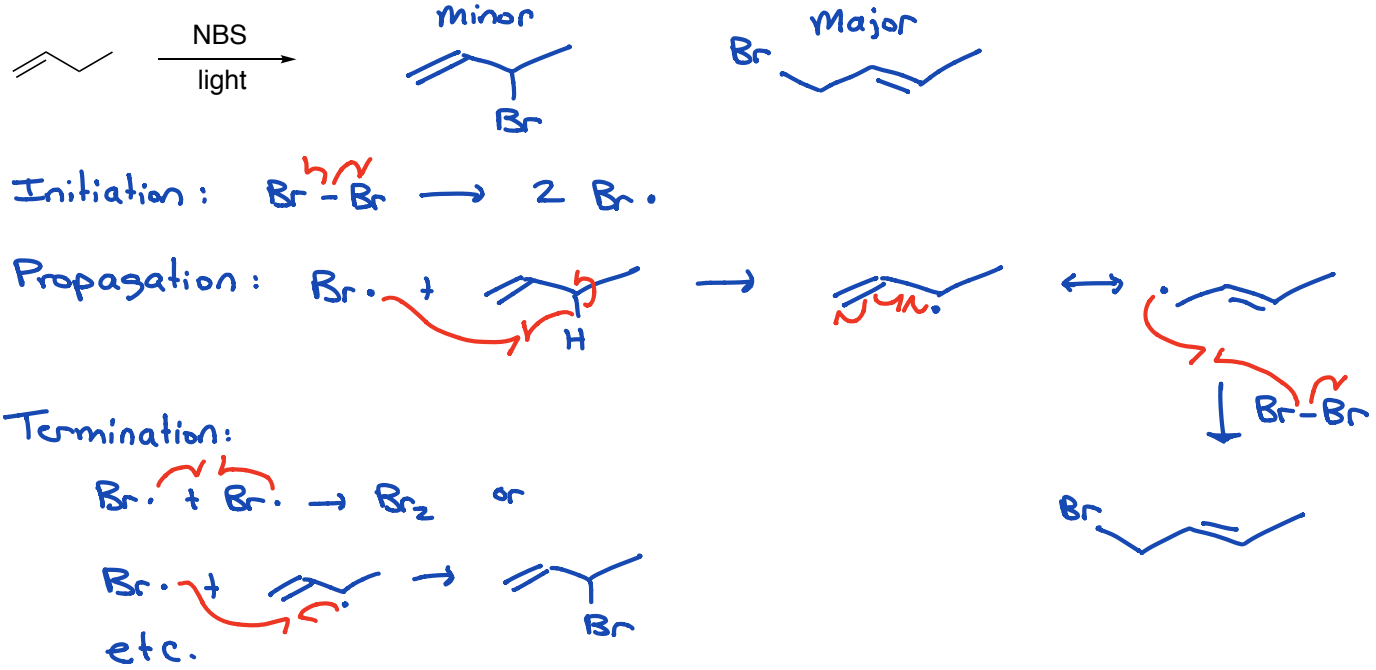

**Reagent Bank**

| | | |
|---|---|---|
| $H_2$, Pd/C | $NaSCH_3$ | NaOH |
| **A** | **B** | **C** |
| 1. TsCl Pyridine 2. NaCN | NaCN | $H_2O$ |
| **D** | **E** | **AB** |
| 1. $BH_3$ 2. NaOH $H_2O_2$ | KOtBu | $Cl_2$ |
| **AC** | **AD** | **AE** |
| $H_2SO_4$ $CH_3OH$ | HCl | NaOH Heat |
| **BC** | **BD** | **BE** |

