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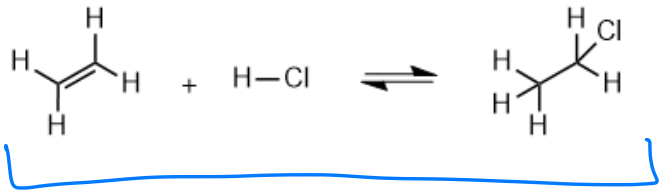
Substitution & Elimination Reactions Exam Review

⊖ = spontaneous

$\Delta G = \Delta H - T\Delta S$

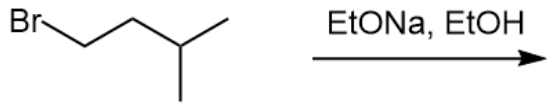
1 Do you expect the forward reaction to be spontaneous? Explain briefly.

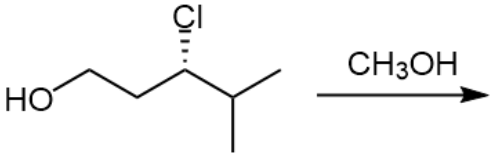


$\Delta H = -17$ kcal/mol

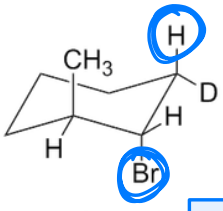
Predict the major and minor products, and provide mechanisms for all products.

2





3



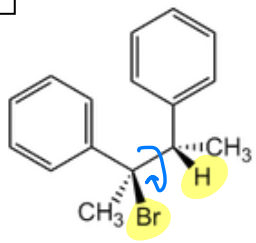
NaOEt

What is the major product of an E2 reaction of the compound shown above?

(strong base)

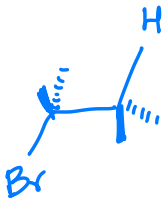
Predict the major product.

4



Base

(E2)



starting material → reagent → product

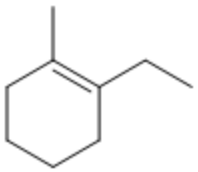
5

In which of the following are the solvents NOT listed in order of increasing polarity?

	less polar		more polar
A)	CH_3COOH	<	CF_3COOH
B)	CH_3OH	<	CH_3CH_2OH
C)	THF	<	CH_3OH
D)	CH_3OH	<	H_2O
E)	aprotic	<	protic

6

Provide TWO possible synthetic routes to the given alkene target molecule. Begin with two different retrosyntheses (what starting material and reagent?).

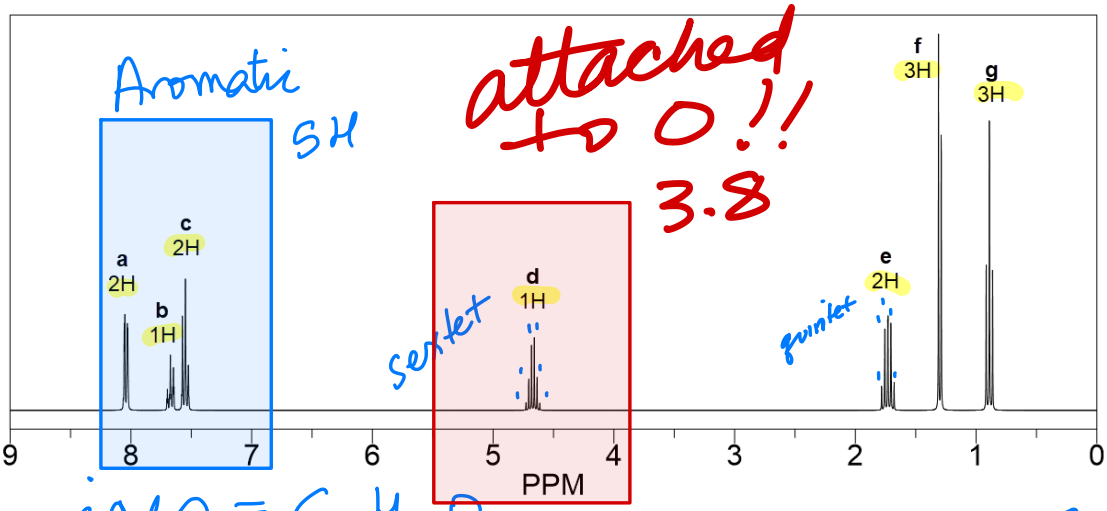


⟹

⟹

7

Provide a structure with the formula $C_{11}H_{14}O_2$ that is consistent with the following NMR spectrum.



