

1) Which of the following correctly describes the bond angle and hybridizations present in formaldehyde?

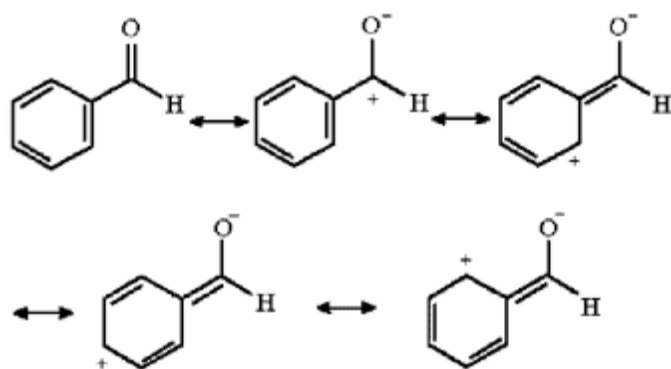
- A) C, sp^2 ; O, sp^3 ; HCO, $\sim 120^\circ$
- B) C, sp^2 ; O, sp^2 ; HCO, $\sim 120^\circ$
- C) C, sp^2 ; O, sp^2 ; HCO, $\sim 109.5^\circ$
- D) C, sp^3 ; O, sp^2 ; HCO, $\sim 109.5^\circ$
- E) C, sp^3 ; O, sp^3 ; HCO, $\sim 109.5^\circ$

Answer: B

Diff: 1

2) Would you expect the carbonyl carbon of benzaldehyde to be more or less electrophilic than that of acetaldehyde? Explain using resonance structures.

Answer: The carbonyl carbon of benzaldehyde would be less electrophilic. Delocalization reduces its partial positive charge as seen in the resonance forms below.



Diff: 2

3) Provide the proper IUPAC name for $(CH_3)_2CHCH_2CH_2COCH=CH_2$.

Answer: 6-methylhept-1-en-3-one

Diff: 2

4) Provide the proper IUPAC name for $PhCH_2CH(CH_3)CH_2CH_2CHO$.

Answer: 4-methyl-5-phenylpentanal

Diff: 1

5) Provide the proper IUPAC name for $CH_3CHOHCH_2COCH_2C(CH_3)_2CH_2CH_3$.

Answer: 2-hydroxy-6,6-dimethyl-4-octanone

Diff: 1

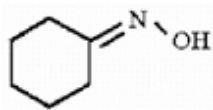
8) Provide the structure of benzophenone.

Answer: PhCOPh

Diff: 1

9) Provide the structure of cyclohexanone oxime.

Answer:



Diff: 2

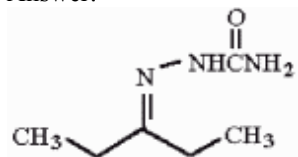
10) Provide the structure of the diethyl acetal of butanal.

Answer: $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{OCH}_2\text{CH}_3)_2$

Diff: 2

13) Provide the structure of the semicarbazone derivative of 3-pentanone.

Answer:



Diff: 3

16) How might one distinguish an aldehyde from a ketone using IR data alone?

Answer: The aldehyde has two C-H stretches at 2700 and 2800 cm^{-1} .

Diff: 2

17) When a carbonyl is part of a conjugated π -network, the C=O stretch:

A) has a higher frequency than in a nonconjugated system.

B) has a lower frequency than in a nonconjugated system.

C) always occurs at 1710 cm^{-1} .

D) occurs around 2700 cm^{-1} .

E) cannot be distinguished from the C=O stretch in a nonconjugated system.

Answer: B

Diff: 2

20) The proton NMR spectrum of an unknown compound contains a triplet at 9.8 ppm. Which of the following could be this unknown?

A) $(\text{CH}_3)_3\text{CCHO}$

B) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$

C) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$

D) $\text{CH}_3\text{COCH}_2\text{Ph}$

E) PhCHO

Answer: C

Diff: 2

21) Provide the major organic product which results when PhCHO is treated with the following sequence of reagents: 1. $\text{CH}_3\text{CH}_2\text{MgBr}$; 2. H_3O^+ ; 3. $\text{Na}_2\text{Cr}_2\text{O}_7$, H_2SO_4 .

Answer: $\text{PhCOCH}_2\text{CH}_3$

Diff: 1

22) By which single reaction can benzene be readily converted into acetophenone?

