

1. (2 pts) Which is the best leaving group for nucleophilic substitution?

- a) -OH **b) -I** c) -Br d) -Cl e) -F

2. (2 pts) Which statement corresponds to an S_N1 reaction?

- a) takes place in one-step
b) the concentration of the nucleophile has no effect on the rate
 c) a primary alkyl halide reacts faster than a secondary alkyl halide
 d) only inversion of configuration is observed at any chiral center that undergoes this type of substitution
 e) a polar, aprotic solvent is the best solvent to use in this type of substitution reaction

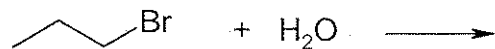
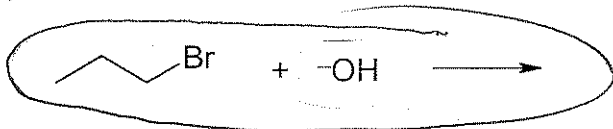
3. (4 pts) The methoxide ion (CH₃O⁻) is a better nucleophile when it is dissolved in dimethyl sulfoxide (DMSO) compared to when it is dissolved in methanol (CH₃OH).

Briefly explain **WHY** this is the case. *The CH₃O⁻ is a better nucleophile in*

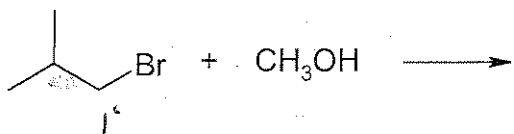
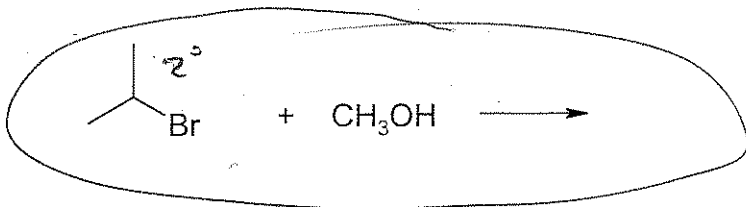
DMSO vs CH₃OH because DMSO is a polar, aprotic solvent while CH₃OH is a polar, protic solvent. Nucleophiles work better in polar, aprotic solvents because these types of solvents - like DMSO - can not hydrogen bond to the charged nucleophile & decrease its nucleophilicity. On the contrary, polar, protic solvents, like CH₃OH, can hydrogen bond to the charged nucleophile & cause its electron density to be less available for nucleophilic substitution.

4. (4 pts, 2 each) Which reaction in each pair is faster? (circle your answer)

a) S_N2 reactions:



b) S_N1 reactions:

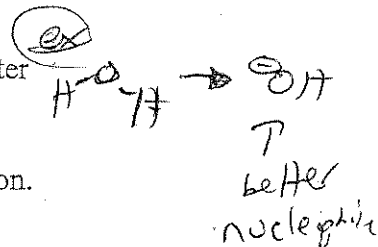


Consequently, nucleophile in a polar, protic solvent is a worse nucleophile than the same nucleophile in a polar, aprotic solvent.

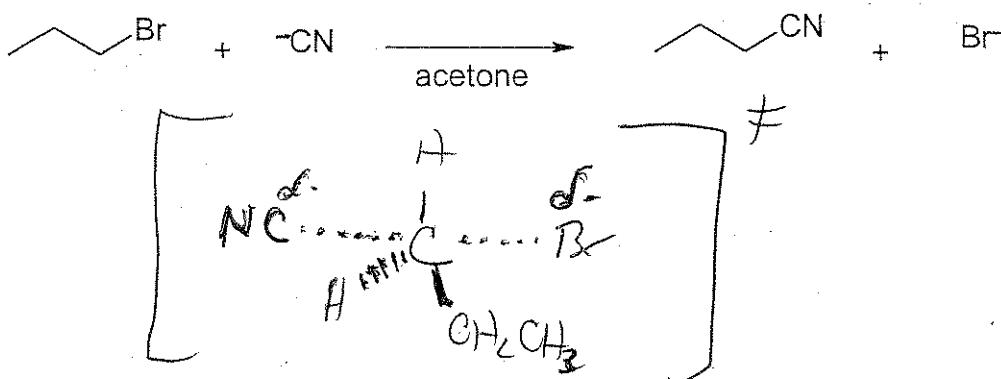
Change to
E2 (then true)

5. (1 pt) True or False E1 elimination must take place through an anticoplanar transition state.