Aromatic 5H

attached to O!! 3.8

d: 1H, septet

e: 2H, quintet

f: 3H

g: 3H

DU C_nH_{2n+2}

satd: $C_{11}H_{24}$

$C_{11}H_{14}$

÷2

H_{10} missing

5 D.U.

pieces = $C_{11}H_{14}O_2$

(4DU)

-C- 1DU

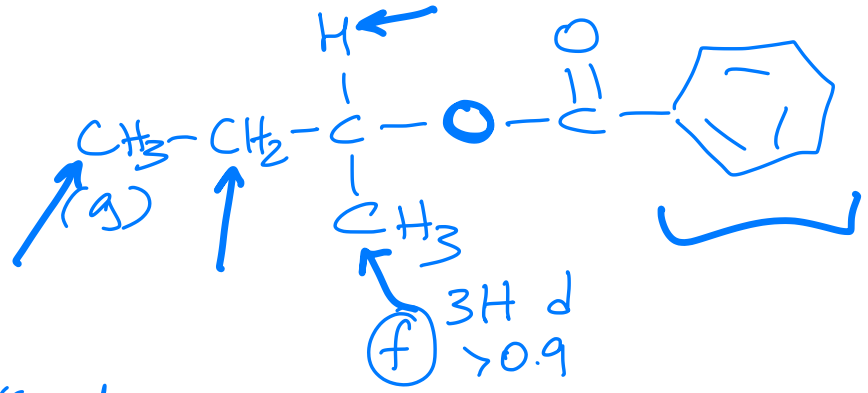
-O-

-CH

-CH_2-

-CH_3

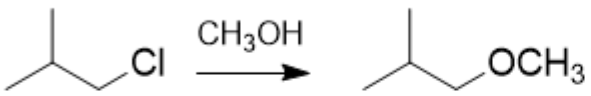
-CH_3

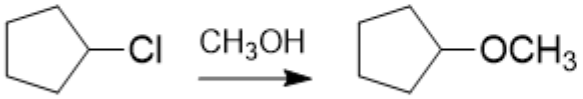


check your answer

VIII. (20 pts) For each of the following pairs of reactions, name the mechanism, indicate which reaction will be faster and briefly explain why. If you expect no significant difference in the reaction rates, say so. (Note: an explanation such as, "secondary is faster" is NOT sufficient - *why* is it faster? Why isn't it slower?)

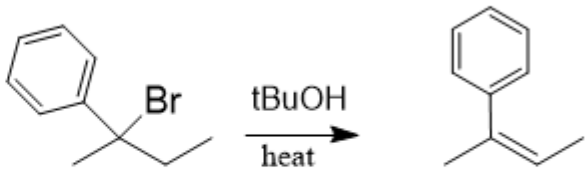
8

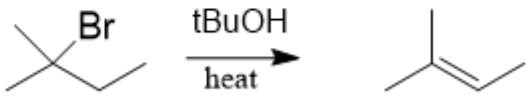
I. 

II. 

mechanism name?
which is faster? Explain.

9

I. 

II. 

mechanism name?
which is faster? Explain.

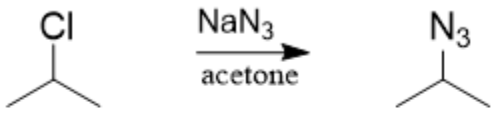
10

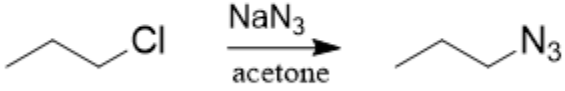
I. $CH_3CH_2Br \xrightarrow[heat]{NaOH} CH_3CH_2OH$

II. $CH_3CH_2Br \xrightarrow{NaOH} CH_3CH_2OH$

mechanism name?
which is faster? Explain.

11

I. 

