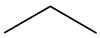
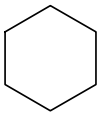
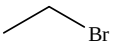
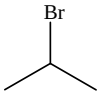
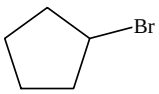
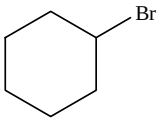
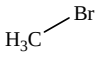
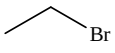
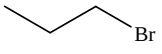
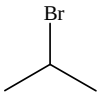
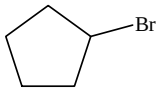
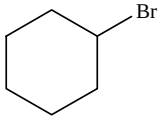
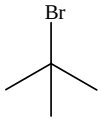
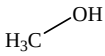
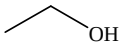
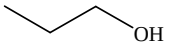
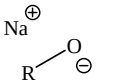
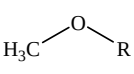
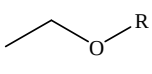
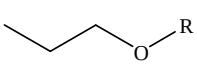
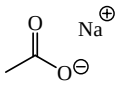
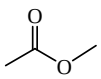
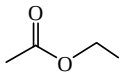
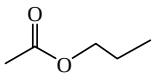
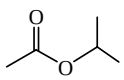
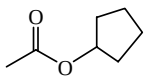
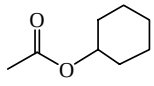
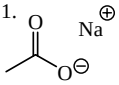
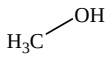
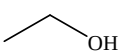
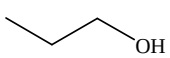
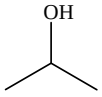
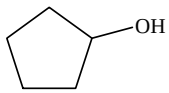
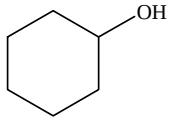
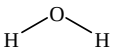
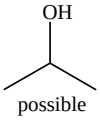
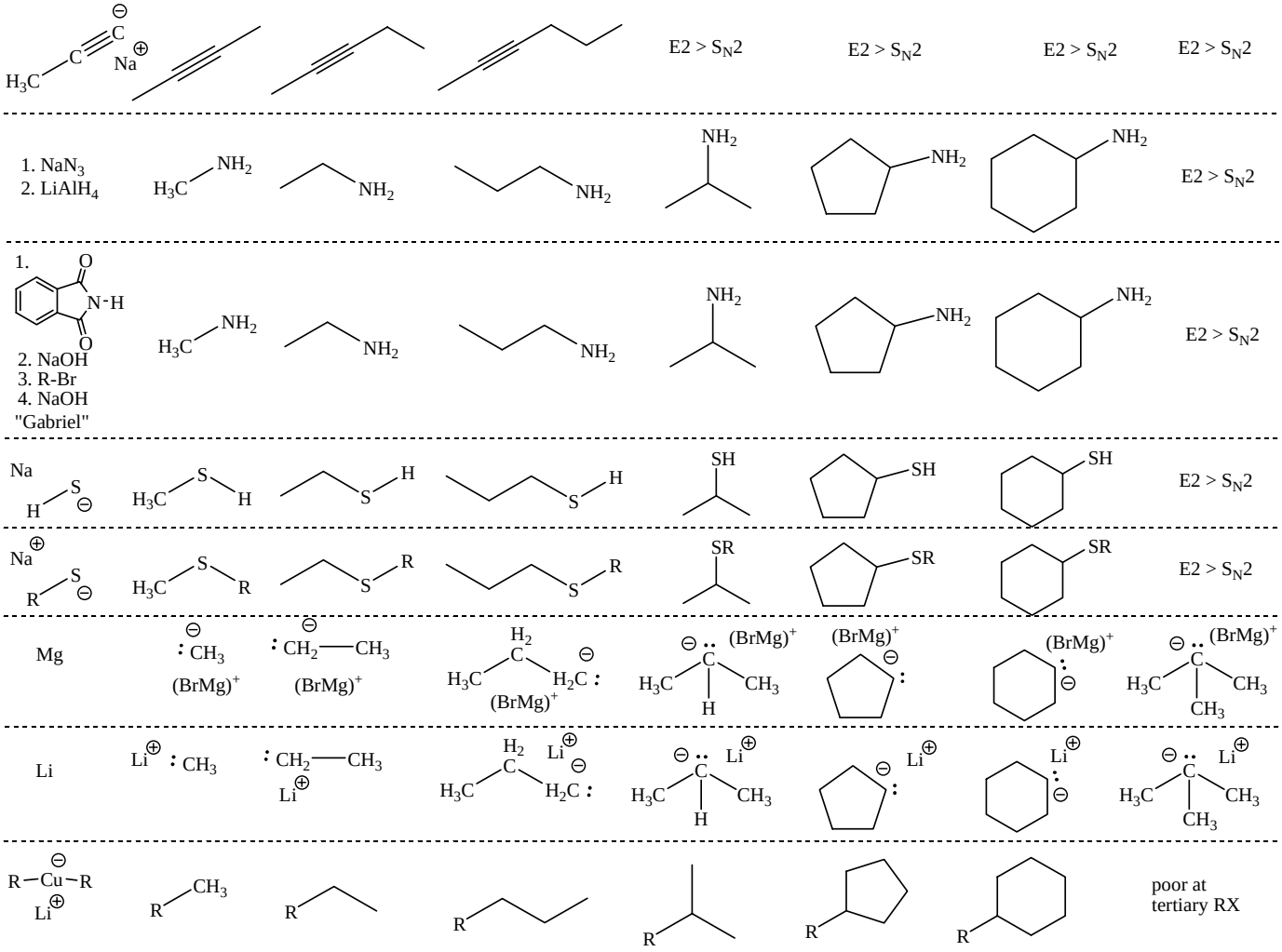
Alkanes

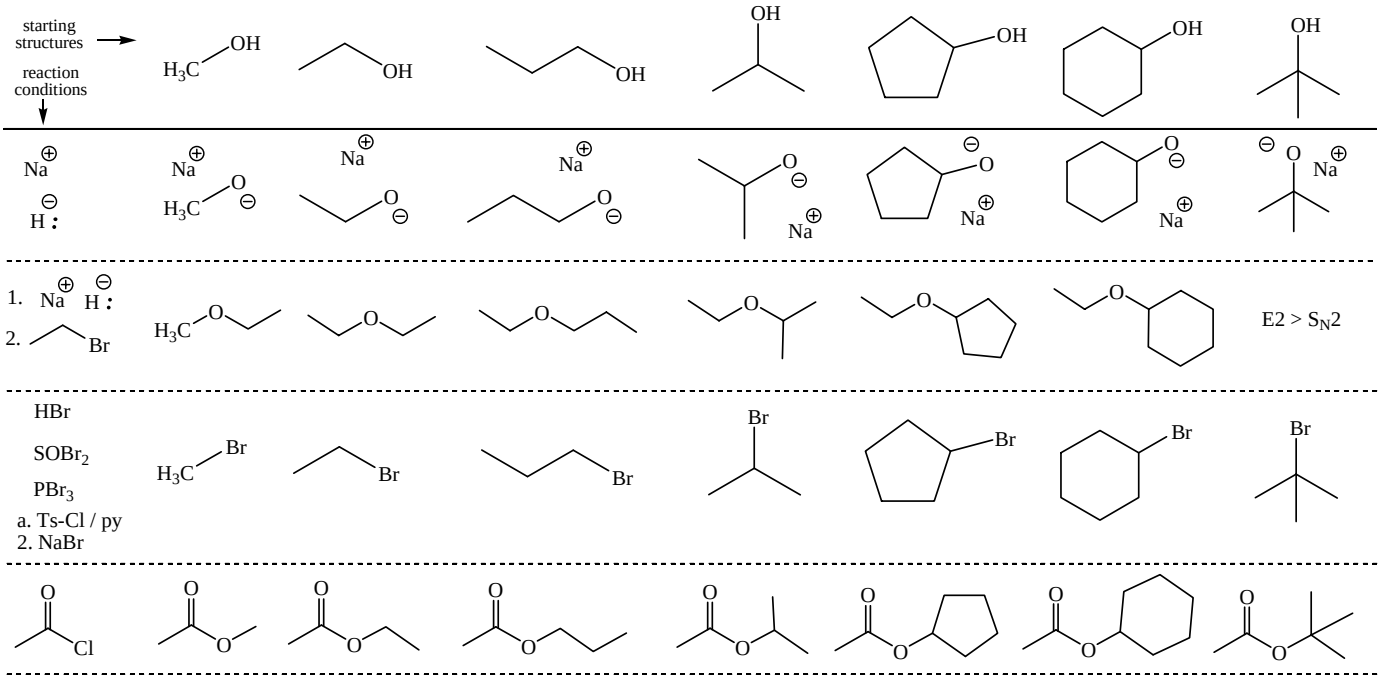
starting structures → / reaction conditions ↓	CH_4				
Br_2 / hν					
O_2 / Δ	1 CO_2 + 2 H_2O	2 CO_2 + 3 H_2O	3 CO_2 + 4 H_2O	5 CO_2 + 5 H_2O	6 CO_2 + 6 H_2O

