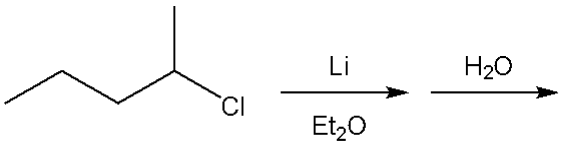
CH320 N

N_HW1

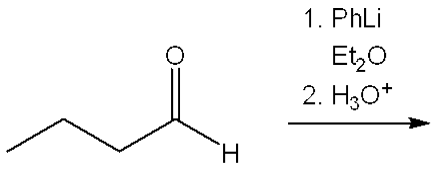
Multiple Choice
Identify the choice that best completes the statement or answers the question. There is only one correct response for each question. Carefully record your answers on the Scantron sheets provided in class. (4 pts each))

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



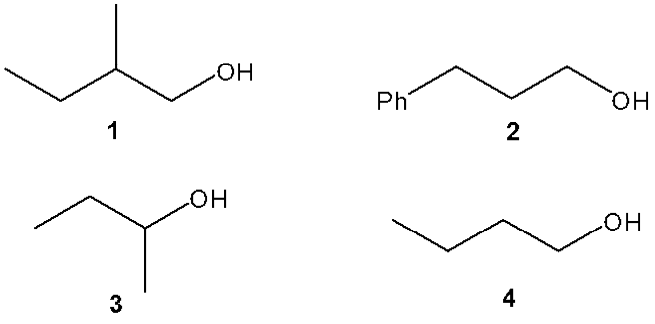
   a. 2-pentanol
   b. pentane
   c. 1-pentene
   d. (*E*)-2-pentene

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



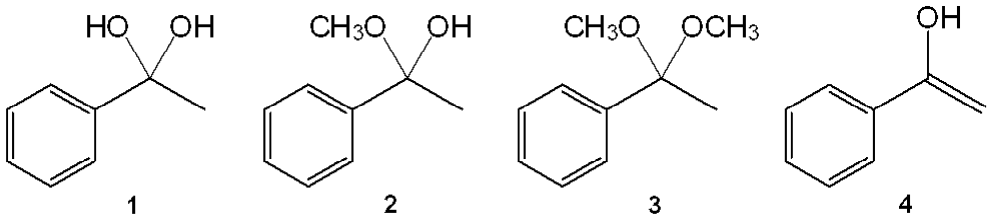
   a. 1-phenyl-1-butanol
   b. 1-phenyl-2-butanol
   c. 2-phenyl-1-butanol
   d. butyrophenone, $PhCOCH_2CH_2CH_3$

3. Which of the following alcohols can be prepared from a Grignard reagent and ethylene oxide?



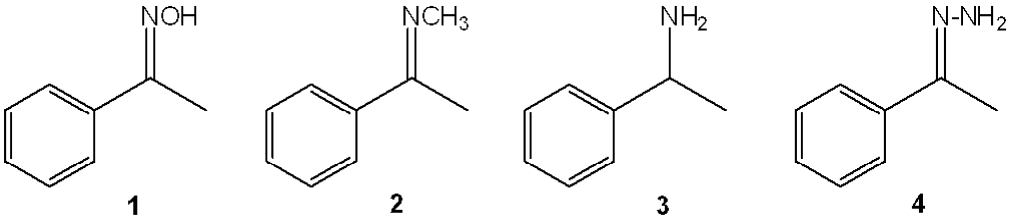
   a. only **1** and **2**
   b. only **1** and **4**
   c. only **1**, **2** and **3**
   d. only **2** and **4**

4. What is the correct assignment of the names of the following functional groups?



a. **1** = enol; **2** = hydrate; **3** = acetal; **4** = hemiacetal
b. **1** = acetal; **2** = hydrate; **3** = enol; **4** = hemiacetal
c. **1** = hydrate; **2** = hemiacetal; **3** = acetal; **4** = enol
d. **1** = enol; **2** = hydrate; **3** = hemiacetal; **4** = enol

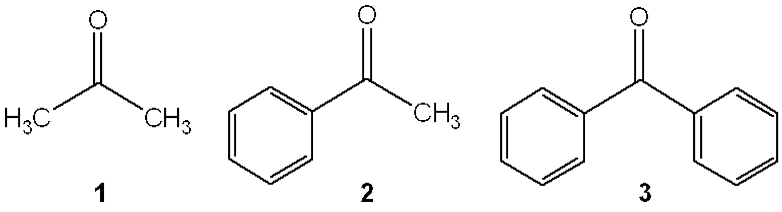
5. What is the correct assignment of the names of the following functional groups?



a. **1** = imine; **2** = amine; **3** = hydrazone; **4** = oxime
b. **1** = hydrazone; **2** = amine; **3** = imine; **4** = oxime
c. **1** = oxime; **2** = imine; **3** = amine; **4** = hydrazone
d. **1** = imine; **2** = hydrazone; **3** = oxime; **4** = amine

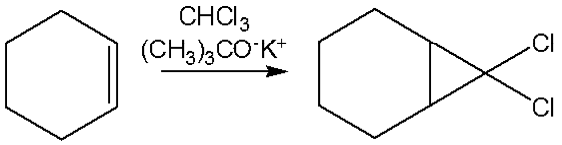
6. Which of the following molecules are deprotonated by ethylmagnesium bromide?
   a. phenol, PhOH
   b. propyne, $CH_3C{\equiv}CH$
   c. dimethylamine, $(CH_3)_2NH$
   d. all of these

7. What is the correct assignment of the names of the following ketones?



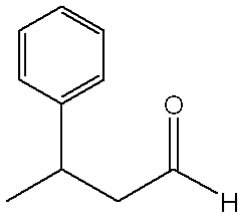
a. **1** = acetone; **2** = phenol; **3** = benzaldehyde
b. **1** = acetone; **2** = acetophenone; **3** = benzophenone
c. **1** = formaldehyde; **2** = benzaldehyde; **3** = acetophenone
d. **1** = acetaldehyde; **2** = acetophenone; **3** = benzaldehyde

8. What reactive intermediates are involved in the following reaction?



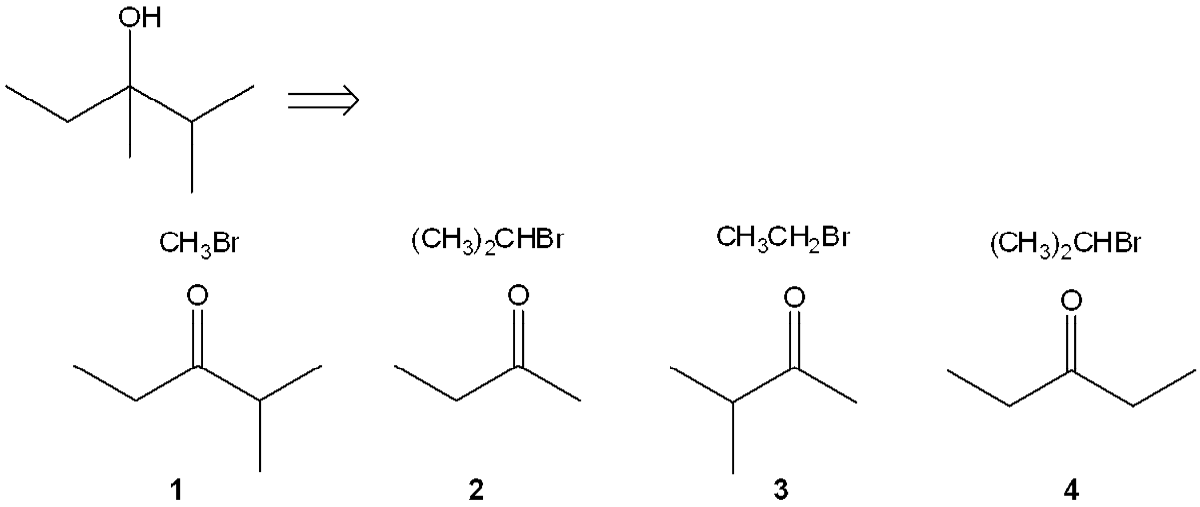
a. the trichloromethyl anion ($Cl_3C:^-$) and dichlorocarbene ($Cl_2C:$)
b. the trichloromethyl cation (Cl_3C^+)
c. the cyclohexyl carbocation
d. the cyclic chloronium ion derived from cyclohexene

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



a. 3-methyl-3-phenylpropanol
b. 3-phenylbutanal
c. 3-phenyl-1-butanone
d. 3-phenylbutanoic acid

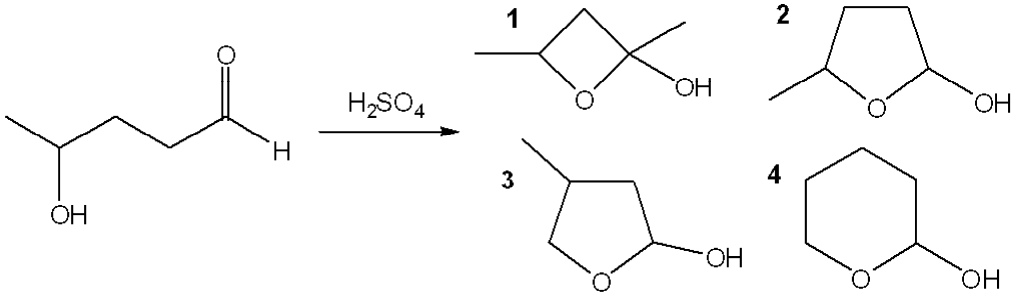
10. Which combination(s) of alkyl bromide and carbonyl compound can be used to prepare the following product by addition of the Grignard reagent derived from the alkyl bromide to the carbonyl compound?



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

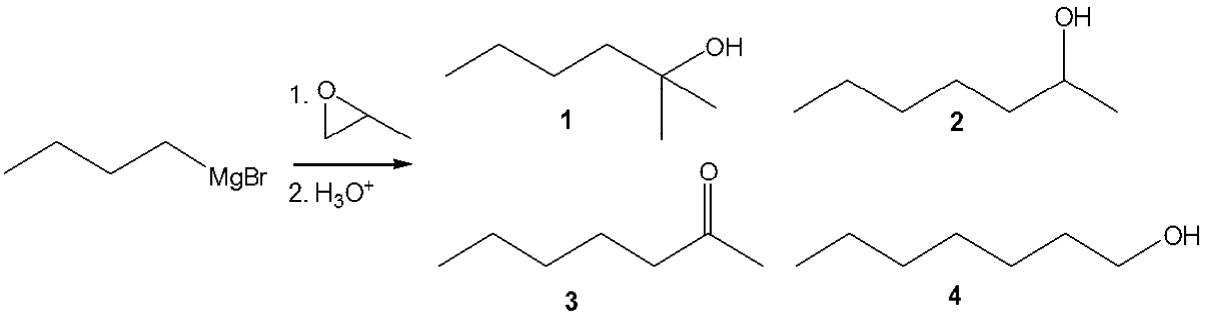
11. Which of the following bonds has the **most** ionic character?
    a. C–Si
    b. C–Cu
    c. C–Zn
    d. C–Li

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



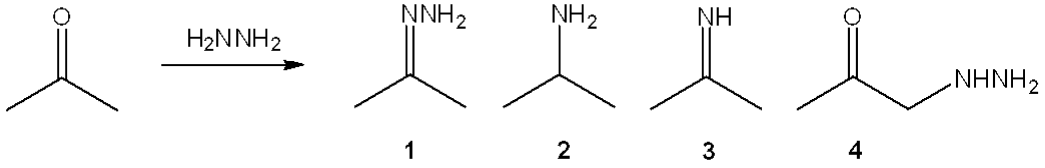
    a. **1**
    b. **2**
    c. **3**
    d. **4**

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



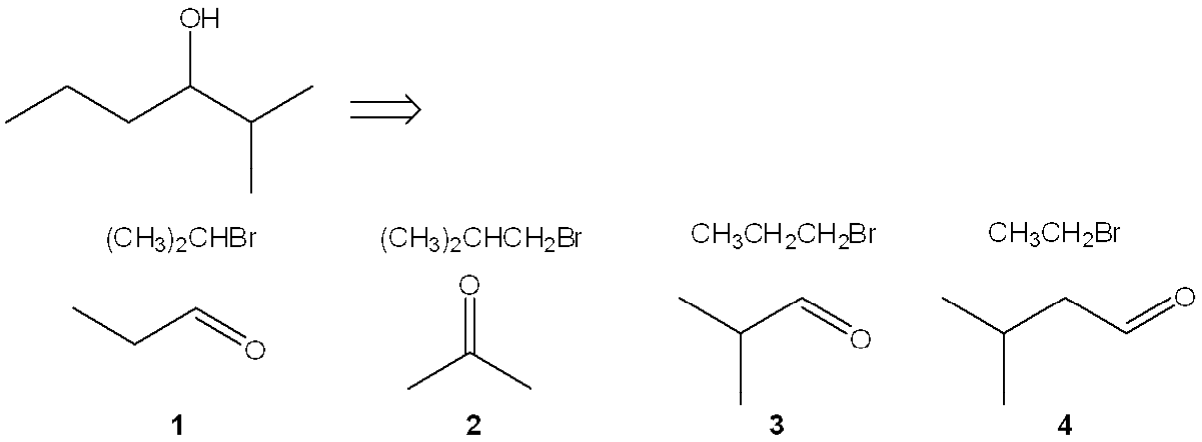
    a. **1**
    b. **2**
    c. **3**
    d. **4**

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



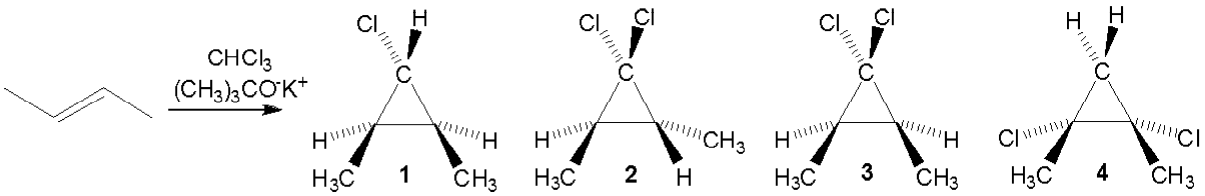
a. **1**
b. **2**
c. **3**
d. **4**

15. Which combination(s) of alkyl bromide and carbonyl compound can be used to prepare the following product by addition of the Grignard reagent derived from the alkyl bromide to the carbonyl compound?