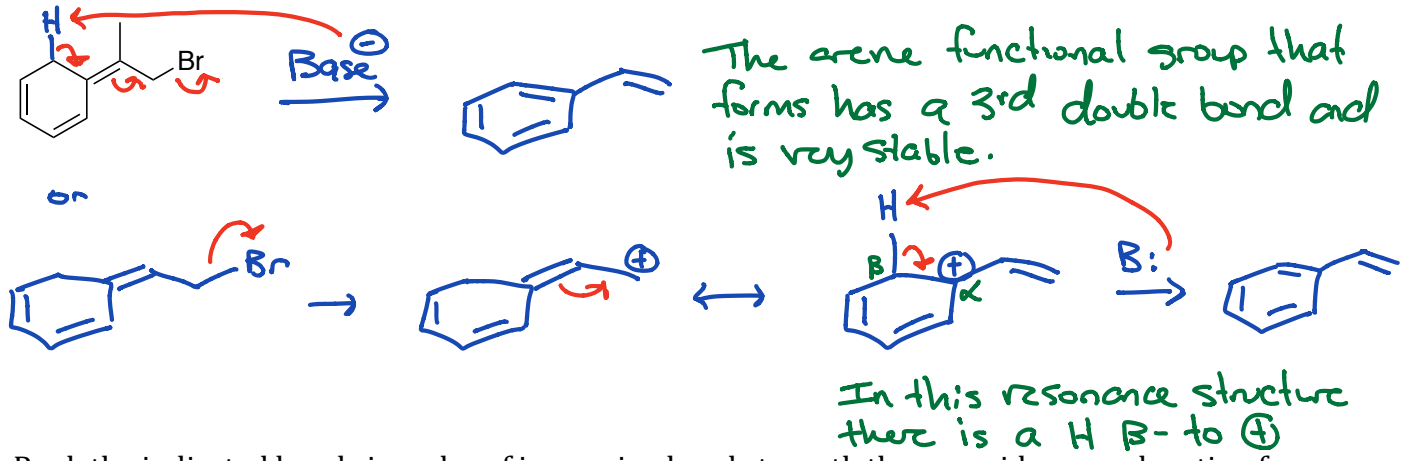
9. Predict the product and show the full electron pushing mechanism for the $S_N1$ reaction below.



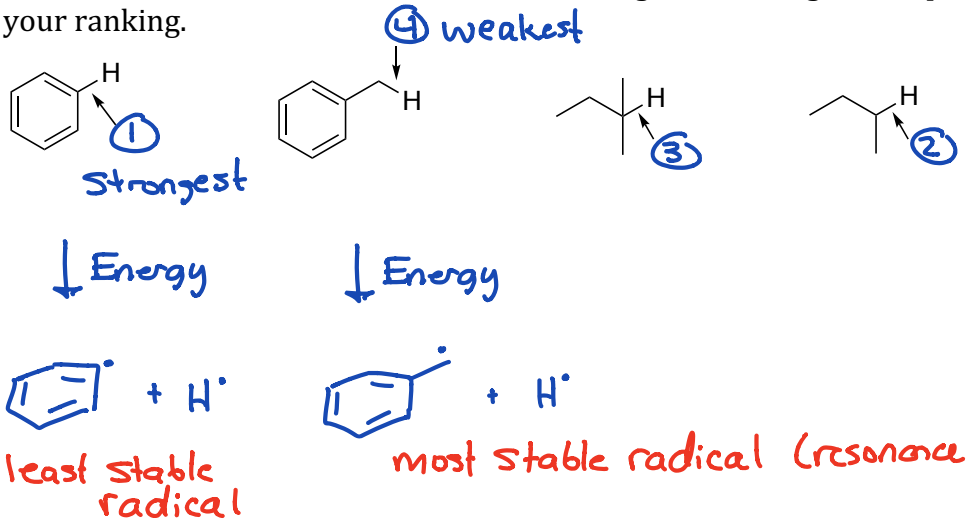
10. Predict the major product for the reaction shown below and then draw the complete electron pushing mechanism. Include initiation, propagation, and termination steps. You can just assume NBS give a steady concentration of $Br_2$.



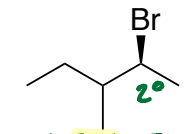

11. Although the compound below does not have any β-hydrogen, it readily undergoes elimination, even in the presence of a weak base such as water. **1.** Predict the elimination product. **2.** Explain why this elimination is so energetically favorable.