6. (1 pt) True or False The conjugate base of a nucleophile tends to be a better nucleophile than the acid itself.



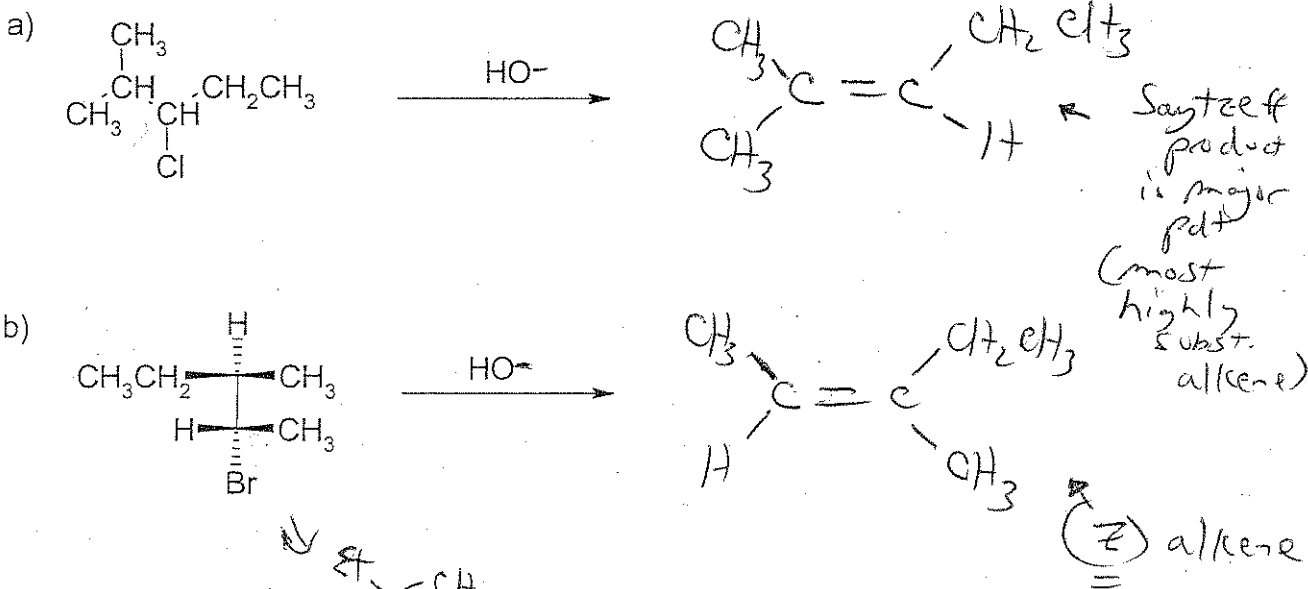
7. (5 pts) a) Draw the transition state structure(s) for the following S_N2 reaction.



b) What happens to the rate of this reaction (i.e. by what factor will the rate increase or decrease by) when the concentration of the alkyl halide and ⁻CN are both increased by a factor of two?

rate = $k_r [\text{R-X}] [\text{CN}^-]$ The rate will increase by a factor of 4.

8. (6 pts, 3 each) Give the major E2 elimination product obtained from the following alkyl halides. Be sure to show stereochemistry where appropriate.



E2
 elimination -
 need anti-coplanar
 T.S.