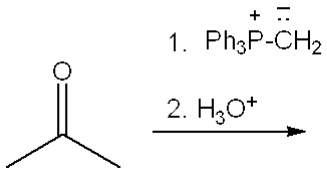
a. only **1**
b. only **3**
c. only **1** and **3**
d. only **2** and **4**

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



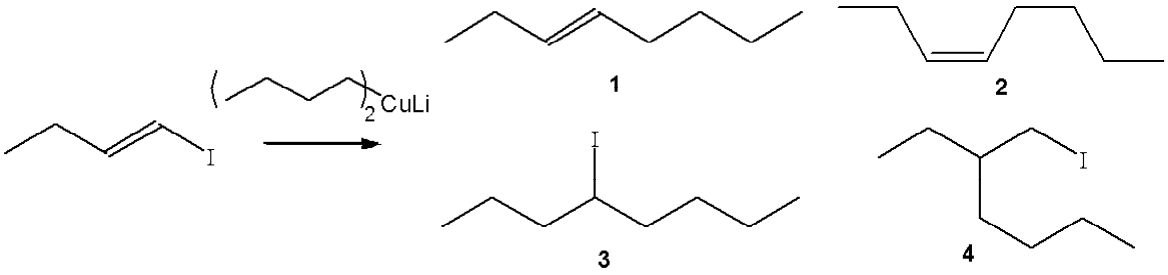
a. **1**
b. **2**
c. **3**
d. **4**

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



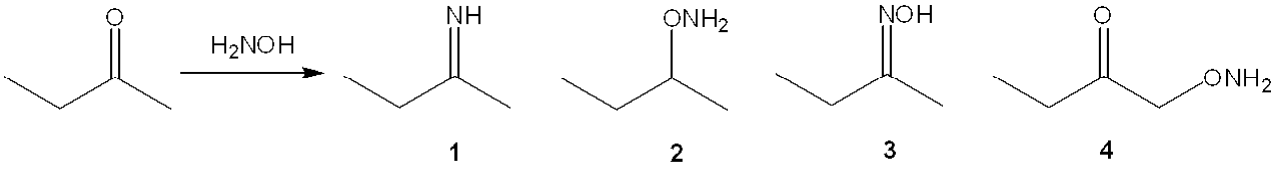
a. 1-butene
b. 2-butene
c. 2-methylpropene
d. 2-methyl-1-propanol

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



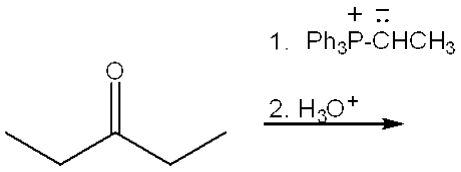
a. **1**
b. **2**
c. **3**
d. **4**

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



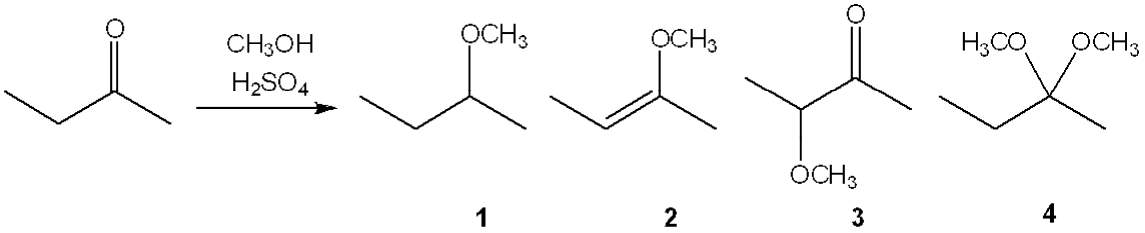
a. **1**
b. **2**
c. **3**
d. **4**

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



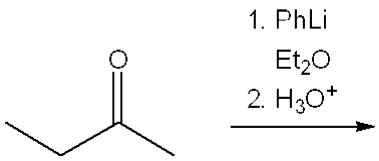
a. 2-methyl-2-heptene
b. 3-ethyl-2-pentene
c. (*Z*) 2-methyl-3-heptene
d. (*E*) 2-methyl-3-heptene

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



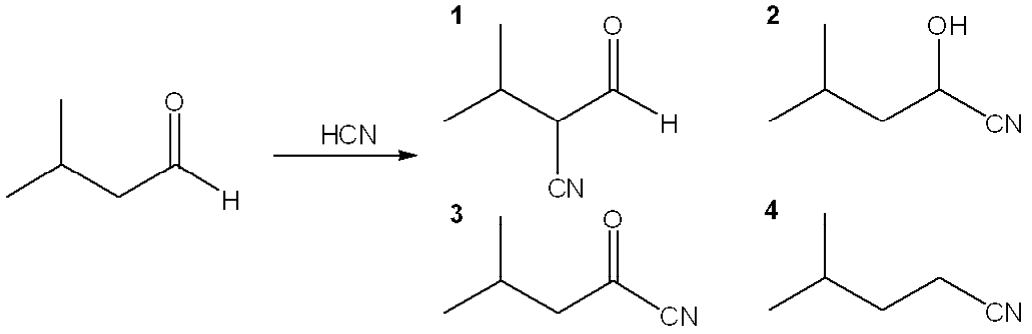
a. **1**
b. **2**
c. **3**
d. **4**

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



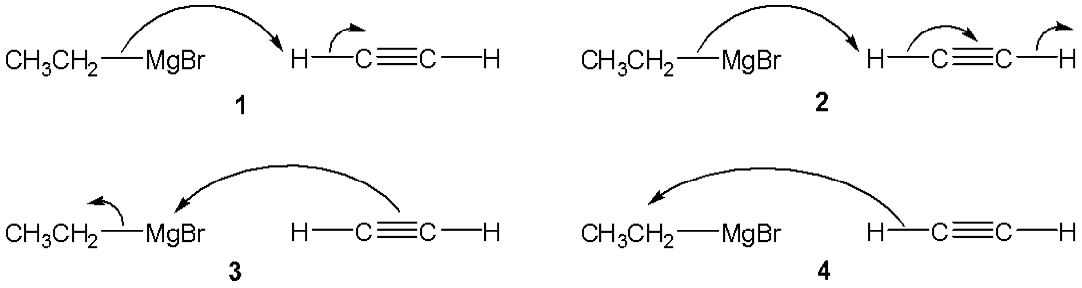
a. 2-phenyl-2-butanol
b. 3-phenyl-2-butanol
c. 3-phenylbutanone
d. propiophenone, $PhCOCH_2CH_3$

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



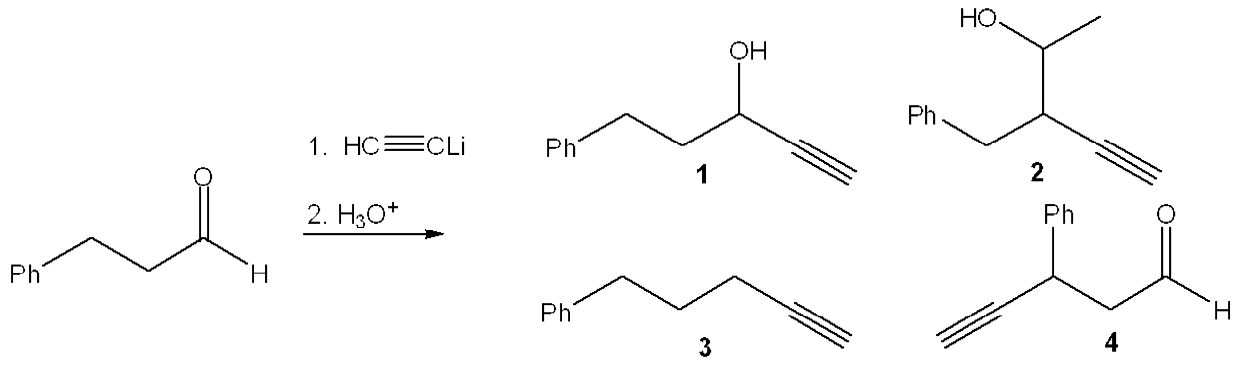
a. **1**
b. **2**
c. **3**
d. **4**

24. Which of the following mechanisms accounts for the acid-base reaction of ethylmagnesum bromide with acetylene to give acetylide anion?



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

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



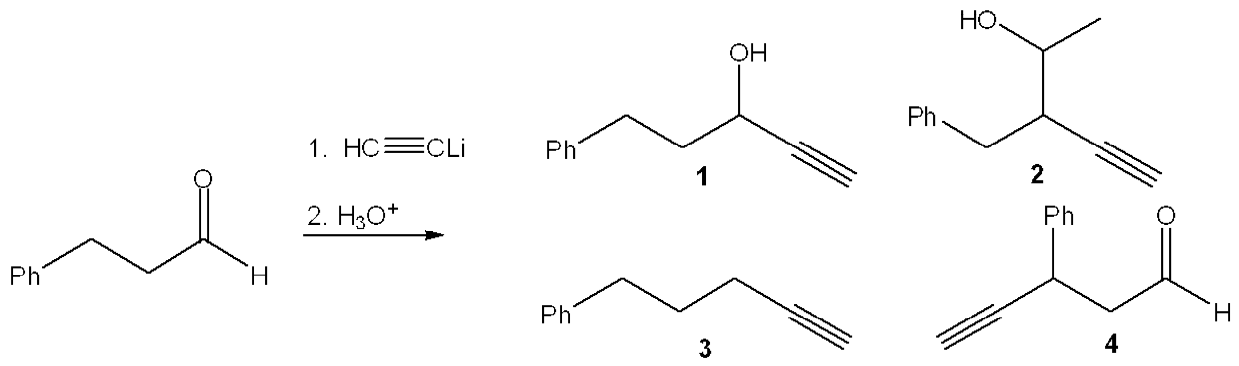
a. **1**
b. **2**
c. **3**
d. **4**

CH320 N

HW2

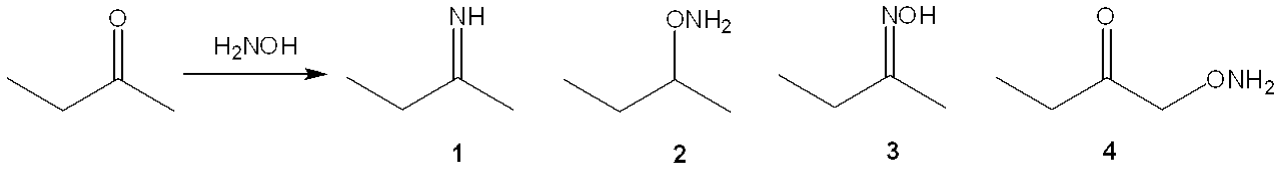
Multiple Choice
Identify the choice that best completes the statement or answers the question. There is only one correct response for each question. Carefully record your answers on the Scantron sheets provided in class. (4 pts each)

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



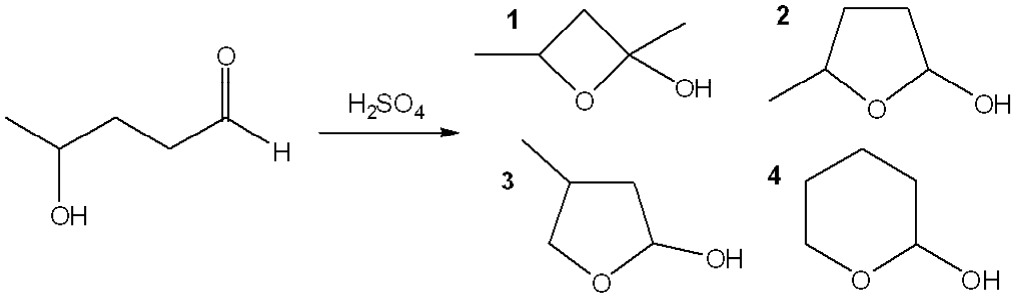
a. **1**
b. **2**
c. **3**
d. **4**

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



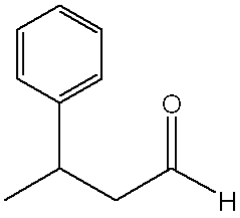
a. **1**
b. **2**
c. **3**
d. **4**

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



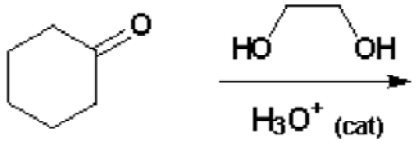
a. **1**
b. **2**
c. **3**
d. **4**

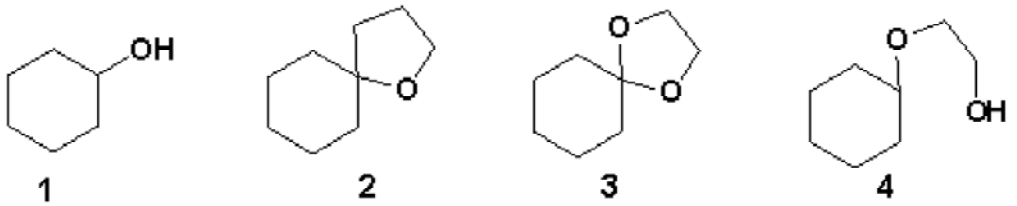
4. What is the IUPAC name of the following compound?



a. 3-phenylbutanoic acid
b. 3-phenyl-1-butanone
c. 3-methyl-3-phenylpropanol
d. 3-phenylbutanal

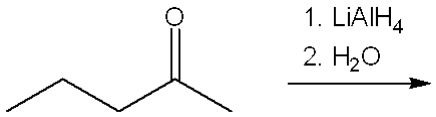
5. The product of this acid catalyzed reaction is:





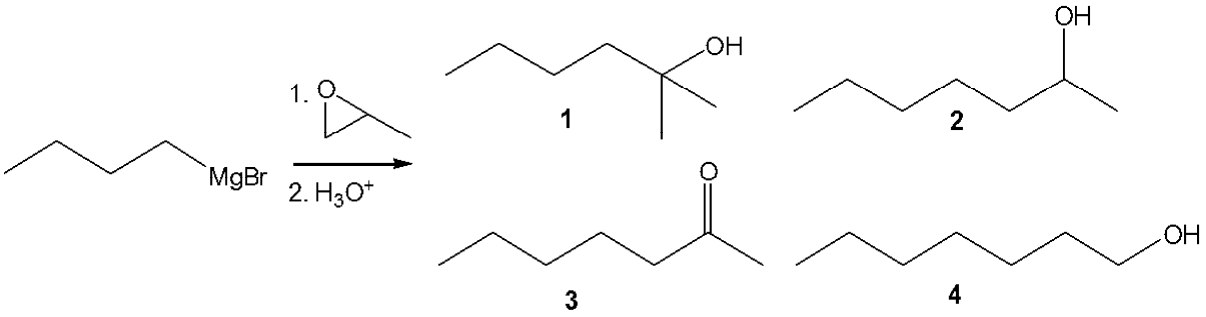
a. 1
b. 2
c. 3
d. 4

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



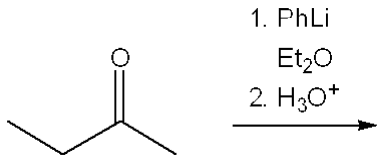
a. (*E*) 2-pentene
b. pentane
c. 2-pentanol
d. 1-pentene

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



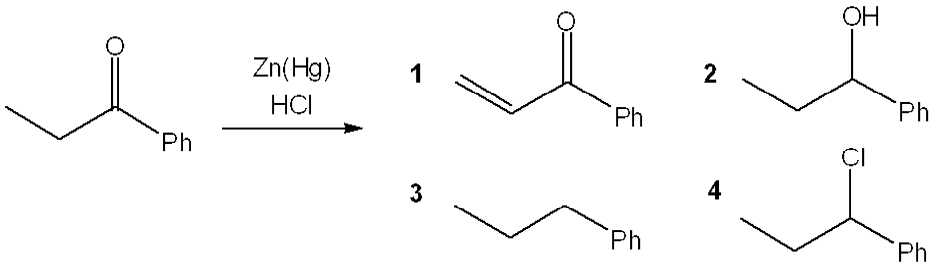
a. **1**
b. **2**
c. **3**
d. **4**

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



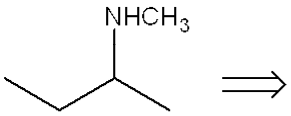
a. propiophenone, $PhCOCH_2CH_3$
b. 3-phenyl-2-butanol
c. 3-phenylbutanone
d. 2-phenyl-2-butanol

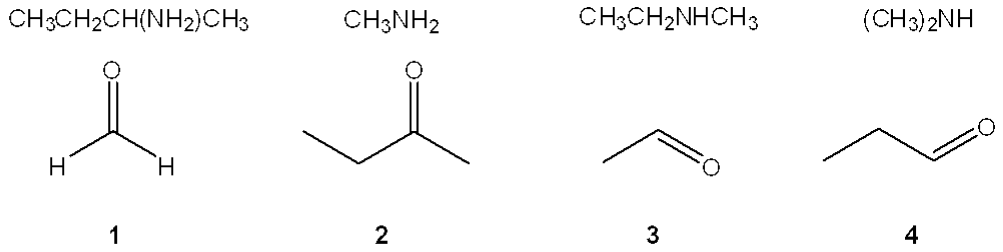
9. What is the major organic product obtained from the following reaction?



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

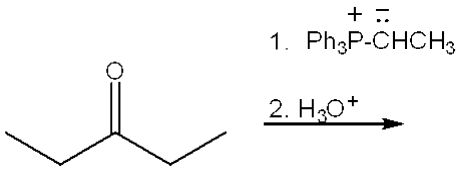
10. Which combination(s) of amine and carbonyl compound can be used to prepare the following product by reductive amination?