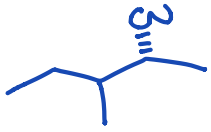


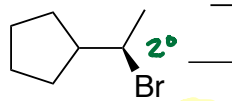

12. Rank the indicated bonds in order of increasing bond strength then provide an explanation for your ranking.



13. Predict the major product(s) for each of the reactions shown below. Indicate the operative mechanism ($S_N1$, $S_N2$, E1, or E2) and show stereochemistry where appropriate.

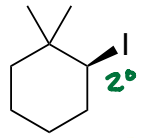
**a.** 

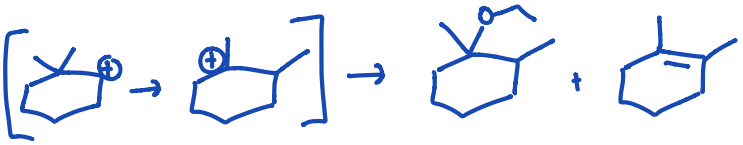
Strong NU SN2 (SN1, E1 if necessary)
NaCN
DMF
-SN2 E2
SN2 mechanism
SN1, SN2, E1, E2



**b.** 

Bulky base
E2
E2 mechanism
SN1, SN2, E1, E2

* Bulky base = Hofmann elimination

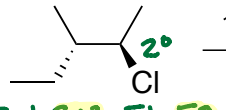
**c.** 

OH
weak base/NU
SN1, E1
SN1 E1 mechanism
SN1, SN2, E1, E2


* The protic solvent will slow down the E2 rxn, but will not prevent it

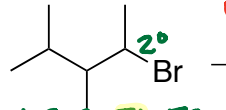
**d.** 

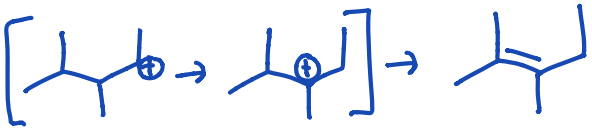
Strong base/NU
$H_3CO^-$
$H_3COH$
-SN1 E1
E2 mechanism
SN2, E2
(SN1, E1 if necessary)
SN1, E1, E2

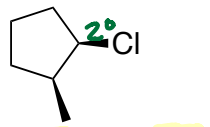

**e.** 

Strong base/NU
O
DMF
-SN2 E2
E2 mechanism
SN2, E2
(SN1, E1 if necessary)
SN1, SN2, E1, E2

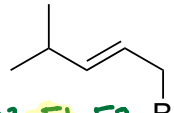

← For 2° substrates with SN2/E2 tie → elimination is favored over substitution

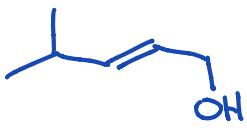
**f.** 

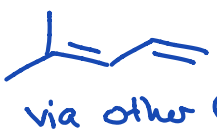
weak base/NU
$CH_3OH$ SN1 E1
Heat
E1, E2
E1 mechanism
SN1, SN2, E1, E2


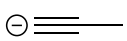
**g.** 

Strong base/NU
$NH_2^-$
DMSO
-SN2 E2
E2 mechanism
SN2, E2
(SN1, E1 if necessary)
SN1, SN2, E1, E2

