CH320/328 M

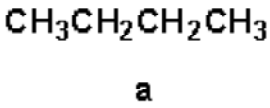
M_HW1

Multiple Choice
Identify the choice that best completes the statement or answers the question. There is only one correct response for each question. (4 pts each)

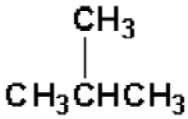
1. Which of the following alkanes has the **highest** boiling point?
   a. 2,3-dimethylbutane
   b. 2-methylpentane
   c. 3-methylpentane
   d. hexane

2. Which of the following compounds is a ketone?
   a. CH_3CH_2COOH
   b. CH_3CH_2CHO
   c. $CH_3CH_2CH_2OH$
   d. CH_3COCH_3

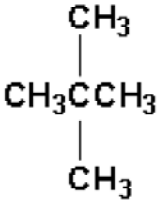
3. What is the correct assignment of **common names** for the following molecules?



a



b



c

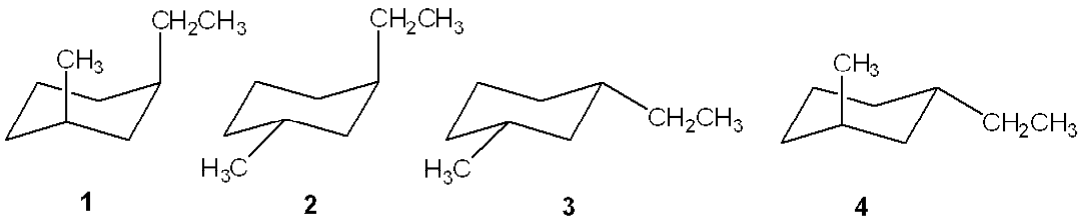
   a. *a*= butane; *b* = neopentane; *c* = isopentane
   b. *a* = neobutane; *b*= isobutane; *c* = pentane
   c. *a*= butane; *b*= isobutane; *c* = isopentane
   d. *a* = butane; *b*= isobutane; *c* = neopentane

4. Which of the following best represents the shape of a 2*p* atomic orbital of carbon?

   a. **1**
   b. **2**
   c. **3**
   d. **4**

5. Which of the following compounds is a meso compound?
   a. (2*R*,3*R*)-dibromobutane
   b. (2*R*,3*S*)-dibromobutane
   c. (2*R*,3*S*)-3-bromo-2-butanol
   d. (2*R*,3*R*)-3-bromo-2-butanol

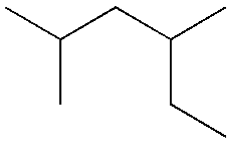
6. Which of the following is the most stable conformation of *trans*-1-ethyl-3-methylcyclohexane?



1 **2** **3** **4**

   a. **1**
   b. **2**
   c. **3**
   d. **4**

7. What is the **IUPAC** name of the following compound?



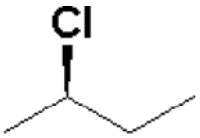
   a. 2-ethyl-4-methylpentane
   b. 2,4-dimethylhexane
   c. 3,5-dimethylhexane
   d. 1,1,3-trimethylpentane

8. Which of the following compounds has 1°, 2°, 3° and 4° carbon atoms?
   a. hexane
   b. 2-methylhexane
   c. 2,2-dimethylhexane
   d. 2,2,3-trimethylhexane

9. Which of the following substituents has the **lowest** priority according to the Cahn-Ingold-Prelog system used in assigning *R* and *S* configurations?
   a. -COOH
   b. -CHO
   c. $-CH_2OH$
   d. $-CH_3$

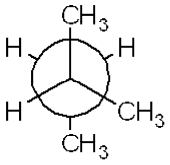
10. Which of the following elements has the highest electronegativity?
    a. N
    b. C
    c. O
    d. S

11. The configuration of the chiral carbon in this compound is:

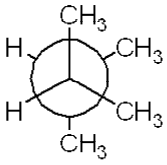


    a. S & R
    b. S
    c. d & l
    d. R

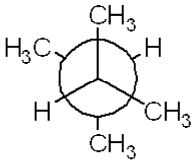
12. Which of the following Newman projections represents the most stable conformation of 2,3-dimethylbutane?



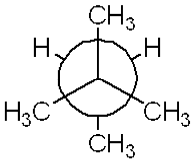
1



2



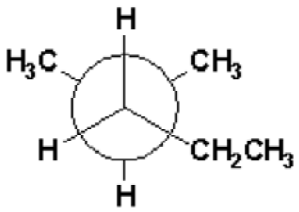
3



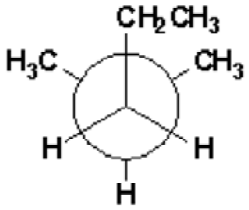
4

    a. **1**
    b. **2**
    c. **3**
    d. **4**

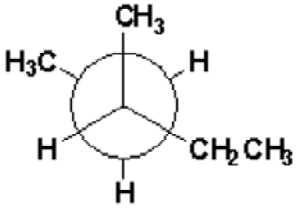
13. The Newman projection of the most stable conformation of 2-methylpentane, $(CH_3)_2CHCH_2CH_2CH_3$, **looking along the C2-C3** bond is:



1



2

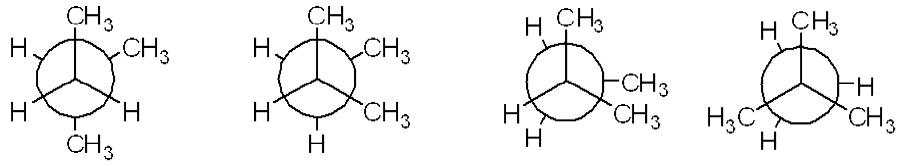


3

    a. 1 & 3
    b. 3
    c. 2
    d. 1

14. What is the approximate C-C-C bond angle in pentane?
    a. 90°
    b. 109°
    c. 120°
    d. 180°

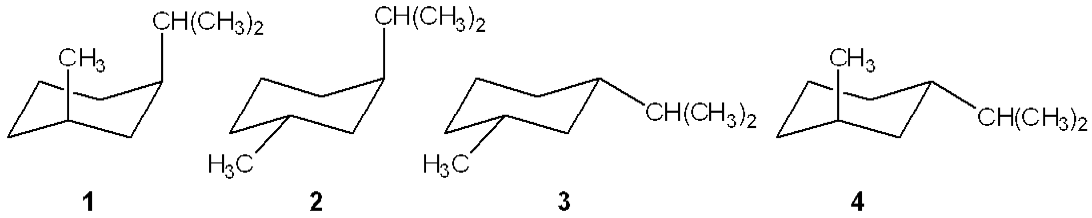
15. Which of the following Newman projections represents the **most stable** conformation of 2-methylbutane?



    a. **1**
    b. **2**
    c. **3**
    d. **4**

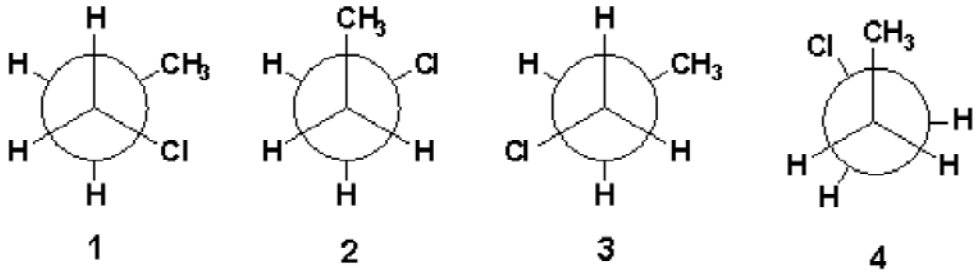
16. What is the name of the linear hydrocarbon with the molecular formula $C_{11}H_{24}$?
    a. heptane
    b. decane
    c. undecane
    d. eicosane

17. Which of the following is the **most stable** conformation of *cis*-1-isopropyl-3-methylcyclohexane?



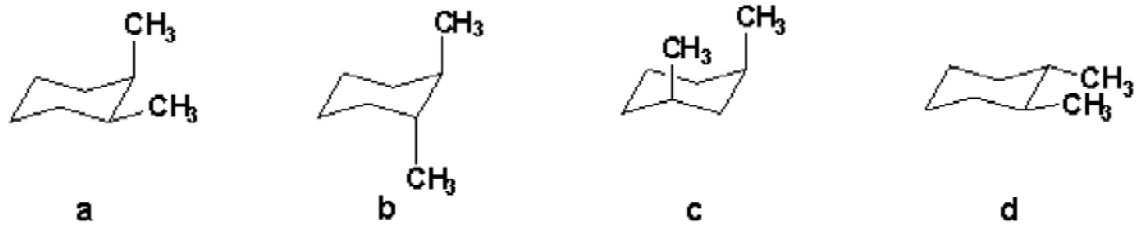
    a. **1**
    b. **2**
    c. **3**
    d. **4**

18. Which of the following conformers are gauche?



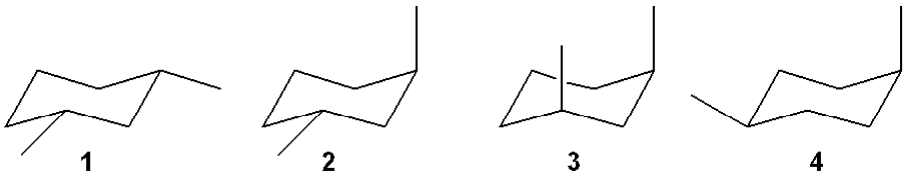
a. 4
b. 3
c. 1,2 & 3
d. 1 & 2

19. Which compound is *cis*-1,2-Dimethylcyclohexane?



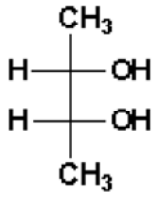
a. a
b. b
c. c
d. d

20. Which of the following structures represents *trans*-1,3-dimethylcyclohexane?



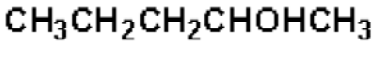
a. **1**
b. **2**
c. **3**
d. **4**

21. How many stereoisomers are possible for this compound?

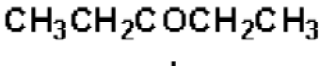


a. only 2
b. 3
c. only one
d. 4

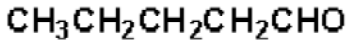
22. Which of the following is a ketone?



