Carbonyl & Multistep Synthesis Practice

INSTRUCTOR ANSWER KEY — COMPLETE EXPLANATIONS

Directions: Answers are in red. Key includes a concise rationale for each item.

1. **NaBH4 followed by aqueous workup reduces a simple ketone to:**

   A. A primary alcohol

   B. A secondary alcohol

   C. An ester

   D. An alkene

   Reasoning: The carbonyl carbon of a ketone becomes the carbon bearing OH and two alkyl groups.

2. **NaBH4 followed by workup reduces an aldehyde (other than formaldehyde) to:**

   A. A primary alcohol

   B. A tertiary alcohol

   C. A ketone

   D. An epoxide

   Reasoning: Aldehyde hydride reduction gives a primary alcohol.

3. **PCC oxidation of a simple primary alcohol under anhydrous conditions normally stops at:**

   A. A ketone

   B. An aldehyde

   C. An ester

   D. An alkene

   Reasoning: Under typical dry PCC conditions, primary alcohols yield aldehydes.

4. **Strong aqueous chromium(VI) oxidation of a primary alcohol commonly yields:**

   A. An aldehyde only

   B. A carboxylic acid

   C. A tertiary alcohol

   D. An ether

   Reasoning: Strong aqueous oxidants typically oxidize primary alcohols past the aldehyde to the acid.

5. **A carboxylic acid and alcohol under acid catalysis and reversible conditions form:**

   A. An ester and water

   B. An amide and ammonia

   C. A ketone and hydrogen

   D. An epoxide

   Reasoning: Fischer esterification is an acid-catalyzed equilibrium between carboxylic acid + alcohol and ester + water.

6. Ketone + Grignard reagent, then H3O+ workup, generally gives:

A. Primary alcohol

B. Secondary alcohol

C. Tertiary alcohol

D. Carboxylic acid

Reasoning: Grignard carbon addition to a ketone adds a third carbon substituent to the alcohol carbon.

7. Formaldehyde + Grignard reagent, then workup, gives:

A. A primary alcohol

B. A secondary alcohol

C. A tertiary alcohol

D. An ester

Reasoning: Addition to H2C=O generates RCH2OH after protonation: a primary alcohol.

8. A nitrile group can often be identified by which IR feature?

A. Strong broad OH 2500–3300

B. Sharp absorption near 2250

C. Aldehyde H near 9.7 ppm

D. Strong C=O near 1715

Reasoning: A C≡N group commonly produces a characteristic IR band near 2250 cm−1.

9. Which reagent converts 1-bromobutane to 1-iodobutane most directly?

A. NaI in acetone

B. H2/Pd

C. PCC

D. H2SO4/H2O

Reasoning: The Finkelstein halide exchange proceeds by SN2 with iodide; acetone favors the exchange.

10. Which reagent converts propanone into propan-2-ol?

A. NaBH4, then workup

B. PCC

C. KMnO4, hot

D. Br2/hν

Reasoning: NaBH4 reduces a ketone to the corresponding secondary alcohol.

11. Which reagent converts propanal into propan-1-ol?

A. NaBH4, then workup

B. PCC

C. Ag2O only

D. NaOEt/EtOH

Reasoning: Hydride reduction of an aldehyde gives a primary alcohol.

12. Which reagent adds HBr across ethene to produce bromoethane?

A. HBr

B. NaBH4

C. NaI in acetone

D. PCC

Reasoning: Electrophilic addition of HBr to symmetric ethene produces bromoethane.

13. Cyclohexene can be converted to cyclohexanol with:

A. Aqueous acid-catalyzed hydration

B. PCC

C. NaNH2/NH3

D. NaI/acetone

Reasoning: Acid-catalyzed hydration adds H and OH across the alkene.

14. Which sequence converts cyclohexene into trans-1,2-cyclohexanediol?

A. mCPBA, then aqueous acid

B. H2/Pd

C. PCC, then water

D. NaBH4, then water

Reasoning: Epoxidation followed by anti epoxide opening gives a trans vicinal diol on cyclohexene.

15. Excess H2/Pd converts 1-butyne into:

A. 1-butene

B. cis-2-butene

C. Butane

D. Butanal

Reasoning: Unrestricted catalytic hydrogenation reduces both alkyne π bonds to yield the alkane.