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

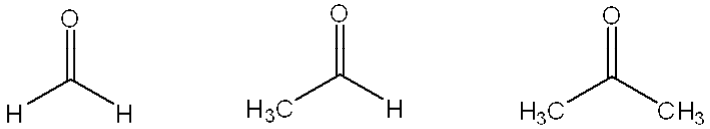
11. What is the major organic product obtained from the following reaction?



a. 3-ethyl-2-pentene
b. 2-methyl-2-heptene
c. (*E*) 2-methyl-3-heptene
d. (*Z*) 2-methyl-3-heptene

12. Which of the following molecules are deprotonated by ethylmagnesium bromide?
a. dimethylamine, $(CH_3)_2NH$
b. phenol, PhOH
c. propyne, $CH_3C{\equiv}CH$
d. all of these

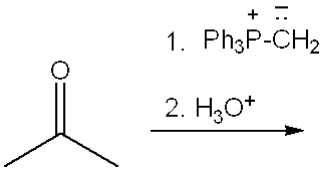
13. What is the correct assignment of the names of the following aldehydes and ketones?



1 **2** **3**

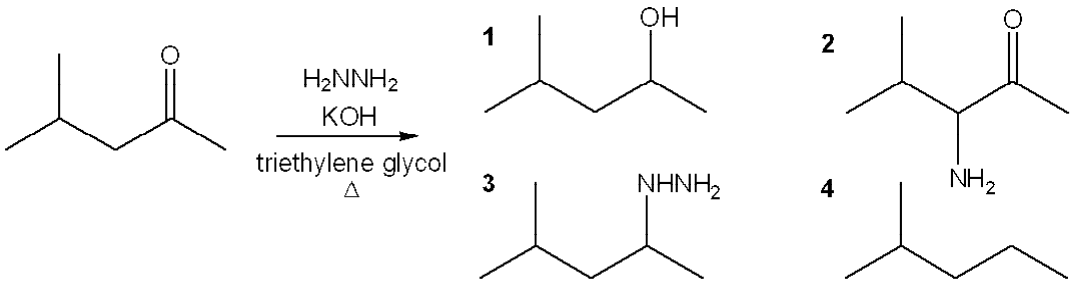
a. **1** = acetone; **2** = acetaldehyde; **3** = formaldehyde
b. **1** = acetaldehyde; **2** = acetone; **3** = acetophenone
c. **1** = formaldehyde; **2** = acetaldehyde; **3** = acetone
d. **1** = acetaldehyde; **2** = acetophenone; **3** = benzophenone

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



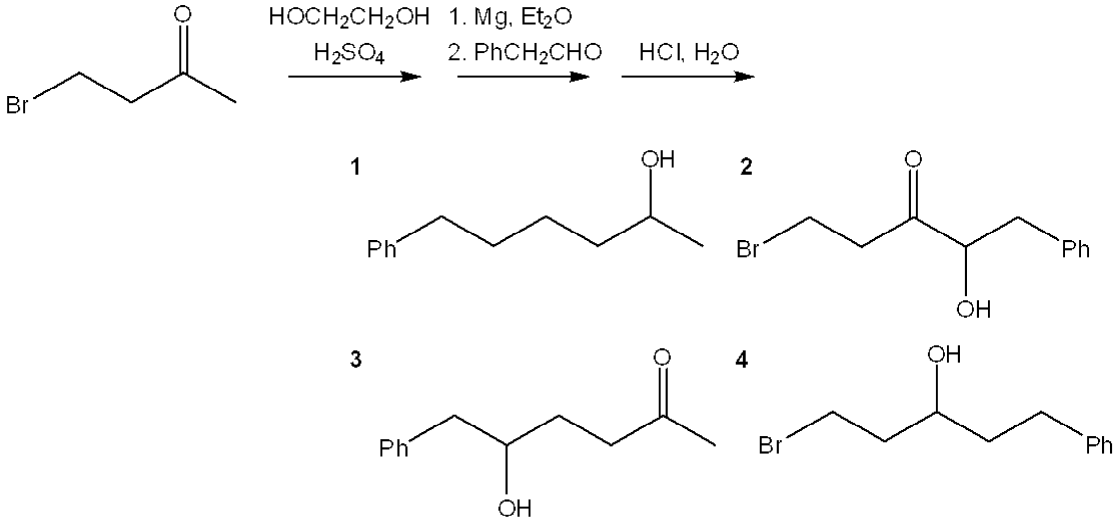
a. 2-butene
b. 2-methylpropene
c. 2-methyl-1-propanol
d. 1-butene

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



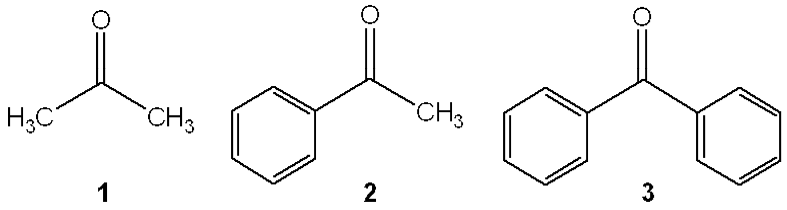
a. **1**
b. **2**
c. **3**
d. **4**

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



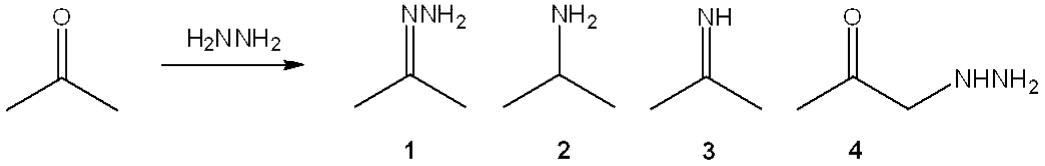
a. **1**
b. **2**
c. **3**
d. **4**

17. What is the correct assignment of the names of the following ketones?



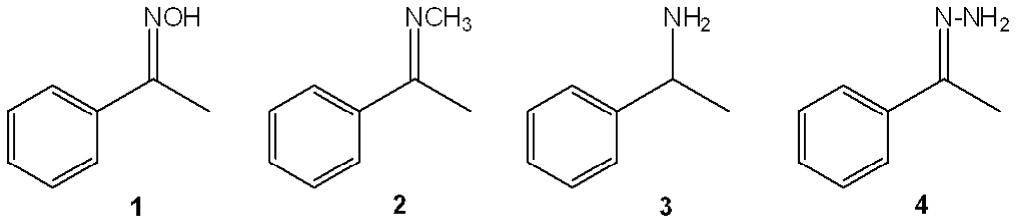
a. **1** = acetone; **2** = acetophenone; **3** = benzophenone
b. **1** = acetone; **2** = phenol; **3** = benzaldehyde
c. **1** = formaldehyde; **2** = benzaldehyde; **3** = acetophenone
d. **1** = acetaldehyde; **2** = acetophenone; **3** = benzaldehyde

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



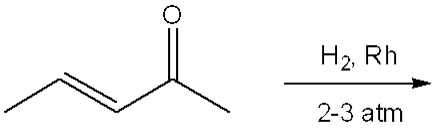
a. **1**
b. **2**
c. **3**
d. **4**

19. What is the correct assignment of the names of the following functional groups?



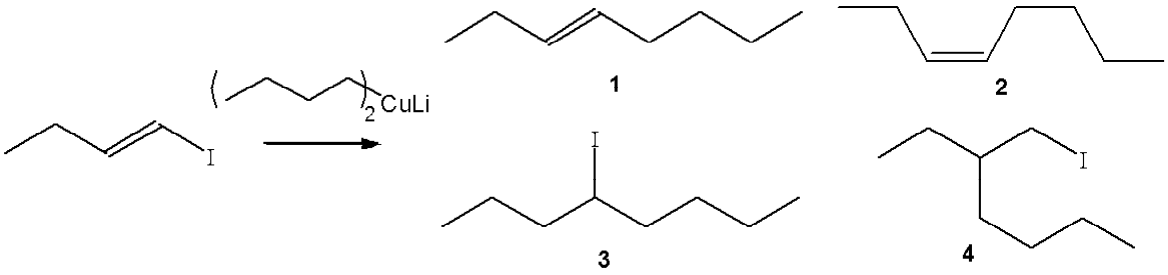
a. **1** = imine; **2** = amine; **3** = hydrazone; **4** = oxime
b. **1** = oxime; **2** = imine; **3** = amine; **4** = hydrazone
c. **1** = hydrazone; **2** = amine; **3** = imine; **4** = oxime
d. **1** = imine; **2** = hydrazone; **3** = oxime; **4** = amine

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



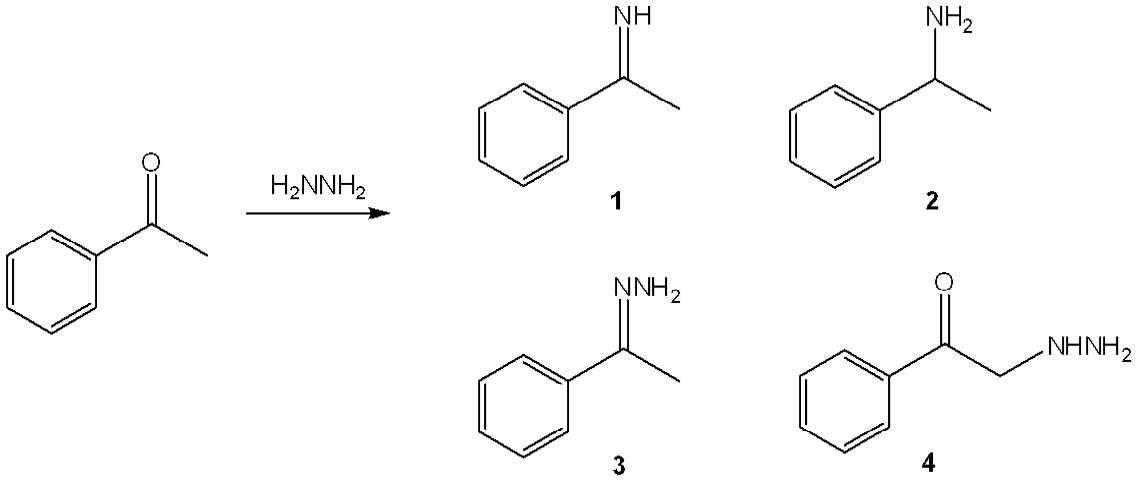
a. 2-pentanone
b. (*E*)-3-penten-2-ol
c. 4-hydroxy-2-pentanone
d. 2-pentanol

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



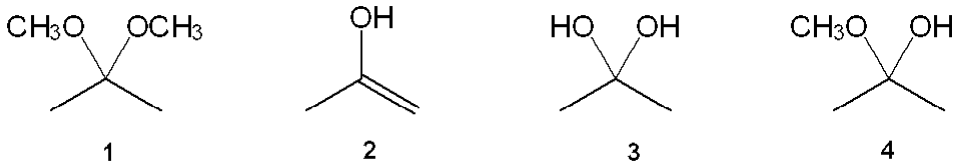
a. **1**
b. **2**
c. **3**
d. **4**

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



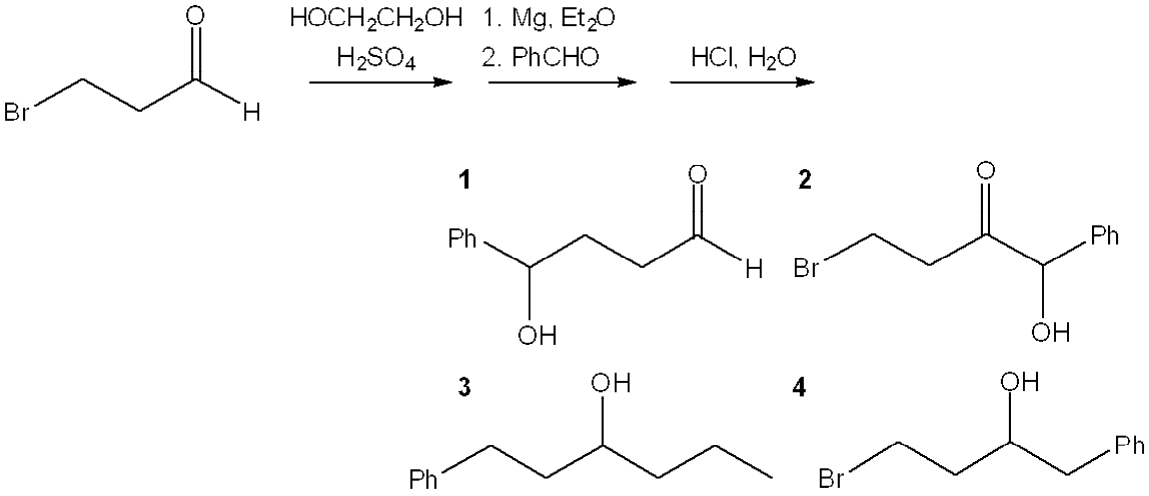
a. **1**
b. **2**
c. **3**
d. **4**

23. What is the correct assignment of the names of the following functional groups?



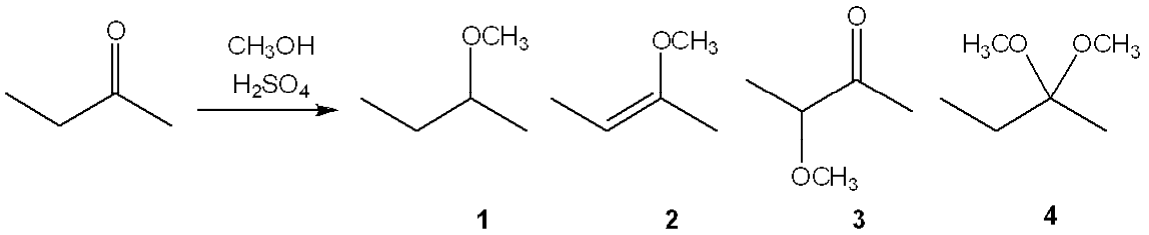
a. **1** = hydrate; **2** = hemiacetal; **3** = acetal; **4** = enol
b. **1** = acetal; **2** = hydrate; **3** = acetal; **4** = hemiacetal
c. **1** = enol; **2** = hydrate; **3** = hemiacetal; **4** = enol
d. **1** = acetal; **2** = enol; **3** = hydrate; **4** = hemiacetal

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



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

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



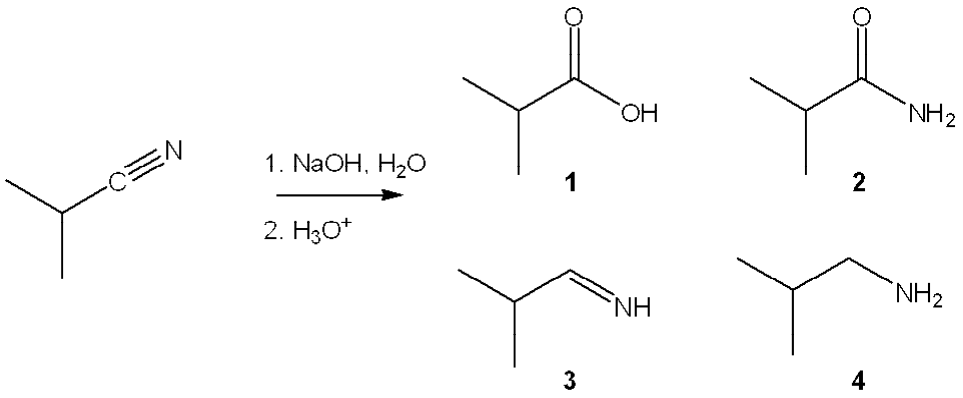
a. **1**
b. **2**
c. **3**
d. **4**

N_HW3

HW3

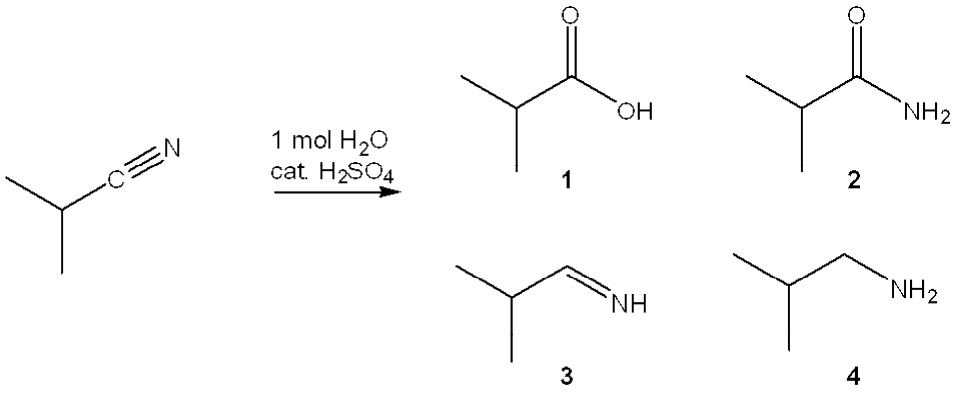
Multiple Choice
Identify the choice that best completes the statement or answers the question. There is only one correct response for each question.