a



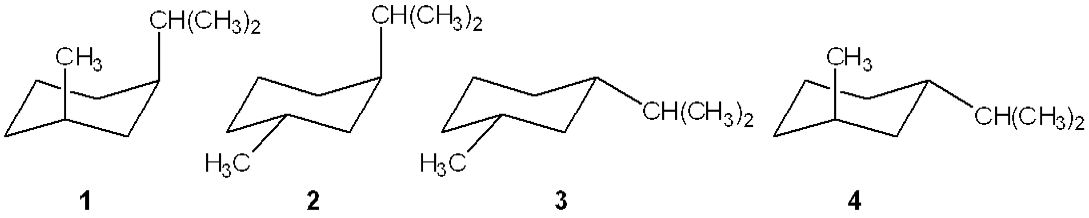
b



c

a. a
b. b
c. c
d. a & b

23. Which of the following is the most stable conformation of *cis*-1-isopropyl-3-methylcyclohexane?



1 2 3 4

a. **1**
b. **2**
c. **3**
d. **4**

24. The general formula for a saturated alkane is:

a. C_nH_{2n}
b. C_nH_{2n-2}
c. C_nH_{2n+2}
d. C_nH_n

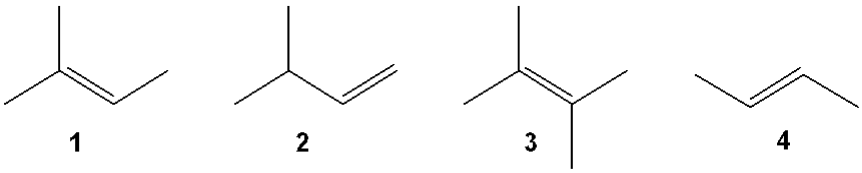
25. Which of the following compounds has **only** 1° and 3° carbon atoms?
a. hexane
b. 2-methylpentane
c. 3-methylpentane
d. 2,3-dimethylbutane

CH320/328 M

M_HW2

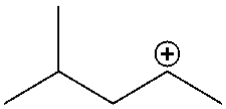
Multiple Choice
Identify the choice that best completes the statement or answers the question. There is only one correct response for each question. (4 pts each)

1. Which of the following alkenes is most likely to undergo rearrangement upon acid-catalyzed hydration (treatment with aqueous H_2SO_4)?



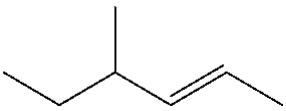
   a. **1**
   b. **2**
   c. **3**
   d. **4**

2. What type of carbocation is shown?



   a. primary
   b. secondary
   c. tertiary
   d. quaternary

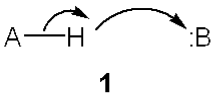
3. What is the IUPAC name of the following compound?



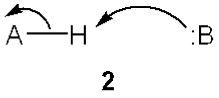
   a. (*E*)-3-methyl-4-hexene
   b. (*Z*)-3-methyl-4-hexene
   c. (*E*)-4-methyl-2-hexene
   d. (*Z*)-4-methyl-2-hexene

4. What is the index of hydrogen deficiency of a compound with a molecular formula of C_6H_8?
   a. 0
   b. 1
   c. 2
   d. 3

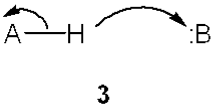
5. Which set of curved arrows accounts for the deprotonation of an acid (A-H) by a base (:B)?



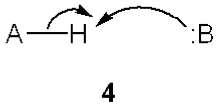
1



2



3



4

a. **1**
b. **2**
c. **3**
d. **4**

6. Which sets of curved arrows accounts for the protonation of propene with HI?

1

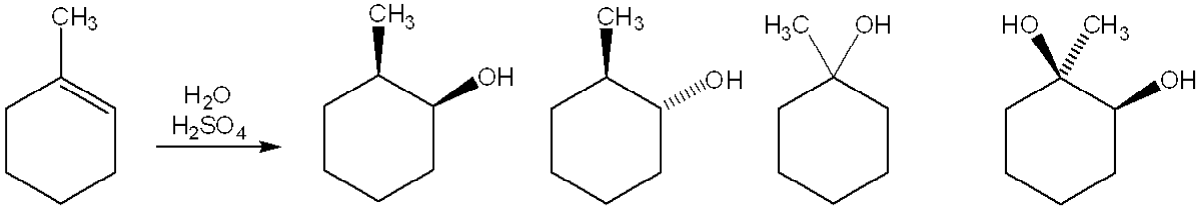
2

3

4

a. **1**
b. **2**
c. **3**
d. **4**

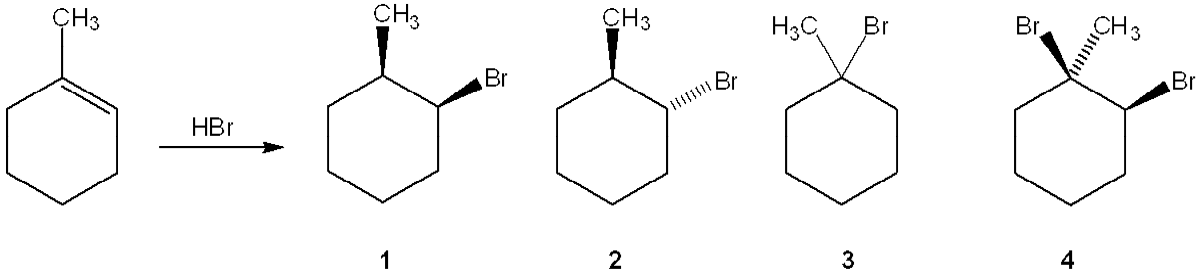
7. What is the major organic product obtained from the following reaction?



1 **2** **3** **4**

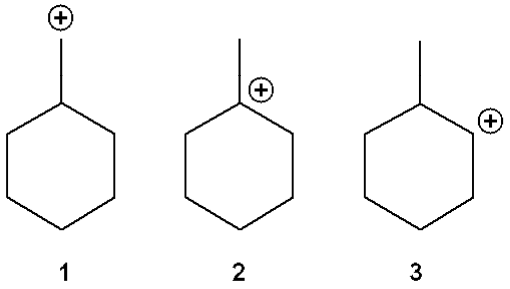
a. **1**
b. **2**
c. **3**
d. **4**

8. What is the major organic product obtained from the following reaction?



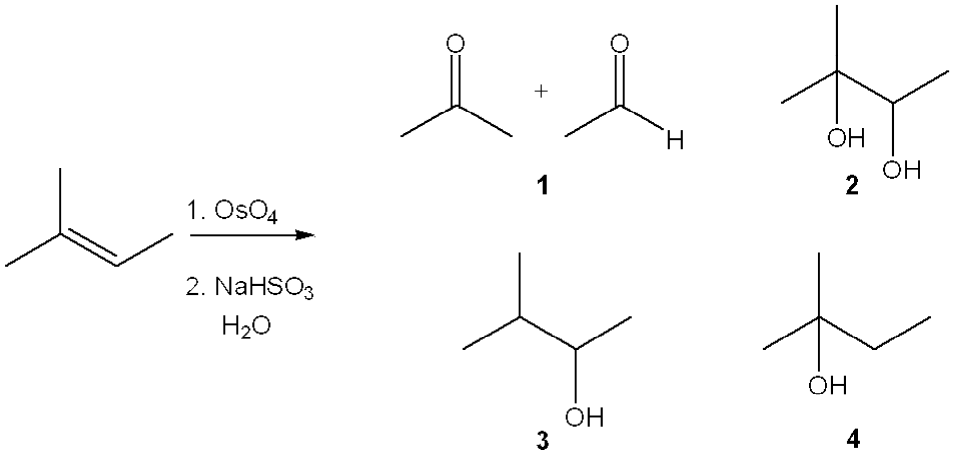
a. **1**
b. **2**
c. **3**
d. **4**

9. What is the correct order of stability of the following carbocations (more stable > less stable)?



a. **1** > **2** > **3**
b. **2** > **1** > **3**
c. **2** > **3** > **1**
d. **3** > **2** > **1**

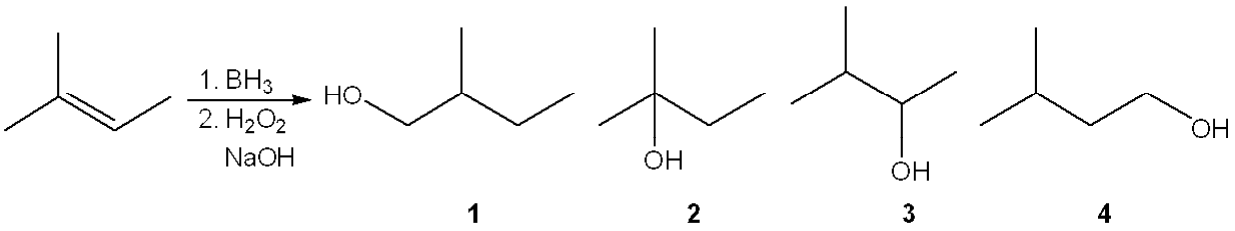
10. What is the major organic product obtained from the following reaction?



