Key

Practice Exam 3

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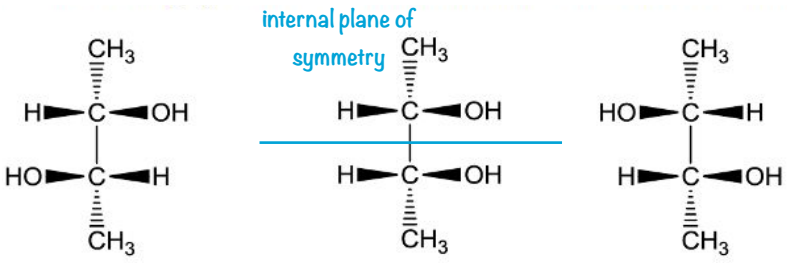
1) What are enantiomers:
   a) Molecules that have a mirror image.
   b) Non-superimposable molecules.
   c) Non-superimposable molecules that are mirror images of each other.
   d) Non-superimposable constitutional isomers.
   e) Molecules that have at least one stereogenic center.

2) Which of the following is achiral?

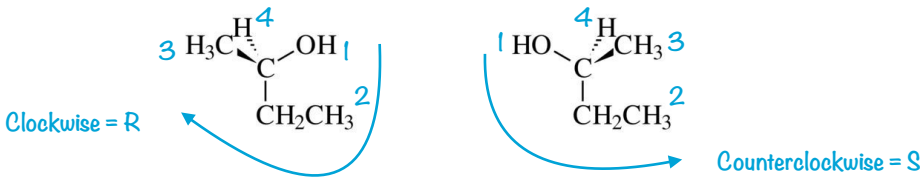


I II III

   a) I
   b) II
   c) III
   d) More than one of these choices.
   e) None of these choices.

.

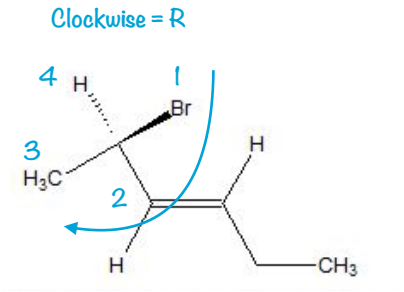
3) Which structure represents (S)-2-butanol?



I II

   a) I
   b) II
   c) More than one of these choices.
   d) None of these choices.

4) What is the IUPAC name of the following compound?



a) (2S)-2-bromo-3-hexene
b) (1S)-1-bromo-1-methyl-2-pentene
c) (1R)-1-bromo-1-methyl-2-pentene
d) (2R)-2-bromo-3-hexene
e) None of the above

5) Which of the following is true of **any** (R)-enantiomer?
a) It rotates plane-polarized light to the right.
b) It rotates plane-polarized light to the left.
c) It is a racemic form.
d) It is the mirror image of the corresponding (S)-enantiomer.
e) It has the highest priority group on the left.

6) If a solution of a compound (20.0g/100 mL of solution) has a measured rotation of +20° in a 2.0 dm tube, the specific rotation is:

$[\alpha] = \frac{\alpha}{c \times l}$

α (observed rotation) = 20 degrees
c (concentration) = 20.0g/100mL
l (length) = 2.0 dm

$= \frac{20}{0.2 \times 2} = \frac{20}{0.4} = 50$

a) +50
b) +25
c) +15
d) +7.5
e) +4.0

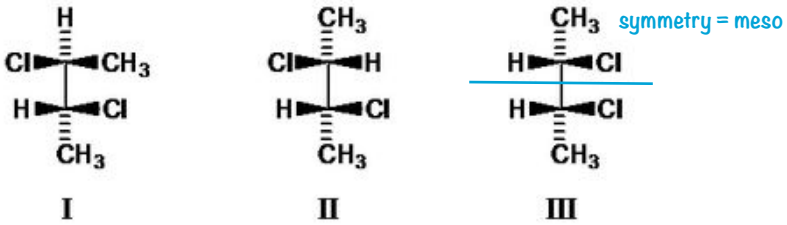
7) What is the enantiomeric excess of a compound that shows a specific rotation $[\alpha]_D^{25}$ = +12.4, where the pure enantiomer has a reference value of $[\alpha]_D^{25}$ = +22.6.

$\left(\frac{12.4}{22.6}\right) \times 100\% = 54.9\%$

a) 22.6%
b) 54.9%
c) 77.5%
d) 63.2%
e) 44.8%

8) Which of the following is a meso compound?