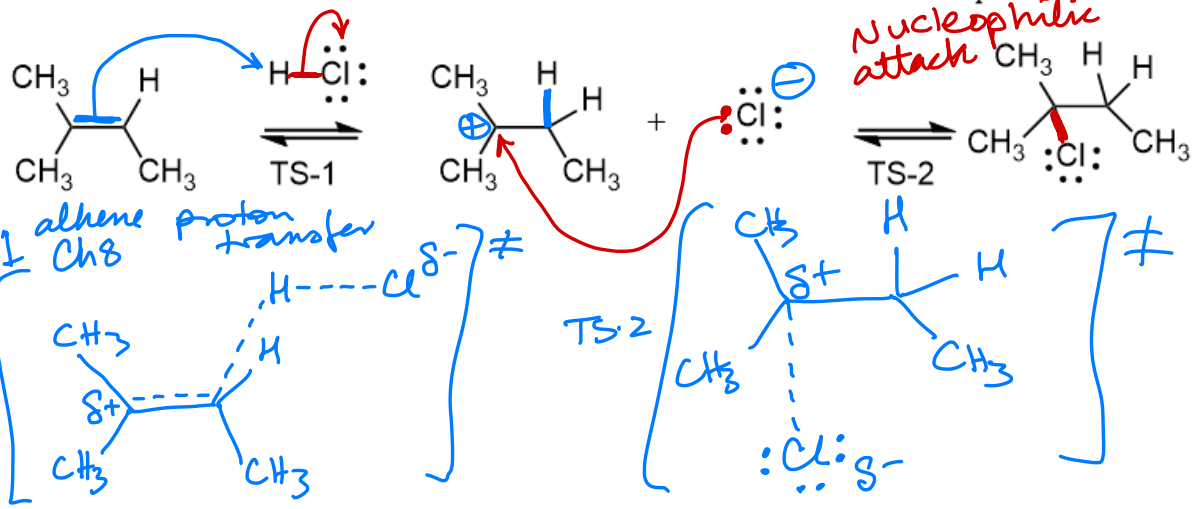
II. 

mechanism name?
which is faster? Explain.

4 5 6 7
B C N O F
Cl
Br
I

12

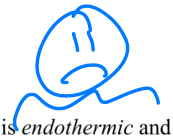
Add in any **missing formal charges**. **Draw curved arrows** for each step of the mechanism.
Draw the **structures of the transition states TS-1 and TS-2** for the two-step mechanism.