Answer: CH_3COCl , AlCl_3 - a Friedel-Crafts acylation reaction

Diff: 2

23) What reagents can be used to convert 1-hexyne into 2-hexanone?

- A) 1. Si_2BH ; 2. H_2O_2 , NaOH
- B) Hg^{2+} , H_2SO_4 , H_2O
- C) 1. O_3 ; 2. $(\text{CH}_3)_2\text{S}$
- D) 1. CH_3MgBr ; 2. CO_2
- E) 1. H_2 , Ni ; 2. $\text{Na}_2\text{Cr}_2\text{O}_7$, H_2SO_4

Answer: B

Diff: 2

24) What reagent can be used to convert benzophenone into triphenylmethanol?

Answer: PhMgBr followed by acidic work up

Diff: 1

25) What reagent can be used to convert 2-methylbutan-1-ol into 2-methylbutanal?

- A) LiAlH_4
- B) $\text{Na}_2\text{Cr}_2\text{O}_7$
- C) O_3
- D) KMnO_4
- E) PCC

Answer: E

Diff: 1

26) Beginning with sodium acetylide (NaCCH), propose a three-step synthesis of hexanal.

Answer: 1. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$

2. Si_2BH

3. H_2O_2 , NaOH

Diff: 3

27) Beginning with 1,3-dithiane, propose a synthesis of 4-heptanone.

Answer: 1. BuLi

2. $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$

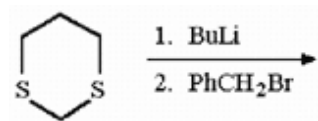
3. BuLi

4. $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$

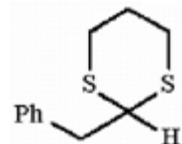
5. HgCl_2 , H_3O^+

Diff: 2

28) Provide the major organic product which results in the reaction shown below.



Answer:



Diff: 2

29) Provide the major organic product which results when $\text{PhCH}_2\text{CH}_2\text{CO}_2\text{H}$ is treated with excess butyllithium followed by H_3O^+ .

Answer: $\text{PhCH}_2\text{CH}_2\text{COCH}_2\text{CH}_2\text{CH}_2\text{CH}_3$

Diff: 1

30) How might one prepare 4-heptanone from $\text{CH}_3\text{CH}_2\text{CH}_2\text{CN}$ in two steps?

Answer: 1. $\text{CH}_3\text{CH}_2\text{CH}_2\text{MgBr}$

2. H_3O^+

Diff: 2

31) Provide the major organic product which results when $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{COCl}$ is treated with $\text{LiAlH}[\text{OC}(\text{CH}_3)_3]_3$.

Answer: $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{CHO}$

Diff: 2

32) Which of the following describes a synthesis of an aldehyde?

A) hydrogenation of an acid chloride using $\text{Pd}/\text{BaSO}_4/\text{S}$ as a poisoned catalyst

B) reaction of a primary alcohol with $\text{Na}_2\text{Cr}_2\text{O}_7$

C) reaction of a ketone with ozone

D) treatment of an alkene with Sia_2BH

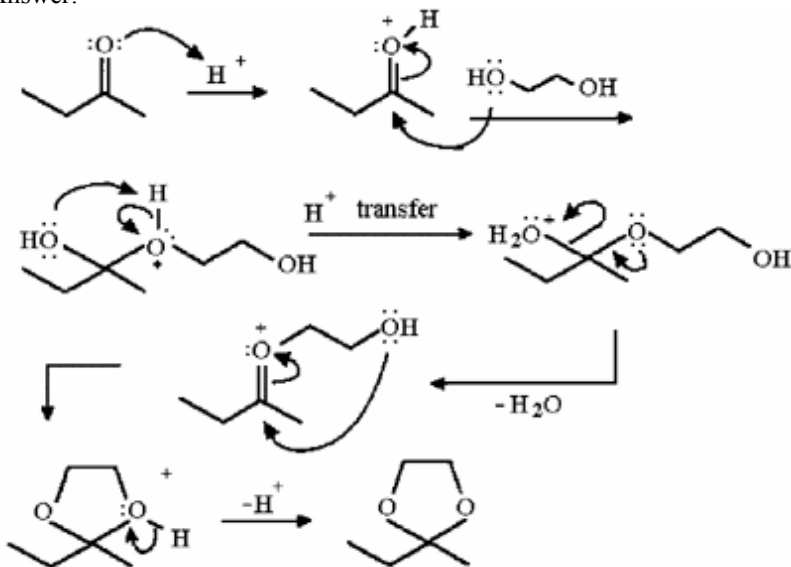
E) none of the above

Answer: A

Diff: 1

33) Provide a detailed, stepwise mechanism for the acid-catalyzed reaction of 2-butanone with ethylene glycol ($\text{HOCH}_2\text{CH}_2\text{OH}$) to produce an acetal.