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



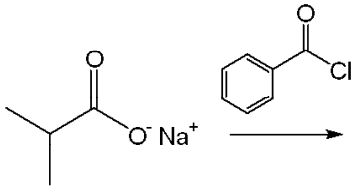
a. **1**
b. **2**
c. **3**
d. **4**

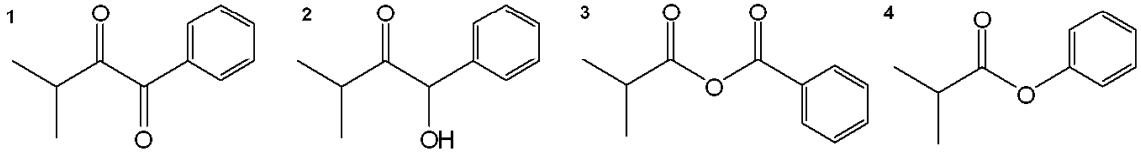
2. What is the major organic product obtained from the following reaction?



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

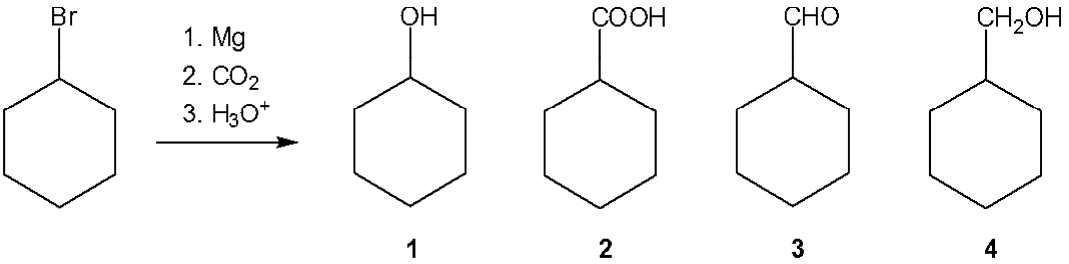
3. What is the major organic product obtained from the following reaction?





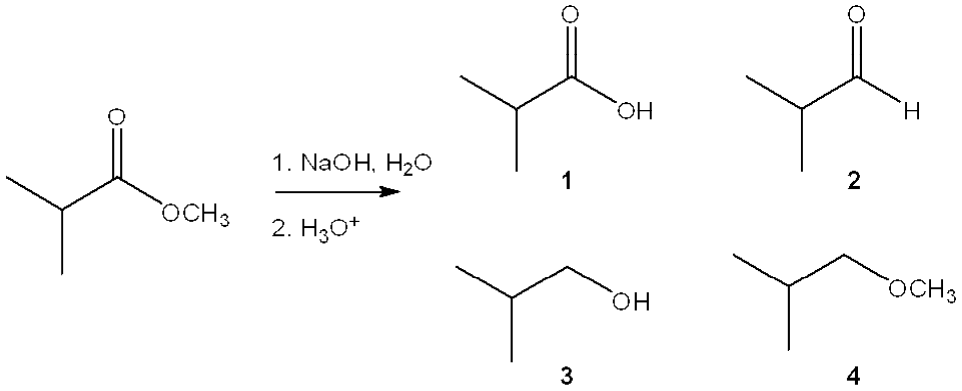
a. **1**
b. **2**
c. **3**
d. **4**

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



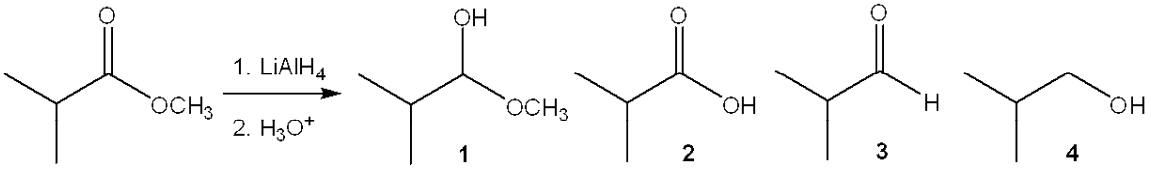
a. **1**
b. **2**
c. **3**
d. **4**

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



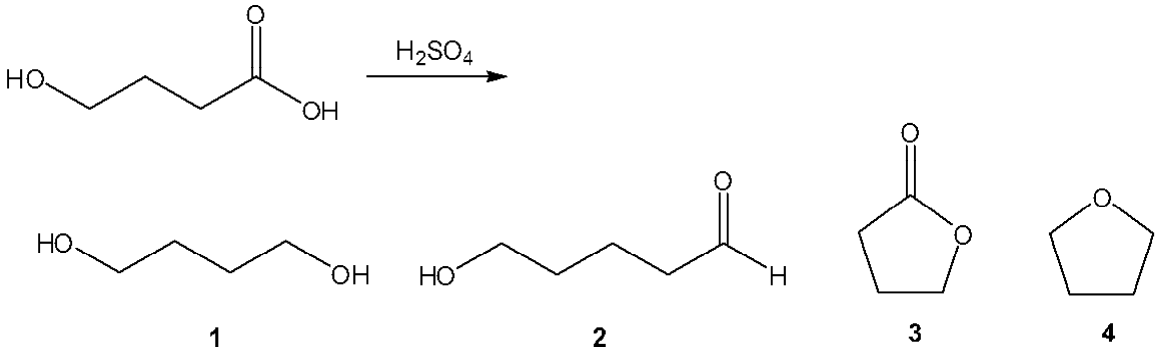
a. **1**
b. **2**
c. **3**
d. **4**

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



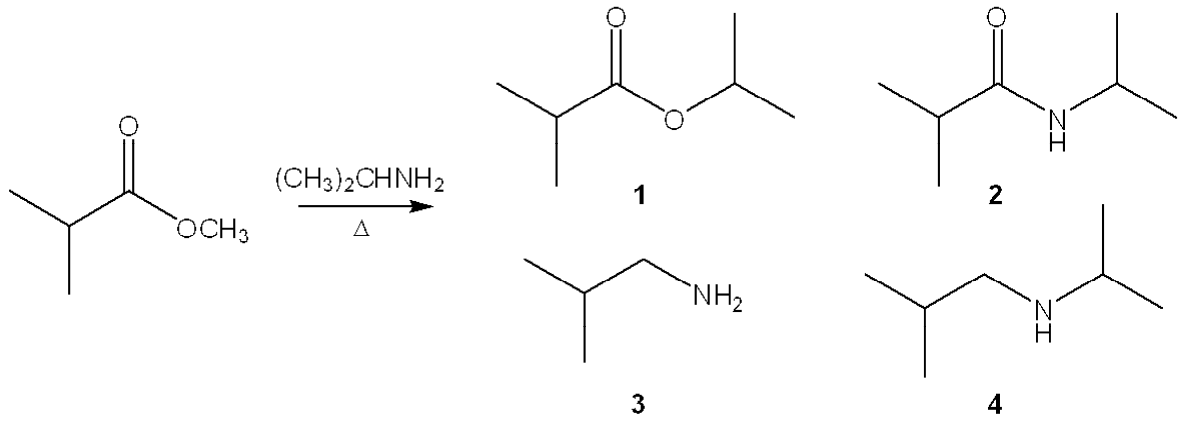
a. **1**
b. **2**
c. **3**
d. **4**

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



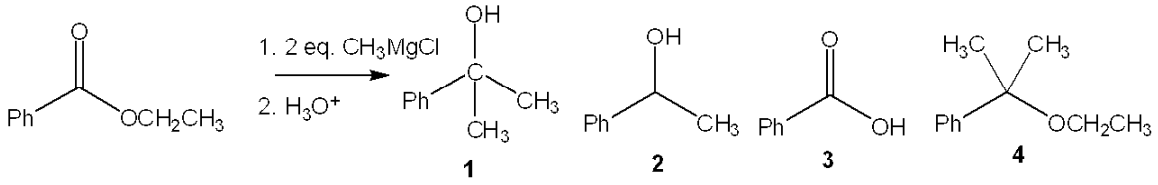
a. **1**
b. **2**
c. **3**
d. **4**

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



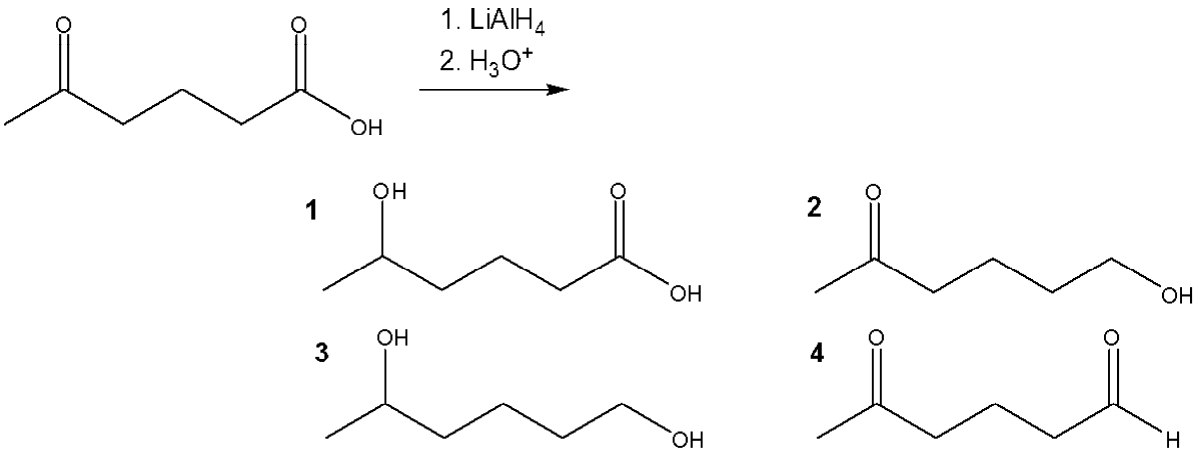
a. **1**
b. **2**
c. **3**
d. **4**

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



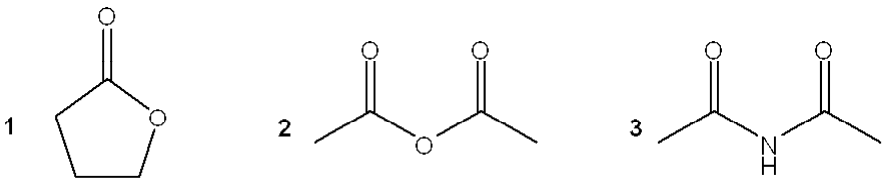
a. **1**
b. **2**
c. **3**
d. **4**

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



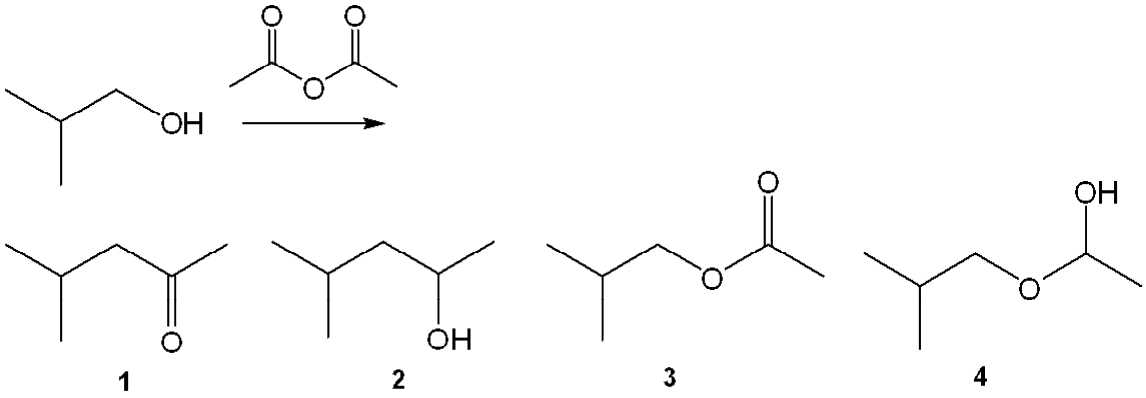
a. **1**
b. **2**
c. **3**
d. **4**

11. What of the following is the correct assignment of the classes of the following compounds?



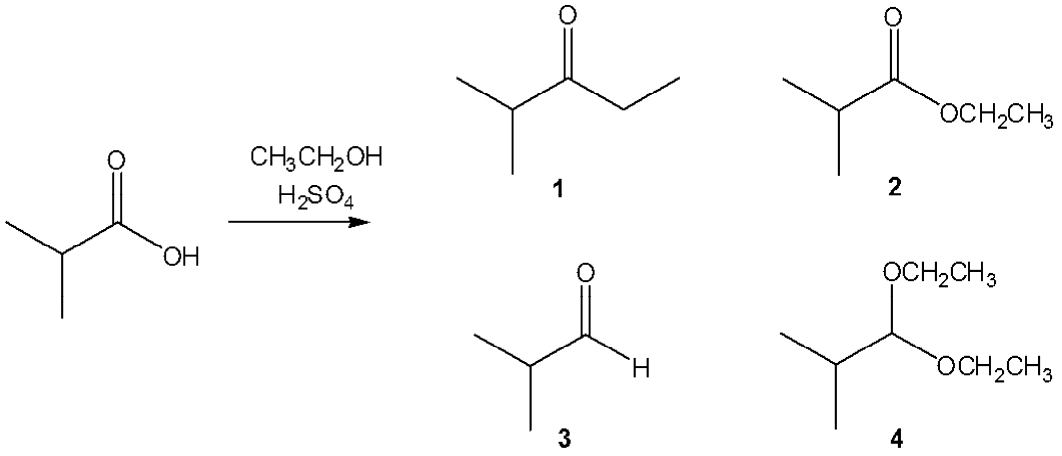
a. **1** = lactone; **2** = ester; **3** = amide
b. **1** = ester; **2** = ester; **3** = imide
c. **1** = ester; **2** = imide; **3** = amide
d. **1** = lactone; **2** = anhydride; **3** = imide

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



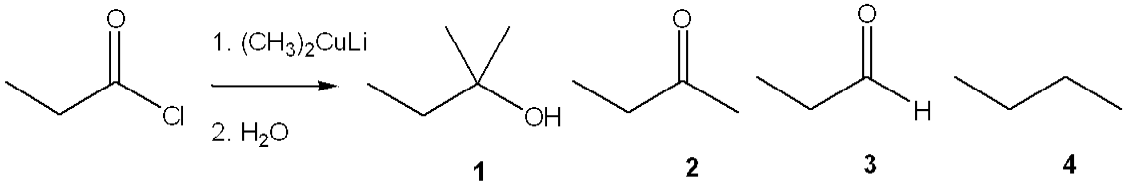
a. **1**
b. **2**
c. **3**
d. **4**

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



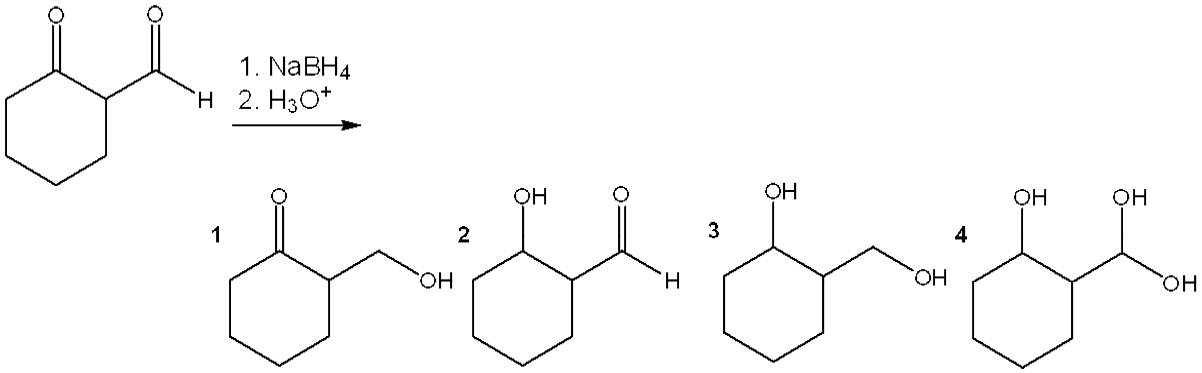
a. **1**
b. **2**
c. **3**
d. **4**

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



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

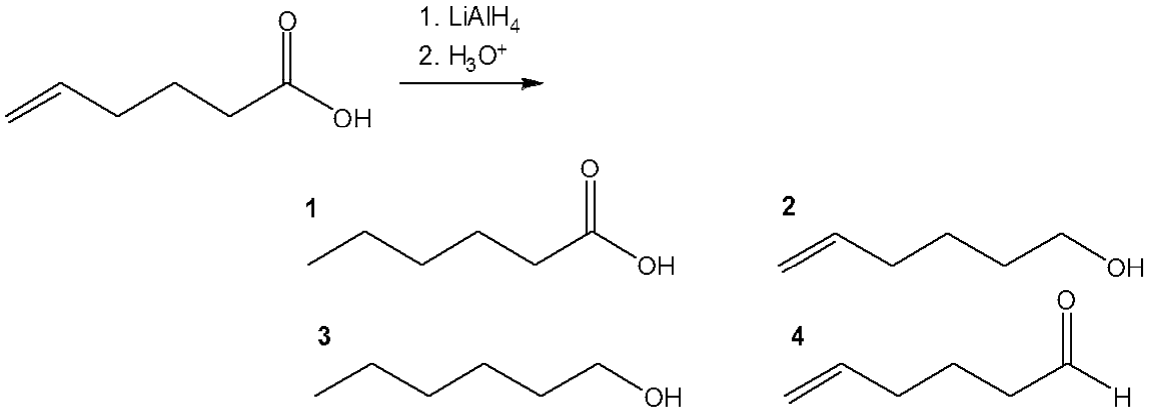
15. What is the major organic product obtained from the following reaction?