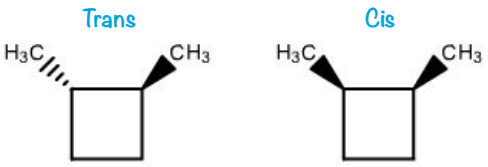
Internal plane of symmetry = meso



a) I
b) II
c) III
d) II and III
e) None of the above

9) These compounds are:

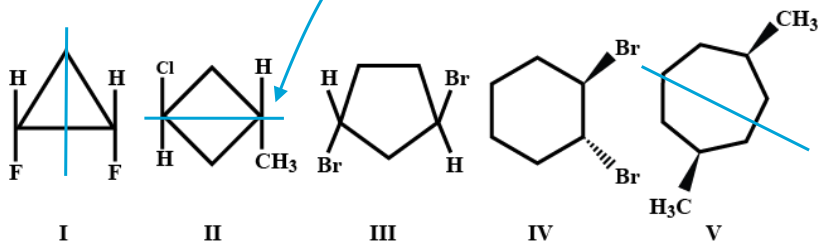
a) Constitutional isomers
b) Enantiomers
c) Identical
d) Diastereomers
e) Not isomeric



10) Which compound does NOT possess a plane of symmetry?

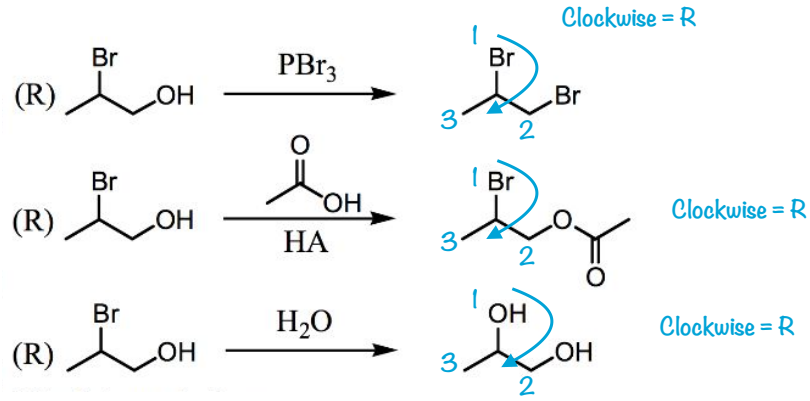
a) I, II, and V
b) I, III, and IV
c) II, III, and IV
d) III and IV
e) V

The substituents on either side are actually in front and behind each other bc the compound is 3D



11) In which of the following reactions is the absolute configuration of the product likely to be the same as that of the reactant?

a)
b)
c)

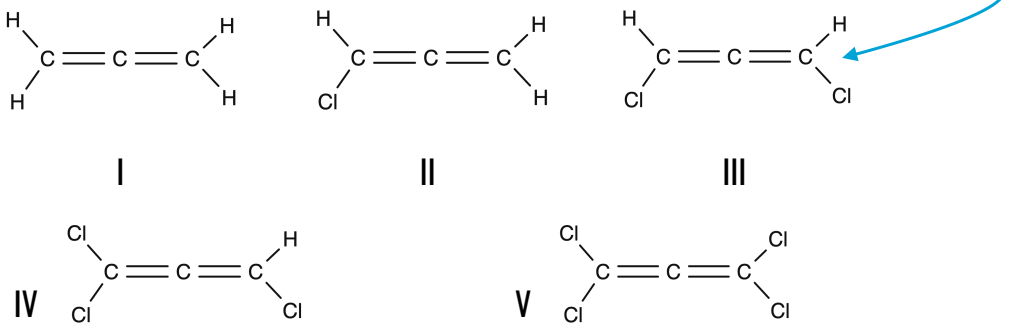


d) All of these choices.
e) Two of these choices.

12) A solution of which of these alkenes will rotate plane polarized light?

a) I
b) II
c) III
d) IV
e) V

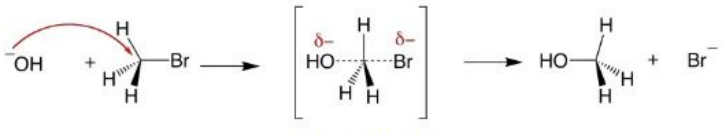
This one is the only one that is chiral.
Chiral molecules rotate plane-polarized light



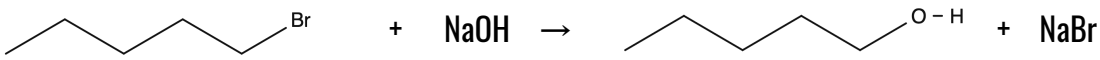
13) Select the rate law for the following reaction,

a) Rate = k [CH_3Br]
b) Rate = k [CH_3Br] [OH^-]
c) Rate = k [CH_3Br]^2 [OH^-]
d) Rate = k [CH_3Br] [OH^-]^2
e) Rate = k [CH_3Br]^2 [OH^-]^2

SN2 reaction rate involve both reactants



14) Consider the S_N2 reaction of pentyl bromide with OH^- ion.



