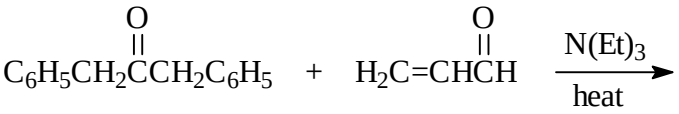
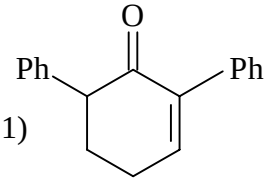
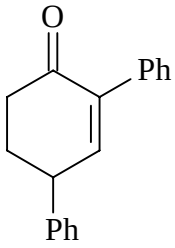
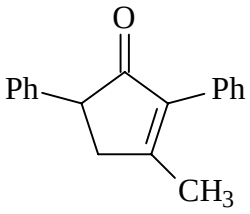
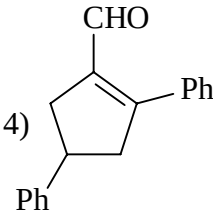
1. Heating a mixture of 1,3-diphenylacetone and acrolein in trimethylamine gives a product, $C_{18}H_{16}O$, in 53% yield. The mechanism for product formation is believed to be a Michael addition followed by an intramolecular aldol condensation. Which of the following is the product of this reaction?



1) 

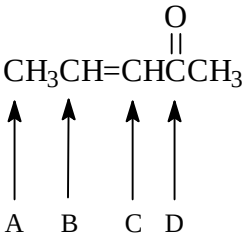
2) 

3) 

4) 

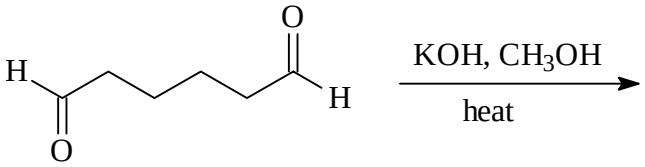
A) is 1
B) is 2
C) is 3
D) is 4

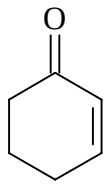
2. Which carbon atoms are most susceptible to nucleophilic attack?

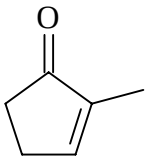


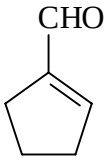
A) A and B
B) B and C
C) B and D
D) A and D

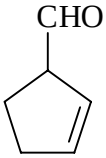
3. What is the product of the following intramolecular aldol condensation reaction?



1) 

2) 

3) 

4) 

A) is 1
B) is 2
C) is 3
D) is 4

4. Benzalacetone is the crossed aldol condensation product formed between benzaldehyde and acetone. Which of the following is the structure of benzalacetone?

1) $C_6H_5CH{=}CHC(=O)CH_3$

2) $C_6H_5CH{=}C(CH_3)_2$

2) $C_6H_5C(=O)CH{=}CHCH_3$

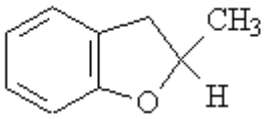
4) $C_6H_5CH_2C(=O)CH{=}CH_2$

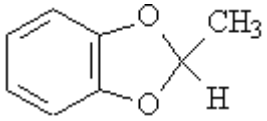
A) is 1
B) is 2
C) is 3
D) is 4

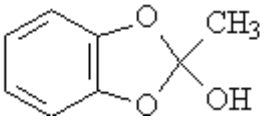
5. Which one of the following reagents adds a methyl group by conjugate (1,4-addition) addition to an α,β-unsaturated ketone or aldehyde?

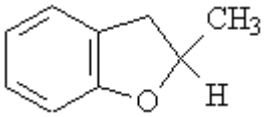
A) $LiCu(CH_3)_2$
B) CH_3MgBr
C) $Hg(O_2CCH_3)_2$
D) CH_3Li

6. Which one of the following gives ethanal, $CH_3CH{=}O$, (as one of two products) when added to an aqueous solution of HCl?