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

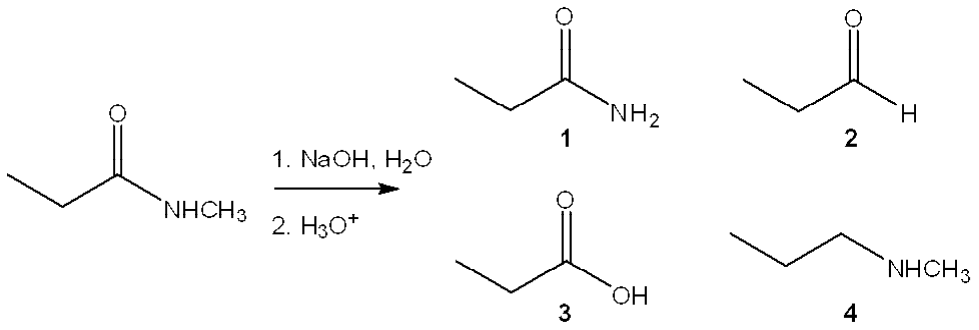
16. Which of the following is the correct order of decreasing reactivity in hydrolysis reactions (more reactive > less reactive)?
    a. esters > amides > acid chlorides
    b. amides > acid chlorides > esters
    c. acid chlorides > esters > amides
    d. esters > acid chlorides > amides

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



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

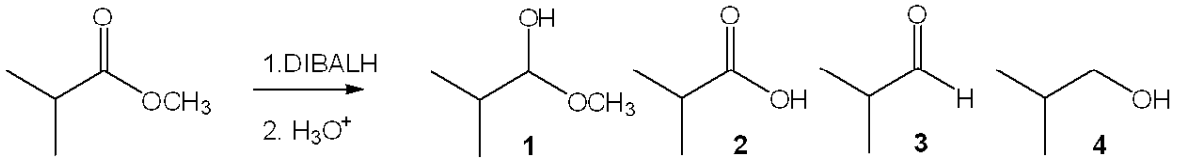
18. What is the major organic product obtained from the following reaction?



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

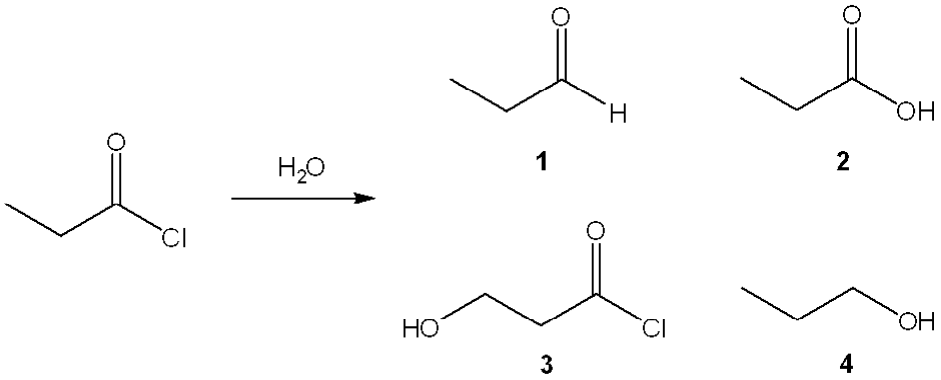
19. Which of the following is the correct order of decreasing leaving group ability in nucleophilic acyl substitutions (better leaving group > worse leaving group)?
    a. $Cl^- > NH_2^- > CH_3O^-$
    b. $NH_2^- > CH_3O^- > Cl^-$
    c. $Cl^- > CH_3O^- > NH_2^-$
    d. $CH_3O^- > Cl^- > NH_2^-$

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



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

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



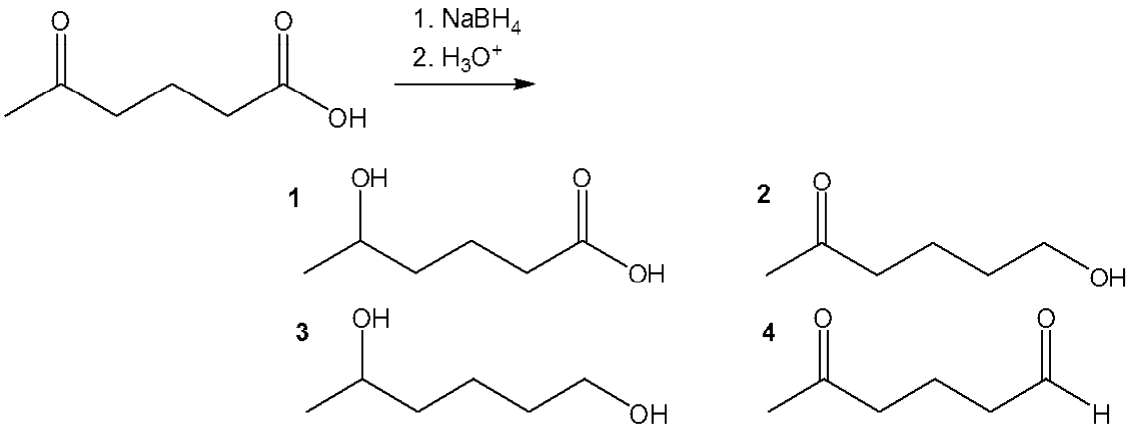
a. **1**
b. **2**
c. **3**
d. **4**

22. Which of the following can be made by acid-promoted hydrolysis of a nitrile?

1. an acid
2. an alcohol
3. an imine
4. an imide

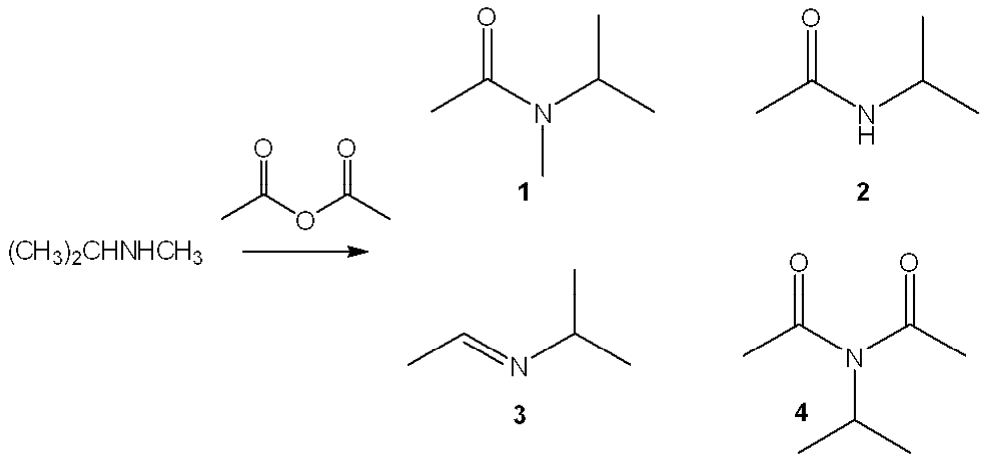
a. only **1**
b. only **1** and **2**
c. only **2** and **3**
d. only **4**

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



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

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



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

25. Which of the following is the most soluble in water?
a. acetic acid
b. pentanol
c. butanoic acid
d. pentanal

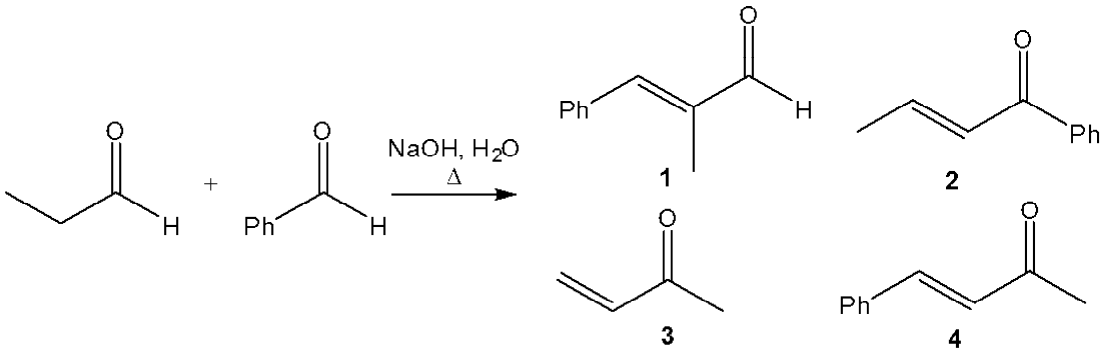
N_HW4

HW4

Multiple Choice

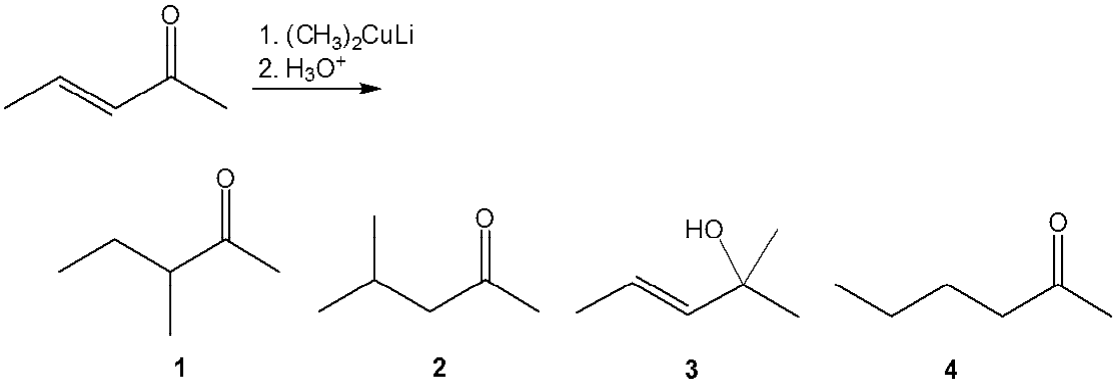
Identify the choice that best completes the statement or answers the question. There is only one correct response for each question.

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



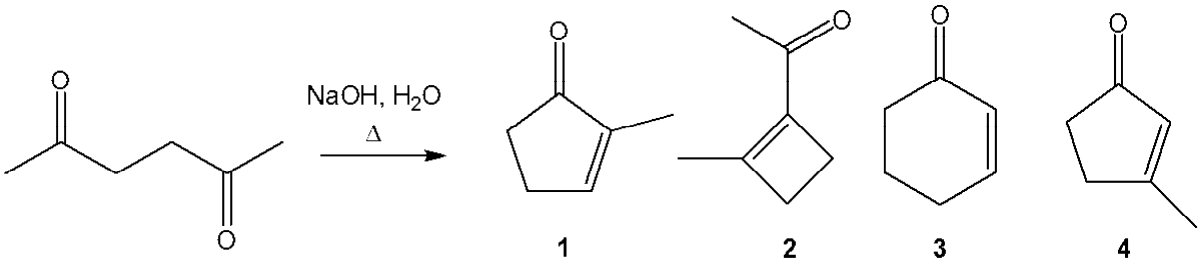
a. **1**
b. **2**
c. **3**
d. **4**

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?



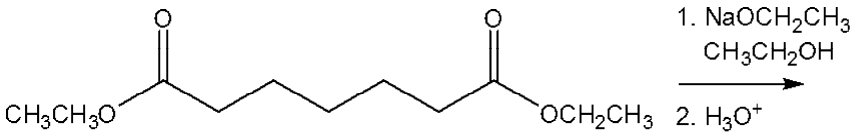
a. **1**
b. **2**
c. **3**
d. **4**

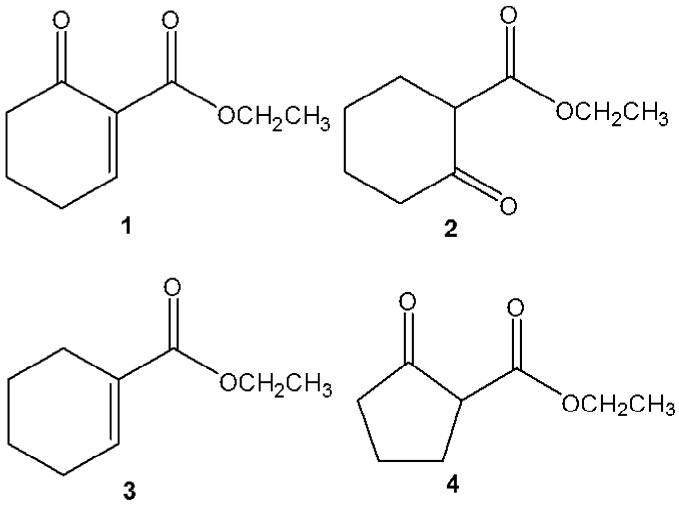
4. Which of the following are intermediates in the acid catalyzed aldol reaction of propanal to form 2-methyl-2-pentenal?