$\Delta G = \Delta H - T\Delta S$

$\Delta H > 0$

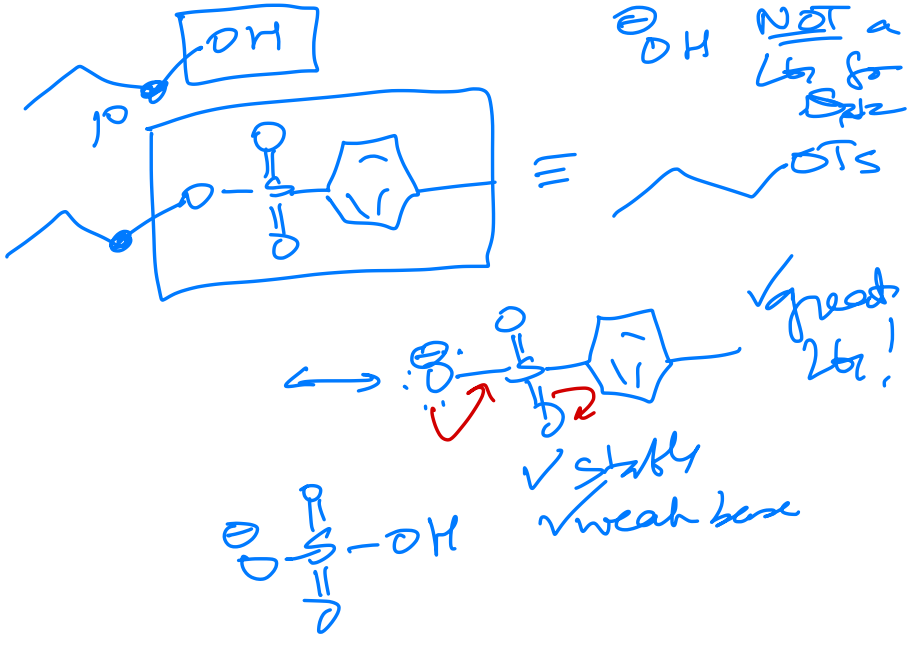
$\Delta S < 0$



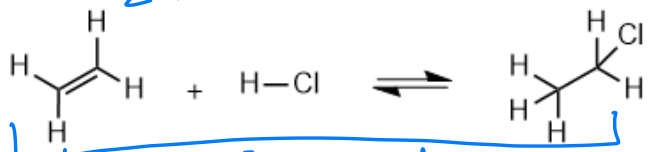
5D) (4 pts) If a reaction is *endothermic* and the system exhibits a *decrease in entropy*, determine whether or not it is spontaneous, and if the sign of ΔG is temperature dependent. **Briefly explain (or show your work). No work = no credit.**

Your answer: [ ]

a) It is spontaneous only at high temperatures.
b) It is spontaneous only at low temperatures.
c) It is spontaneous at all temperatures.
d) It is not spontaneous at any temperature.



1 Do you expect the forward reaction to be spontaneous? Explain briefly.



A) The forward reaction will be spontaneous at all temperatures because it is exothermic and there is an increase in entropy.

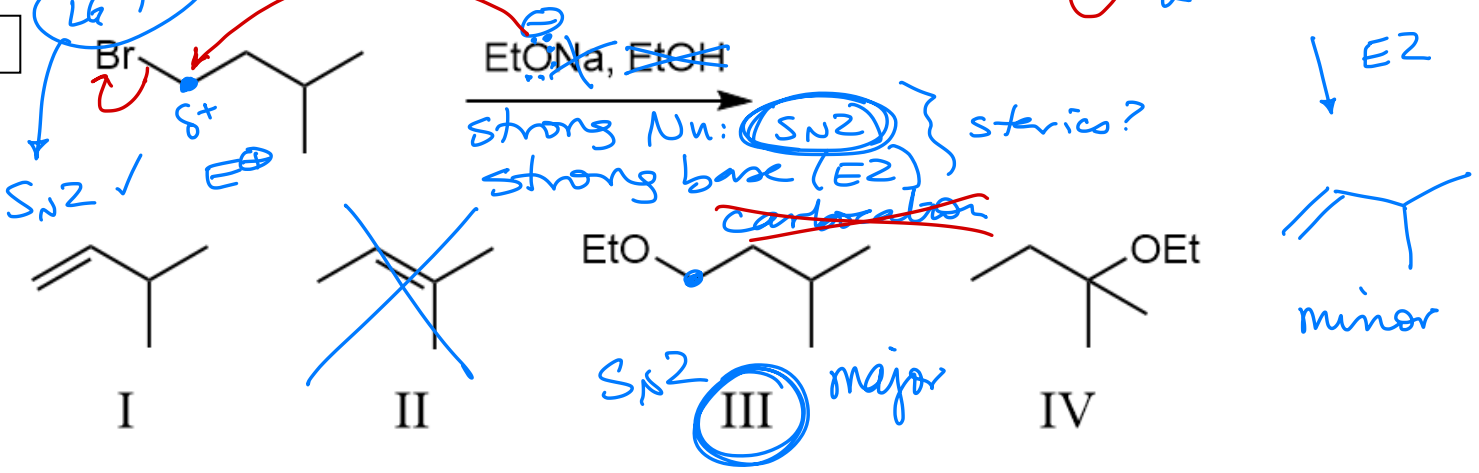
B) The forward reaction will be spontaneous at low temperatures because it is exothermic and there is an increase in entropy.

C) The forward reaction will be spontaneous at high temperatures because it is exothermic and there is an increase in entropy.

D) The forward reaction will be spontaneous at low temperatures because it is exothermic and there is a decrease in entropy.

E) The forward reaction will be spontaneous at high temperatures because it is exothermic and there is a decrease in entropy.

2a Predict the major product(s) and minor product(s).



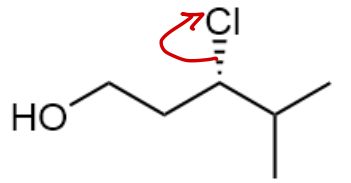
Major product(s)?

A) I only
B) II only
C) III only
D) I and III
E) II and IV

Minor product(s)?

A) I only
B) II only
C) III only
D) I and III
E) II and IV

2b Of the following, which is NOT expected to be a likely product?



