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1

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

- A) C, sp²; O, sp³; HCO, ~120°
- B) C, sp²; O, sp²; HCO, ~120°
- C) C, sp²; O, sp²; HCO, ~109.5°
- D) C, sp³; O, sp²; HCO, ~109.5°
- E) C, sp³; O, sp³; HCO, ~109.5°

B) C, sp²; O, sp²; HCO, ~120°

2

The positively polarized carbon atom of a carbonyl group acts as:

- A) an electrophile and a Lewis base.
- B) a nucleophile and a Lewis base.
- C) an electrophile and a Lewis acid.
- D) a nucleophile and a Lewis acid.

E) both a Lewis acid and a Lewis base.

C) an electrophile and a Lewis acid

3

The double bond between carbon and oxygen is similar to an alkene $C=C$, except that $C=O$ is:

A) shorter and weaker.

B) shorter and stronger.

C) longer and weaker.

D) longer and stronger.

E) longer.

B) shorter and stronger.

4

Another name for β -methoxybutyraldehyde is:

A) 2-methoxypropanal.

B) 3-methoxypropanal.

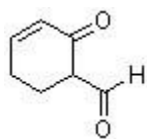
C) 2-methoxybutanal.

D) 3-methoxybutanal.

E) 2-methoxypentanal.

D) 3-methoxybutanal

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What is the correct IUPAC name for the following compound?

A) 2-oxocyclohex-3-ene carbaldehyde

B) 5-formylcyclohex-2-enone

C) 2-formylcyclohex-5-enone

D) 3-oxocyclohex-4-enal

A) 2-oxocyclohex-3-ene carbaldehyde

6

Which of the following represents the correct ranking in terms of increasing boiling point?

- A) n-butane < 1-butanol < diethyl ether < 2-butanone
- B) n-butane < 2-butanone < diethyl ether < 1-butanol
- C) 2-butanone < n-butane < diethyl ether < 1-butanol
- D) n-butane < diethyl ether < 1-butanol < 2-butanone
- E) n-butane < diethyl ether < 2-butanone < 1-butanol

E) n-butane < diethyl ether < 2-butanone < 1-butanol

7

Which of the following compounds is most soluble in water?

- A) acetone
- B) cyclohexanone
- C) 2-butanone
- D) 3-butanone
- E) benzophenone

A) acetone

8

When a carbonyl is part of a conjugated π -network, the $\text{C}=\text{O}$ 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 $\text{C}=\text{O}$ stretch in a nonconjugated system

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

9

What name is given to the linear polymer which contains many formaldehyde units?

- A) trioxane
- B) formalin
- C) paraformaldehyde
- D) polyacetaldehyde
- E) polyalal

C) paraformaldehyde

10

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

E) PCC

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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

B) Hg^{2+} , H_2SO_4 , H_2O

12

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

E) none of the above

13

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

B) a ketone

14

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

C) an aldehyde

15

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

The THF reagent one

16

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

E) none of the above

17

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

B) a ketone

18

Which of the following describes a synthesis of an aldehyde?

- A) hydrogenation of an acid chloride using Pd/BaSO₄/S as a poisoned catalyst
- B) reaction of a primary alcohol with Na₂Cr₂O₇
- C) reaction of a ketone with ozone

D) treatment of an alkene with Sia₂BH

E) none of the above

A) hydrogenation of an acid chloride using Pd/BaSO₄/S as a poisoned catalyst

19

Which series of reactions described below, if any, will result in the formation of 2-methylpentan-3-one starting with 1-propanol?

A) 1. (CH₃)₂CHMgBr/ diethyl ether

2. dilute H₃O⁺

3. PCC

B) 1. Na₂Cr₂O₇/H₂SO₄ and heat

2. SOCl₂

3. 2 (CH₃)₂CHMgBr/ diethyl ether

4. H₃O⁺

C) 1. Na₂Cr₂O₇/H₂SO₄ and heat

2. (CH₃)₂CHMgBr/ diethyl ether

3. dilute H₃O⁺

4. LiAlH₄

D) 1. PCC

2. (CH₃)₂CHLi/ diethyl ether

3. dilute H₃O⁺

4. Na₂Cr₂O₇/H₂SO₄ and heat

E) none of the above

D) 1. PCC

2. (CH₃)₂CHLi/ diethyl ether

3. dilute H₃O⁺

4. Na₂Cr₂O₇/H₂SO₄ and heat

20

When the carbonyl group of a neutral ketone is protonated,:

A) the resulting species becomes more electrophilic.

B) the resulting species is activated toward nucleophilic attack.

C) subsequent nucleophilic attack on the resulting species is said to occur under acid-catalyzed conditions.

D) the resulting species has a positive charge.

E) all of the above

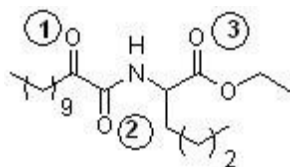
E) all of the above

21

Consider the equilibrium of each of the carbonyl compounds with HCN to produce cyanohydrins. Which is the correct ranking of compounds in order of increasing K_{eq} for this equilibrium?