a. **1**
b. **2**
c. **3**
d. **4**

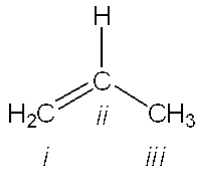
11. Which of the following compounds is the **strongest acid**?
    a. CH_3COOH
    b. FCH_2COOH
    c. $ClCH_2COOH$
    d. $BrCH_2COOH$

12. What is the major organic product obtained from the following reaction?



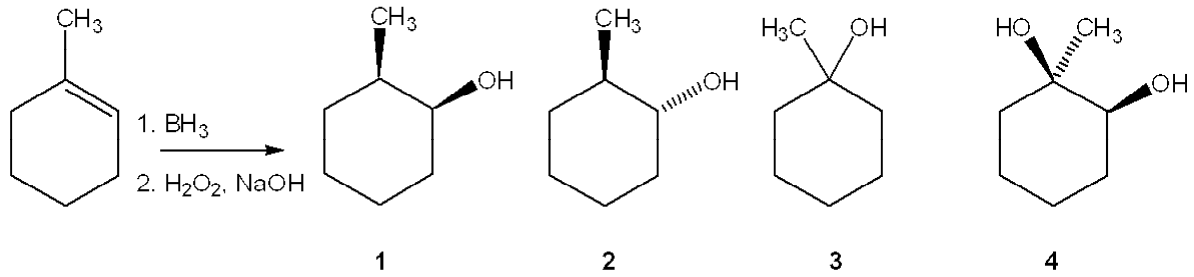
a. **1**
b. **2**
c. **3**
d. **4**

13. What is the hybridization of carbon atoms labeled *i* - *iii* in the following structure?



a. *i* = sp^2; *ii* = sp^2; *iii* = sp^2
b. *i* = *sp*; *ii* = *sp*; *iii* = sp^3
c. *i* = sp^2; *ii* = *sp*; *iii* = sp^3
d. *i* = sp^2; *ii* = sp^2; *iii* = sp^3

14. What is the major organic product obtained from the following reaction?

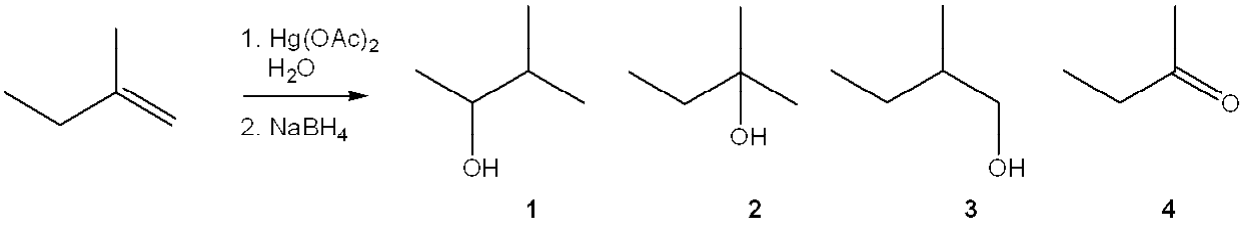


a. **1**
b. **2**
c. **3**
d. **4**

15. Which of the following concepts explains Markovnikov's rule as applied to the addition of HBr to propene?
a. the relative stability of carbocations
b. the nucleophilicity of bromide anion
c. the acidity of HBr
d. the Aufbau principle

16. Which of the following is present in the **highest concentration** upon dissolution of acetic acid in water?
a. OH^-
b. H_3O^+
c. CH_3COOH
d. CH_3COOH^+

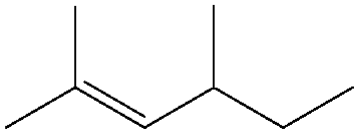
17. What is the major organic product obtained from the following reaction?



a. **1**
b. **2**
c. **3**
d. **4**

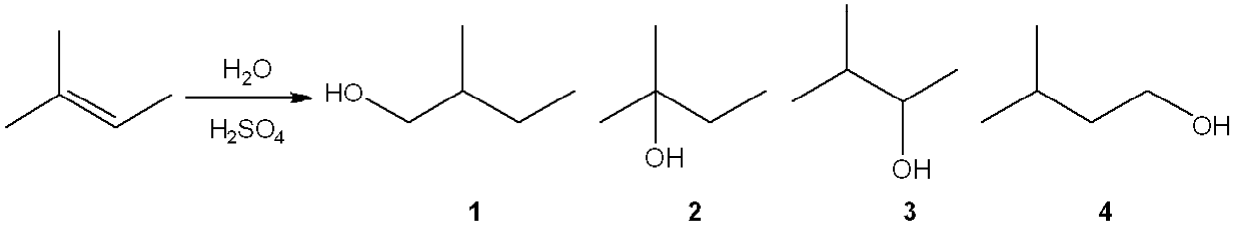
18. What is the index of hydrogen deficiency of a compound with a molecular formula of C_5H_{10}?
a. 0
b. 1
c. 2
d. 3

19. What is the IUPAC name of the following compound?



a. 1,3-dimethylhexene
b. 2,4-dimethyl-2-hexene
c. 2,4-dimethyl-1-hexene
d. 3,5-dimethyl-4-hexene

20. What is the major organic product obtained from the following reaction?



a. **1**
b. **2**
c. **3**
d. **4**

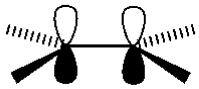
21. Which of the following is the **strongest base**?
    a. NaOH
    b. $NaHCO_3$
    c. H_2O
    d. CH_3OH

22. Which species is the **conjugate acid** in the following acid-base reaction?

    a. **1**
    b. **2**
    c. **3**
    d. **4**

23. What is the index of hydrogen deficiency of a compound with a molecular formula of C_5H_9Br?
    a. 0
    b. 1
    c. 2
    d. 3

24. What type of molecular orbital is formed by the overlap of atomic orbitals shown?



    a. s bonding
    b. s antibonding
    c. p bonding
    d. p antibonding

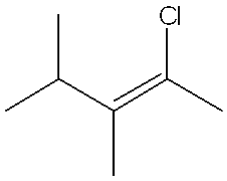
25. Which of the following concepts explains why tertiary carbocations are more stable than primary and secondary carbocations?
    a. electronegativity
    b. resonance
    c. hyperconjugation
    d. the octet rule

CH320/328 M

M_HW3

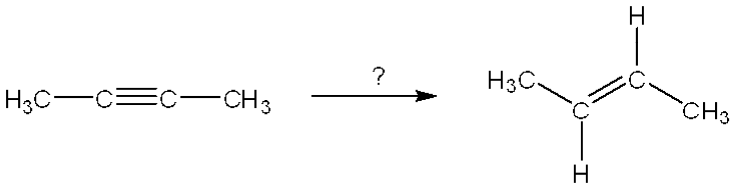
Multiple Choice
Identify the choice that best completes the statement or answers the question. There is only one correct response for each question. (4 pts each)

1. What is the IUPAC name of the following compound?



   a. (*E*)-1-chloro-1,2,3-trimethyl-1-butene
   b. (*Z*)-1-chloro-1,2,3-trimethyl-1-butene
   c. (*E*)-2-chloro-3,4-dimethyl-2-pentene
   d. (*Z*)-2-chloro-3,4-dimethyl-2-pentene

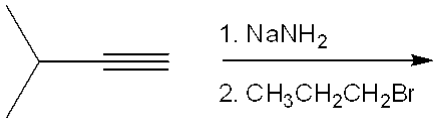
2. What is the best choice of reagent(s) to perform the following transformation?



   a. H_2/Pt
   b. H_2/Lindlar catalyst
   c. Na/NH_3
   d. BH_3; followed by H_2O_2, NaOH

3. What is the approximate C-C-C bond angle in propyne?
   a. 90°
   b. 109°
   c. 120°
   d. 180°

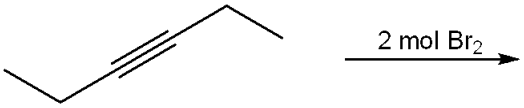
4. What is the major organic product obtained from the following reaction?



a. 2-methyl-3-hexene
b. 2-methyl-3-heptyne
c. 2-bromo-3-methylbutane
d. 2-methyl-2-butene

5. Which of the following bonds has the **lowest** bond dissociation enthalpy?
a. C-H
b. C-F
c. C-Br
d. C-I

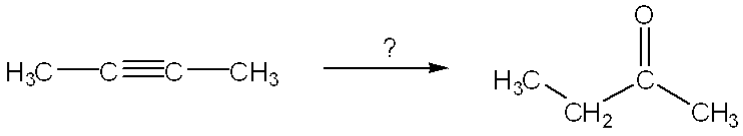
6. What is the major organic product obtained from the following reaction?



a. 3,4-dibromohexane
b. 3,3-dibromohexane
c. (*Z*)-3,4-dibromohexene
d. 3,3,4,4-tetrabromohexane

7. What type of *reactive intermediate* is formed upon irradiation of a solution of toluene (Ph-CH_3) and bromine?
a. benzylic carbocation
b. benzylic carbanion
c. benzylic radical
d. cyclic bromonium ion