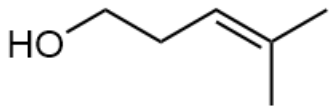
CH_3OH

carbocation! $S_N1/E1$/R

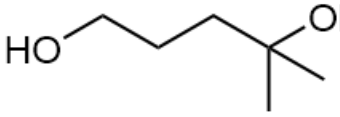
weak Nu: ~~S_N2~~

weak base ~~$E2$~~

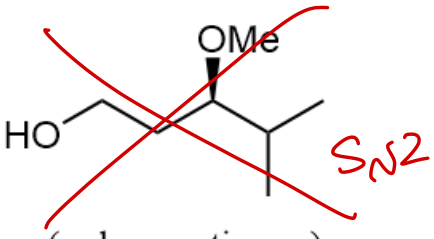
A)



B)



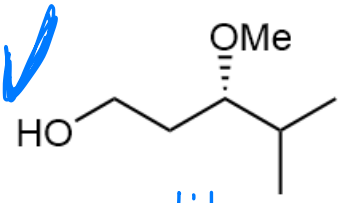
C)



S_N2

(only enantiomer)

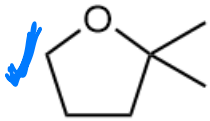
D)

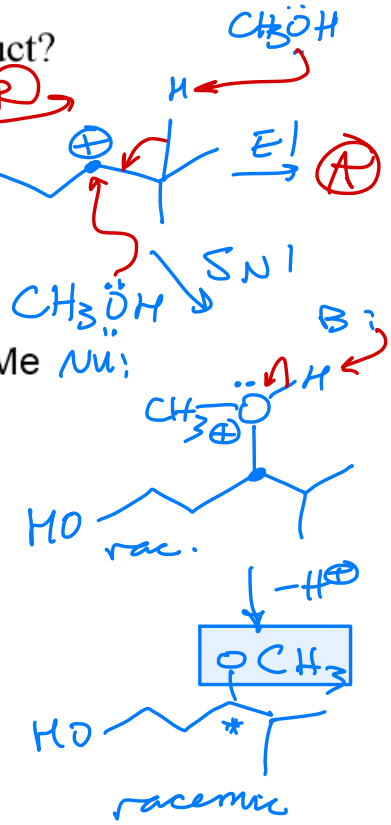


1:1

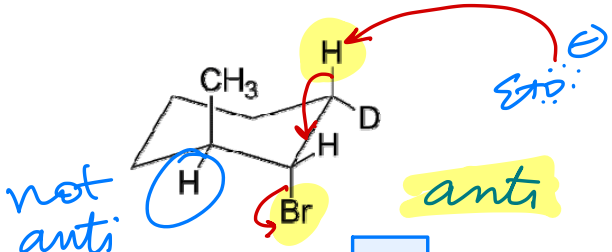
(racemic)

E)





3

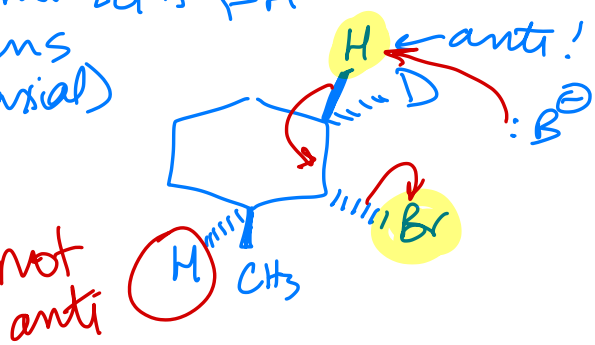


What is the major product of an E2 reaction of the compound shown above?