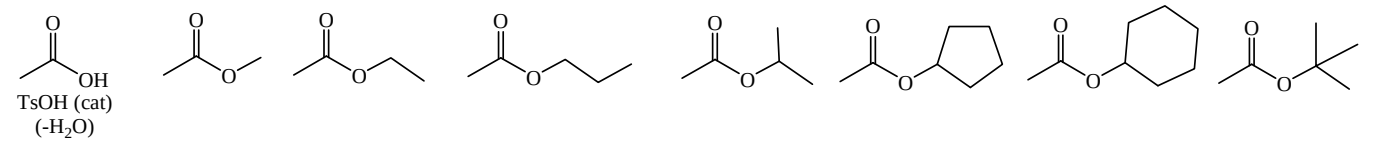
Bromoalkanes

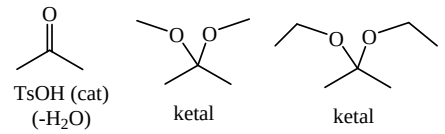
starting structures → / reaction conditions ↓							
				E2 > S_N2	E2 > S_N2	E2 > S_N2	E2 > S_N2
				E2 > S_N2	E2 > S_N2	E2 > S_N2	E2 > S_N2
							E2 > S_N2
1.  2. NaOH							E2 > S_N2
	N.R.	N.R.	N.R.	 possible rearrangement	possible rearrangement	possible rearrangement	possible rearrangement
	N.R.	N.R.	N.R.	possible rearrangement	possible rearrangement	possible rearrangement	possible rearrangement
	N.R.	N.R.	N.R.				
							E2 > S_N2
				E2 > S_N2	E2 > S_N2	E2 > S_N2	E2 > S_N2

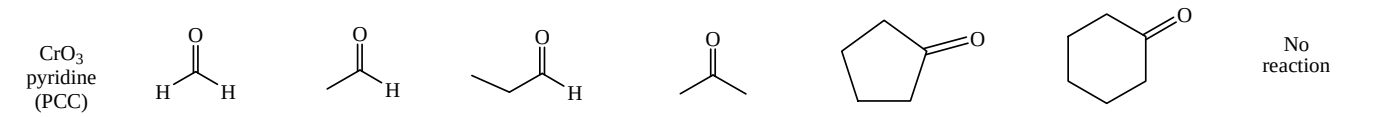

E2 > S_N2
E2 > S_N2
E2 > S_N2
E2 > S_N2
1. NaN_3
2. $LiAlH_4$
E2 > S_N2
1.
2. NaOH
3. R-Br
4. NaOH
"Gabriel"
E2 > S_N2
E2 > S_N2
E2 > S_N2
Mg
Li
poor at
tertiary RX

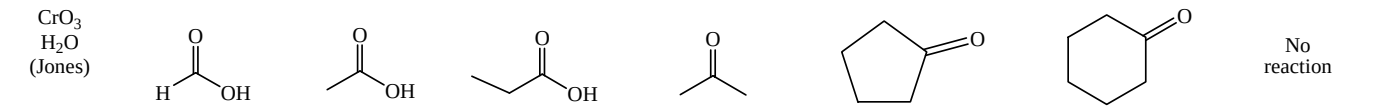
Alcohols


starting
structures
reaction
conditions
1. $NaBH_4$
2.
E2 > S_N2
HBr
$SOBr_2$
PBr_3
a. Ts-Cl / py
2. NaBr