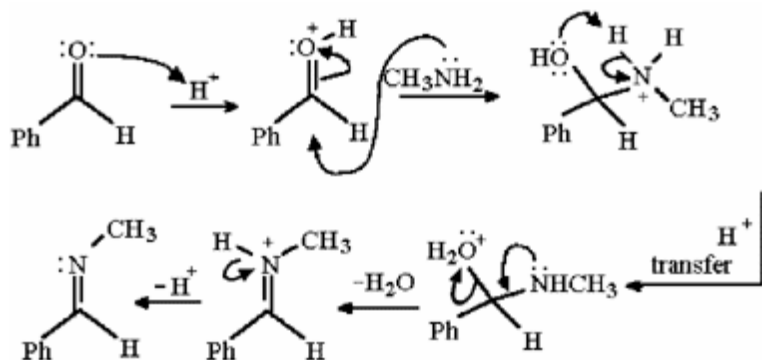
Answer:



Diff: 3

34) Provide a detailed, stepwise mechanism for the acid-catalyzed condensation reaction between benzaldehyde and methylamine.

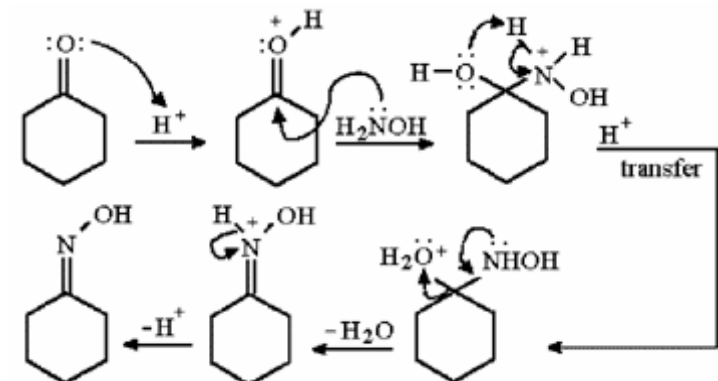
Answer:



Diff: 3

35) Provide a detailed, stepwise mechanism for the acid-catalyzed condensation reaction between cyclohexanone and H_2NOH .

Answer:



Diff: 3

36) Provide the major organic product which results when PhCHOHCH_3 is treated with PCC.

Answer: PhCOCH_3

Diff: 1

37) Provide the major organic product which results when pentanal is subjected to the following sequence of steps:

1. PhMgBr ; 2. H_3O^+ ; 3. PCC

Answer: $\text{PhCOCH}_2\text{CH}_2\text{CH}_2\text{CH}_3$

Diff: 2

39) Draw two major resonance forms of the cation which results when cyclohexanone's carbonyl group is protonated.

Answer:



Diff: 2

40) Propose a synthesis of 4-phenylbutan-2-ol from 3-phenylpropanal.

Answer: 1. CH_3MgBr

2. H_3O^+

Diff: 2

41) Propose a synthesis of 3-methylhept-4-yn-3-ol from but-1-yne.

Answer: 1. NaNH_2

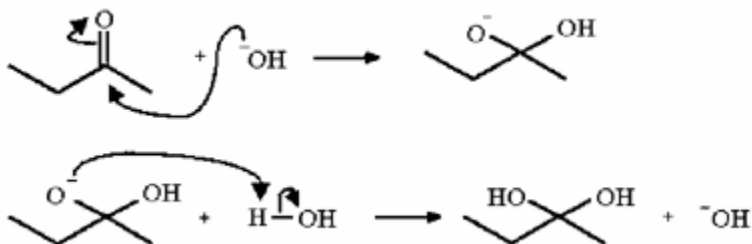
2. $\text{CH}_3\text{COCH}_2\text{CH}_3$

3. H_3O^+

Diff: 3

42) Provide a detailed, stepwise mechanism for the base-catalyzed hydration of 2-butanone.

Answer:



Diff: 2

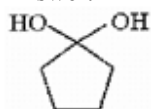
43) Why are the equilibrium constants for hydration of aldehydes typically greater than those of ketones?