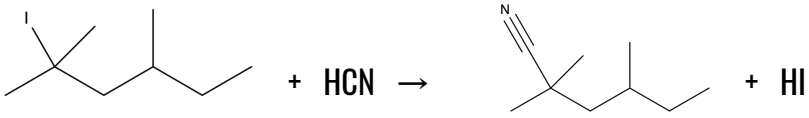
Assuming no other changes, what effect on the rate would result from simultaneously doubling the concentrations of both pentyl bromide and OH^- ion?

a) No effect.
b) It would double the rate.
c) It would triple the rate.
d) It would increase the rate four times.
e) It would increase the rate six times.

Since the reaction rate for an SN2 is based on the concentration of both reactants, if both double, it would look like this:

Rate = k 2[R-Br] 2[OH-]
Rate = 4 x original

15) Consider the S_N1 reaction of 2-iodo-2,4-dimethylhexane with HCN ion.



Assuming no other changes, what effect on the rate would result from simultaneously doubling the concentrations of both pentyl bromide and OH^- ion?

a) No effect.
b) It would double the rate.
c) It would triple the rate.
d) It would increase the rate four times.
e) It would increase the rate six times.

Since the reaction rate for an SN1 is based on the concentration of only the electrophile, if both double, it would look like this:

Rate = k 2[R-I]
Rate = 2 x original

16) The reaction,

Has the following thermodynamic values at 28.0°C: $\Delta H = -78.6$ kJ mol^{-1}; $\Delta S = 49.2$ J mol^{-1}. What is the value of ΔG for this reaction?

a) -93.4 kJ mol^{-1}
b) +93.4 kJ mol^{-1}
c) -86.5 kJ mol^{-1}
d) +86.5 kJ mol^{-1}
e) None of these choices.

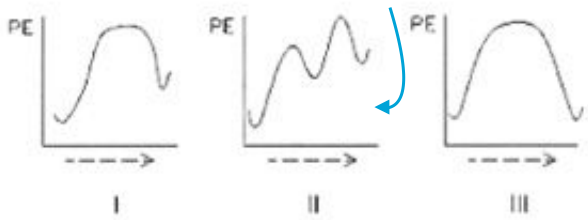
ΔH = -78.6 kJ
ΔS = 49.2 J = 0.0492 kJ
T = 28 C = 301 K

ΔG = ΔH - TΔS
= -78.6 kJ - (301 K x 0.0492 kJ)
= -78.6 kJ - 14.8 kJ
= -93.4 kJ

17) Select the potential energy diagram that represents an endothermic (endergonic) reaction.

a) I
b) II
c) III
d) IV
e) V

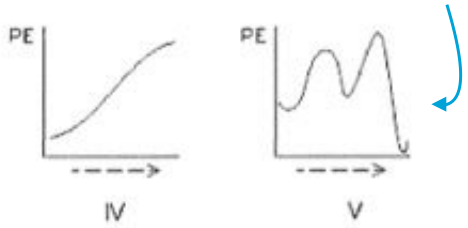
Products have a higher amount of energy than reactants,



18) Select the potential energy diagram above that represents a two-step exothermic (exergonic) reaction.

a) I
b) II
c) III
d) IV
e) V

Products have a lower amount of energy than reactants,



19) The difference in the bond energies of reactants and the transition state of a reaction is designated by the notation:

a) $\Delta H°$
b) $\Delta H^{‡}$
c) $\Delta G°$
d) $\Delta G^{‡}$
e) $\Delta S^{‡}$

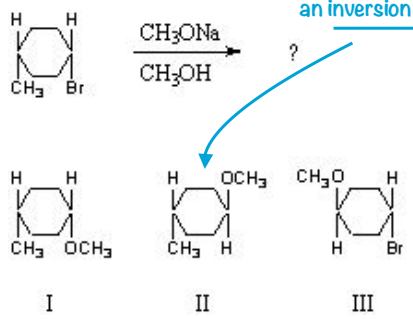
20) Which will be true for <u>any</u> actual or potential nucleophilic substitution reaction?

a) $\Delta H°$ is positive.
b) $\Delta H°$ is negative.
c) $\Delta G^{\ddagger}$ is positive.
d) $\Delta G°$ is positive.
e) $\Delta G°$ is negative.