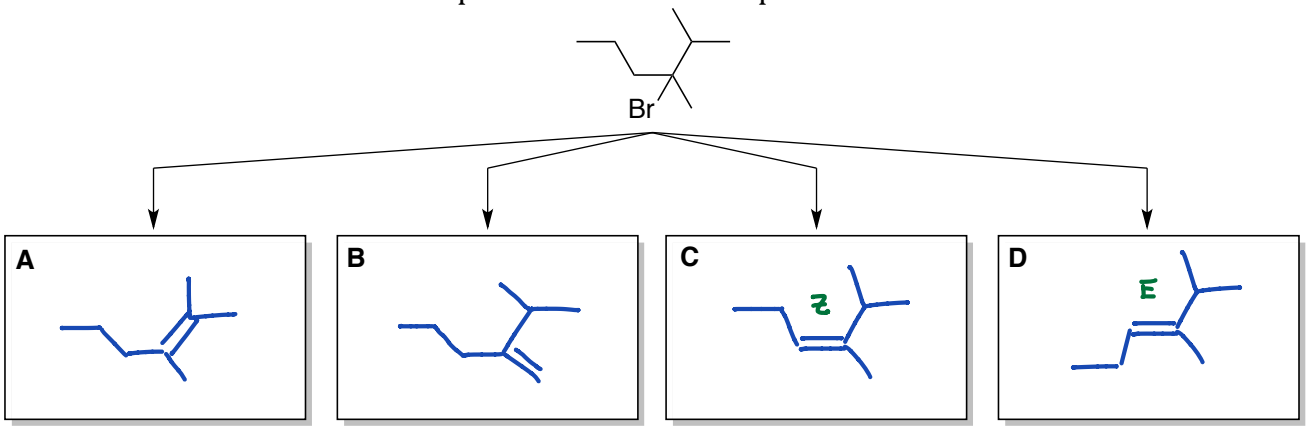

**h.** 

weak base/NU
$H_2O$ SN1 E1
SN1 E1 mechanism
SN1, SN2, E1, E2


+

via other ⊕ resonance structure

**i.** $H_3C-I$
methyl
SN2

Strong NU / base
SN2, E2
SN2 mechanism


14. The alkyl iodide shown below has the potential to form four different products upon elimination. Draw each of these products in the boxes provided.

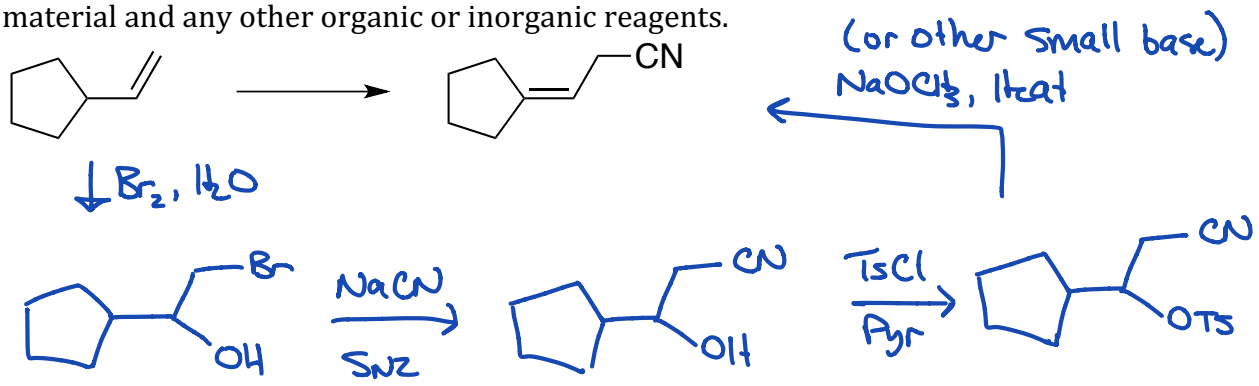



a. Which one would be the major product if NaOtBu (bulky base) were used as the base?
B

b. If the reaction were carried out in $CH_3CH_2O^-$ and acetone, what mechanism would predominate?
E2

c. Which one would be the major product if $CH_3CH_2O^-$ were used as the base?
A

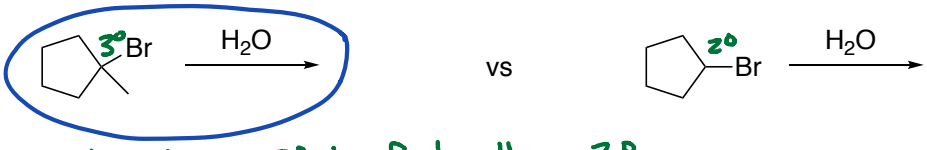
15. Provide a reasonable synthesis for the compound shown below using the provided starting material and any other organic or inorganic reagents.




*See Pg 8 for alternative synthesis

16. Circle the faster reaction in each set and provide a very brief explanation for your choice.

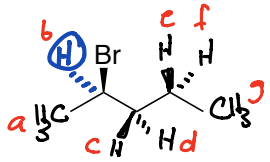

Regardless of halide nucleophile, the SN2 will be faster in the polar aprotic solvent



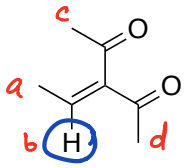

SN1, E1 → 3° is faster than 2°

17. For each compound below: **a.** Circle the proton(s) that you would expect to be the most downfield (you may need to draw in the protons). **b.** Determine the number of distinct protons in each structure.