1. enol
2. enolate
3. tetrahedral carbonyl intermediate
4. aldol

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

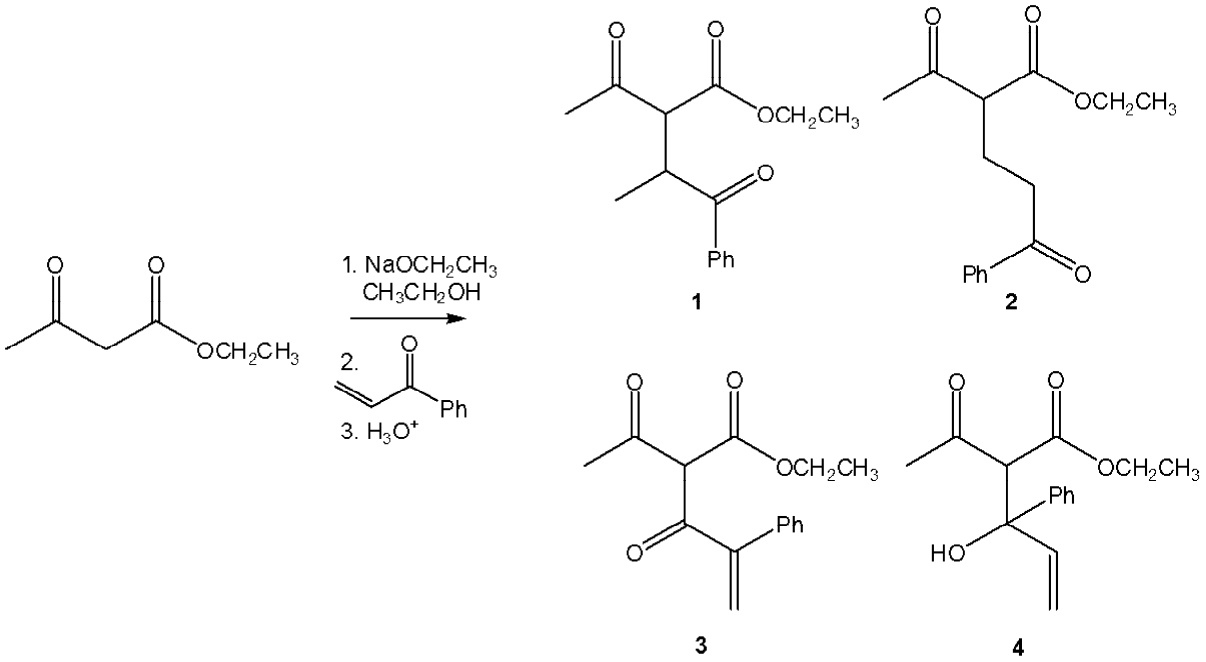
5. What is the major organic product obtained from the following reaction?





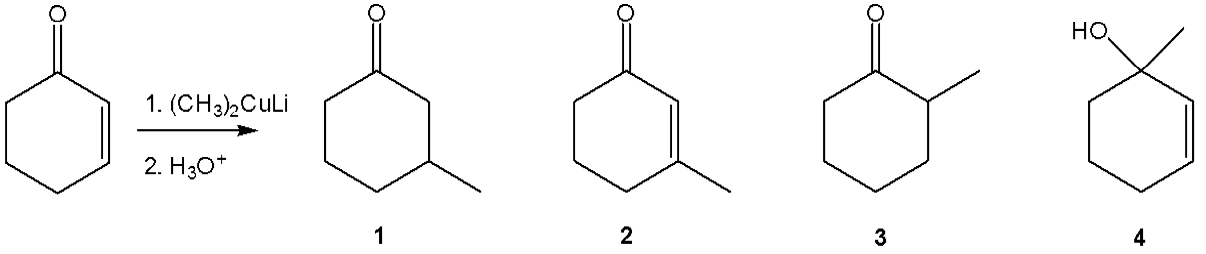
a. **1**
b. **2**
c. **3**
d. **4**

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



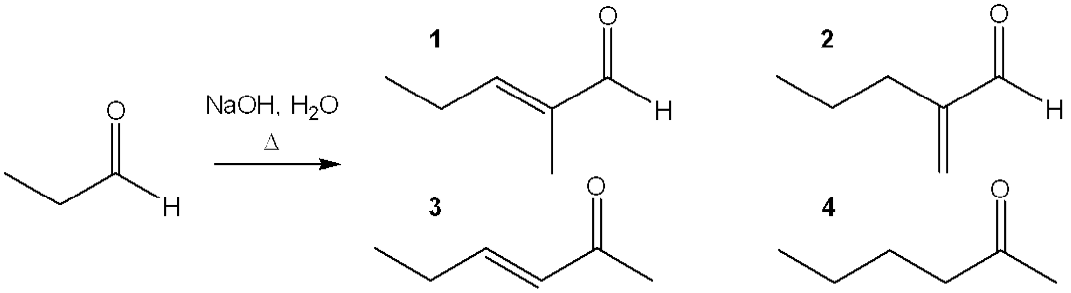
a. **1**
b. **2**
c. **3**
d. **4**

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



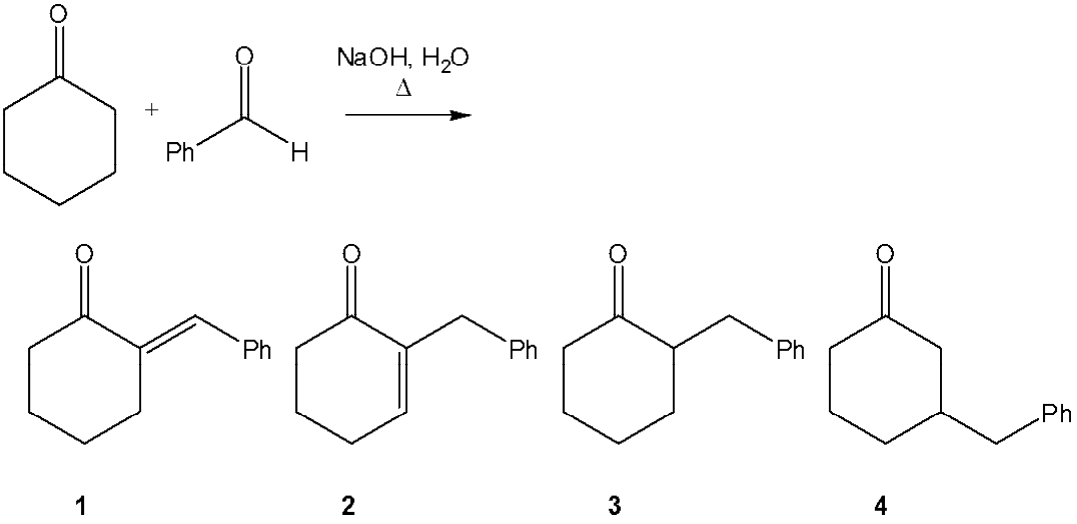
a. **1**
b. **2**
c. **3**
d. **4**

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



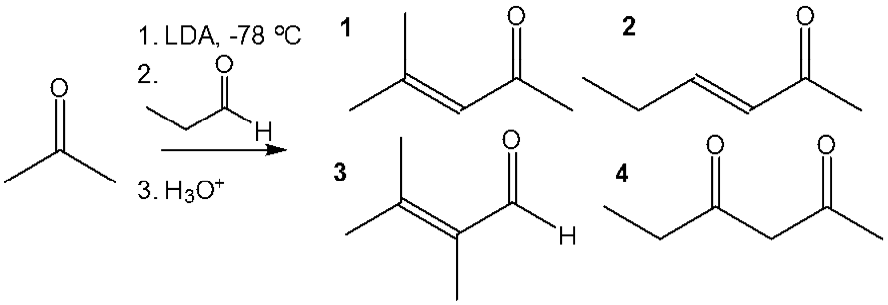
a. **1**
b. **2**
c. **3**
d. **4**

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



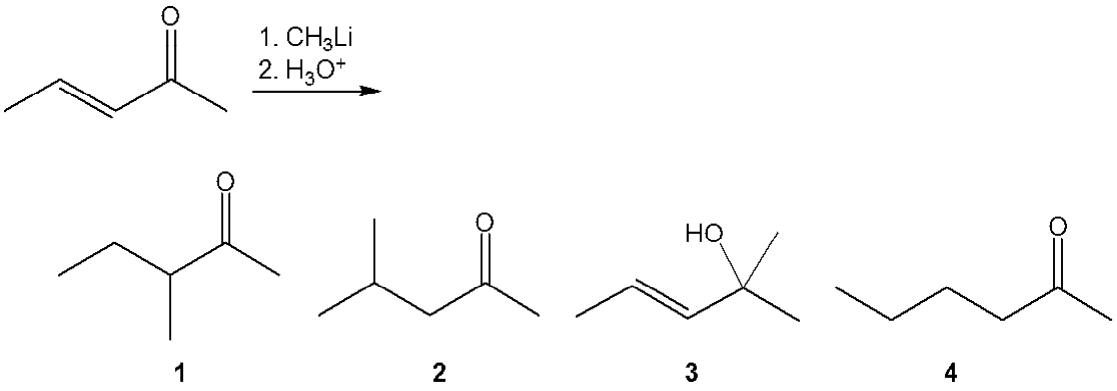
a. **1**
b. **2**
c. **3**
d. **4**

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



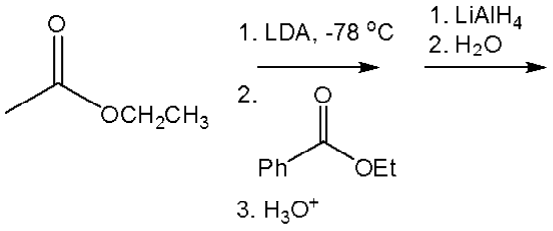
a. **1**
b. **2**
c. **3**
d. **4**

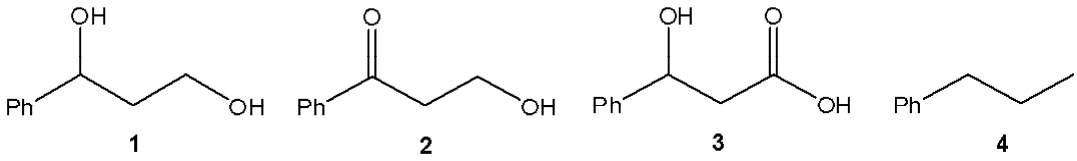
11. What is the major organic product obtained from the following reaction?



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

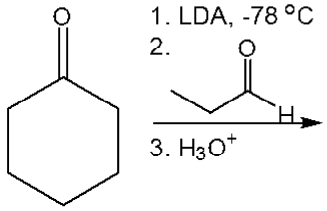
12. What is the major organic product obtained from the following sequence of reactions?

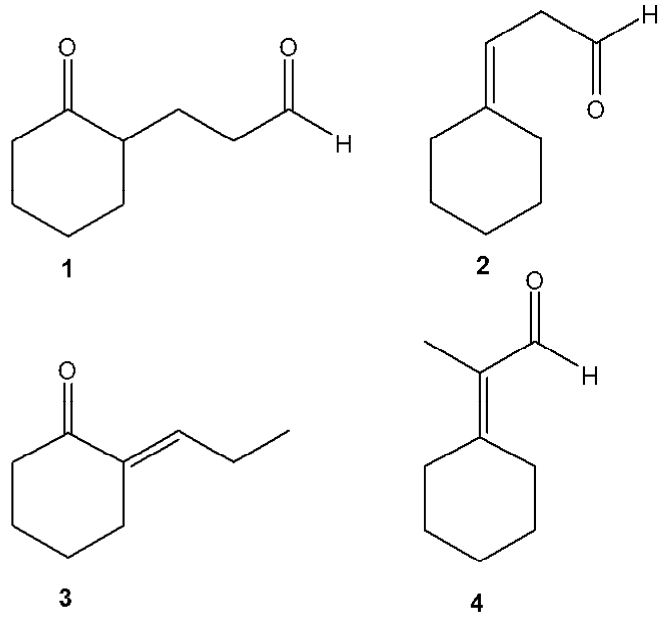




a. **1**
b. **2**
c. **3**
d. **4**

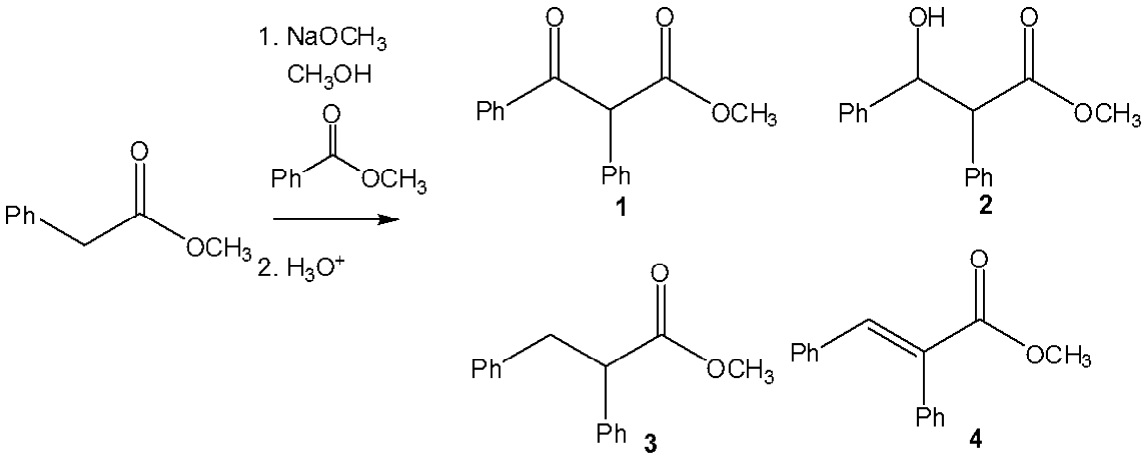
13. What is the major organic product obtained from the following reaction?





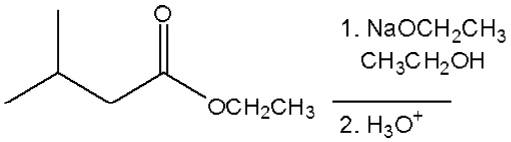
a. **1**
b. **2**
c. **3**
d. **4**

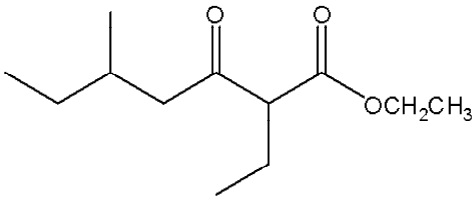
14. What is the major organic product obtained from the following reaction?



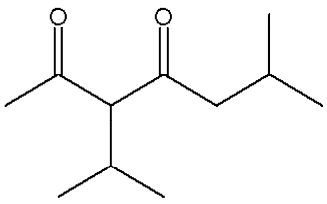
a. **1**
b. **2**
c. **3**
d. **4**

15. What is the major organic product obtained from the following reaction? (Hint: 2 moles of the ester are required)

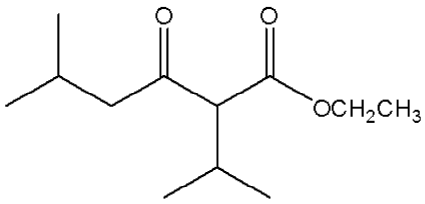




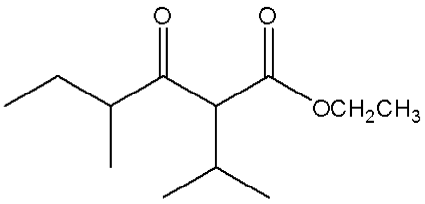
1



2



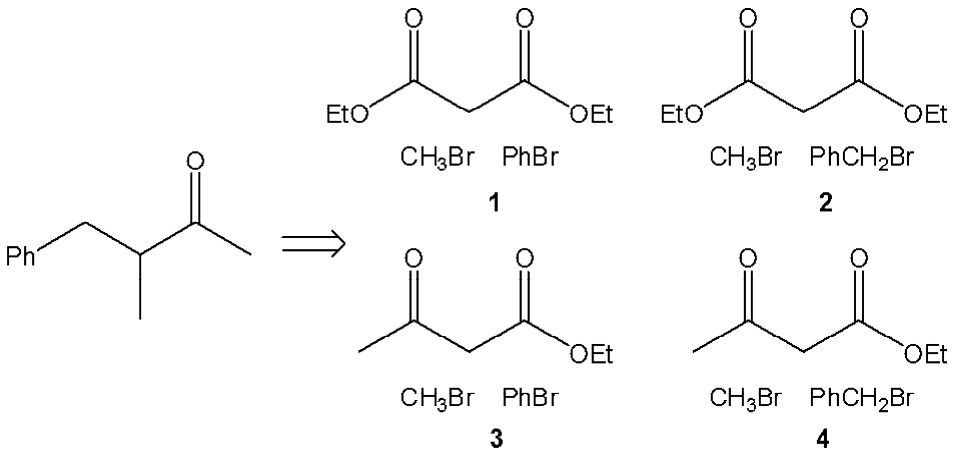
3



4

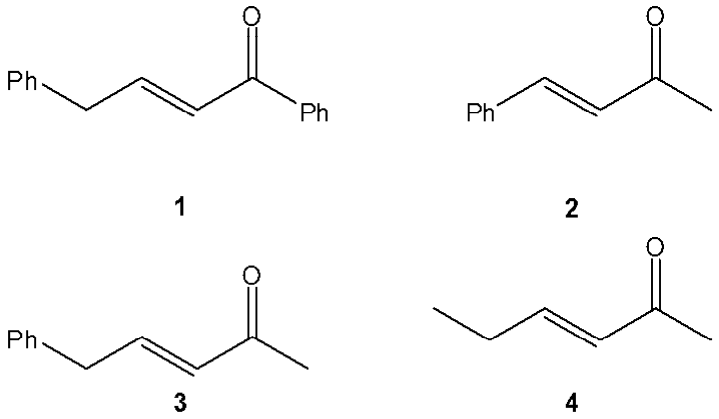
a. **1**
b. **2**
c. **3**
d. **4**

16. Which combination of organic bromide(s) and dicarbonyl compound can be used to prepare the following product (in a multistep synthesis)?