- A) $\text{H}_2\text{CO} < \text{cyclohexanone} < \text{CH}_3\text{CHO} < \text{2-methylcyclohexanone}$
 B) $\text{CH}_3\text{CHO} < \text{2-methylcyclohexanone} < \text{cyclohexanone} < \text{H}_2\text{CO}$
 C) $\text{cyclohexanone} < \text{2-methylcyclohexanone} < \text{H}_2\text{CO} < \text{CH}_3\text{CHO}$
 D) $\text{cyclohexanone} < \text{2-methylcyclohexanone} < \text{CH}_3\text{CHO} < \text{H}_2\text{CO}$
 E) $\text{2-methylcyclohexanone} < \text{cyclohexanone} < \text{CH}_3\text{CHO} < \text{H}_2\text{CO}$
- E) $\text{2-methylcyclohexanone} < \text{cyclohexanone} < \text{CH}_3\text{CHO} < \text{H}_2\text{CO}$

22

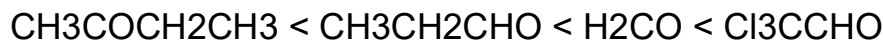


The following compound has been found effective in treating pain and inflammation (J. Med. Chem. 2007, 4222). Which sequence correctly ranks each carbonyl group in order of increasing reactivity toward nucleophilic addition?

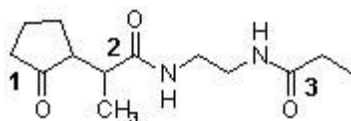
- A) $1 < 2 < 3$
 B) $2 < 3 < 1$
 C) $3 < 1 < 2$
 D) $1 < 3 < 2$
- B) $2 < 3 < 1$

23

Rank the following compounds in order of their propensity to become a hydrate in water (i.e., start with the least easy to hydrate: $\text{CH}_3\text{COCH}_2\text{CH}_3$, H_2CO , Cl_3CCHO , and $\text{CH}_3\text{CH}_2\text{CHO}$)



24



Which sequence ranks the following carbonyl compounds in order of increasing rate of

nucleophilic addition?

- A) $2 < 3 < 1$
- B) $3 < 2 < 1$
- C) $2 < 1 < 3$
- D) $1 < 3 < 2$

A) $2 < 3 < 1$

25

An ylide is a molecule that can be described as a:

- A) carbanion bound to a negatively charged heteroatom.
- B) carbocation bound to a positively charged heteroatom.
- C) carbocation bound to a carbon radical.
- D) carbocation bound to a diazonium ion.
- E) carbanion bound to a positively charged heteroatom.

Answer: E

E) carbanion bound to a positively charged heteroatom

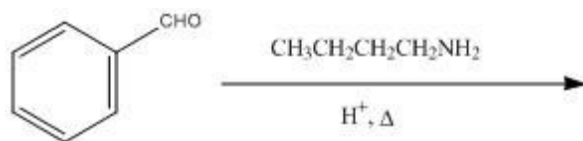
26

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

A) an imine

27



What product will result from the reaction shown?

- A) imine
- B) amino acid
- C) amino alcohol
- D) hydrazine
- E) hydroxylamine

A) imine

28



What product will result from the reaction shown?

- A) acetal
- B) hydrazine
- C) ester
- D) ylide
- E) ketone

A) acetal

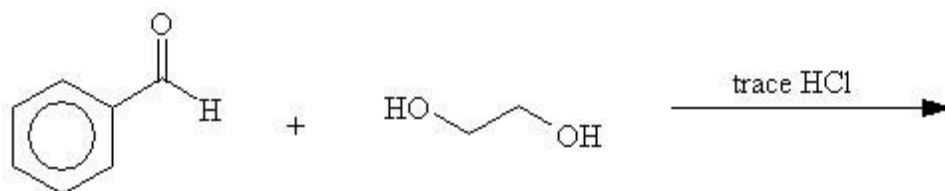
29

Acetals will react with _____.

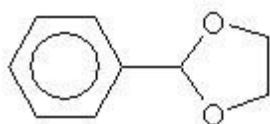
- A) $\text{H}_3\text{O}^{\oplus}$
- B) NaOCH_3
- C) PhLi
- D) $\text{CH}_3\text{CH}_2\text{MgBr}$
- E) NaBH_4

A) $\text{H}_3\text{O}^{\oplus}$

30



What would be the product of the following reaction?



A)

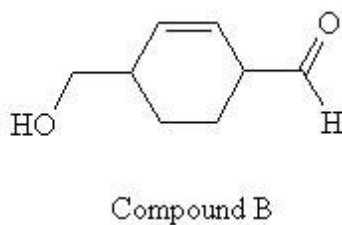
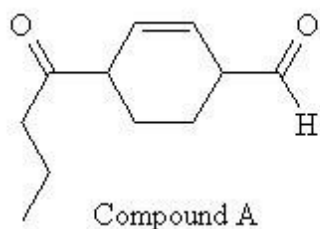
31

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.

B) They are more favorable on entropy grounds

32



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

33

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

E) a hydrazone

34

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

D) Zn(Hg), conc. HCl

35

Which of the following carbonyl compounds may be made from 1,3-dithiane?

- 1) methyl vinyl ketone
- 2) 2-pentanone
- 3) 3,3-dimethyl-2-butanone
- 4) 2-phenylethanal

- A) 1 & 4
- B) 2 only
- C) 2 & 3
- D) 2 & 4

D) 2 & 4

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