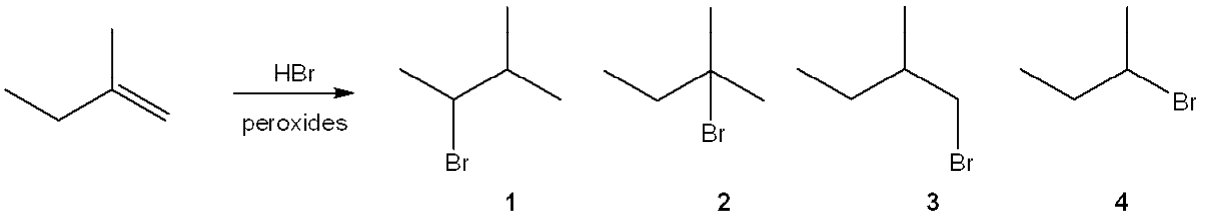
8. What is the best choice of reagent(s) to perform the following transformation?



a. H_2/Lindlar catalyst
b. Na/NH_3
c. $(sia)_2BH$; followed by H_2O_2, NaOH
d. BH_3; followed by H_2O_2, NaOH

9. What is the **geometry** of the central carbon atom of a *tert*-butyl radical?
   a. tetrahedral
   b. trigonal planar
   c. trigonal pyramidal
   d. square planar

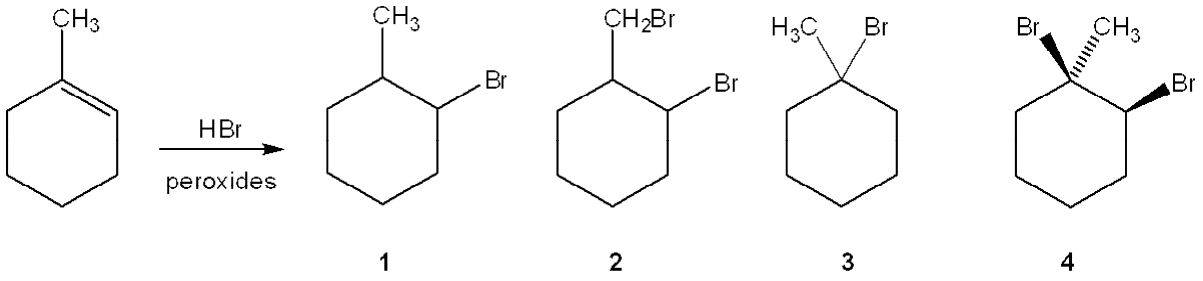
10. What is the major organic product obtained from the following reaction?



   a. **1**
   b. **2**
   c. **3**
   d. **4**

11. What type of reactive intermediate is formed in the reaction of propene with hydrogen bromide in the *presence of peroxides* to give 1-bromopropane?
   a. 1° radical
   b. 1° carbocation
   c. 1° radical
   d. 2° radical

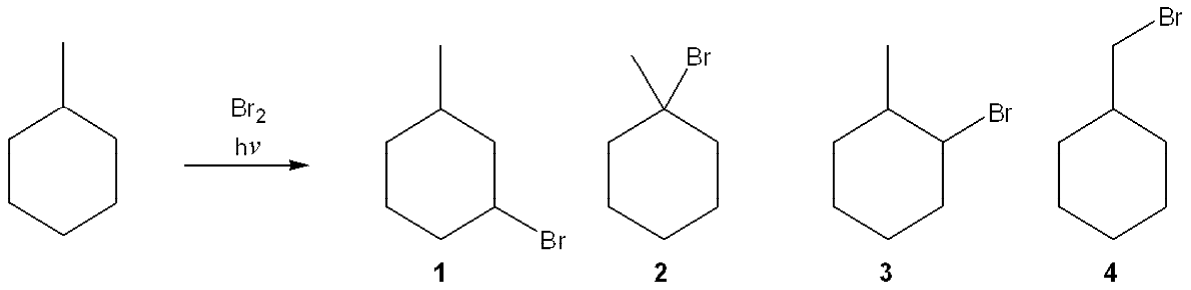
12. What is the major organic product obtained from the following reaction?



   a. **1**
   b. **2**
   c. **3**
   d. **4**

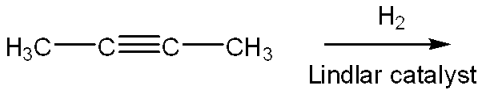
13. Which of the following has the lowest pK_a?
   a. butane
   b. 1-butene
   c. 1-butyne
   d. 2-butyne

14. What is the major organic product obtained from the following reaction?



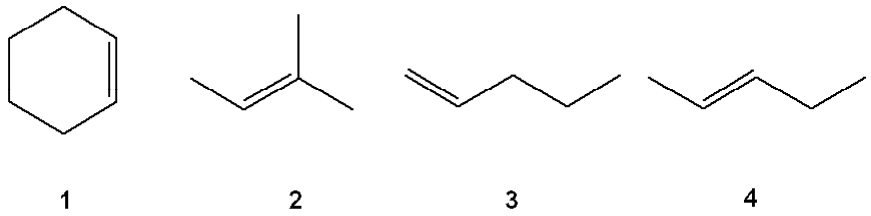
a. **1**
b. **2**
c. **3**
d. **4**

15. What is the major organic product obtained from the following reaction?



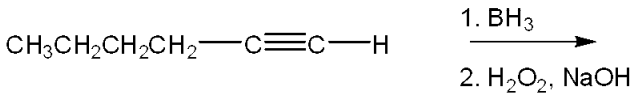
a. butane
b. 1-butene
c. *cis*-2-butene
d. *trans*-2-butene

16. Which of the following alkenes undergoes allylic bromination to form a single monobrominated product?



a. **1**
b. **2**
c. **3**
d. **4**

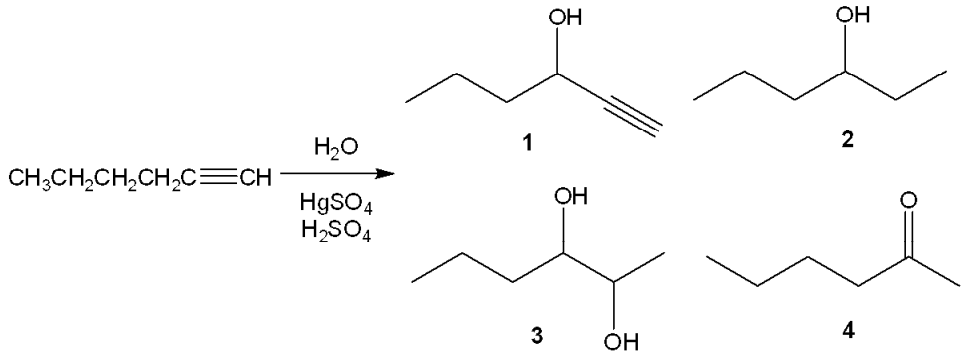
17. What is the major organic product obtained from the following reaction?



a. 2-hexanone
b. hexanal
c. 2-hexanol
d. *cis*-2-hexene

18. What is the characteristic of a radical chain initiation step?
a. radicals are formed
b. substitution products are formed
c. a radical reacts with a molecule to give a new radical and a new molecule
d. two radicals combine to give a molecule

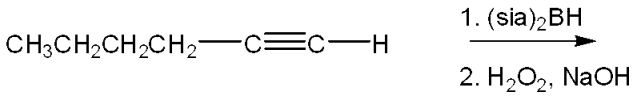
19. What is the major organic product obtained from the following reaction?



a. **1**
b. **2**
c. **3**
d. **4**

20. Which of the following bonds has the lowest bond dissociation enthalpy?
a. C-H
b. C-F
c. C-Br
d. C-I

21. What is the major organic product obtained from the following reaction?

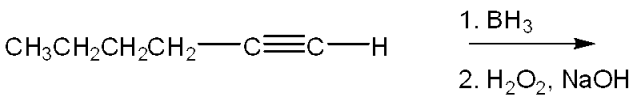


a. 2-hexanone
b. hexanal
c. 2-hexanol
d. *cis*-2-hexene

22. Which of the following statements is *not* true?
a. Bromine radicals add to the least substituted end of a carbon-carbon double bond of an alkene.
b. The major anti-Markovnikov product obtained upon addition of HBr to alkenes in the presence of a peroxide is formed in a radical termination step.
c. Two radicals combine in radical termination steps.
d. Alkoxy radicals remove a hydrogen atom from HBr to give an alcohol and a bromine atom.

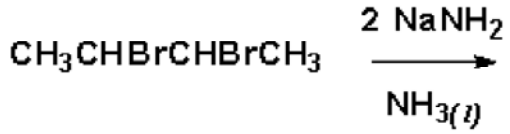
23. Which of the following statements is *not* true?
a. homolytic cleavage of a bond in a neutral molecule gives two radicals
b. radicals have one or more unpaired electrons
c. movement of single electrons is depicted using a "fishhook arrow"
d. the C-F bond is the weakest bond between carbon atom and a halogen

24. What is the major organic product obtained from the following reaction?



a. 2-hexanone
b. hexanal
c. 2-hexanol
d. *cis*-2-hexene

25. What is the major organic product obtained from the following reaction?



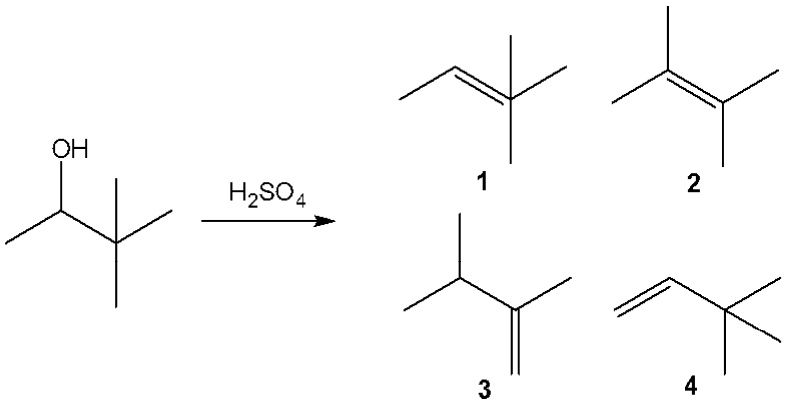
a. (*E*) 2-butene
b. (*Z*) 2-butene
c. 2-butyne
d. 1-butyne