1) 

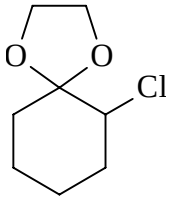
3) 

2) 

4) 

A) is 1
B) is 2
C) is 3
D) is 4

7. Acid-catalyzed hydrolysis of the cyclic acetal below gives:



A) ethanal and 2-chlorocyclohexanol
B) 1,2-ethanediol and 2-chlorocyclohexanol
C) ethanol and 2-chlorocyclohexanol
D) 1,2-ethanediol and 2-chlorocyclohexanone

8. What is the final product of the following sequence of reactions?

$(CH_3)_2CHOH \xrightarrow{PBr_3} \xrightarrow[\text{diethyl ether}]{Mg} \xrightarrow[2)\ H_3O^+]{1)\ \text{O}} \xrightarrow[CH_2Cl_2]{PCC}$

1) $(CH_3)_2CHOCH_2CH_2OH$

3) $(CH_3)_2CHCH_2CHO$

2) $(CH_3)_2CHC(=O)CH_3$

4) $(CH_3)_2CHCH_2CO_2H$

A) is 1
B) is 2
C) is 3
D) is 4

9. Consider the three compounds below.

(A) $CH_3CH_2OCH_2CH_3$

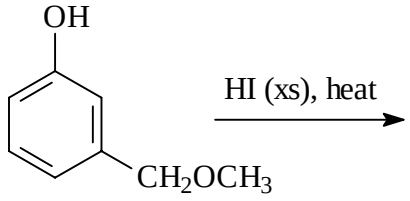
(B) $CH_3CH_2CH_2CH_2CH_3$

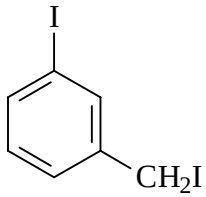
(C) $CH_3CH_2CH_2CH_2OH$

The two most similar in boiling point are _____ and the two most similar in solubility in water are _____.

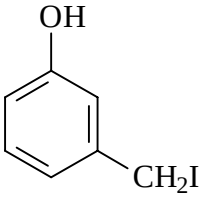
A) A and C, B and C
B) A and B, A and C
C) B and C, A and B
D) A and C, A and C

10. What are the products of the reaction below?

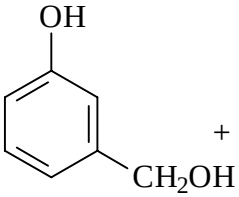


1) 

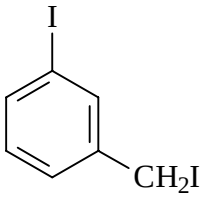
+ CH_3OH

3) 

+ CH_3I

2) 

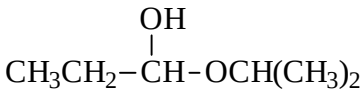
+ CH_3I

4) 

+ CH_3I

A) is 1
B) is 2
C) is 3
D) is 4

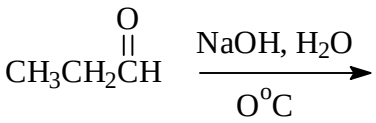
11. The compound shown to the right is the hemiacetal formed between:



A) propanal and 2-propanol
B) 2-methylpropanal and ethanol
C) acetone and 1-propanol
D) ethanal and 2-methyl-1-propanol

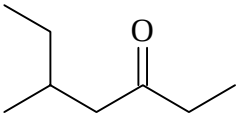
A. is 1
B. is 2
C. is 3
D. is 4

12. What is the aldol addition product of propanal?



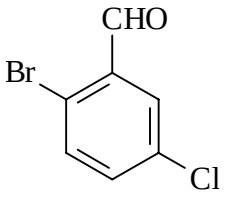
A) 2-hydroxy-2-methylpentanal
B) 3-hydroxy-2-methylpentanal
C) 3-hydroxyhexanal
D) 4-hydroxyhexanal

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



A) 3-methyl-5-heptanone
B) 5-ethyl-3-hexanone
C) 5-methyl-3-heptanone
D) 2-ethyl-4-hexanone

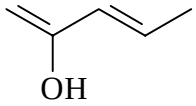
14. Which of the following is an acceptable IUPAC name for the compound below?



A) *o*-bromo-*m*-chlorobenzaldehyde
B) 6-bromo-3-chlorobenzaldehyde
C) 2-bromo-5-chlorobenzaldehyde
D) 1-bromo-4-chlorobenzaldehyde

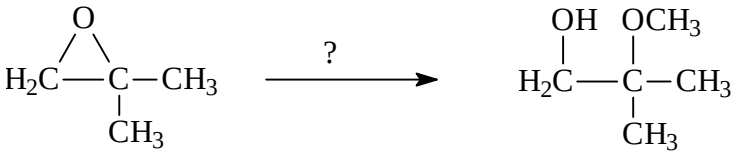
15. What is the relationship between keto and enol tautomers?
A) resonance forms
B) stereoisomers
C) constitutional isomers
D) different conformations of the same compound