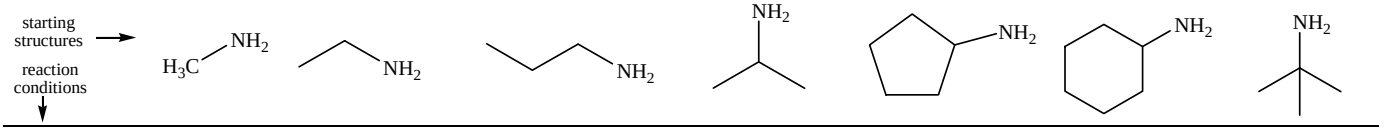


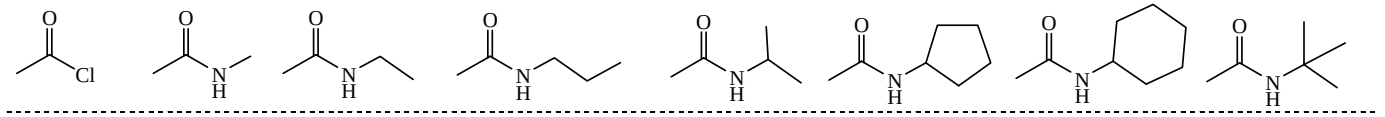


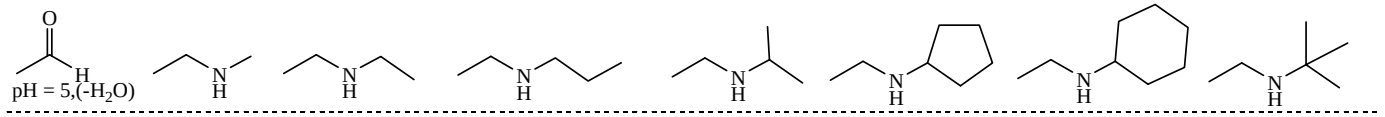


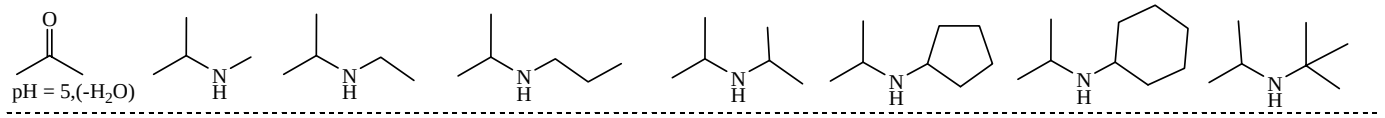


Amines

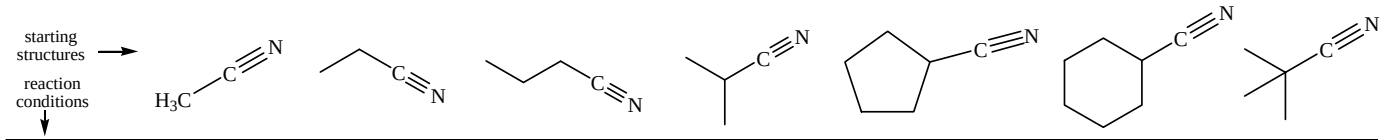


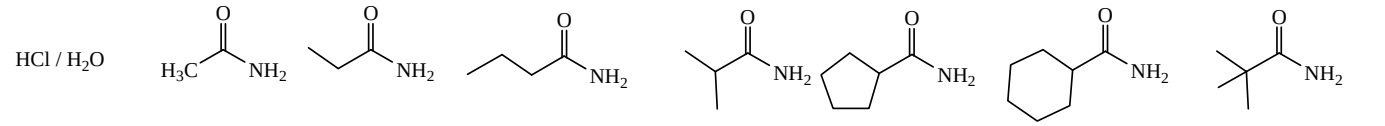


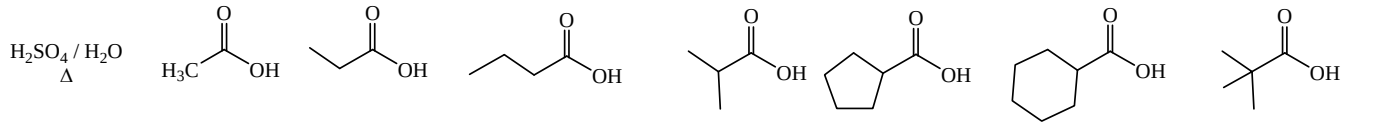


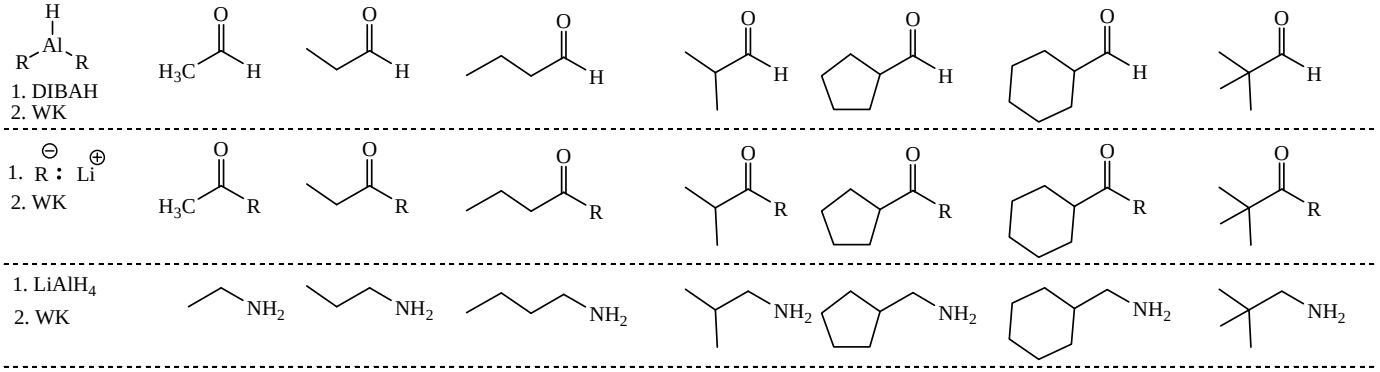


Nitriles

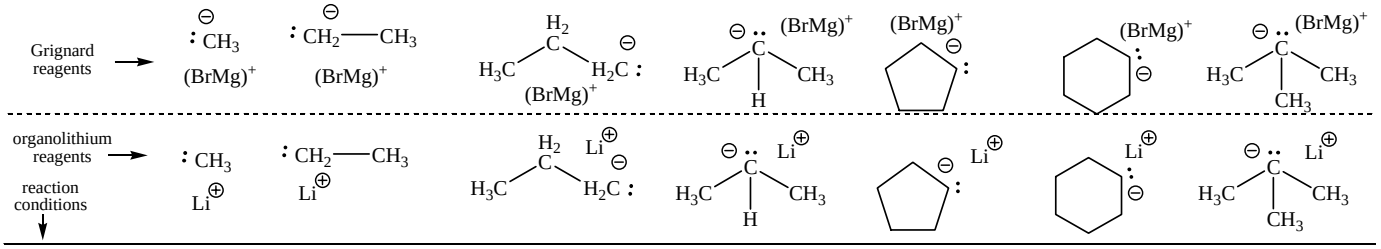


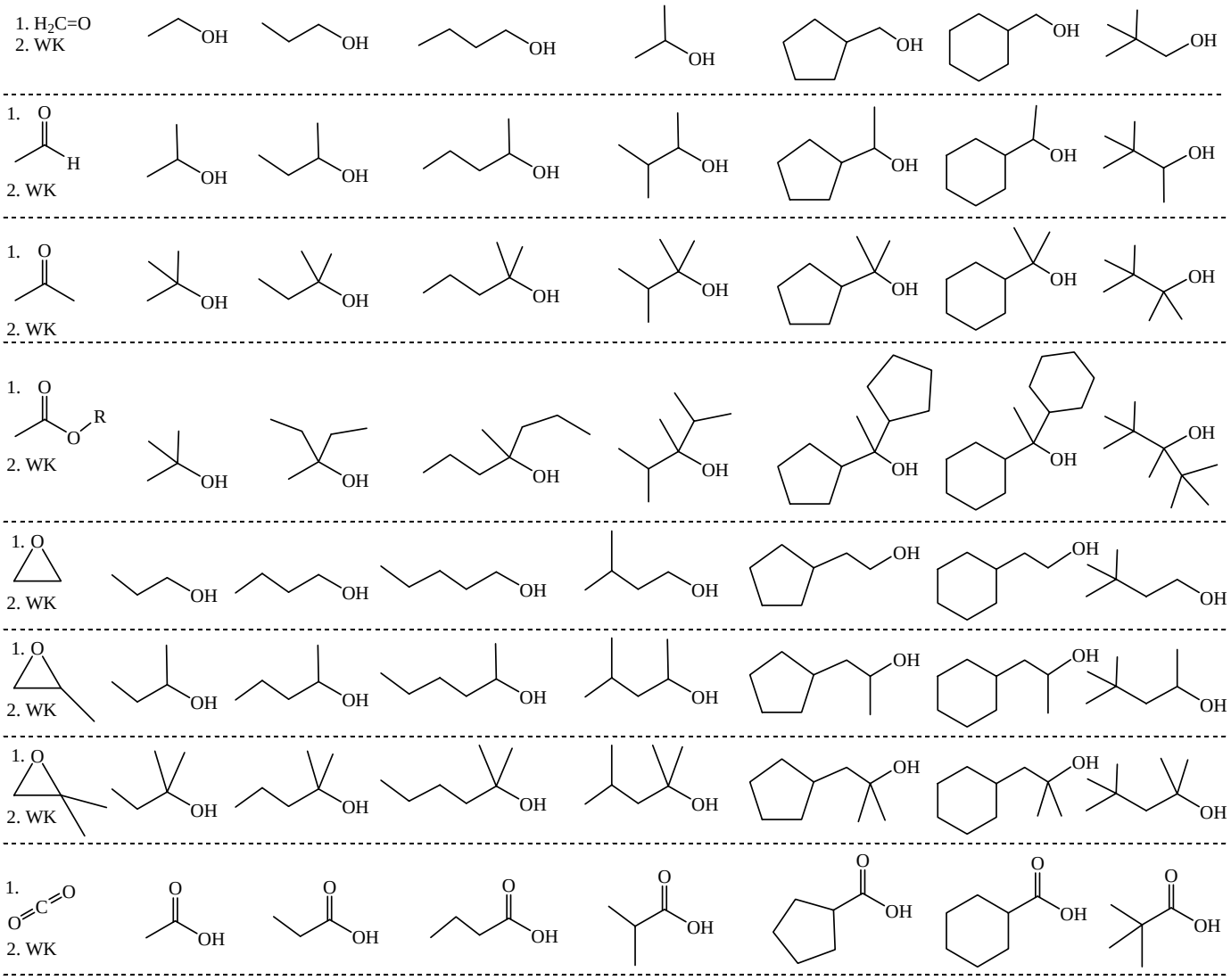


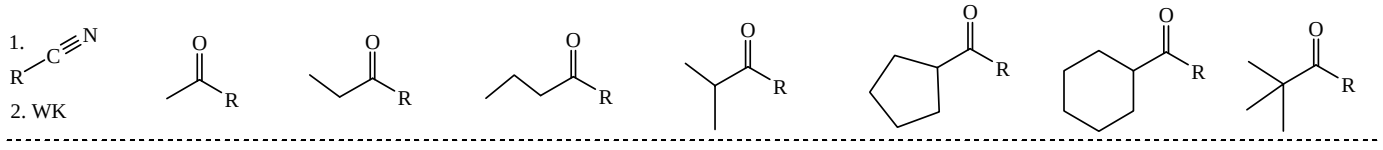


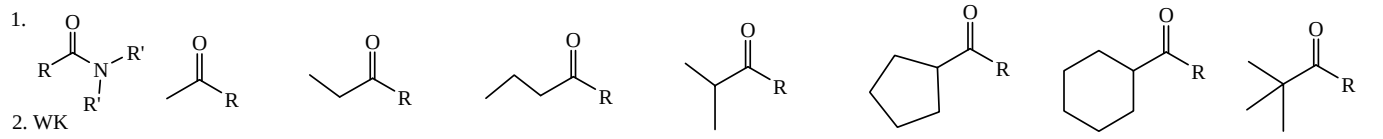


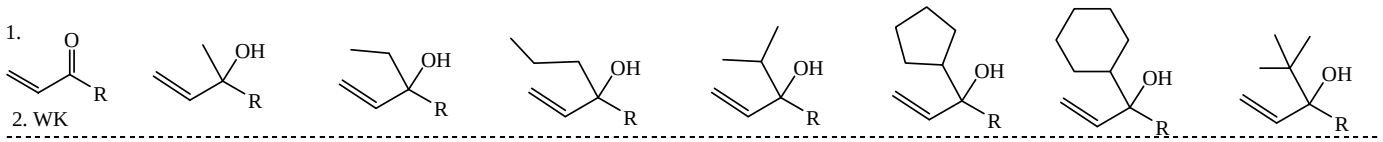
Organometallics – except for reactions with RCO_2H, these reagents react in a similar manner