CH320/328 M

M_HW4

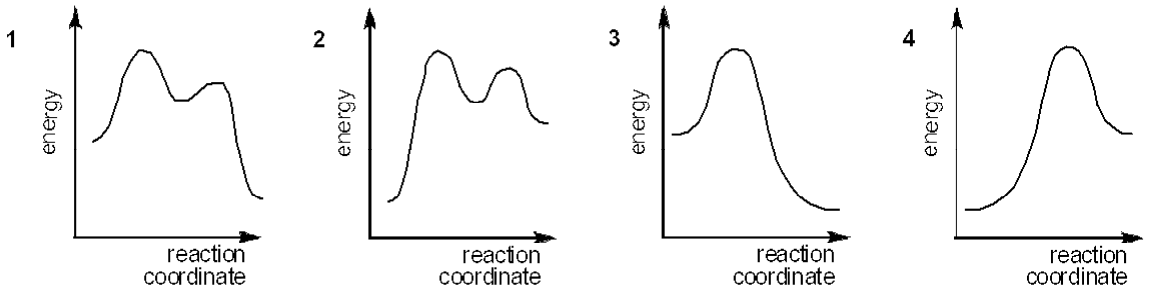
Multiple Choice
Identify the choice that best completes the statement or answers the question. There is only one correct response for each question. (4 pts each)

1. What is the major organic product obtained from the following reaction?



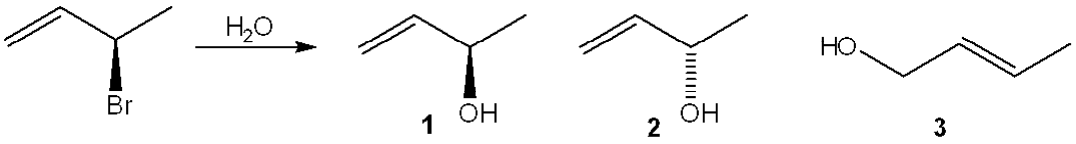
a. **1**
b. **2**
c. **3**
d. **4**

2. Which of the following energy diagrams represents the course of an exothermic S_N2 reaction?



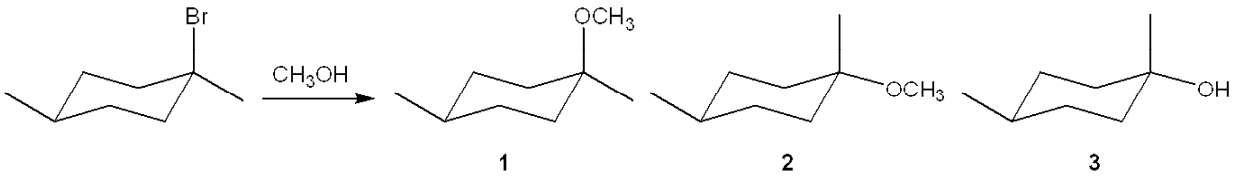
a. **1**
b. **2**
c. **3**
d. **4**

3. What is(are) the major organic product(s) obtained from the following substitution reaction?



a. only **1**
b. only **2**
c. only **1** and **2**
d. **1**, **2** and **3**

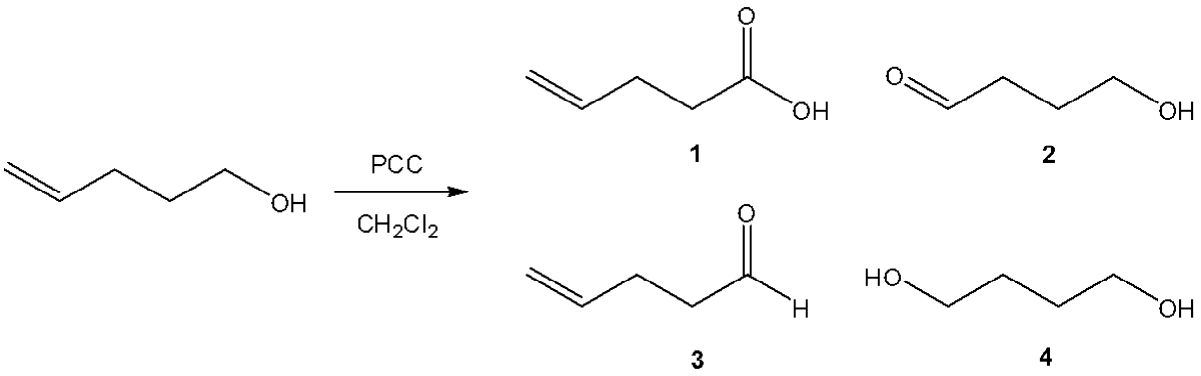
4. What is(are) the major organic product(s) obtained from the following substitution reaction?



a. only **1**
b. only **2**
c. only **3**
d. a mixture of **1** and **2**

5. Which of the following statements is *not* true regarding S_N1 reactions?
   a. A carbocation intermediate is formed.
   b. The mechanism has only one step.
   c. Polar, protic solvents are good choices for S_N1 reactions.
   d. The stereochemical outcome is racemization at the carbon bearing the leaving group.

6. What is the major organic product obtained from the following reaction?



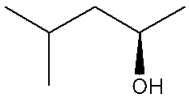
a. **1**
b. **2**
c. **3**
d. **4**

7. What is the major product formed upon treatment of (*R*) 1-bromo-4-methylhexane with sodium cyanide?
   a. (*R*) 1-cyano-4-methylhexane
   b. (*S*) 1-cyano-4-methylhexane
   c. (*R*) 4-methyl-1-hexene
   d. (*S*) 4-methyl-1-hexene

8. Which of the following anions is the best leaving group in an S_N1 reaction?
   a. F^-
   b. HO^-
   c. NH_2^-
   d. Cl^-

9. The reaction of *tert*-butyl bromide, $(CH_3)_3CBr$, with methanol in an inert solvent proceeds by an S_N1 mechanism to give *tert*-butyl methyl ether, $(CH_3)_3COCH_3$. What is the effect of doubling the concentration of methanol on the rate of the reaction?
   a. the rate remains the same
   b. the rate decreases by a factor of 2
   c. the rate increases by a factor of 2
   d. the rate increases by a factor of 4

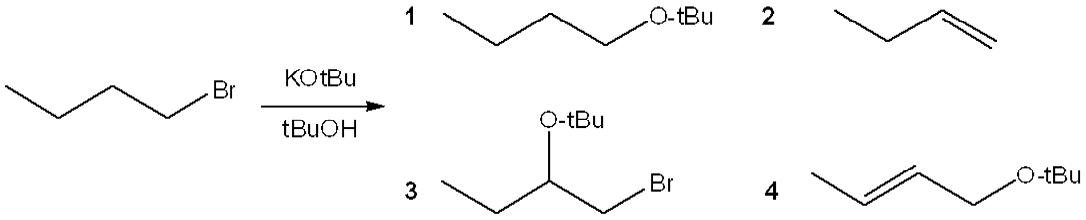
10. What is the IUPAC name of the following compound?



a. (*R*)-2-methyl-4-pentanol
b. (*S*)-2-methyl-4-pentanol
c. (*R*)-4-methyl-2-pentanol
d. (*S*)-4-methyl-2-pentanol

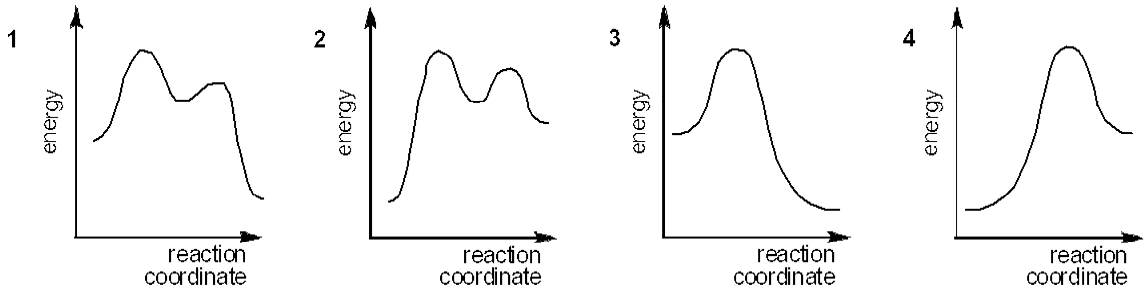
11. Which of the following sets consists of only **polar protic** solvents?
a. water, DMF, DMSO
b. acetic acid, methanol, water
c. DMSO, ethanol, acetonitrile
d. DMF, acetonitrile, DMSO

12. What is the major organic product obtained from the following reaction?



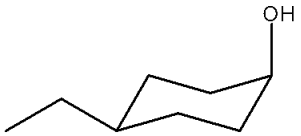
a. **1**
b. **2**
c. **3**
d. **4**

13. Which of the following energy diagrams represents the course of an exothermic S_N1 reaction?



a. **1**
b. **2**
c. **3**
d. **4**

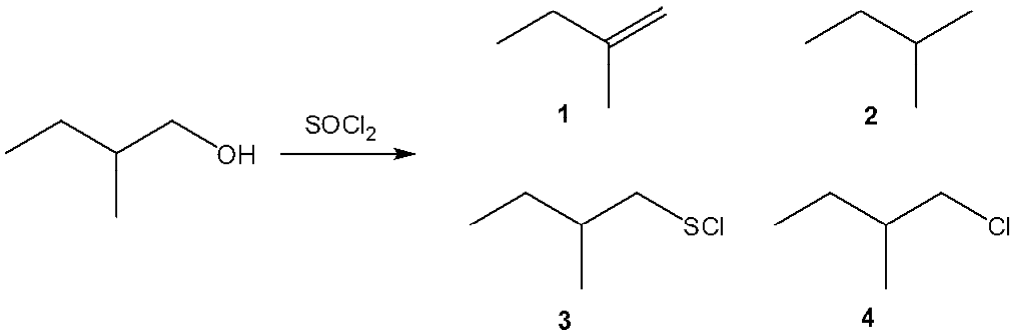
14. What is the IUPAC name of the following compound?



a. *cis*-4-ethylcyclohexanol
b. *trans*-4-ethylcyclohexanol
c. *cis*-4-hydroxy-1-ethylcyclohexane
d. *trans*-4-hydroxy-1-ethylcyclohexane

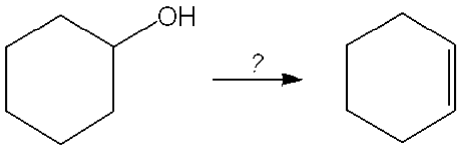
15. Which of the following statements is *not* true regarding S_N2 reactions?
a. A carbocation intermediate is formed.
b. The mechanism has only one step.
c. Aprotic solvents are good choices for S_N1 reactions.
d. The stereochemical outcome is inversion at the carbon bearing the leaving group.