16. Identify the keto form of the following enol.



A) 1-penten-3-one
B) (*E*)-3-penten-2-one
C) 2-pentanone
D) (*E*)-3-pentenal

17. Which of the followings reagents would be used to carry out the reaction shown above?



1) CH_3OH, $CH_3O^-Na^+$

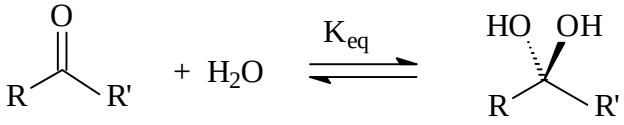
2) CH_3OH, H_2SO_4

3) CH_3MgBr/ether followed by H_3O^+

4) H_2O/H_2SO_4 followed by CH_3OH

A) is 1
B) is 2
C) is 3
D) is 4

18. Which of the following has the largest K_{eq} for the formation of the hydrate (as shown below)?



1) CH_3CCH_3 (O) 2) CH_3CCH_2Cl (O) 3) CH_3CCHCl_2 (O) 4) CH_3CCCl_3 (O)

A) is 1
B) is 2
C) is 3
D) is 4

19. Which of the following reacts with $(CH_3CH_2)_2NH$ to give the compound shown below?
$CH_3CH_2CH{=}CHN(CH_2CH_3)_2$

1) $CH_3CH_2CH_2CH_2Br$

2) $CH_3CH_2CH_2\overset{\overset{O}{\|}}{C}H$

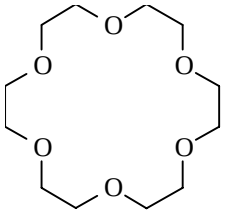
3) $CH_3CH_2\overset{\overset{O}{\|}}{C}CH_3$

4) $CH_3CH_2CH_2\overset{\overset{O}{\|}}{C}OH$

A) is 1
B) is 2
C) is 3
D) is 4

20. The role of 18-crown-6 in the reaction shown below is to:

$$CH_3CH_2CH_2CH_2Br + KF \xrightarrow[C_6H_6,\ heat]{\text{18-crown-6}} CH_3CH_2CH_2CH_2F + KBr$$



18-crown-6

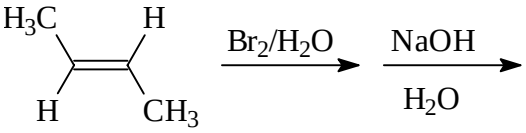
A) complex F^- by ion-dipole attraction and make it more nucleophilic.
B) remove Br^- by ion-dipole attraction and shift the equilibrium to the products.
C) complex K^+ by ion-dipole attraction increasing the solubility of KF and the nucleophilicity of F^-.
D) stabilize the carbocation in the substitution reaction.

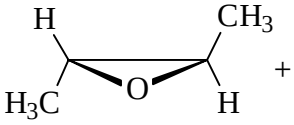
21. Which of the following yields an epoxide on treatment with NaOH?
A) *cis*-2-bromocyclohexanol
B) *trans*-2-bromocyclohexanol
C) *cis*-1,2-cyclohexanediol
D) 3-bromocyclohexene

22. Which of the following reacts the fastest with NaOH, H_2O?

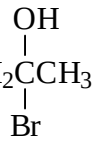
A) ethylene oxide (oxirane)
B) *cis*-2,3-dimethyloxirane
C) *trans*-2,3-dimethyloxirane
D) 2,2,3,3-tetramethyloxirane

23. What is the product of the following sequence of reactions?

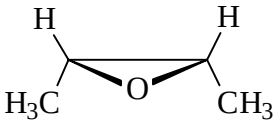


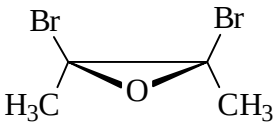
1) 

+ enantiomer

3) 

+ enantiomer

2) 

4) 

A) is 1
B) is 2
C) is 3
D) is 4

24. Which reagent(s) below converts cyclohexene to *trans*-1,2-cyclohexanediol?

1) OsO_4, $(CH_3)_3COOH$, $(CH_3)_3COH$, NaOH

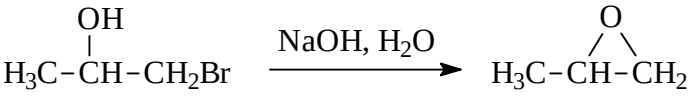
2) O_3 followed by Zn/H_2O

3) $CH_3\overset{\overset{O}{\|}}{C}OOH$ followed by $NaOH/H_2O$

4) HIO_4

A) is 1
B) is 2
C) is 3
D) is 4

25. The reaction shown below can be described as an:



A) acid-base reaction followed by an intramolecular Williamson ether synthesis.
B) acid-base reaction followed by an intramolecular S_N1 reaction.
C) E2 reaction followed by an addition reaction to a double bond.
D) S_N2 reaction followed by an intramolecular Williamson ether synthesis.