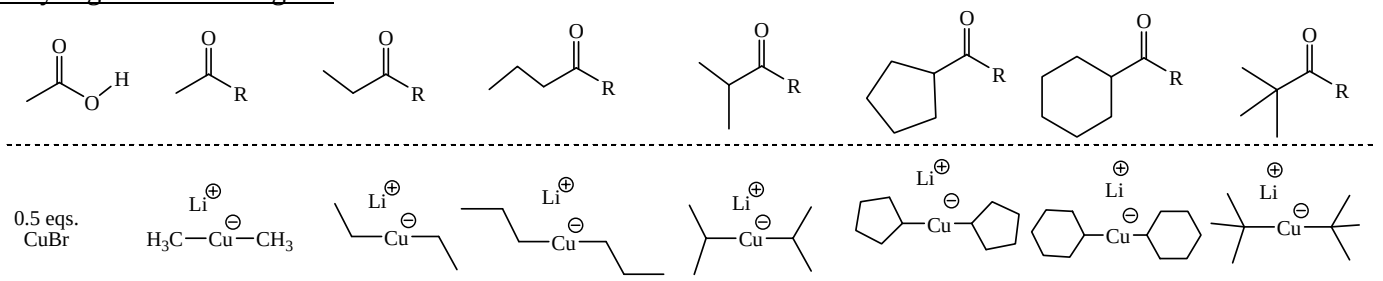




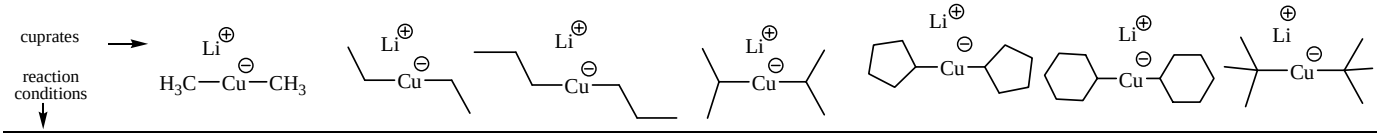


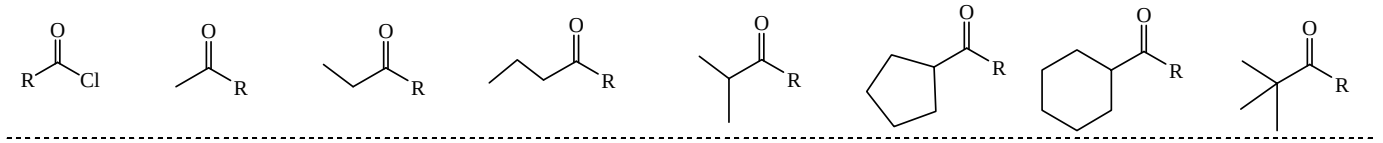


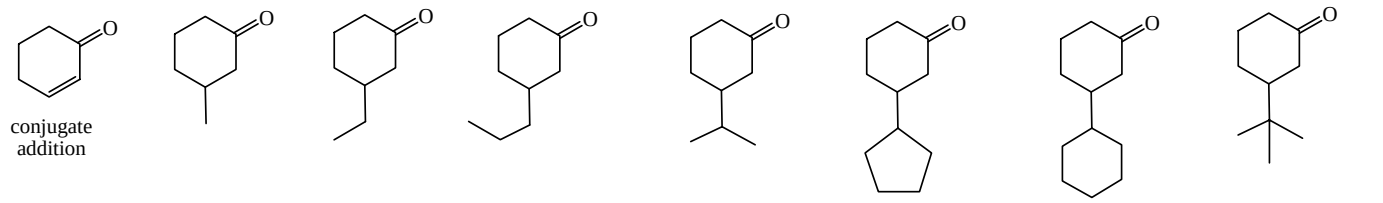
Only organolithium reagents



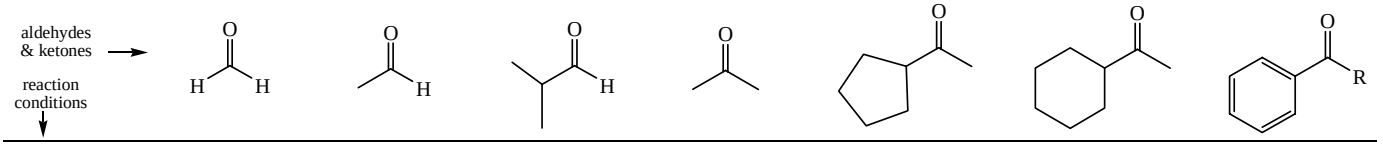
Cuprates – Organocopper reagents

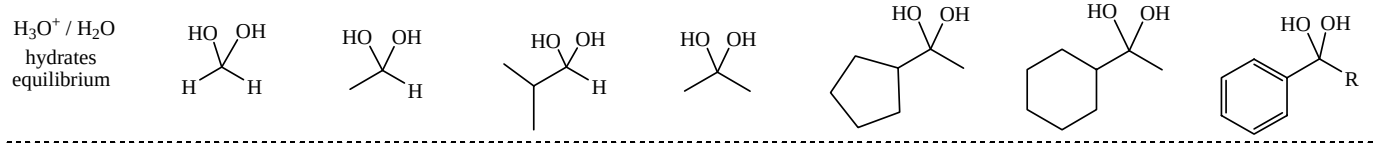


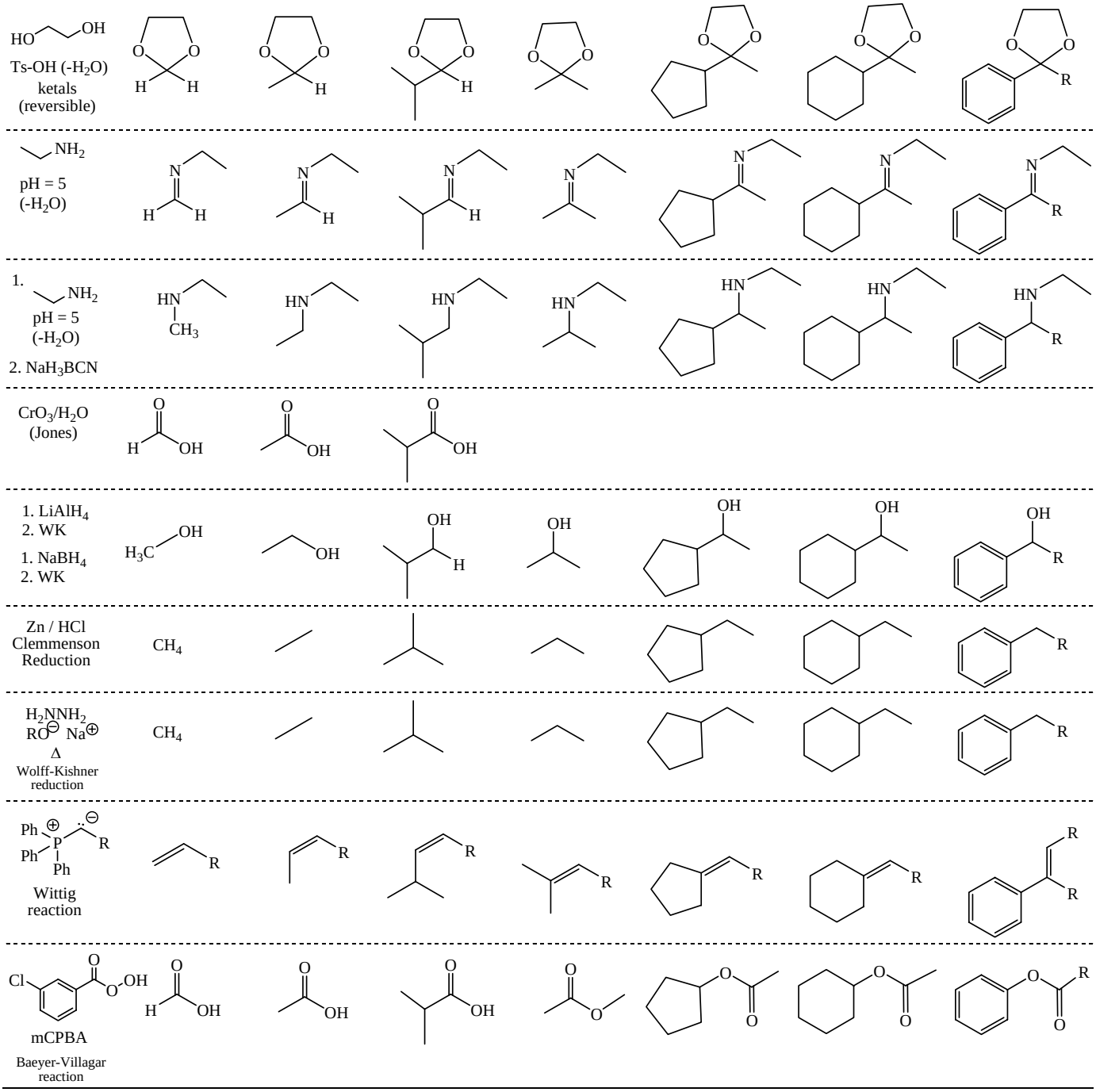


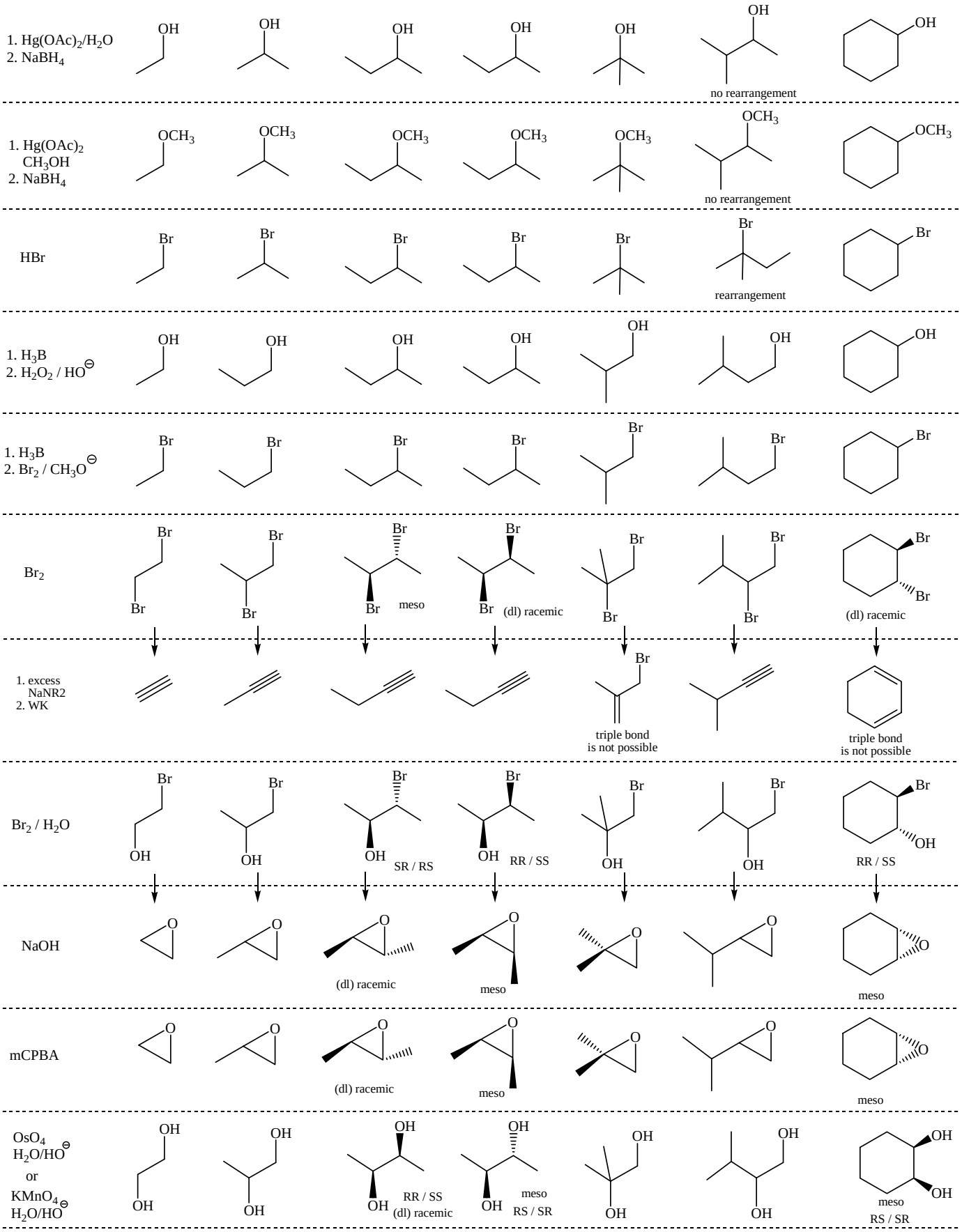


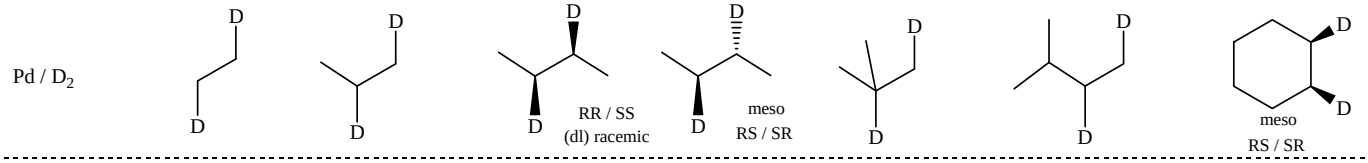
Aldehydes and Ketones