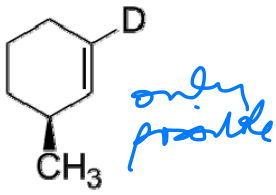
anti LG + BH

strong base

trans (diaxial)

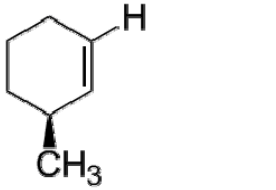


A)

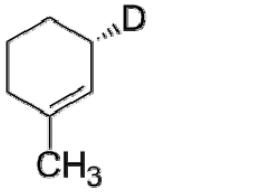


only product

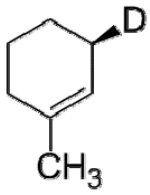
B)



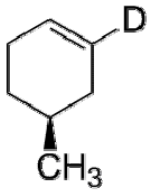
C)

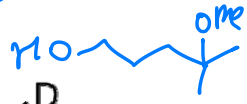


D)

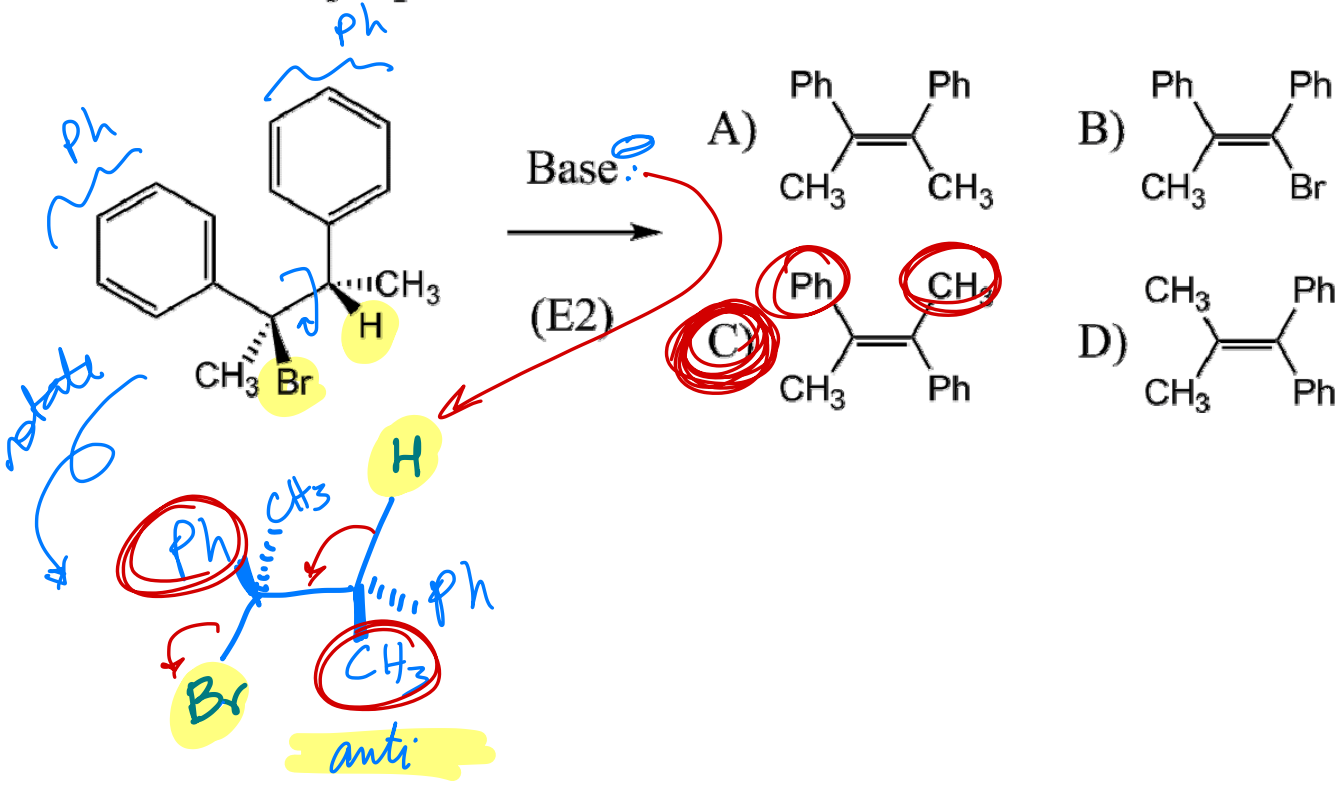


E)