16. What is the major organic product obtained from the following reaction?



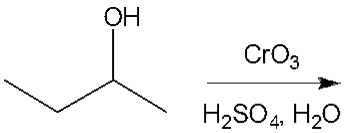
a. **1**
b. **2**
c. **3**
d. **4**

17. What is the **best** choice of reagent to perform the following transformation?



a. H_2SO_4
b. H_2O
c. $NaOCH_3$
d. KOtBu

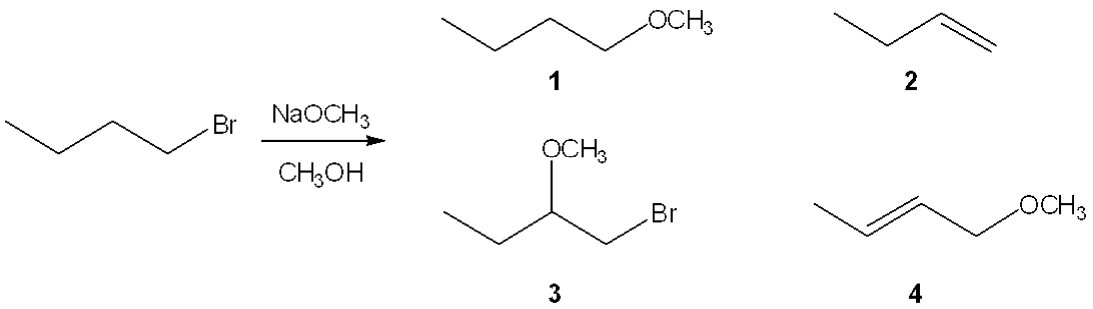
18. What is the major organic product obtained from the following reaction?



a. 1-butene, $CH_3CH_2CH{=}CH_2$
b. butanal, $CH_3CH_2CH_2CHO$
c. butanone, $CH_3CH_2COCH_3$
d. butanoic acid, $CH_3CH_2CH_2COOH$

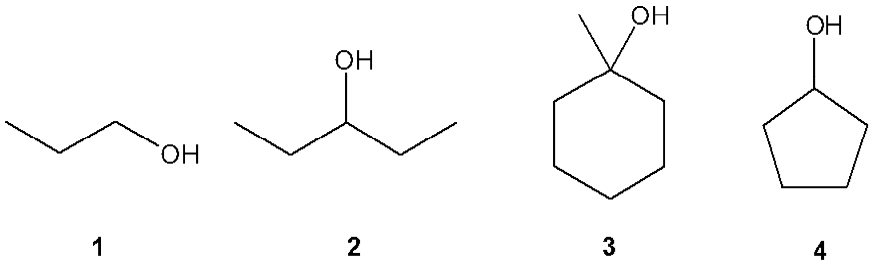
19. Which of the following is *not* a characteristic of S_N2 reactions?
a. the electrophilic carbon undergoes inversion of stereochemistry
b. the rate is proportional to the concentration of substrate
c. the rate is proportional to the concentration of nucleophile
d. the rate is independent of the solvent

20. What is the major organic product obtained from the following reaction?



a. **1**
b. **2**
c. **3**
d. **4**

21. Which of the following alcohols undergoes the most rapid dehydration upon treatment with H_2SO_4 to give an alkene?

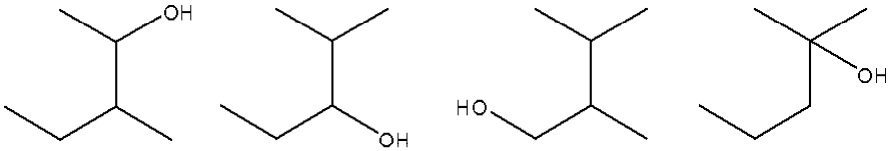


1 **2** **3** **4**

a. **1**
b. **2**
c. **3**
d. **4**

22. Which of the following has the highest boiling point?
a. pentane
b. methyl propyl ether
c. diethyl ether
d. 1-butanol

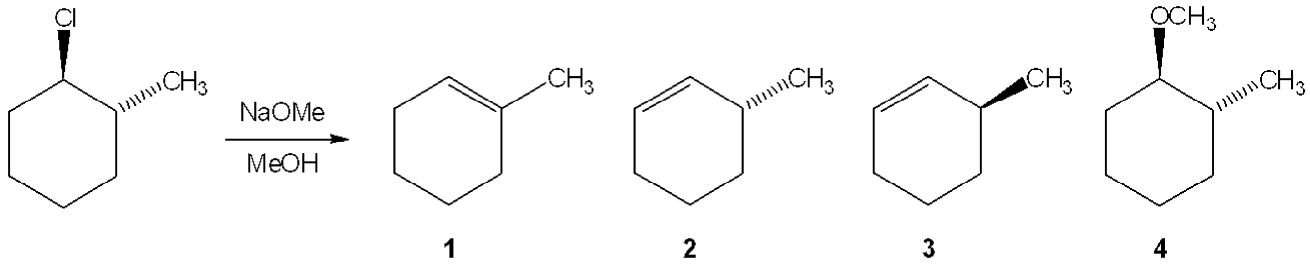
23. Which of the following is/are primary (1°) alcohols?



1 **2** **3** **4**

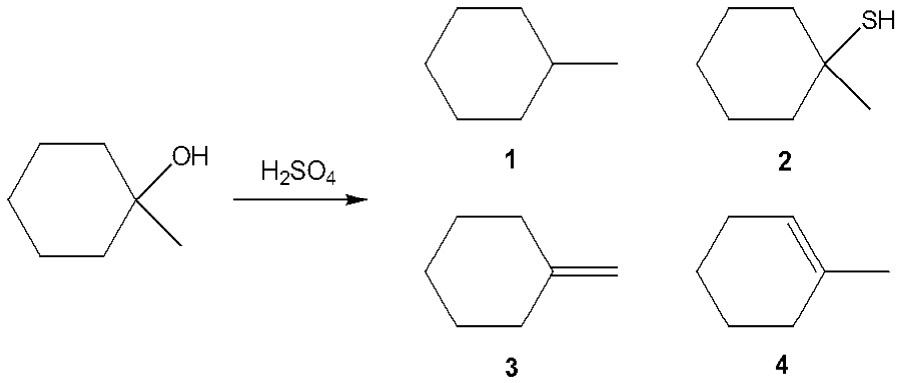
a. only **1**
b. only **3**
c. only **1** and **3**
d. only **2**, **3**, and **4**

24. What is the major elimination product obtained from the following reaction?



a. **1**
b. **2**
c. **3**
d. **4**

25. What is the major organic product obtained from the following reaction?



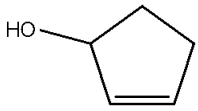
a. **1**
b. **2**
c. **3**
d. **4**

CH320/328 M

M_HW5

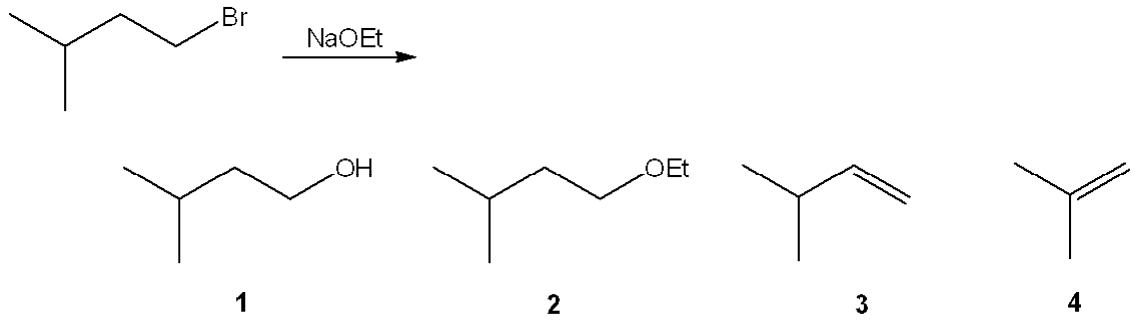
Multiple Choice
Identify the choice that best completes the statement or answers the question. There is only one correct response for each question.