21) What product(s) would you expect to obtain from the following S_N2 reaction?

a) I
b) II
c) An equimolar mixture of I and II.
d) III
e) None of these choices.

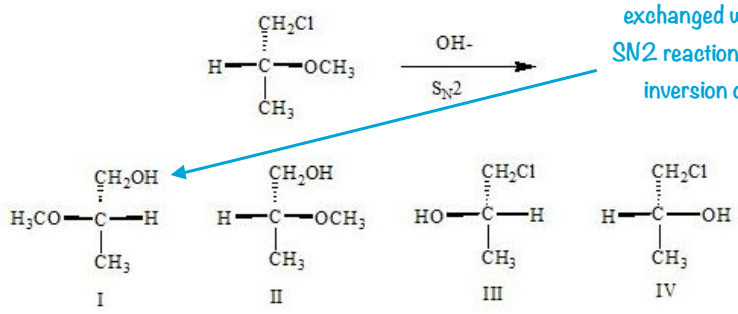
Br is LG, so it should be exchanged with OCH3, and an SN2 reaction should have an inversion of configuration



22) The major product of the following reaction would be:

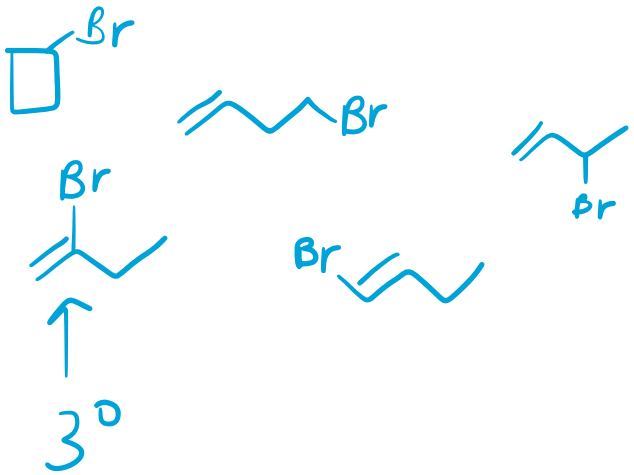
a) I
b) II
c) III
d) IV
e) An equimolar mixture of I and II.

Cl is LG, so it should be exchanged with OH, and an SN2 reaction should have an inversion of configuration



23) Which of the following alkyl bromide isomers would most likely undergo an S_N1 reaction?

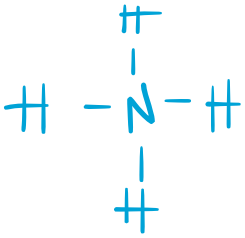
a) Bromocyclobutane
b) 4-bromo-1-butene
c) 3-bromo-1-butene
d) 1-bromo-1-butene
e) 2-bromo-1-butene



24) Which of the following is not a nucleophilic?

a) H_2O
b) CH_3O^-
c) NH_3
d) NH_4^+
e) All are nucleophiles.

Has to have at least one nonbonded electron pair



25) Which is the strongest nucleophile?

a) OH^-
b) $CH_3CH_2O^-$
c) CH_3COO^-
d) CH_3CH_2OH
e) H_2O

RO- > HO- >> RCO2- > ROH > H2O

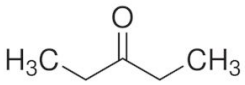
26) Which S_N2 reaction would you expect to take place most rapidly? Assume that the concentrations of the reactants and the temperature are the same in each instance.

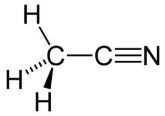
a) $CH_3CH_2O^- + CH_3Br \rightarrow CH_3OCH_2CH_3 + Br^-$
b) $CH_3CH_2OH + CH_3Br \rightarrow CH_3O^+H\text{-}CH_2CH_3 + Br^-$
c) $CH_3CH_2O^- + CH_3Cl \rightarrow CH_3OCH_2CH_3 + Cl^-$
d) $CH_3CH_2OH + CH_3Cl \rightarrow CH_3O^+H\text{-}CH_2CH_3 + Cl^-$
e) $CH_3CH_2O^- + CH_3I \rightarrow CH_3OCH_2CH_3 + I^-$

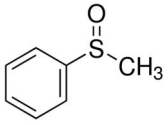
SN2: I- > Br- > Cl- > F-

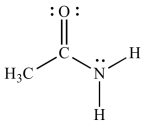
Stong base/nucleophile (- charge)