26. Which of the following is <u>not</u> a good method to make *tert*-butyl methyl ether?

1) $(CH_3)_3CO^-Na^+ + CH_3Br \longrightarrow$

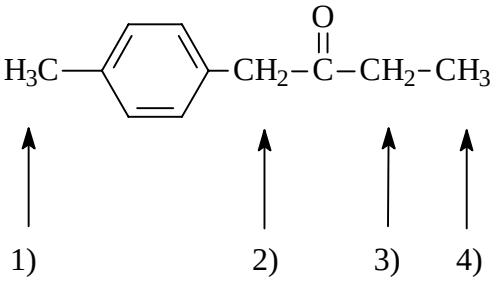
2) $(CH_3)_3CBr + CH_3O^-Na^+ \longrightarrow$

3) $H_2C{=}C(CH_3)_2 + CH_3OH \xrightarrow{H^+}$

4) $(CH_3)_3CBr + CH_3OH \xrightarrow{heat}$

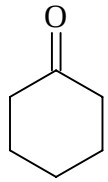
A) is 1
B) is 2
C) is 3
D) is 4

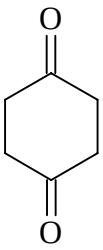
27. Identify the most acid hydrogen for the following compound.

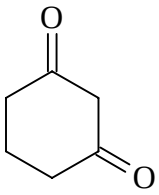


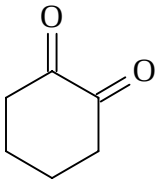
A) is 1
B) is 2
C) is 3
D) is 4

28. Which of the following has the largest acid dissociation constant, K_a?

1) 

2) 

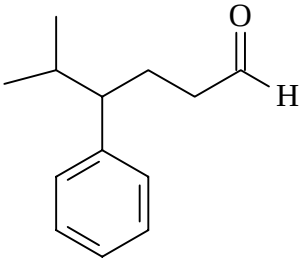
3) 

4) 

A) is 1
B) is 2
C) is 3
D) is 4

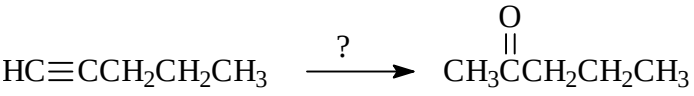
29. The C-O-C bond angle in dimethyl ether is closest to:
A) 90^0
B) 109^0
C) 120^0
D) 180^0

30. Identify the correct IUPAC name of the compound below?



A) 4-benzyl-5-methylhexanal
B) 5-isopropyl-5-phenylbutanal
C) 2-methyl-3-phenylhexanal
D) 5-methyl-4-phenylhexanal

31. Identify the reagents needed to carry out the following conversion.



1) H_2/Lindlar Pd followed by H_2SO_4/H_2O 3) H_2O, $HgSO_4/H_2SO_4$

2) O_3 followed by H_2O 4) $LiAlH_4$ followed by H_2O

A) is 1
B) is 2
C) is 3
D) is 4

32. Match the boiling points with the following three isomers of $C_4H_{10}O_2$.

	$CH_3OCH_2CH_2OCH_3$	$CH_3CH_2OCH_2CH_2OH$	$HOCH_2CH_2CH_2CH_2OH$
A)	85^0C	230^0C	135^0C
B)	230^0C	85^0C	135^0C
C)	85^0C	135^0C	230^0C
D)	135^0C	230^0C	85^0C

33. What reagents and/or reaction sequence below would convert *trans*-3-hexene to *meso*-3,4-hexanediol?

1) OsO_4, $(CH_3)_3COOH$, $(CH_3)_3COH$, NaOH 3) O_3 followed by Zn/H_2O

2) B_2H_6/diglyme followed by H_2O_2/NaOH 4) CH_3CO_3H followed by $NaOH/H_2O$

A) is 1
B) is 2
C) is 3
D) is 4

Answer Key

1. A
2. C
3. C
4. A
5. A
6. C
7. D
8. C
9. B
10. C
11. A
12. B
13. C
14. C
15. C
16. B
17. B
18. D
19. B
20. C
21. B
22. A
23. A
24. C
25. A
26. B
27. B
28. C
29. B
30. D
31. C
32. C
33. D