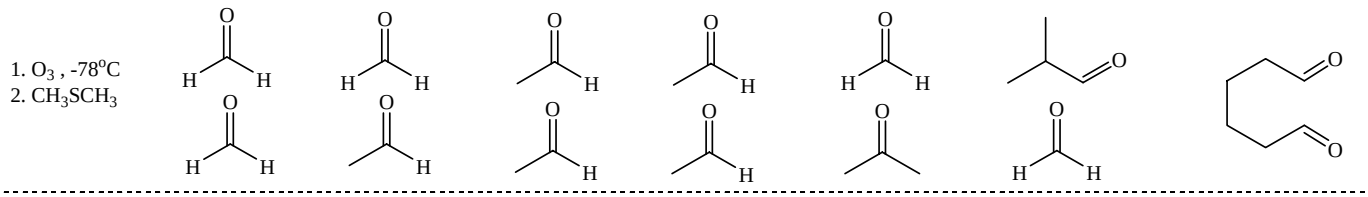


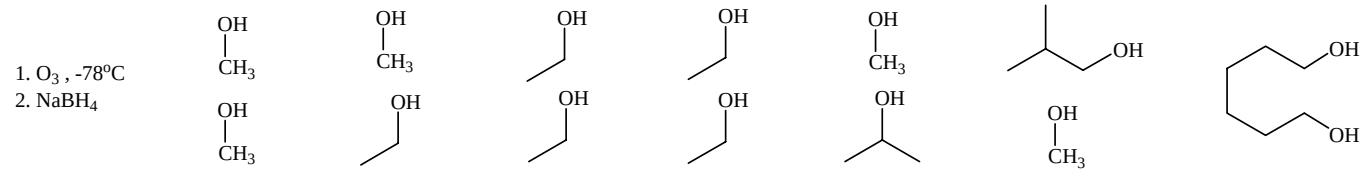


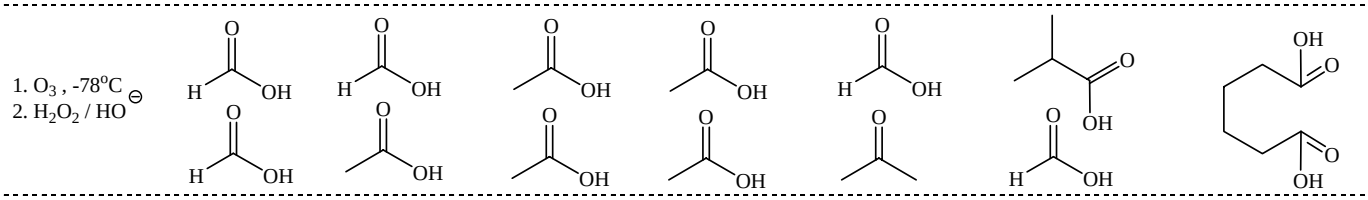

HO OH
Ts-OH (-H2O)
ketals
(reversible)
NH2
pH = 5
(-H2O)
1.
NH2
pH = 5
(-H2O)
2. NaH3BCN
CrO3/H2O
(Jones)
1. LiAlH4
2. WK
1. NaBH4
2. WK
Zn / HCl
Clemmenson
Reduction
CH4
H2NNH2
RO⊖ Na⊕
Δ
Wolff-Kishner
reduction
CH4
Ph
P
Ph
Ph
R
Wittig
reaction
Cl
mCPBA
Baeyer-Villagar
reaction
alkenes
reaction
conditions
H2SO4
H2O
rearrangement