1. What is the IUPAC name of the following compound?



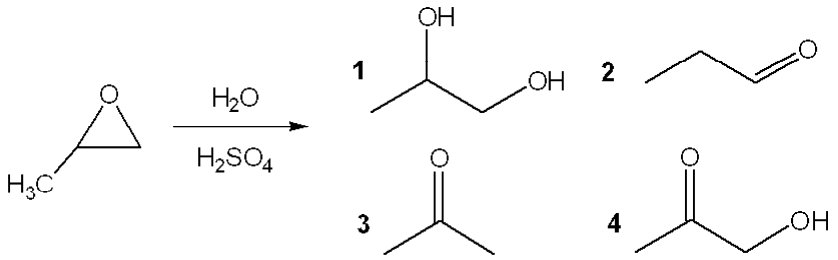
   a. 2-cyclopentenol
   b. 3-cyclopentenol
   c. cyclopenten-3-ol
   d. cyclopenten-2-ol

2. What is the major organic product obtained from the following reaction?



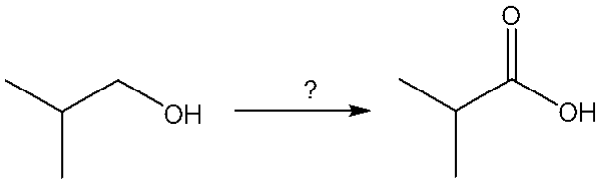
   a. **1**
   b. **2**
   c. **3**
   d. **4**

3. What is the major organic product obtained from the following reaction?



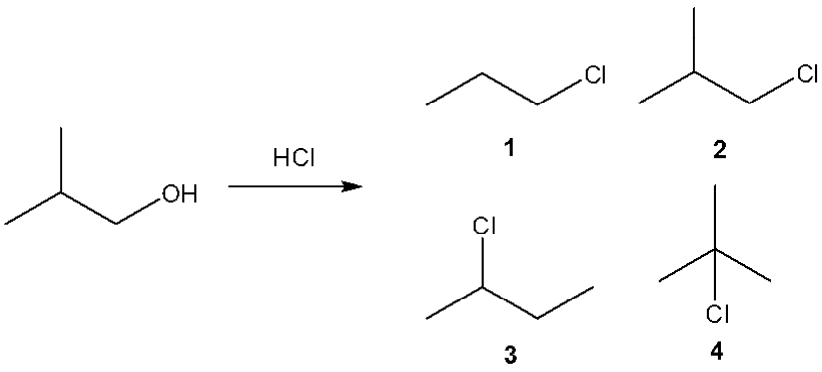
a. **1**
b. **2**
c. **3**
d. **4**

4. What is the **best** choice of reagent to achieve the following transformation?



a. CrO_3
b. NaOH
c. PCC
d. HIO_4
e. The correct reagent is not listed.

5. What is the major organic product obtained from the following reaction?



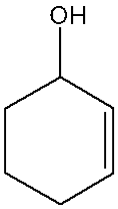
a. **1**
b. **2**
c. **3**
d. **4**
e. The correct product is not shown.

6. What is the major organic product obtained from the reaction of 2,2-dimethyl-1-propanol aqueous HBr at reflux?
   a. 1-bromo-2,2-dimethylpropane
   b. 1-bromo-2-methylbutane
   c. 2-bromo-2-methylbutane
   d. 3-bromo-2-methylbutane
   e. The correct product is not listed.

7. What type of reactive intermediate is formed in the reaction of *tert*-butyl alcohol with HCl to give *tert*-butyl chloride?
   a. *tert*-butyl radical
   b. *tert*-butyl anion
   c. *tert*-butyl cation
   d. *tert*-butoxide

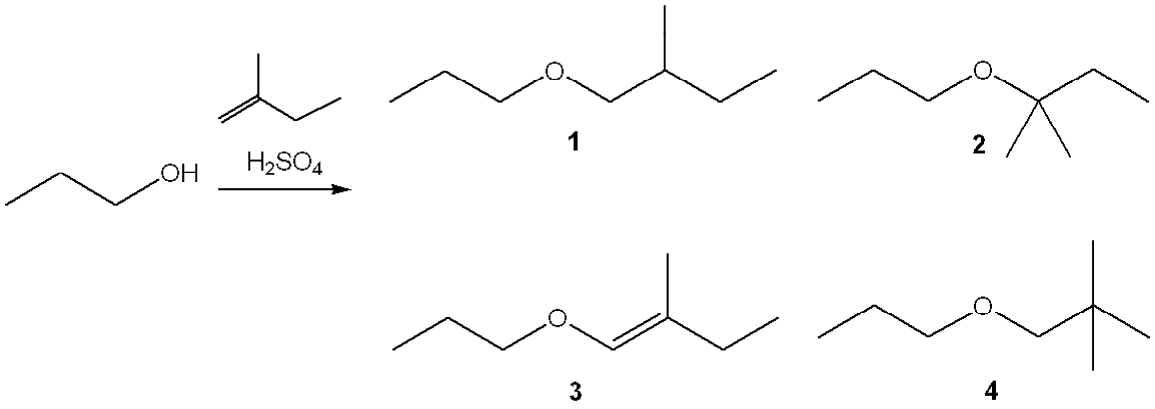
8. What type of reactive intermediate is formed in the reaction of methyl propene with methanol in the presence of an acid catalyst to give methyl *tert*-butyl ether (MTBE)?
   a. *tert*-butyl cation
   b. *tert*-butyl radical
   c. *tert*-butyl anion
   d. *tert*-butoxide

9. What is the IUPAC name of the following compound?



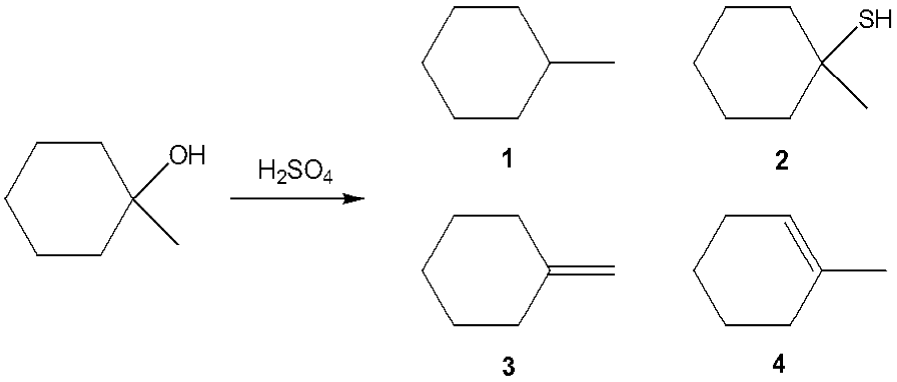
   a. cyclohexen-3-ol
   b. cyclohexen-2-ol
   c. 2-cyclohexenol
   d. 3-cyclohexenol

10. What is the major organic product obtained from the following reaction?



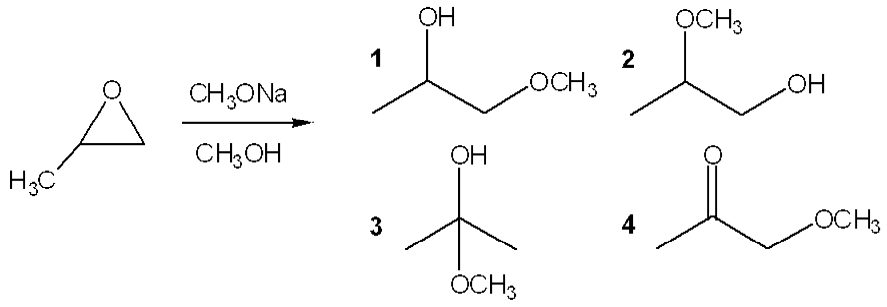
a. **1**
b. **2**
c. **3**
d. **4**

11. What is the major organic product obtained from the following reaction?



a. **1**
b. **2**
c. **3**
d. **4**

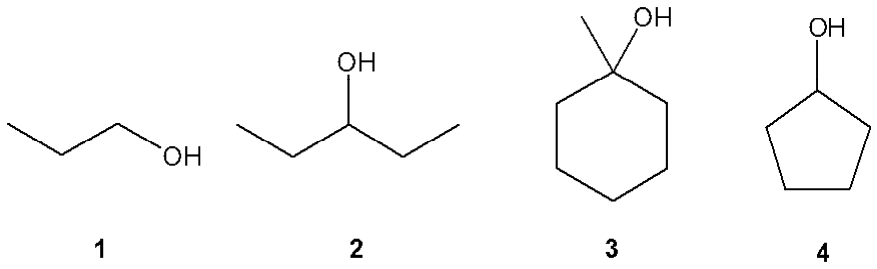
12. What is the major organic product obtained from the following reaction?



a. **1**
b. **2**
c. **3**
d. **4**

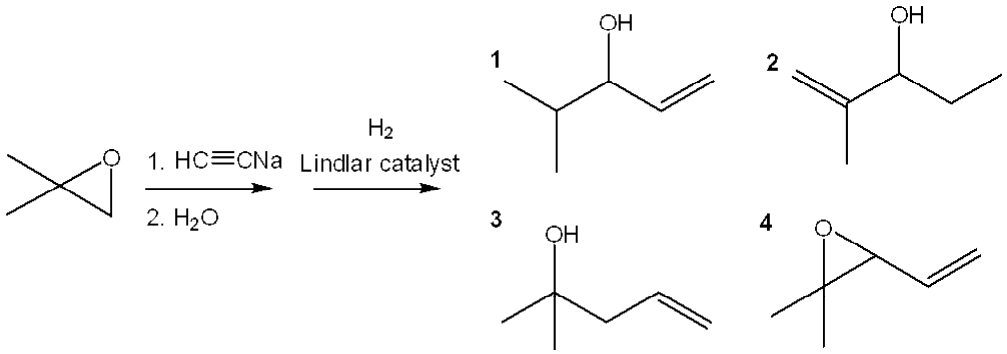
13. Which of the following ethers *cannot* be prepared by a Williamson ether synthesis?
    a. *tert*-butyl phenyl ether
    b. isopropyl methyl ether
    c. anisole
    d. *tert*-butyl methyl ether