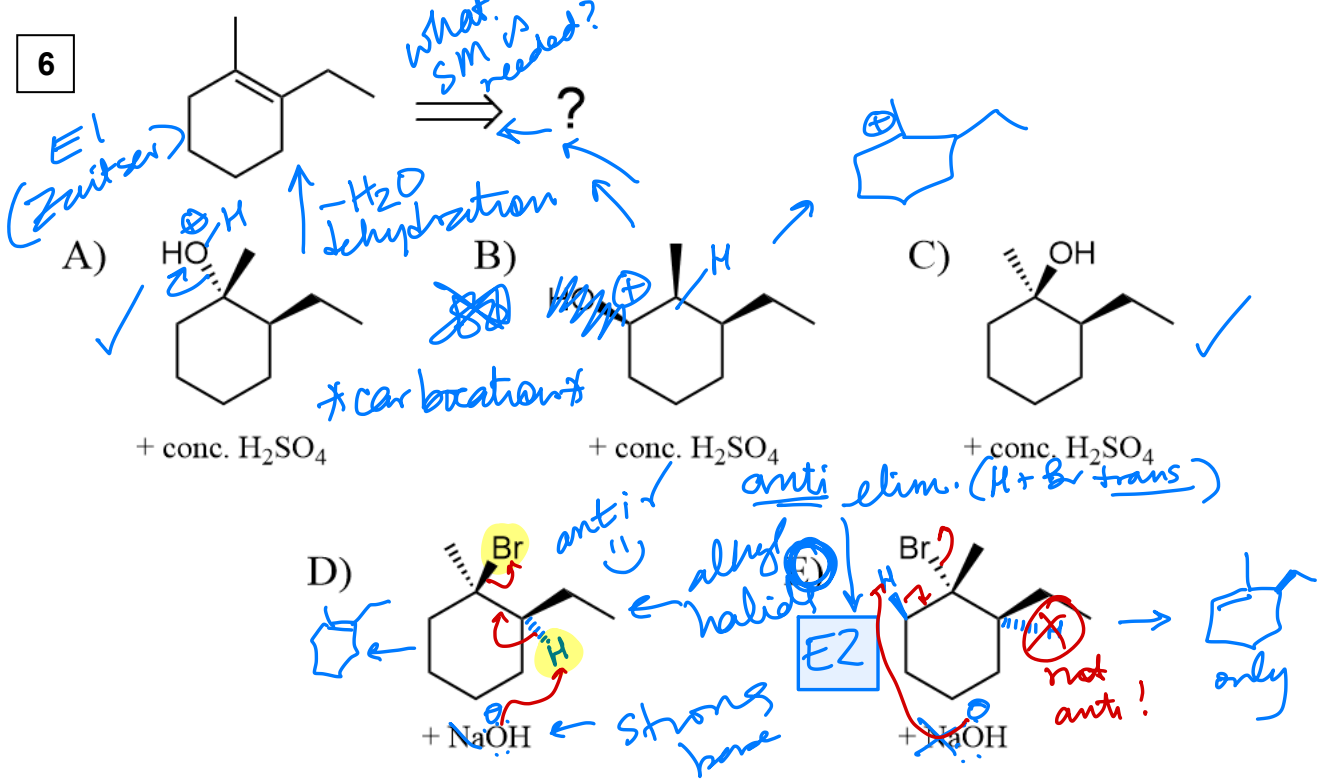


4 Predict the major product.



Which of the following does NOT represent an efficient synthesis of the desired target molecule?

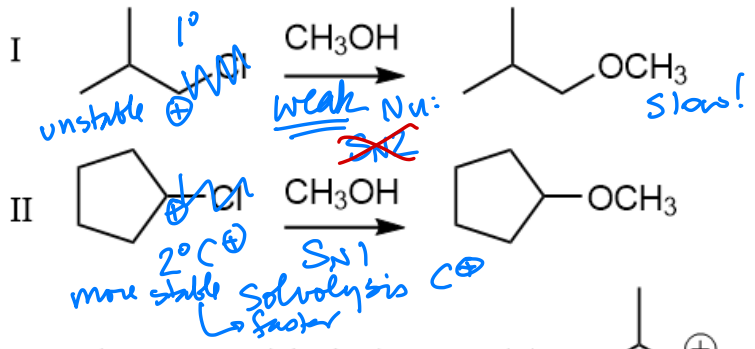
6



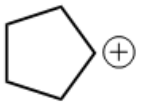
8

Which of the following is the FASTER reaction? Explain briefly.

substitution LG → Nu:



A) I is faster because this is less stable:

B) II is faster because this is more stable:  (SN1)