1. Hg(OAc)2/H2O
2. NaBH4
no rearrangement
1. Hg(OAc)2
CH3OH
2. NaBH4
no rearrangement
HBr
rearrangement
1. H3B
2. H2O2 / HO⊖
1. H3B
2. Br2 / CH3O⊖
Br2
meso
(dl) racemic
(dl) racemic
1. excess
NaNR2
2. WK
triple bond
is not possible
triple bond
is not possible
Br2 / H2O
SR / RS
RR / SS
RR / SS
NaOH
(dl) racemic
meso
meso
mCPBA
(dl) racemic
meso
meso
OsO4
H2O/HO⊖
or
KMnO4
H2O/HO⊖
RR / SS
(dl) racemic
meso
RS / SR
meso
RS / SR

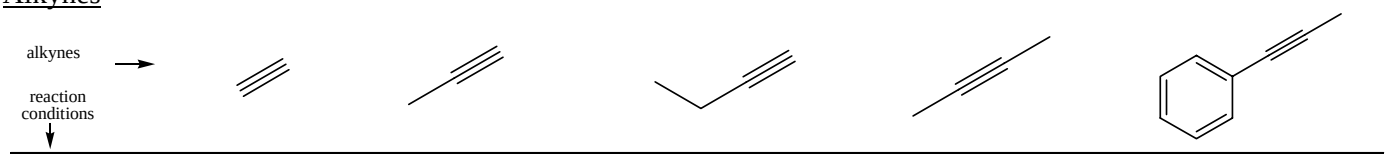

Pd / D2
RR / SS
(dl) racemic
meso
RS / SR
meso
RS / SR

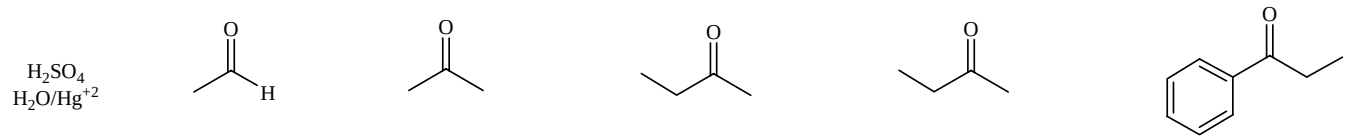

1. O3 , -78°C
2. CH3SCH3

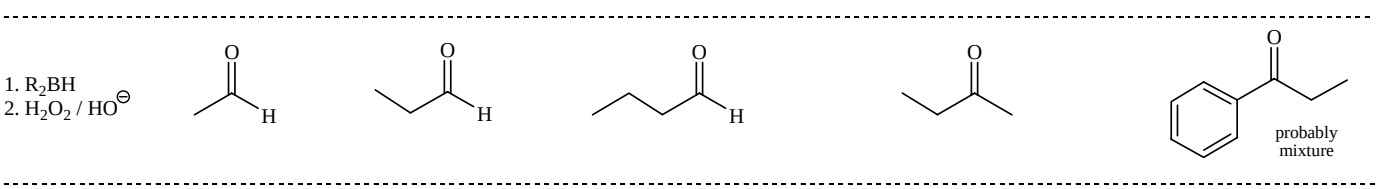

1. O3 , -78°C
2. NaBH4

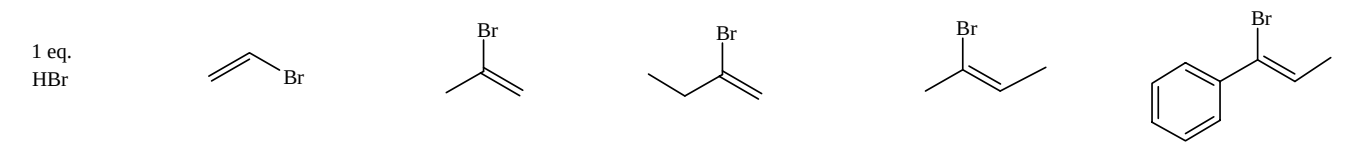

1. O3 , -78°C
2. H2O2 / HO⊖

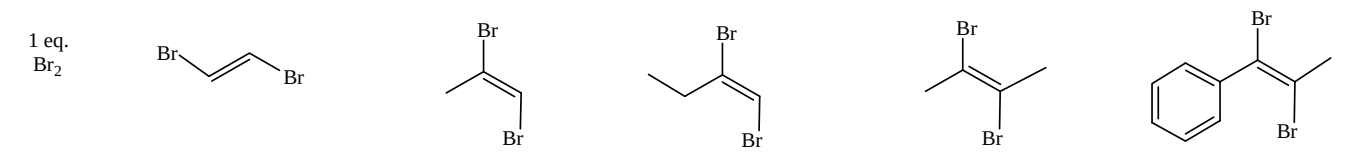
Alkynes

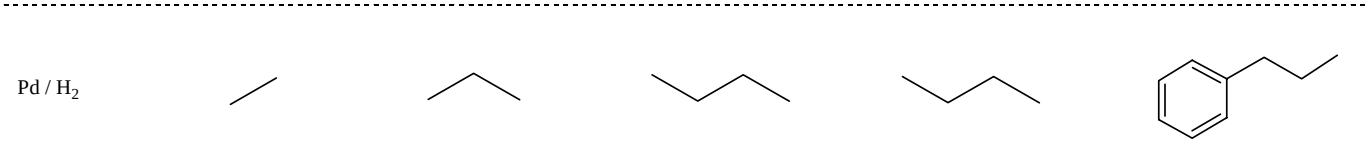

alkynes
reaction
conditions


H2SO4
H2O/Hg+2

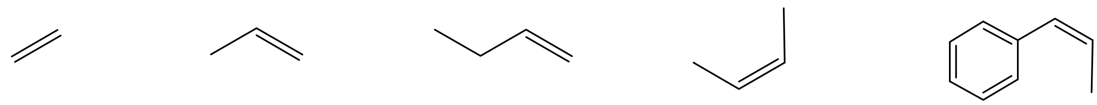

1. R2BH
2. H2O2 / HO⊖
probably
mixture


1 eq.
HBr


1 eq.
Br2


Pd / H2

Pd / D_2
quinoline
(Lindlar's cat.)

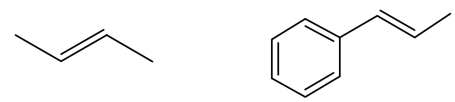


Na / NH_3
(Birch Reduction)

does not work well on terminal alkynes

does not work well on terminal alkynes

does not work well on terminal alkynes



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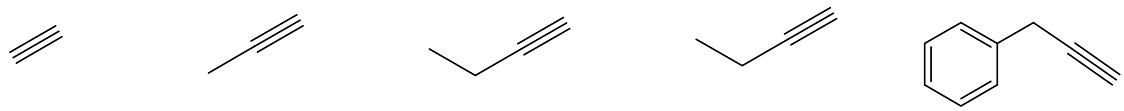
1. excess NaNR2
2. WK
(zipper rxn)



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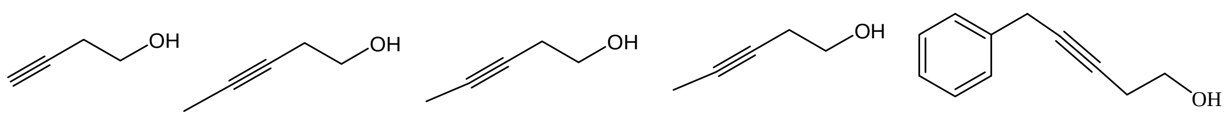
1. excess NaNR2
2. 