Answer: The carbonyl group of an aldehyde is stabilized by only one electron donating alkyl group. Therefore, its carbonyl group has more partial positive charge than that of a ketone. Aldehydes are more electrophilic and less stable than ketones.

Diff: 3

44) Provide the structure of the hydrate of cyclopentanone.

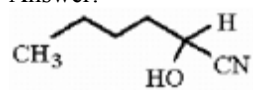
Answer:



Diff: 1

46) Provide the structure of the compound which results when HCN adds to pentanal.

Answer:



Diff: 2

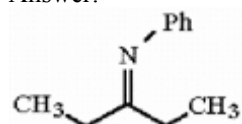
47) Conversion of aldehydes and ketones to imines is an acid-catalyzed process. Explain why this conversion is actually hindered by the presence of too much acid.

Answer: At very low pH, much more of the amine is protonated and can no longer function as a nucleophile.

Diff: 3

48) Provide the major organic product of the reaction of aniline with 3-pentanone.

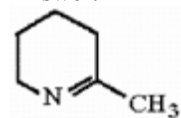
Answer:



Diff: 2

49) When H₂NCH₂CH₂CH₂CH₂COCH₃ is heated in the presence of an acid catalyst, a reaction occurs. The product has the formula C₆H₁₁N. Provide the structure of this product.

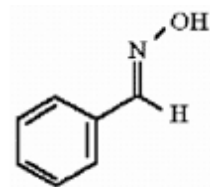
Answer:



Diff: 3

50) Provide the structure of the major organic product which results when benzaldehyde reacts with hydroxylamine in the presence of acid.

Answer:



Diff: 2

51) Provide the structure of the compound which reacts with a ketone to form its hydrazone derivative.

Answer: H_2NNH_2

Diff: 1

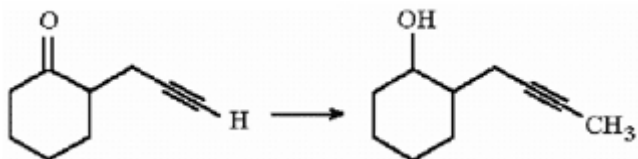
52) Which of the following is also known as a Schiff base?

- A) an imine
- B) a cyanohydrin
- C) a hydrate
- D) sodium hydroxide
- E) an aldehyde

Answer: A

Diff: 2

53) Propose a sequence of steps to carry out the following conversion.



Answer: 1. $\text{HOCH}_2\text{CH}_2\text{OH}$, H^+

2. NaNH_2

3. CH_3I

4. H_3O^+

5. NaBH_4 or LiAlH_4

Diff: 3

54) Why do acetal-forming reactions that use ethylene glycol have more favorable equilibrium constants than those using methanol?

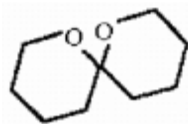
- A) Ethylene glycol reacts more rapidly.
- B) They are more favorable on entropy grounds.
- C) They are more favorable on enthalpy grounds.
- D) Ethylene glycol is acidic and catalyzes the reaction.
- E) The ethylene acetal can serve as a protecting group.

Answer: B

Diff: 3

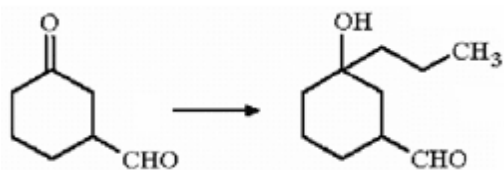
55) When $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{COCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ is heated in the presence of an acid catalyst, a reaction occurs. This product has the formula $\text{C}_9\text{H}_{16}\text{O}_2$. Provide the structure of this product.

Answer:



Diff: 3

56) Propose a sequence of steps to carry out the following conversion.



Answer: 1. HOCH₂CH₂OH, H⁺

2. CH₃CH₂CH₂MgBr

3. H₃O⁺

Diff: 2

57) What intermediate occurs when a ketone undergoes a Wolff-Kishner reduction?