6 distinct H

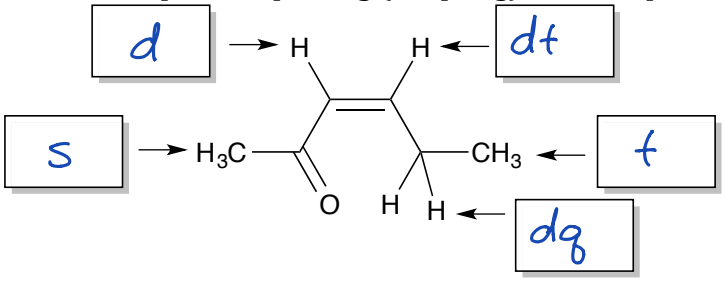



7 distinct H

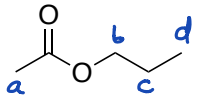


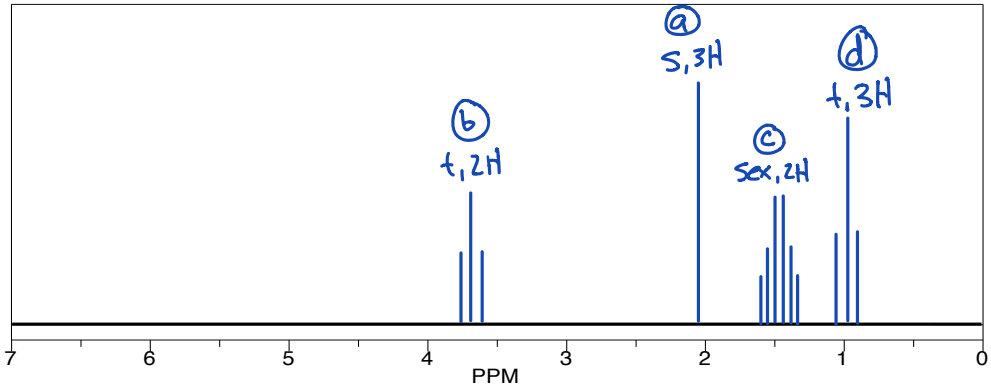

4 distinct H

18. Label the expected splitting (coupling) for each proton in the molecule below.

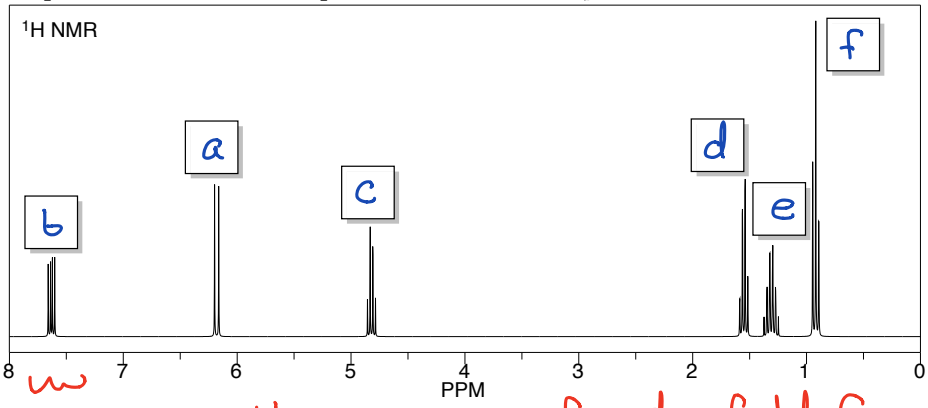


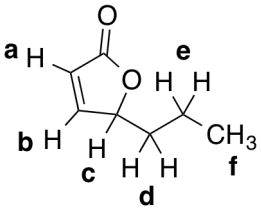

19. Construct a simulated $^1$H NMR spectrum for the molecule shown below. Be sure to draw signals with correct splitting and write the appropriate integration values above each signal.