C) I is faster because LG has less sterics (SN2)

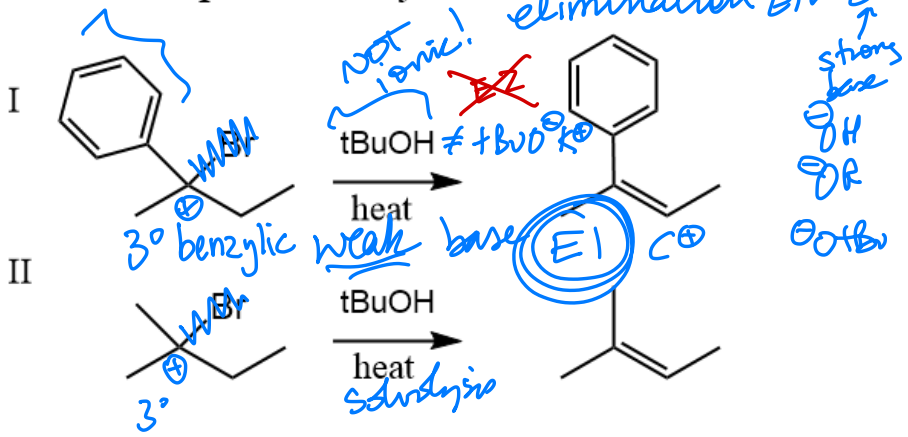
D) II is faster because LG is allylic

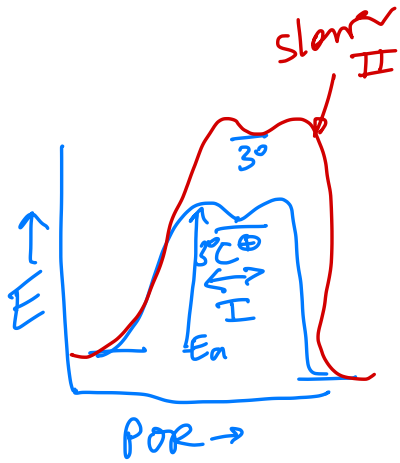
E) neither reaction should be faster

9

Which of the following is the FASTER reaction? Explain briefly.

RBr → alkene elimination E1 or E2





A) I is faster because the LG has less sterics.

B) II is faster because the LG has less sterics.

C) I is faster because it has a more stable product.

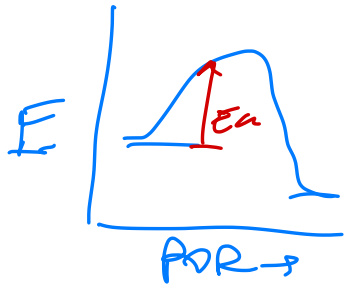
D) II is faster because it has a tertiary carbocation.

E) I is faster because the carbocation intermediate has resonance.

10 Which of the following is the FASTER reaction? Explain briefly.

I $CH_3CH_2Br \xrightarrow[\text{heat}]{NaOH} CH_3CH_2OH$

II $CH_3CH_2Br \xrightarrow{NaOH} CH_3CH_2OH$



A) I is faster because it has a lower E_a.

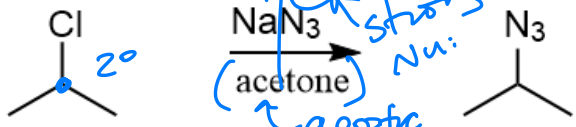
B) II is faster because it has a lower E_a.

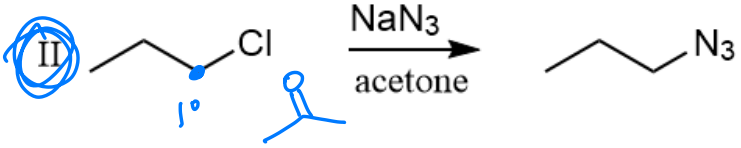
C) I is faster because more kinetic energy results in more high-energy collisions.

D) II is faster because it is an exothermic reaction.

E) I is faster because heat lowers the energy of the carbocation intermediate.

11 Which of the following is the FASTER reaction? Explain briefly.

I 

II 

A) I is faster because this is more stable: 

B) II is faster because this is less stable: 

C) I is faster because LG has less sterics

D) II is faster because LG has less sterics