3. WK



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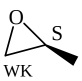
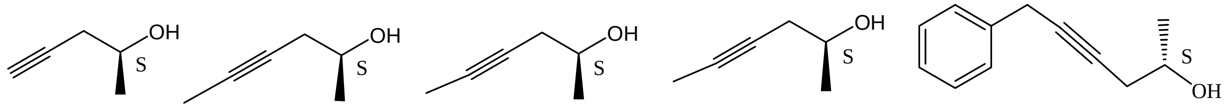
1. excess NaNR2
2. 

3. WK



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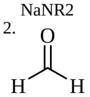
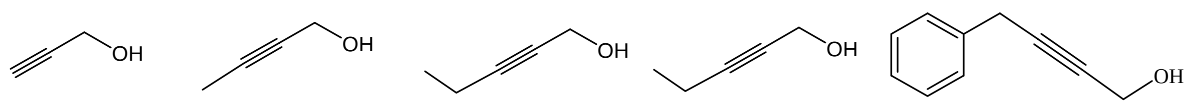
1. excess NaNR2
2. 

3. WK



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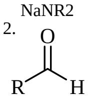
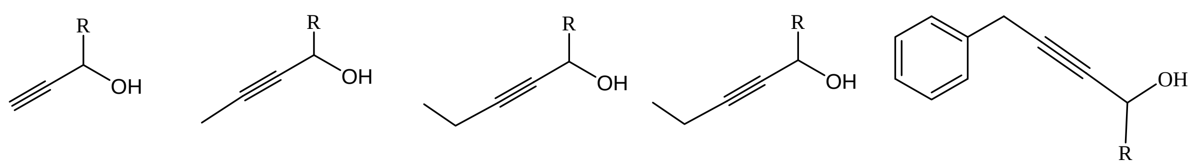
1. excess NaNR2
2. 

3. WK



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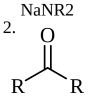
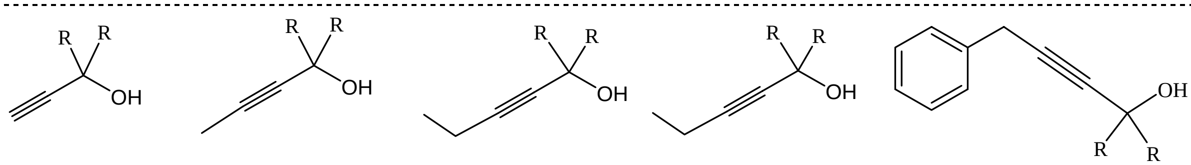
1. excess NaNR2
2. 

3. WK

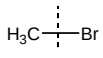


Propose synthetic reactions for the indicated target structures from the given starting materials. Show the starting material (methane, ethane and propane), a reaction arrow with the reagent and a product for each synthetic step of your synthesis. If a compound has been prepared earlier you do not need to remake it (just refer to the part where you made it). Common organic reagents may be used as needed. Additional "carbon" compounds available include bromobenzene, cyclohexane, carbon dioxide and sodium cyanide.

1. Given starting material = methane,(CH_4)

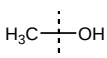
Target molecules (the part from methane has the "C" written out).

1



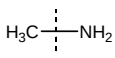
methane + Br_2/hν
2 + HBr
2 + PBr_3
2 + $SOBr_2$
2 + a. TsCl/py
b. NaBr

2

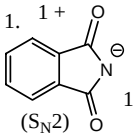


a. 1 + ester (S_N2)
b. ester + NaOH
31 + H_3O^+, H_2O
a. 31+HgX_2/H_2O
b. $NaBH_4$
a. 13 + $NaBH_4$
b. WK

3

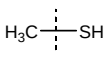


1. 1 +



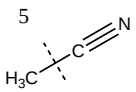
(S_N2)
2. NaOH

4



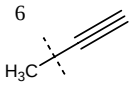
1 + NaSH (S_N2)

5



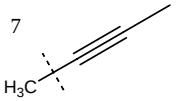
1 + NaCN (S_N2)

6



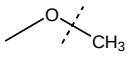
a. 40 + $NaNR_2$
b. bromomethane

7



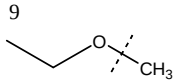
a. propyne + $NaNR_2$
b. bromomethane

8



(2 ways)

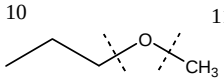
9



(2 ways)

$RO^{\ominus}$ + RBr (S_N2)

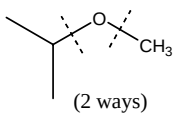
10



(2 ways)

$RO^{\ominus}$ + RBr (S_N2)

11

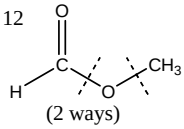


(2 ways)

RO + RBr (S_N2)

ROH + RBr (S_N1)

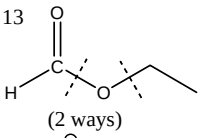
12



(2 ways)

$RCO_2^{\ominus}$ + RBr (S_N2)
RCOCl + ROH
(acyl substitution)

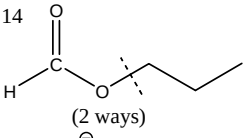
13



(2 ways)

$RCO_2^{\ominus}$ + RBr (S_N2)
RCOCl + ROH
(acyl substitution)

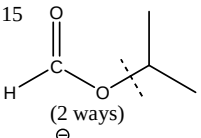
14



(2 ways)

$RCO_2^{\ominus}$ + RBr (S_N2)
RCOCl + ROH
(acyl substitution)

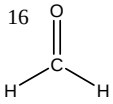
15



(2 ways)

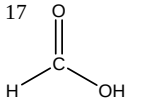
$RCO_2^{\ominus}$ + RBr (S_N2)
RCOCl + ROH
(acyl substitution)

16



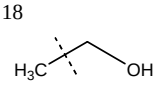
2 + CrO_3/py
(PCC)

17



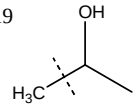
2 + CrO_3/H_2O
(Jones)

18



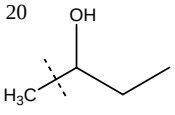
a. 1 + Mg (or Li)
b. methanal
c. WK

19



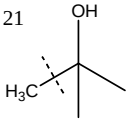
a. 1 + Mg (or Li)
b. ethanal
c. WK

20



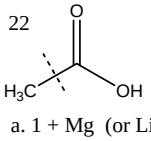
a. 1 + Mg (or Li)
b. propanal
c. WK

21



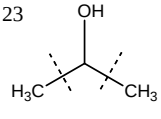
a. 1 + Mg (or Li)
b. propanone
c. WK

22



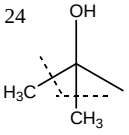
a. 1 + Mg (or Li)
b. CO_2
c. WK

23



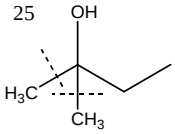
a. 1 + Mg (or Li)
b. alkyl methanoate
c. WK

24



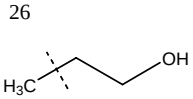
a. 1 + Mg (or Li)
b. alkyl ethanoate
c. WK

25



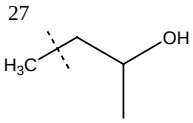
a. 1 + Mg (or Li)
b. alkyl propanoate
c. WK

26



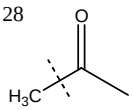
a. 1 + Mg (or Li)
b. 2C epoxide
c. WK

27



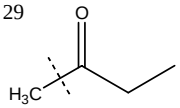
a. 1 + Mg (or Li)
b.3C epoxide
c. WK

28



acid chloride + cuprate
a. 1 + Mg (or Li)
b. ethanenitrile
ethanoic acid +
2 eqs methyl lithium

29

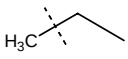


acid chloride + cuprate
a. 1 + Mg (or Li)
b. propanenitrile
propanoic acid +
2 eqs methyl lithium

30

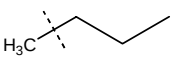
(2 ways)
cuprate + RBr

31



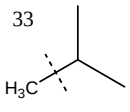
(2 ways)
cuprate + RBr

32



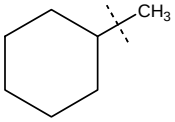
(2 ways)
cuprate + RBr

33



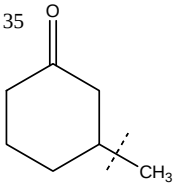
(2 ways)
cuprate + RBr

34



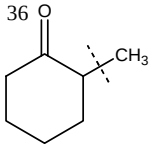
(2 ways)
cuprate + RBr

35



cuprate + enone
(conjugate addition)

36

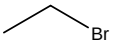


1. ketone + LDA
2. RBr (compound 1)

a. enamine + 1
b. H_2O (hydrolysis)