20. A molecule and its NMR spectra are shown below. Correctly label each peak with the letter of the proton that it corresponds to.

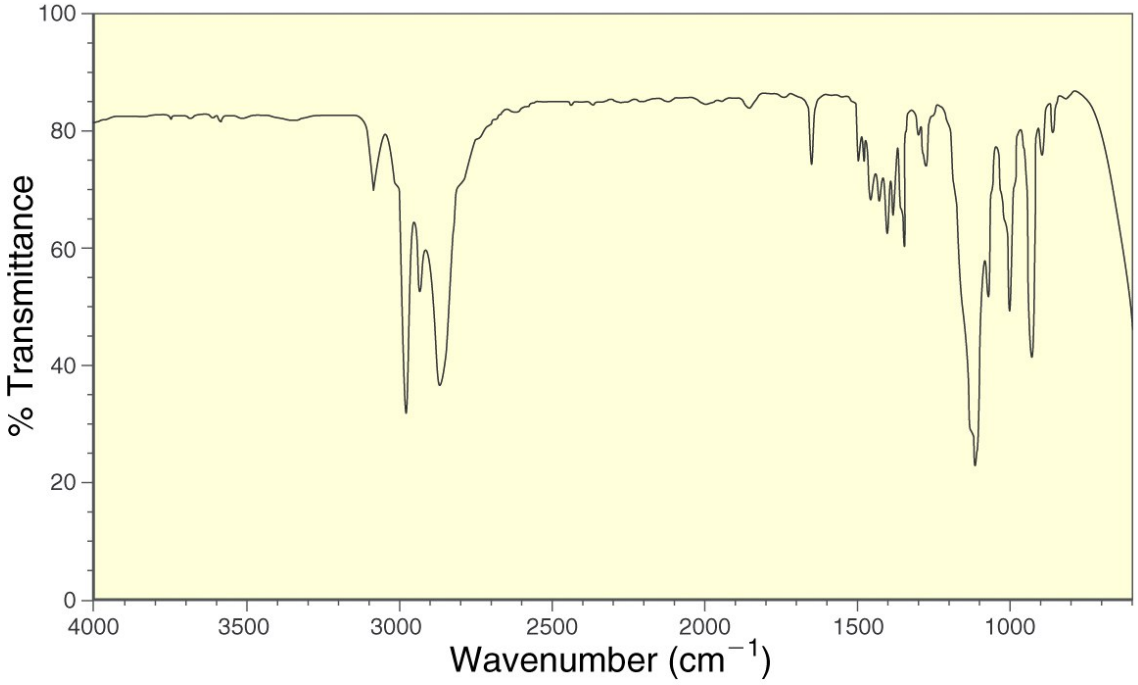


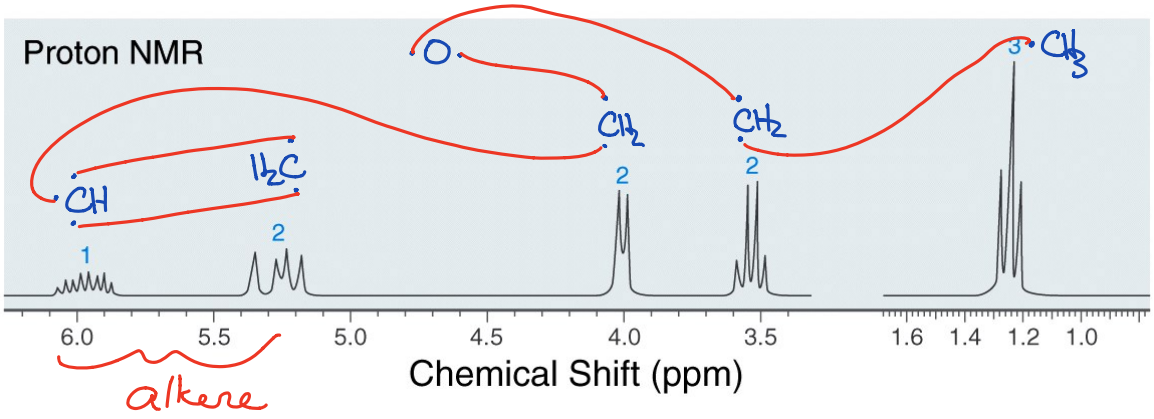



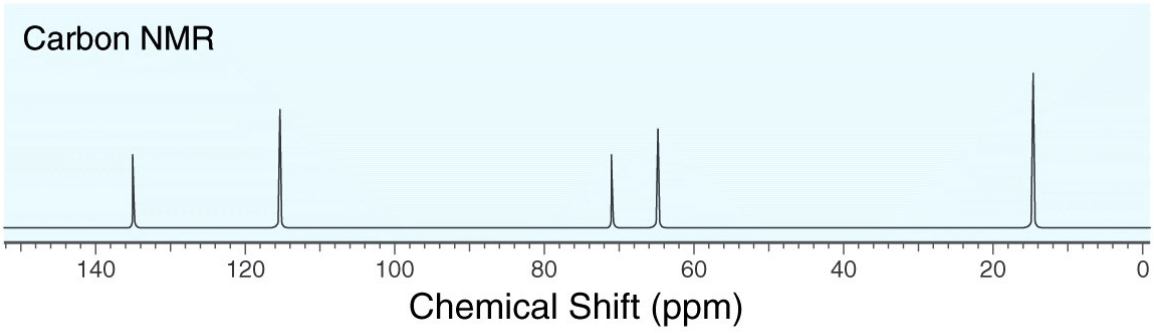

This vinyl H is unusually far downfield for reasons that we did not have a chance to cover.

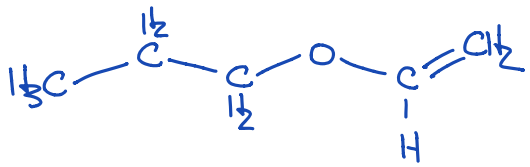
