

1. (32 points) Circle the letter *on the right* which corresponds to the answer to each question. There is only one correct answer for each question.

(i) Which of the following is the definition of a Lewis base?

- A. A proton donor  
B. An electron pair donor  
C. A hydroxide ion donor  
D. An electron pair acceptor

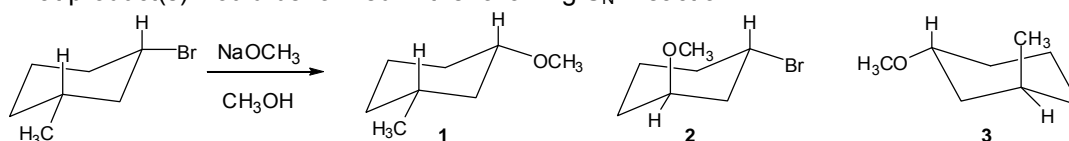
A  
B  
C  
D

(ii) In which of the following solvents will acetic acid dissociate to the greatest extent?

- E.  $\text{Cl}_2\text{C}=\text{CCl}_2$  F.  $\text{CCl}_4$  G.  $(\text{CH}_3\text{CH}_2)_2\text{O}$  H.  $\text{H}_2\text{O}$

E  
F  
G  
H

(iii) What product(s) would be formed in the following  $\text{S}_{\text{N}}2$  reaction?



- I. only 1 J. only 2 K. only 3 L. only 1 and 3

I  
J  
K  
L

(iv) Which is the weakest nucleophile in polar aprotic solvents?

- M.  $\text{I}^-$  N.  $\text{Br}^-$  O.  $\text{Cl}^-$  P.  $\text{F}^-$

M  
N  
O  
P

(v) Which of the following statements is *not* true regarding reaction of (R)-2-bromobutane with  $\text{NaOCH}_3$ ?

- Q. Doubling the hydroxide ion concentration would double the rate of the reaction. (Assume that all other experimental conditions are unchanged.)  
R. The reaction occurs with inversion of configuration.  
S. Doubling the concentration of (R)-2-bromobutane would double the rate of the reaction. (Assume that all other experimental conditions are unchanged.)  
T. The rate of reaction decreases at higher temperatures

Q  
R  
S  
T

(vi) Which of the following is the poorest leaving group?

- U.  $\text{I}^-$  V.  $\text{Br}^-$  W.  $\text{Cl}^-$  X.  $\text{H}^-$

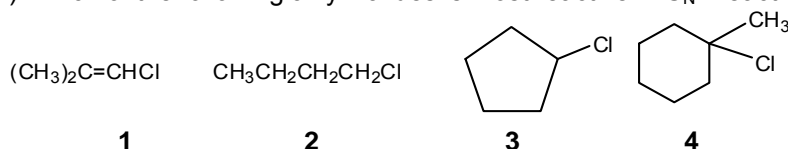
U  
V  
W  
X

(vii) Which of the following nucleophilic substitution mechanistic steps would be least likely to occur?

- Y.  $\text{Br}^- + \text{CH}_3\text{-OH}_2^+ \rightarrow \text{CH}_3\text{-Br} + \text{H}_2\text{O}$  Z.  $\text{I}^- + \text{CH}_3\text{-Cl} \rightarrow \text{CH}_3\text{-I} + \text{Cl}^-$   
AA.  $\text{NH}_3 + \text{CH}_3\text{-OH}_2^+ \rightarrow \text{CH}_3\text{-NH}_3^+ + \text{H}_2\text{O}$  BB.  $(\text{CH}_3)_3\text{C-Br} \rightarrow (\text{CH}_3)_3\text{C}^+ + \text{Br}^-$