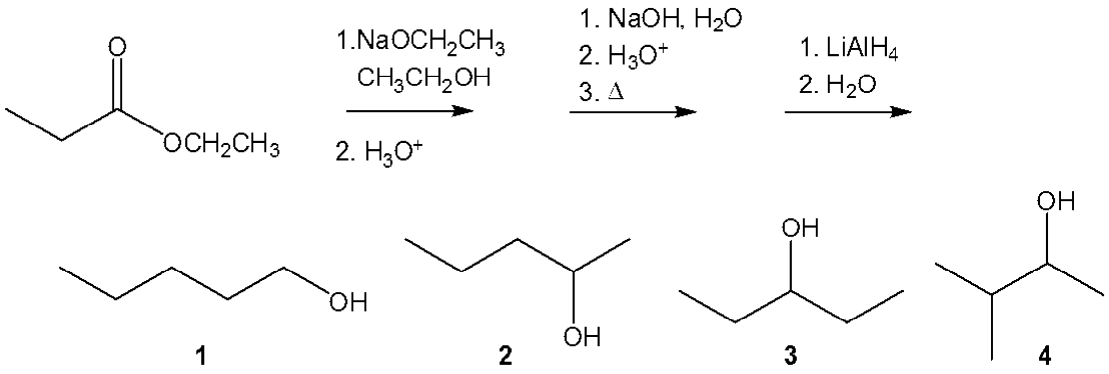
a. **1**
b. **2**
c. **3**
d. **4**

17. Which of the following compounds **will be the ONLY product** prepared by a mixed aldol condensation by treatment of a mixture of both carbonyl compounds with NaOH?



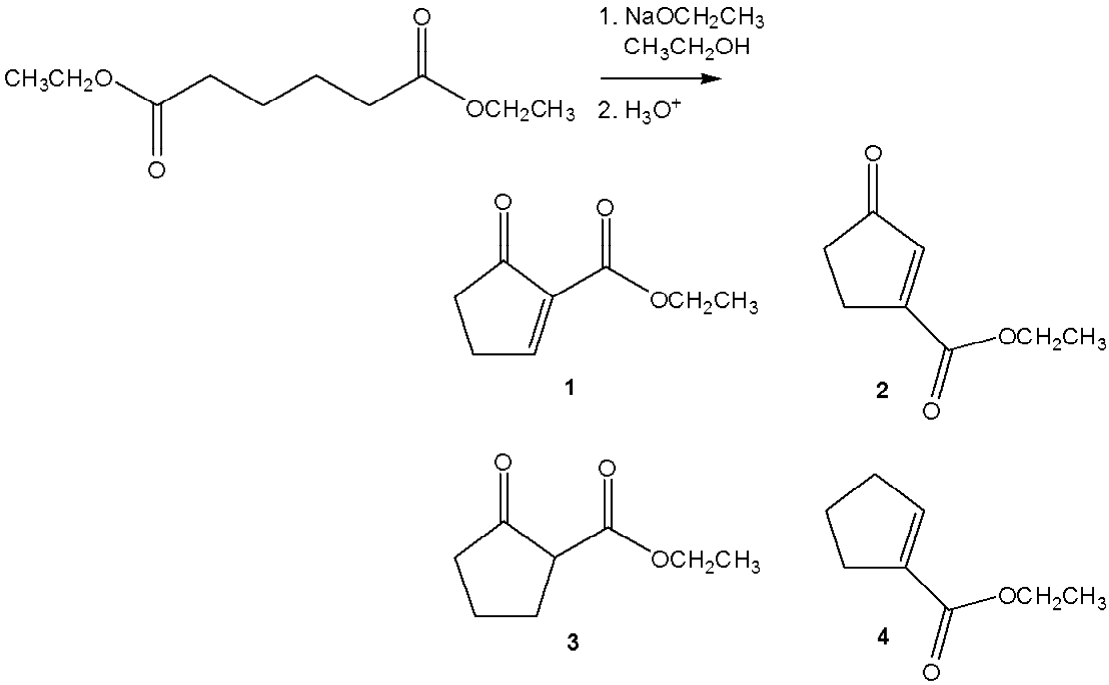
a. **1**
b. **2**
c. **3**
d. **4**

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



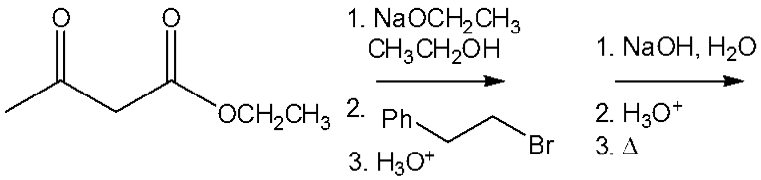
a. **1**
b. **2**
c. **3**
d. **4**

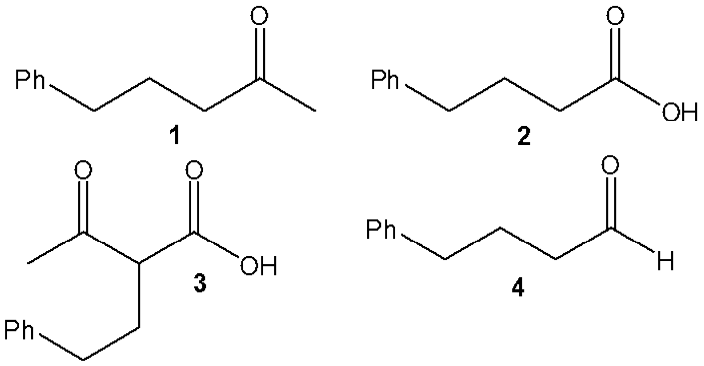
19. What is the major organic product obtained from the following reaction?



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

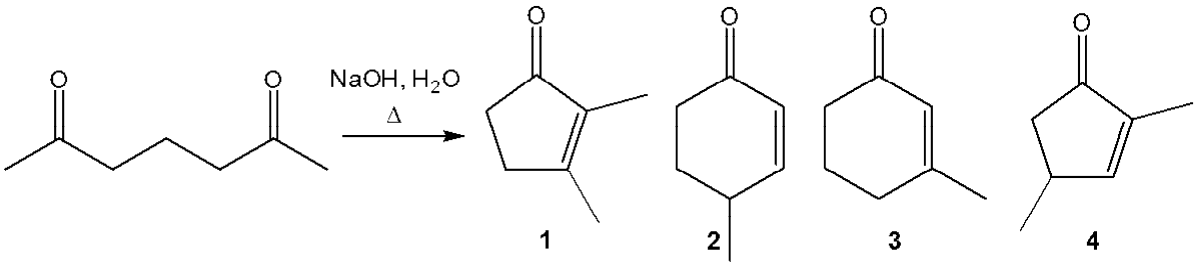
20. What is the major organic product obtained from the following sequence of reactions?





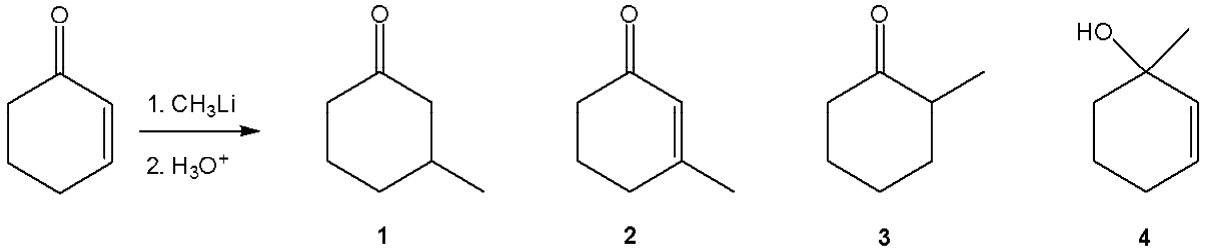
a. **1**
b. **2**
c. **3**
d. **4**

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



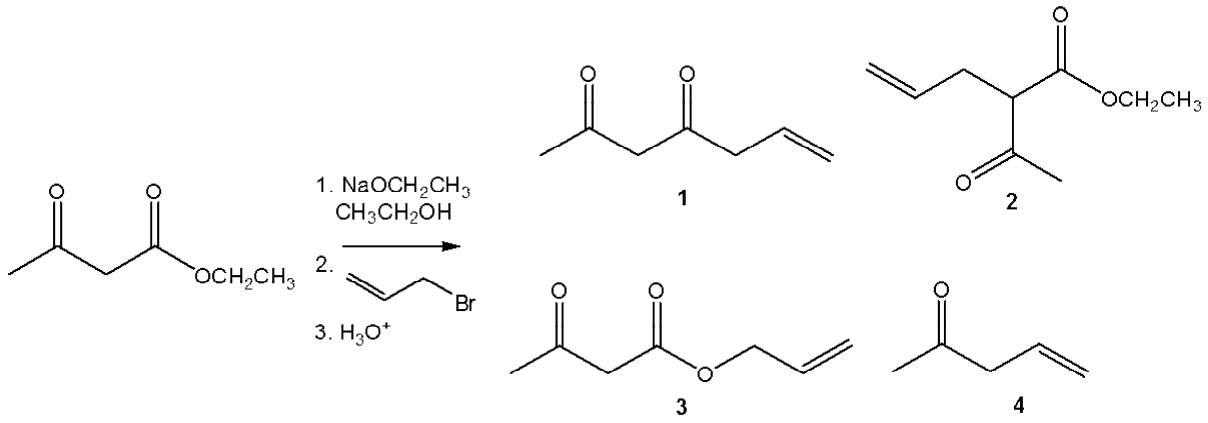
a. **1**
b. **2**
c. **3**
d. **4**

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



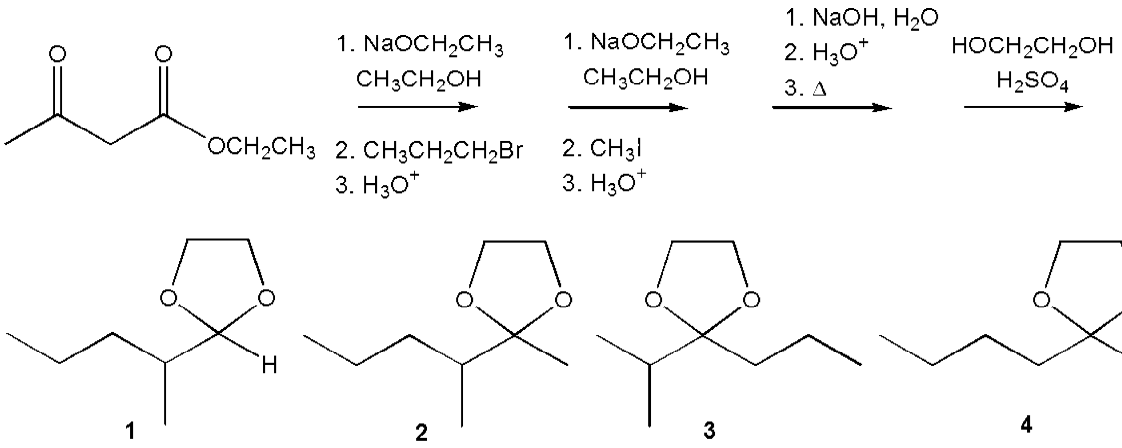
a. **1**
b. **2**
c. **3**
d. **4**

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



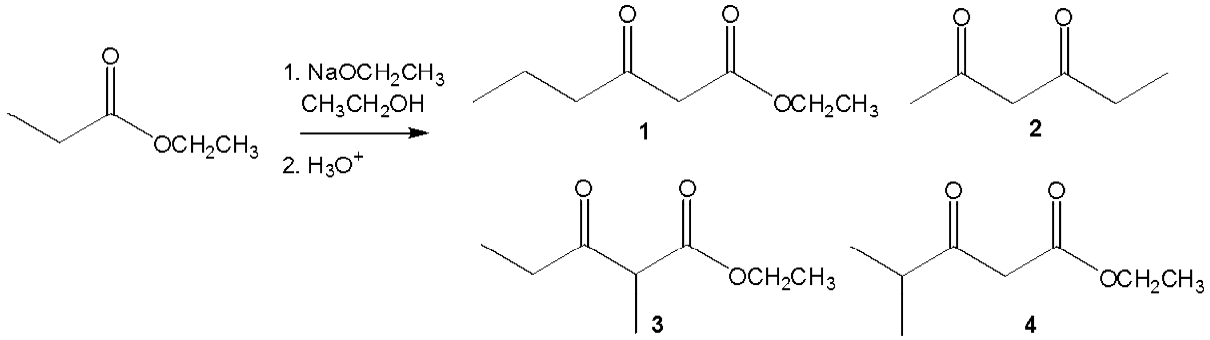
a. **1**
b. **2**
c. **3**
d. **4**

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



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**

N_HW5

HW5

Multiple Choice

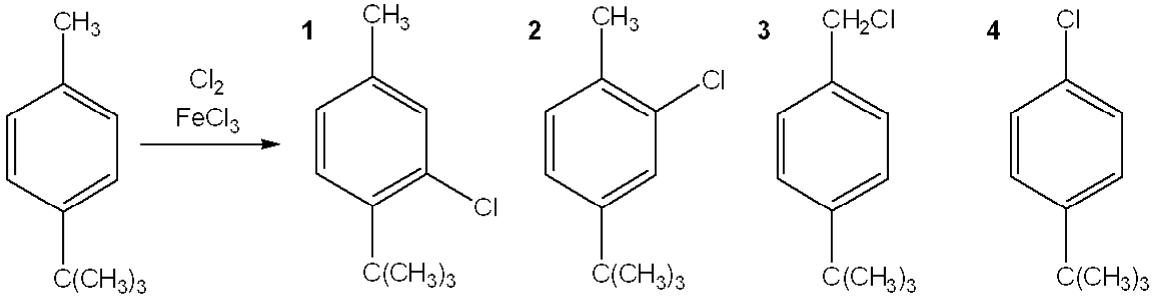
Identify the choice that best completes the statement or answers the question. There is only one correct response for each question.