21. Deduce the structure of a compound with the molecular formula **$C_5H_{10}O$** that exhibits the following IR, $^1$H NMR, and $^{13}$C NMR spectra. *The IR and $^{13}$C spectra may be useful, but are not necessary to answer this question. You should be able to deduce the structure from the $^1$H NMR alone.*

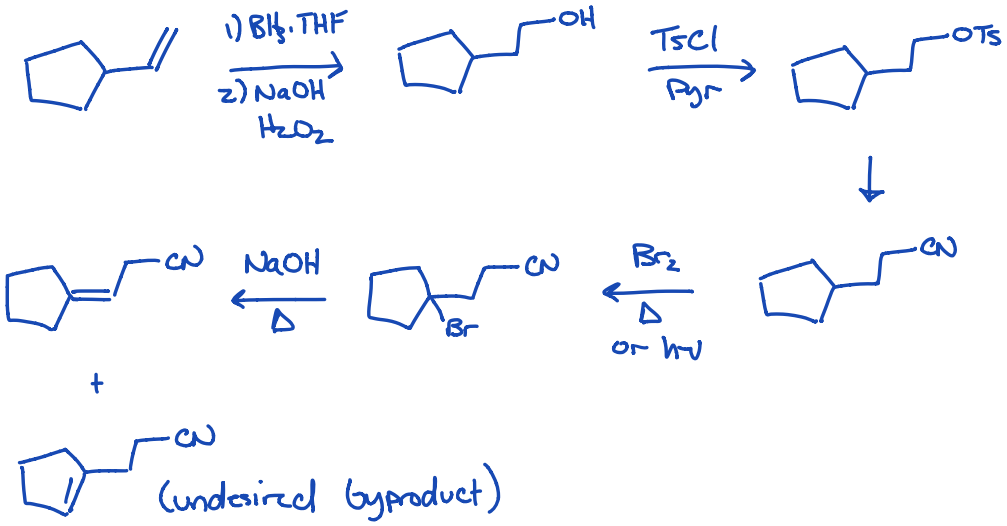
$C_5H_{10}O$ => 1 unsaturation




1) BH3·THF
2) NaOH
H2O2
OH
TsCl
Pyr
OTs
CN
NaOH
Δ
CN
Br
Br2
Δ
or hν
CN
+
CN
(undesired byproduct)