Y  
Z  
AA  
BB

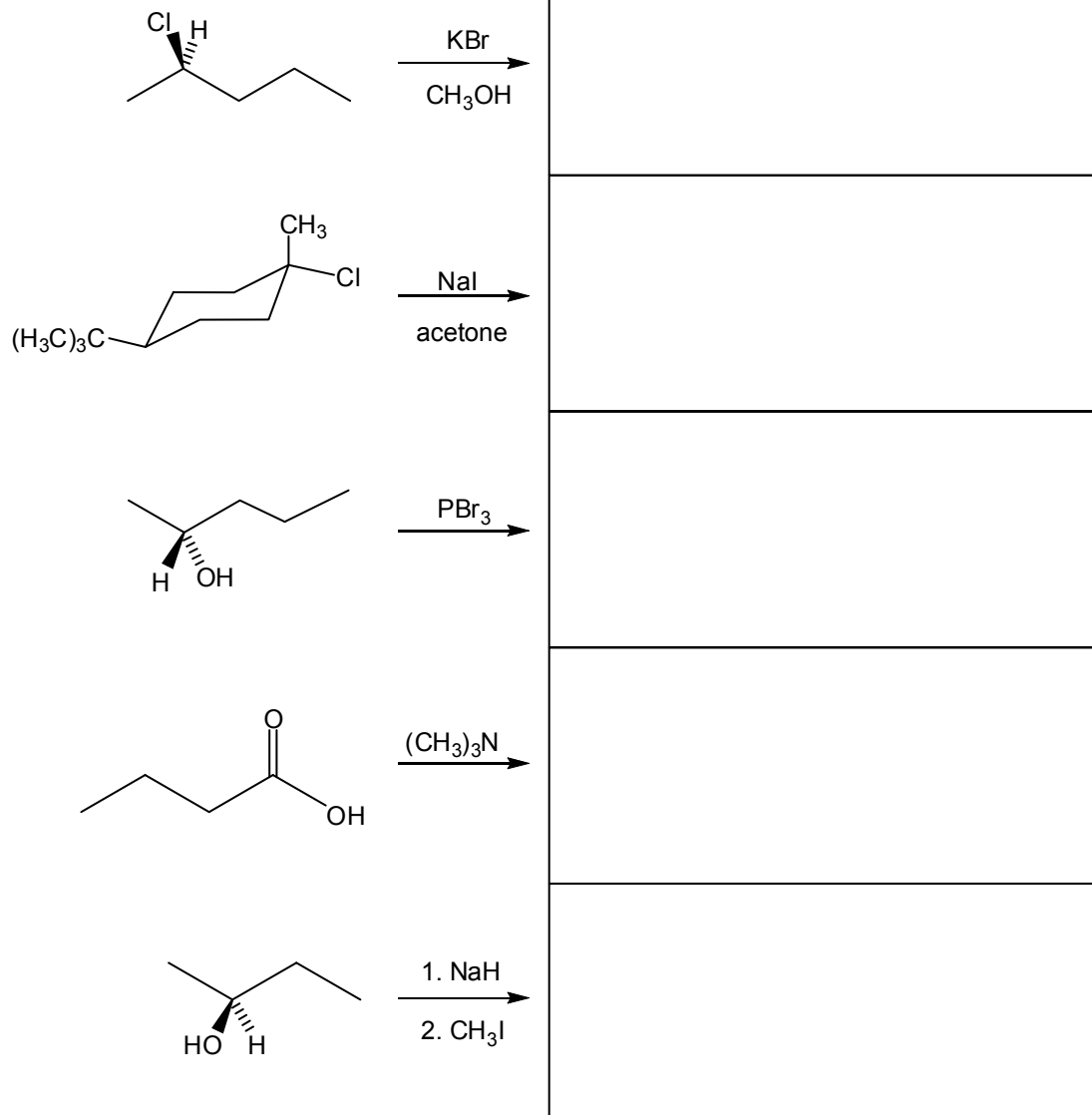
(viii) Which of the following alkyl halides is most reactive in  $\text{S}_{\text{N}}1$  reactions?



- CC. 1 DD. 2 EE. 3 FF. 4

CC  
DD  
EE  
FF

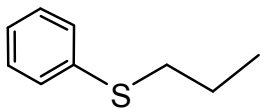
2. (25 points) Give structures of the major organic product(s) for each of the following reactions.



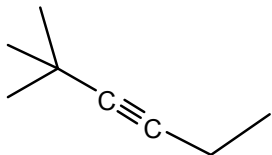
3. (9 points) Explain why treatment of *tert*-butyl methyl ether with cold conc. HI gives methanol and *tert*-butyl iodide and *not tert*-butyl alcohol and methyl iodide

4. (12 points) Suggest syntheses of the following molecules from an appropriate alkyl halide and any other starting materials. *[Both of these can be completed in a single synthetic step. Show starting materials and reagents, NOT the mechanism]*

a.



b.



5. (10 points) Suggest a synthesis of 3-methyl-3-ethoxypentane from 3-methyl pentane . *[This transformation cannot be completed in a single synthetic step. Show starting materials, isolated synthetic intermediates, and reagents; NOT the mechanism]*

6. (12 points) Explain the following order of reactivity *in terms of structural features*. Draw a key structure if it helps in providing an explanation.

(a) Acetylene,  $\text{HC}\equiv\text{CH}$ , is a stronger acid than ethane,  $\text{CH}_3\text{CH}_3$ .

(b) Trimethylamine,  $(\text{CH}_3)_3\text{N}$ , is a stronger base than acetonitrile,  $\text{CH}_3\text{CN}$ .