A) a cyanohydrin

B) a hydrated aldehyde

C) a carboxylate

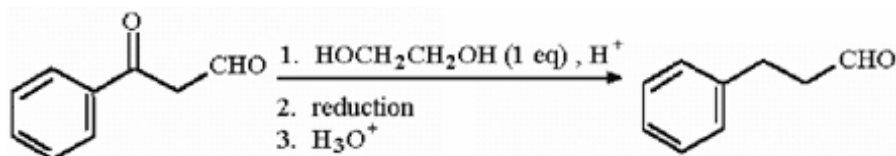
D) a semicarbazone

E) a hydrazone

Answer: E

Diff: 2

58) Which would be more appropriate as the reduction in the following sequence, a Clemmensen or a Wolff-Kishner? Explain.



Answer: Wolff-Kishner. The acidic conditions of the Clemmensen would remove the protecting group causing reduction of the aldehyde as well.

Diff: 3

59) The reagent which converts a carbonyl group of a ketone into a methylene group is:

A) Na, NH₃, CH₃CH₂OH

B) LiAlH₄

C) NaBH₄, CH₃CH₂OH

D) Zn(Hg), conc. HCl

E) LiAlH[OC(CH₃)₃]₃

Answer: D

Diff: 2

60) Acetals will react with:

A) H₃O⁺

B) NaOCH₃

C) PhLi

D) CH₃CH₂MgBr

E) NaBH₄

Answer: A

Diff: 1

67) Propose a synthesis of 3-heptanone from propanal.

Answer: 1. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{MgBr}$, Et_2O

2. H_3O^+

3. $\text{Na}_2\text{Cr}_2\text{O}_7$, H_2SO_4

Diff: 2

68) Name the compound generated when 1-methylcyclohexene is subjected to O_3 followed by dimethyl sulfide.

Answer: 6-oxoheptanal

Diff: 3

69) Name the compound generated when ethylbenzene is treated with CO , HCl , AlCl_3 , and CuCl .

Answer: *p*-ethylbenzaldehyde

Diff: 2

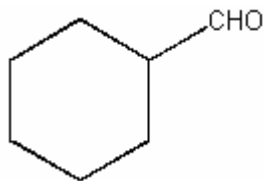
70) What organic compound is generated when PhCOCl is treated with $(\text{CH}_3\text{CH}_2\text{CH}_2)_2\text{CuLi}$?

Answer: $\text{PhCOCH}_2\text{CH}_2\text{CH}_3$

Diff: 2

71) Provide the structure of cyclohexanecarbaldehyde.

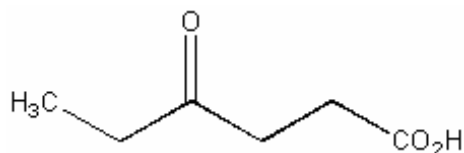
Answer:



Diff: 1

72) Provide the structure of 4-oxohexanoic acid.

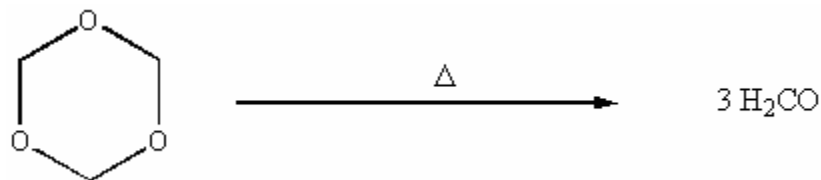
Answer:



Diff: 1

73) Trioxane is a cyclic trimer of formaldehyde that can be converted to formaldehyde upon heating. Show this reaction.

Answer:



Diff: 2

76) Oxidation of a 1° alcohol with chromic acid results in the production of _____.

- A) an ester
- B) a ketone
- C) an aldehyde
- D) an ether
- E) none of the above

Answer: E

Diff: 2

77) Oxidation of a 2° alcohol with chromic acid results in the production of _____.

- A) an ester
- B) a ketone
- C) an aldehyde
- D) an ether
- E) none of the above

Answer: B

Diff: 2

78) Oxidation of a 3° alcohol with chromic acid results in the production of _____.

- A) an ester
- B) a ketone
- C) an aldehyde
- D) an ether
- E) none of the above

Answer: E

Diff: 2

79) Oxidation of a 1° alcohol with pyridinium chlorochromate results in the production of _____.

- A) an ester
- B) a ketone
- C) an aldehyde
- D) an ether
- E) none of the above

Answer: C

Diff: 2

80) Treatment of a nitrile with a Grignard reagent followed by hydrolysis results in _____.