14. Which of the following alcohols reacts fastest with HBr to give the corresponding alkyl bromide?



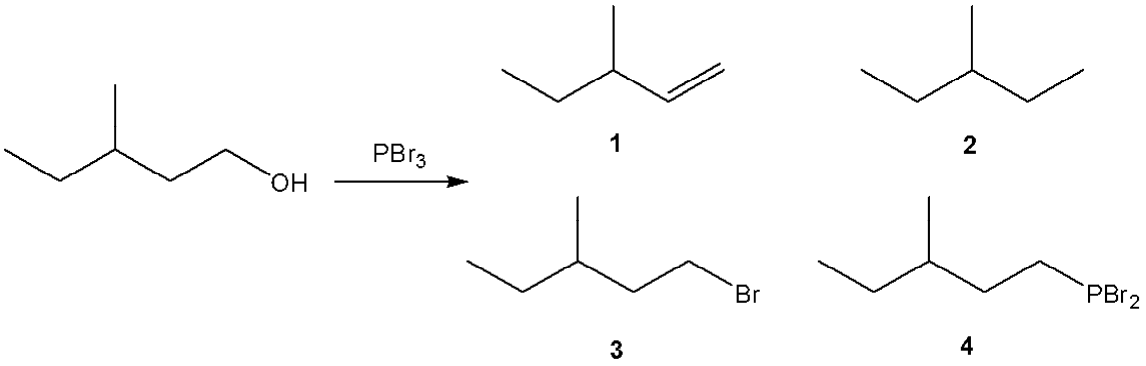
a. **1**
b. **2**
c. **3**
d. **4**

15. What is the major organic product obtained from the following sequence of reactions?



a. **1**
b. **2**
c. **3**
d. **4**

16. What is the major organic product obtained from the following reaction?



a. **1**
b. **2**
c. **3**
d. **4**
e. The correct product is not shown.

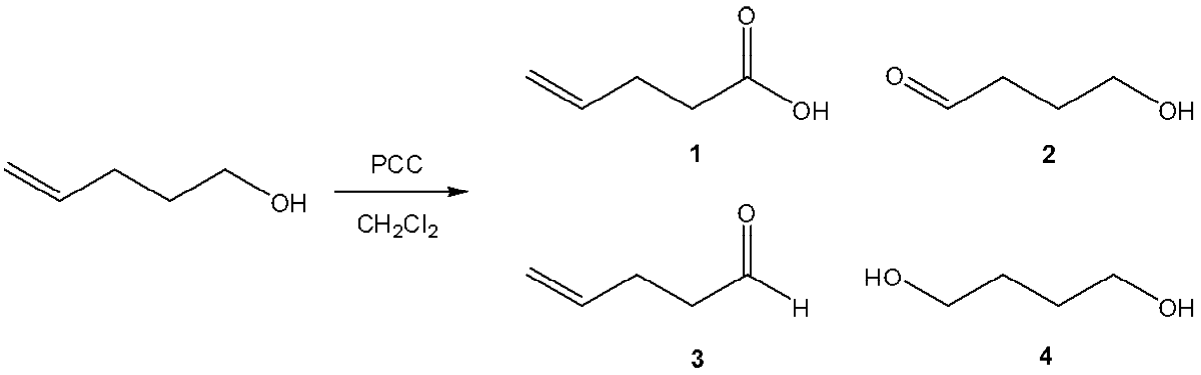
17. What is the major organic product obtained from the reaction of 2,2-dimethyl-1-propanol aqueous HBr at reflux?
    a. 1-bromo-2,2-dimethylpropane
    b. 1-bromo-2-methylbutane
    c. 2-bromo-2-methylbutane
    d. 3-bromo-2-methylbutane

18. Which of the following statements are true?

1. ethanol is more soluble in water than dimethyl ether
2. ethanol has a higher boiling point than dimethyl ether
3. ethanol has the same molecular weight as dimethyl ether

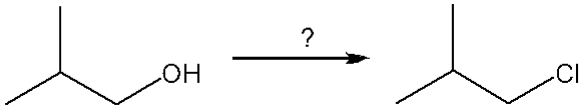
a. only **1**
b. only **1** and **2**
c. only **1** and **3**
d. **1**, **2** and **3**

19. What is the major organic product obtained from the following reaction?



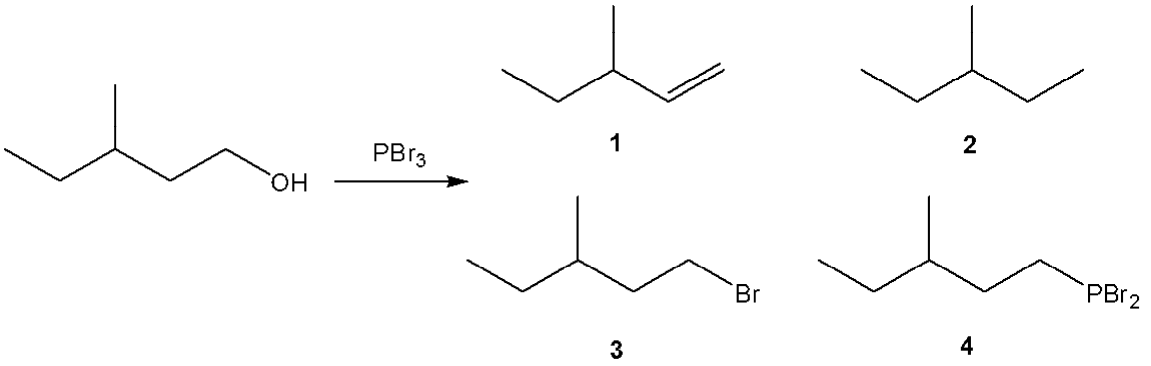
a. **1**
b. **2**
c. **3**
d. **4**

20. What is the best choice of reagent to achieve the following transformation?



a. HCl
b. Cl_2, light
c. $SOCl_2$, pyridine
d. HOCl, H_2O

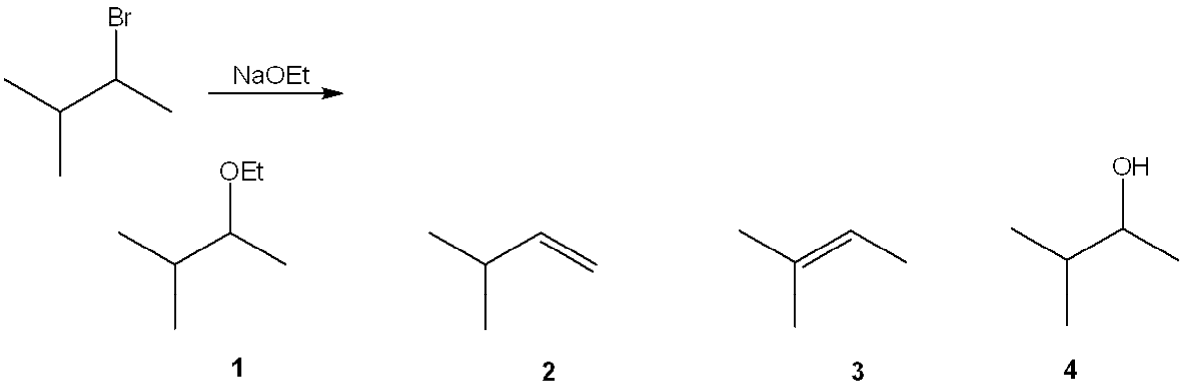
21. What is the major organic product obtained from the following reaction?



a. **1**
b. **2**
c. **3**
d. **4**

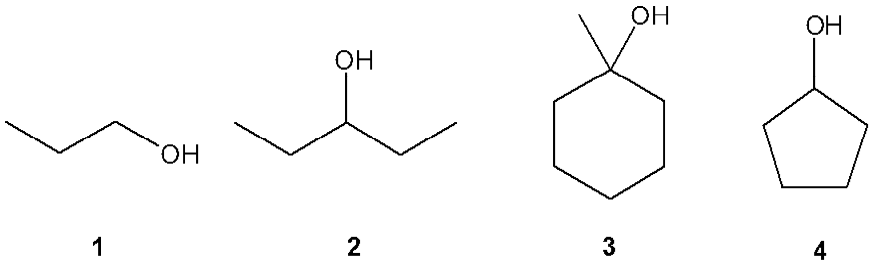
22. What type of reactive intermediate is formed in the reaction of *tert*-butyl alcohol with H_2SO_4 to give methylpropene?
a. *tert*-butyl cation
b. *tert*-butyl anion
c. *tert*-butyl radical
d. *tert*-butoxide

23. What is the major organic product obtained from the following reaction?



a. **1**
b. **2**
c. **3**
d. **4**

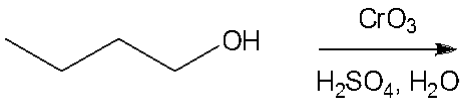
24. Which of the following alcohols undergoes the most rapid dehydration upon treatment with H_2SO_4 to give an alkene?



1 2 3 4

a. **1**
b. **2**
c. **3**
d. **4**

25. What is the major organic product obtained from the following reaction?



a. 1-butene, $CH_3CH_2CH{=}CH_2$
b. butanal, $CH_3CH_2CH_2CHO$
c. butanone, $CH_3CH_2COCH_3$
d. butanoic acid, $CH_3CH_2CH_2COOH$
e. The correct product is not listed.