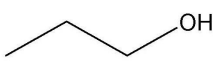
27) Which is not a polar aprotic solvent?

a) 

b) 

c) 

d) 

e) 

Polar aprotic solvents lack OH and NH bonds

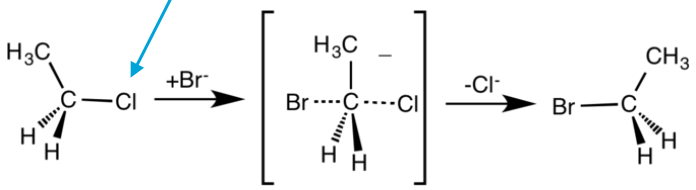
28) Which of the following is <u>not</u> true concerning the strength of a nucleophile?

a) Nucleophilicity may not parallel basicity.
b) Negatively charged nucleophiles are always more reactive than their conjugate acids.
c) The greater the strength of a nucleophile, the faster an S_N2 reaction will occur.
d) Strong bases are always good nucleophiles.
e) None of these answer choices are correct.

29) Identify the leaving group in the following reaction.

a) CH_3CH_2Cl
b) Br^-
c) Cl^-
d) CH_3CH_2Br
e) None of these

Originally attached, but gets exchanged with the strong base



30) Which nucleophilic substitution reaction is not likely to occur?

a) $CH_3\text{-}Br + I^- \rightarrow CH_3\text{-}I + Br^-$
b) $CH_3\text{-}Br + {}^-OCH_3 \rightarrow CH_3\text{-}OCH_3 + Br^-$
c) $CH_3\text{-}OH + I^- \rightarrow CH_3\text{-}I + OH^-$
d) $CH_3\text{-}I + {}^-OCH_3 \rightarrow CH_3\text{-}OCH_3 + I^-$
e) $CH_3\text{-}Cl + I^- \rightarrow CH_3\text{-}I + Cl^-$

OH is not a good LG, so it is not likely to be kicked off by the I-

31) S_N1 reactions are favored when

a) Tertiary substrates are used.
b) The nucleophile concentration is high.
c) When the LG is a strong base.
d) A non-polar solvent is used.
e) None of the above.

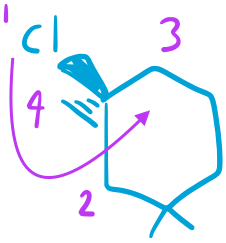
32) Increasing the temperature of a reaction will speed up the overall rate as this will increase the energy of activation for the reaction.

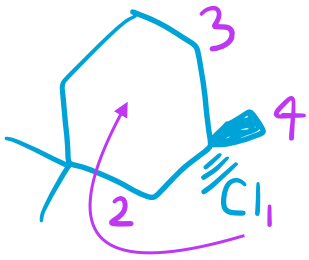
a) True
b) False

33) Racemic mixtures form in S_N1 reactions when leaving group departures in a loss of chirality followed by subsequent attack of the same nucleophile.

a) True
b) False

34) Draw a dash-wedge structure for (2S)-2-chloro-2,4,4-trimethylcyclohexane.





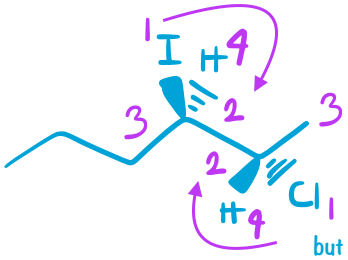
There are multiple ways to draw this, depending on where you start your numbering and which direction you go

Apparent R, but actual S configuration because the lowest group isn't to the back

35) An equimolar mixture of two enantiomers is called a _____Racemic mixture_____.

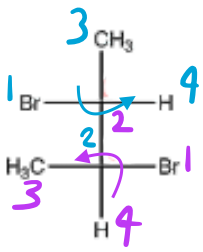
36) Draw a dash-wedge structure for (2S, 3R)-2-chloro-3-iodohexane.

3 is an R configuration



2 is an apparent R configuration, but it is flipped bc the H is facing the front. It is actually an S

37) What is the complete IUPAC name of the following substance (remember to give stereochemical details, as relevant)?



Apparent S, but the horizontal lines are coming forward, so it is actually an R configuration

S configuration

4 carbons = butane
2,3-dibromo

(2S, 3R) - 2,3-dibromobutane

38) What are stereoisomers? Explain the types of stereoisomers with examples.

Stereoisomers are isomers that different in the spatial arrangement of atoms, rather than the order that they are connected. R and S configurations are good examples of stereoisomers as they are connected the same but arranged differently.