- A) an ester
- B) a ketone
- C) an aldehyde
- D) an ether
- E) an alcohol

Answer: B

Diff: 3

81) What compound is produced when 1,3-dithiane is subjected to the following sequence of reagents:

1. n-BuLi 2. CH₃CH₂Br 3. n-BuLi 4. (CH₃)₂CHCH₂CH₂I 5. HgCl₂, H₃O⁺?

Answer: CH₃CH₂COCH₂CH₂CH(CH₃)₂

Diff: 3

82) Why is (CH₃)₃CCHO not available via a 1,3-dithiane based synthesis?

Answer: A dithiane based synthesis of (CH₃)₃CCHO would require the dithiane anion to react with (CH₃)₃CBr in an S_N2 process. Tertiary halides do not undergo S_N2 reactions because they are excessively hindered.

Diff: 3

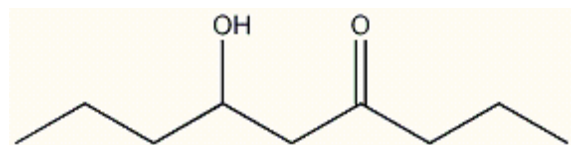
83) What compound is produced when 1,3-dithiane is subjected to the following sequence of reagents:

1. n-BuLi 2. (CH₃)₃CCH₂CH₂CH₂I 3. HgCl₂, H₃O⁺?

Answer: (CH₃)₃CCH₂CH₂CH₂CHO

Diff: 3

84) Provide the IUPAC name for the following compound.



Answer: 6-hydroxy-4-nonanone or 6-hydroxynonan-4-one

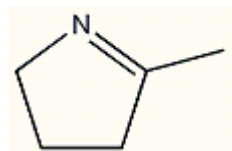
Diff: 2

85) Provide the IUPAC name for (CH₃)₃CCH₂CHClCH₂CHO.

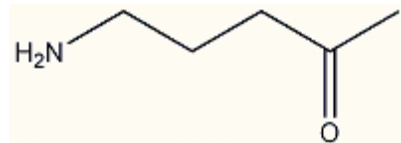
Answer: 3-chloro-5,5-dimethylhexanal

Diff: 2

87) Give the structure of the acyclic compound from which the following imine was formed.

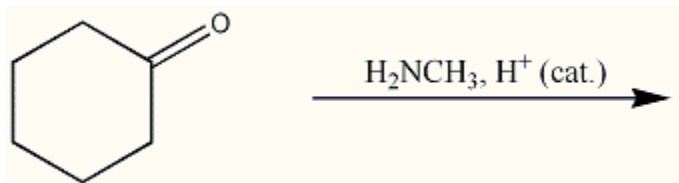


Answer:

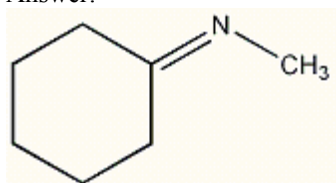


Diff: 2

88) Provide the major organic product of the following reaction.



Answer:

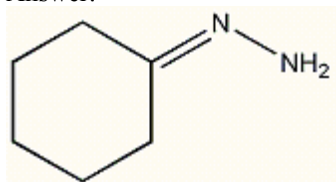


Diff: 2

89) Provide the major organic product of the following reaction.

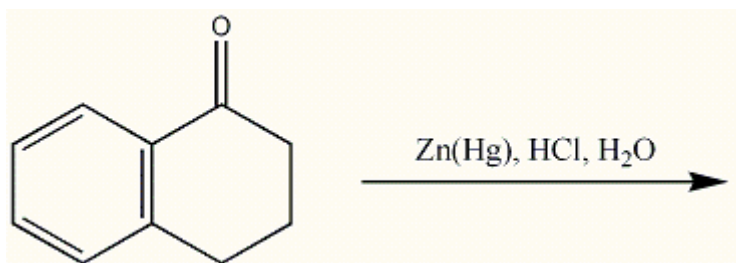


Answer:

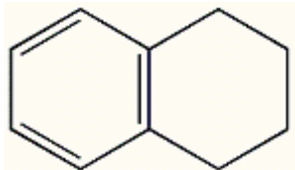


Diff: 2

90) Provide the major organic product of the following reaction.



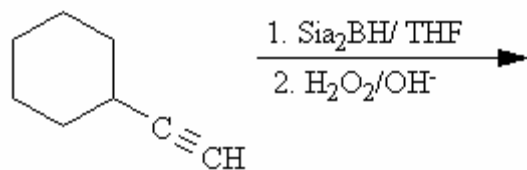
Answer:



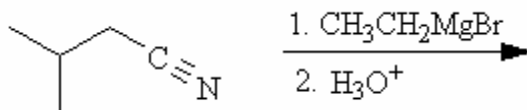
Diff: 2

91) Which of the following reactions will not yield a ketone product?