1. Which of the following will remove aniline from a solution of aniline in diethyl ether?
   a. aqueous KBr
   b. aqueous HCl
   c. aqueous NaOH
   d. aqueous CH_3COONa

2. What is the hybridization of the nitrogen atom of pyridine?
   a. *s*
   b. *sp*
   c. sp^2
   d. sp^3

3. Which of the following sets of substituents are all *ortho/para* directing in electrophilic aromatic substitution reactions?
   a. Cl, CH_3, CN
   b. CN, NO_2, $COCH_3$
   c. Br, OH, $COCH_3$
   d. Cl, OH, CH_3

4. What is the major organic product obtained from the following reaction? *(Hint: consider steric factors as well as electronic.)*

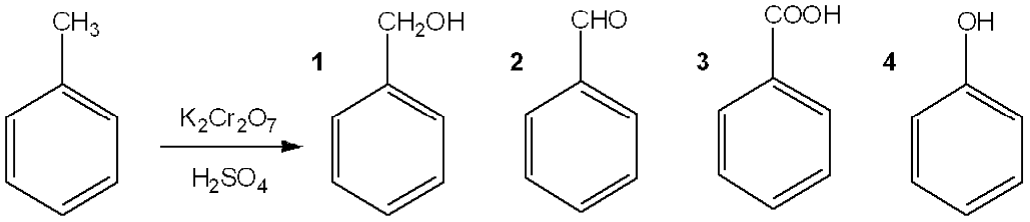


   a. **1**
   b. **2**
   c. **3**
   d. **4**

5. Which of the following is the weakest base?
   a. aniline
   b. 3-nitroaniline
   c. 4-nitroaniline
   d. 4-methoxyaniline

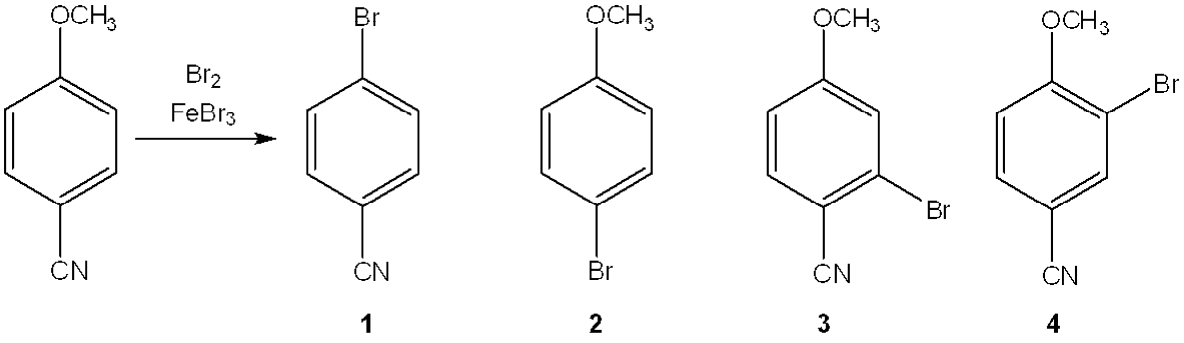
6. Which of the following undergoes the *most rapid* sulfonation upon treatment with fuming sulfuric acid?
   a. benzene
   b. benzoic acid
   c. benzonitrile
   d. nitrobenzene

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



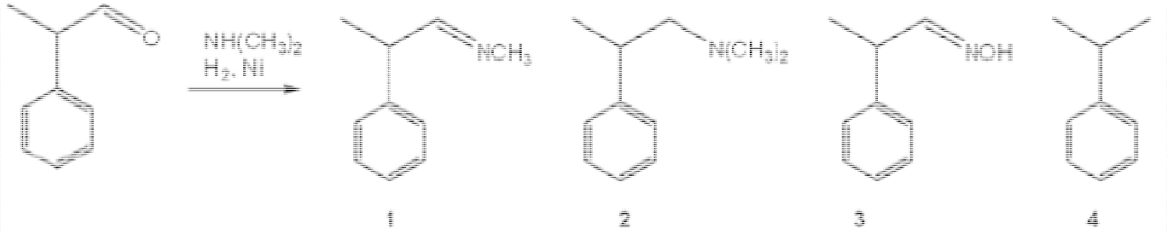
   a. **1**
   b. **2**
   c. **3**
   d. **4**

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



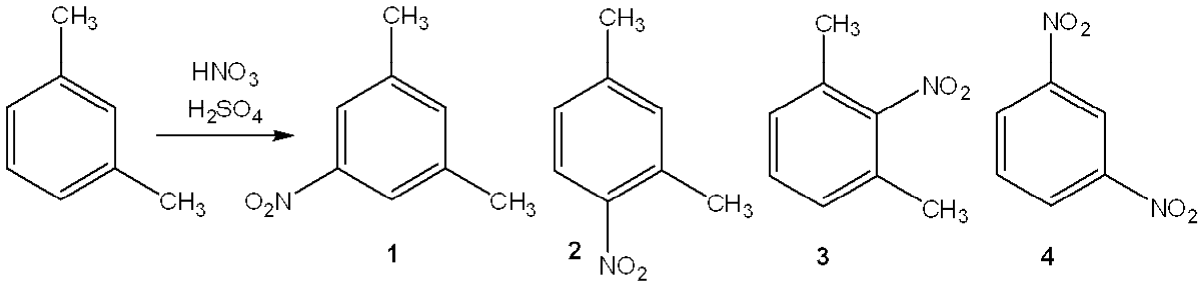
   a. **1**
   b. **2**
   c. **3**
   d. **4**

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



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

10. What is the **major** organic product obtained from the following reaction? *(Hint: consider steric factors as well as electronic.)*

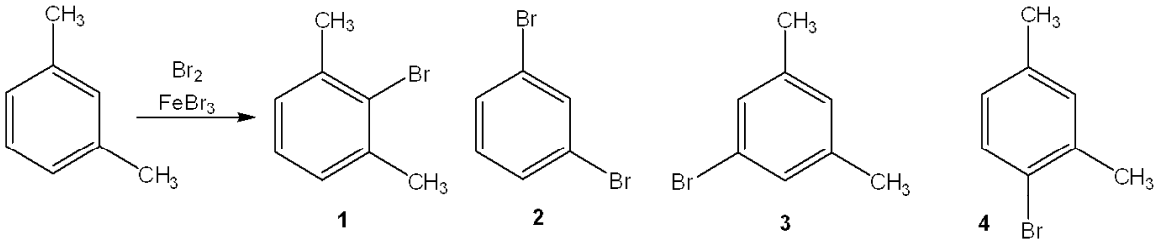


a. **1**
b. **2**
c. **3**
d. **4**

11. What is the intermediate in the reaction of ethylbenzene with NBS in the presence of benzoyl peroxide to give 1-bromo-1-phenylethane?
    a. Benzylic anion
    b. Benzylic cation
    c. Benzylic radical
    d. Benzylic carbene

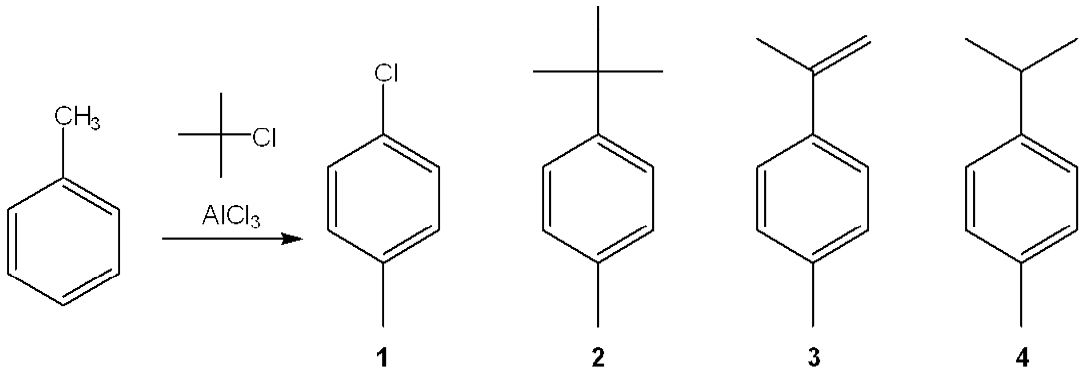
12. Which of the following substituents is ortho/para directing *and* deactivating in electrophilic aromatic substitution reactions?
    a. NO_2
    b. OH
    c. CH_3
    d. Cl

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



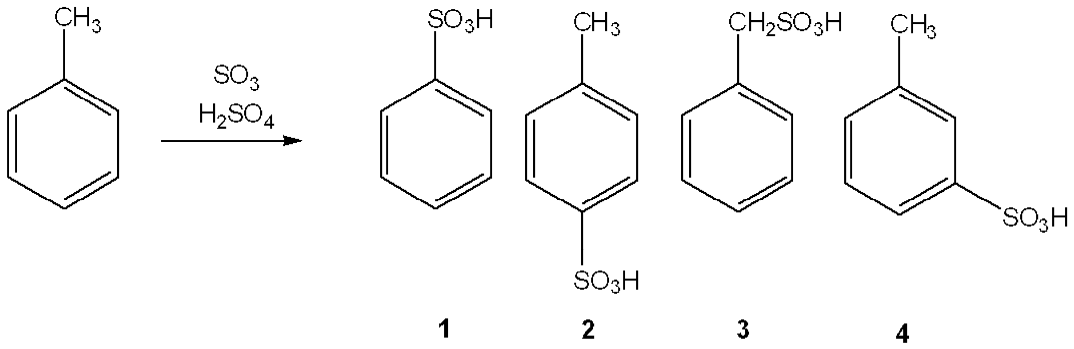
a. **1**
b. **2**
c. **3**
d. **4**

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



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

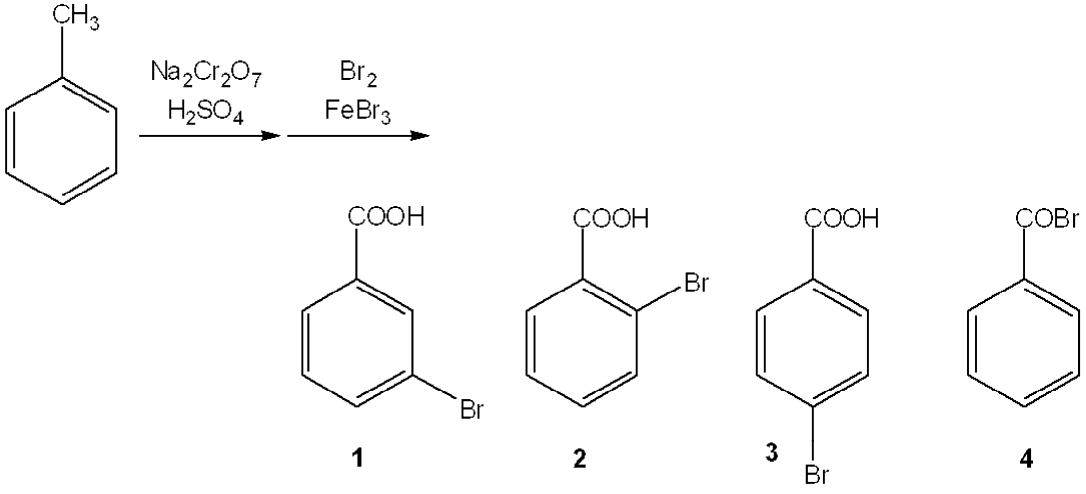
15. What is the **major** organic product obtained from the following reaction?



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

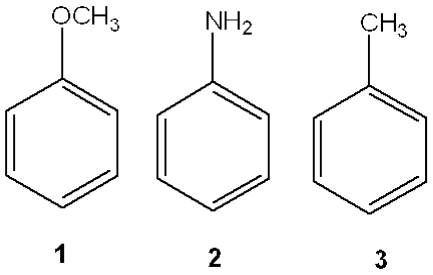
16. Which of the following sets of substituents are all *ortho/para* directing in electrophilic aromatic substitution reactions?
    a. Br, CH_3, NO_2
    b. Cl, OCH_3, $COCH_3$
    c. CH_3, NH_2, Br
    d. NO_2, $COCH_3$, COOH

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



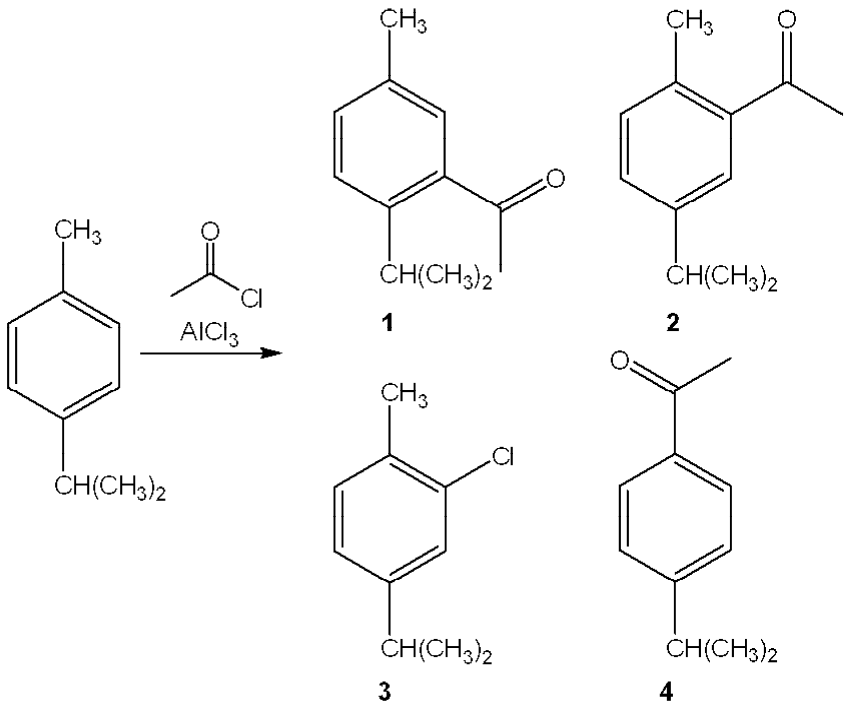
a. **1**
b. **2**
c. **3**
d. **4**

18. What is the correct assignment of the names of the following substituted benzenes?



a. **1** = anisole; **2** = aniline; **3** = toluene
b. **1** = benzaldehyde; **2** = anisole; **3** = toluene
c. **1** = anisole; **2** = xylene; **3** = toluene
d. **1** = phenol; **2** = aniline; **3** = anisole

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

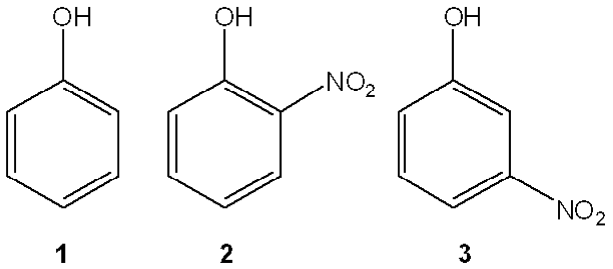


a. **1**
b. **2**
c. **3**
d. **4**

20. Which of the following is the strongest base?
    a. ammonia
    b. dimethylamine
    c. aniline
    d. 4-nitroaniline

21. Which of the following sets of substituents are all *deactivating groups* in electrophilic aromatic substitution reactions?
    a. CH_3, NH_2, OH
    b. CH_3, Br, $COCH_3$
    c. $COCH_3$, NO_2, Br
    d. Cl, OH, CH_2CH_3

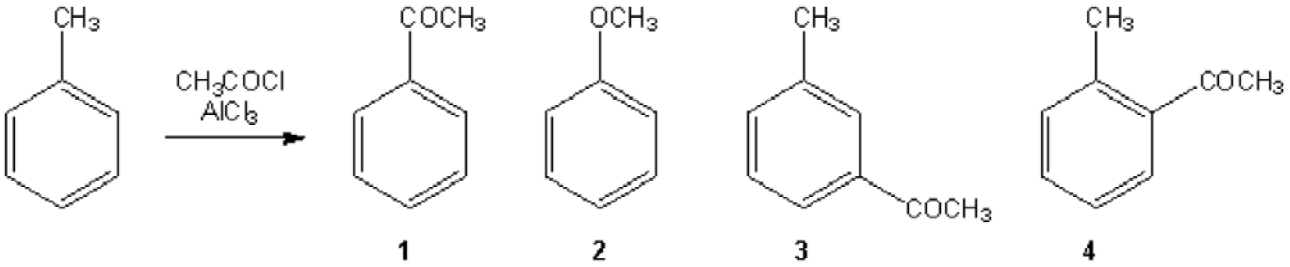
22. Which of the following has the compounds shown in the correct order of **decreasing** acidity (i.e., more acidic > less acidic)?



1 **2** **3**

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

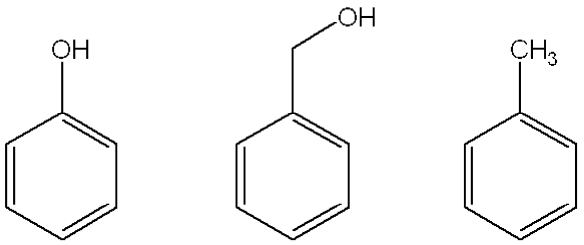
23. What is the **major** organic product obtained from the following reaction?



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

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

24. Which of the following has the compounds shown in the correct order of **decreasing** acidity (i.e., more acidic > less acidic)?



1 **2** **3**

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

25. Which of the following substituents is ortho/para directing *and* deactivating in electrophilic aromatic substitution reactions?
    a. CH_2CH_3
    b. $COCH_3$
    c. Br
    d. NH_3