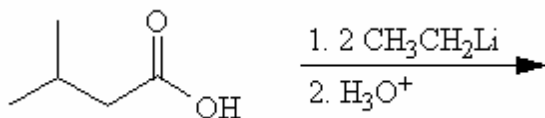
A)



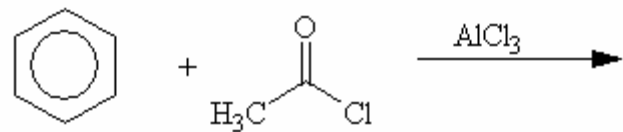
B)



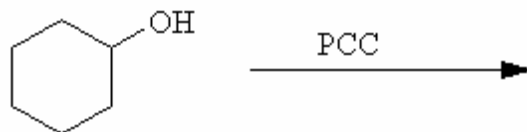
C)



D)



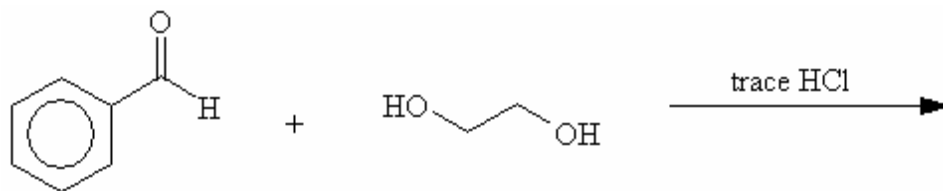
E)



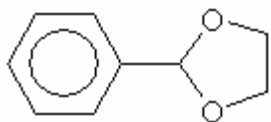
Answer: A

Diff: 2

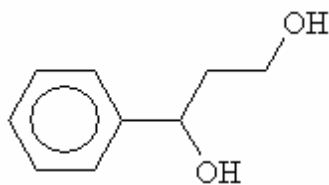
93) What would be the product of the following reaction?



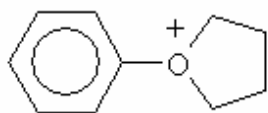
A)



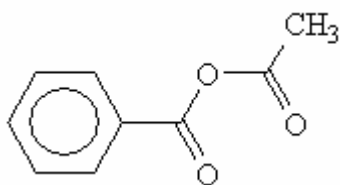
B)



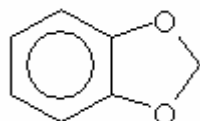
C)



D)



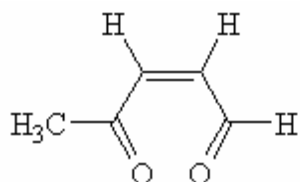
E)



Answer: A

Diff: 2

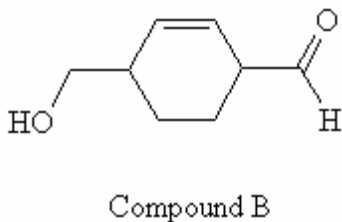
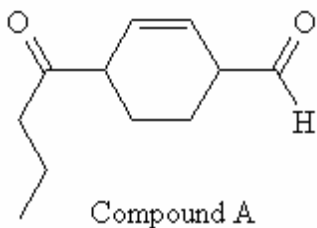
94) Give an IUPAC name to the following compound. Be sure to include configurational information in the name.



Answer: (Z)-4-oxo-2-pentalenal or (Z)-4-oxopent-2-enal

Diff: 2

95) Which series of reactions described below will result in the formation of compound A, starting with compound B?



- A) 1. HO-(CH₂)₂-OH /trace H₃O⁺
2. DMSO (COCl₂)/Et₃N, CH₂Cl₂
3. MgBr-(CH₂)₂-CH₃/diethylether
4. work-up with H₃O⁺
- B) 1. PCC
3. SOCl₂
4. LiCu-((CH₂)₂-CH₃)₂
5. work-up with H₃O⁺
- C) 1. Na₂Cr₂O₇/H₂SO₄
2. SOCl₂
3. 2 MgBr-(CH₂)₂-CH₃/diethylether
4. work-up with H₃O⁺

D) both A and B

E) both B and C

Answer: A

Diff: 2