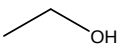
2. Given starting material = ethane,(CH_3CH_3)

1



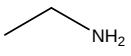
ethane + $Br_2/h\nu$
2 + HBr
2 + PBr_3
2 + $SOBr_2$
2 + a. TsCl/py
b. NaBr

2

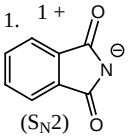


a. 1 + ester (S_N2)
b. ester + NaOH
31 + H_3O^+, H_2O
a. 31+HgX_2/H_2O
b. $NaBH_4$
a. 13 + $NaBH_4$
b. WK

3

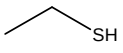


1. 1 +



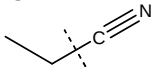
(S_N2)
2. NaOH

4



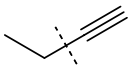
1 + NaSH (S_N2)

5



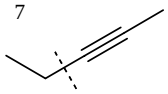
1 + NaCN (S_N2)

6



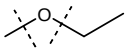
a. 40 + $NaNR_2$
b. bromoethane

7



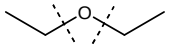
a. propyne + $NaNR_2$
b. bromoethane

8



(2 ways)

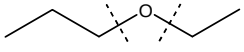
9



(2 ways)

$RO^{\ominus}$ + RBr (S_N2)

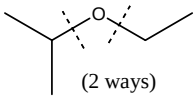
10



(2 ways)

$RO^{\ominus}$ + RBr (S_N2)

11

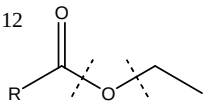


(2 ways)

RO + RBr (S_N2)

ROH + RBr (S_N1)

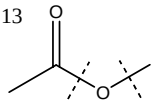
12



(2 ways)

$RCO_2^{\ominus}$ + RBr
(S_N2)
RCOCl + ROH
(acyl substitution)

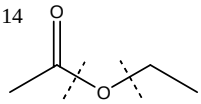
13



(2 ways)

$RCO_2^{\ominus}$ + RBr
(S_N2)
RCOCl + ROH
(acyl substitution)

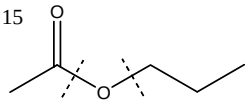
14



(2 ways)

$RCO_2^{\ominus}$ + RBr
(S_N2)
RCOCl + ROH
(acyl substitution)

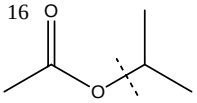
15



(2 ways)

$RCO_2^{\ominus}$ + RBr
(S_N2)
RCOCl + ROH
(acyl substitution)

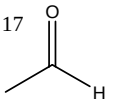
16



(2 ways)

$RCO_2^{\ominus}$ + RBr
(S_N2)
RCOCl + ROH
(acyl substitution)

17

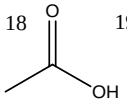


a. 40 + R_2BH
b. H_2O_2 / $HO^{\ominus}$

40 + H_3O^+/H_2O

2 + CrO_3/py (PCC)

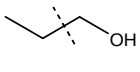
18



2 + CrO_3/H_2O
(Jones)
a. CH_3Br/Mg
b. CO_2
c. WK

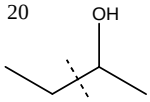
ethanenitrile
+ $H_2SO_4/H_2O/\Delta$

19



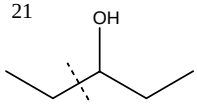
a. 1 + Mg (or Li)
b. methanal
c. WK

20



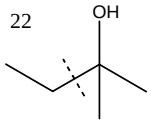
a. 1 + Mg (or Li)
b. ethanal
c. WK

21



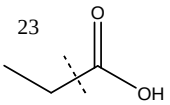
a. 1 + Mg (or Li)
b. propanal
c. WK

22



a. 1 + Mg (or Li)
b. propanone
c. WK

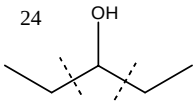
23



a. 1 + Mg (or Li)
b. CO_2
c. WK

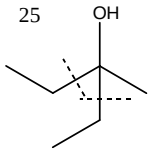
5 + H_2SO_4/H_2O

24



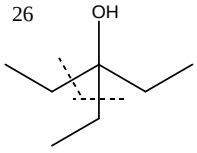
a. 1 + Mg (or Li)
b. alkyl methanoate
c. WK

25



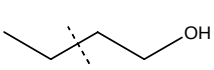
a. 1 + Mg (or Li)
b. alkyl ethanoate
c. WK

26



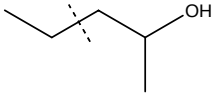
a. 1 + Mg (or Li)
b. alkyl propanoate
c. WK

27



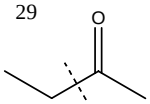
a. 1 + Mg (or Li)
b. 2C epoxide
c. WK

28



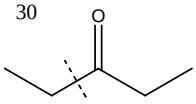
a. 1 + Mg (or Li)
b.3C epoxide
c. WK

29



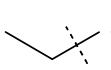
acid chloride + cuprate
a. 1 + Mg (or Li)
b. ethanenitrile
ethanoic acid +
2 eqs ethyl lithium

30



acid chloride + cuprate
a. 1 + Mg (or Li)
b. propanenitrile
ethanoic acid +
2 eqs propyl lithium

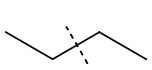
31



(2 ways)

cuprate + RBr

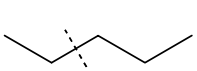
32



(2 ways)

cuprate + RBr

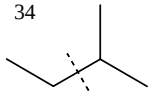
33



(2 ways)

cuprate + RBr

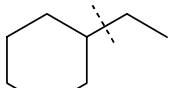
34



(2 ways)

cuprate + RBr

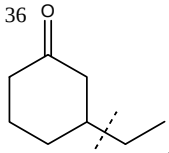
35



(2 ways)

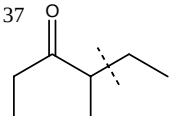
cuprate + RBr

36



cuprate + enone
(conjugate addition)

37



1. ketone + LDA
2. RBr (compound 1)

a. enamine + 1
b. H_2O (hydrolysis)

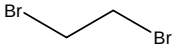
38

1 + K^+ t-butoxide

2 + H_2SO_4/Δ

Wittig =
methanal + ylid

39



Br_2

40

a. 39 + $NaNR_2$
b. WK

41

Br_2 / H_2O

42

38 + mCPBA

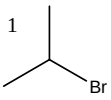
41 + NaOH

43

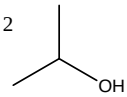
38 + OsO_4
(or $KMnO_4$)

3. Given starting material = propane,($CH_3CH_2CH_3$)

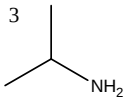
a.

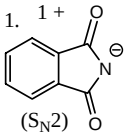
1 

propane + Br_2/hν
2 + HBr
2 + PBr_3
2 + $SOBr_2$
2 + a. TsCl/py
b. NaBr

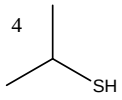
2 

a. 1 + ester (S_N2)
b. ester + NaOH
31 + H_3O^+, H_2O
a. 31+HgX_2/H_2O
b. $NaBH_4$
a. 13 + $NaBH_4$
b. WK

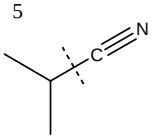
3 

1. 1 + 

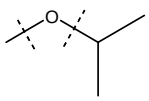
(S_N2)
2. NaOH

4 

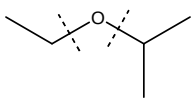
1 + NaSH (S_N2)

5 

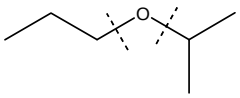
1 + NaCN (S_N2)

8 

(2 ways)
$RO^{\ominus}$ + RBr (S_N2)
ROH + RBr (S_N1)

9 

(2 ways)
RO + RBr (S_N2)
ROH + RBr (S_N1)

10 

(2 ways)
RO + RBr (S_N2)
ROH + RBr (S_N1)

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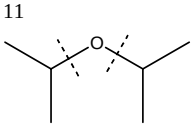
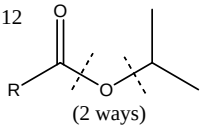
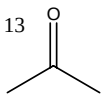
11 

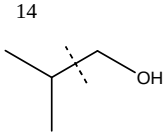
ROH + RBr (S_N1)

12 

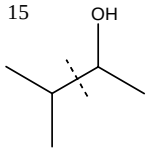
(2 ways)
$RCO_2^{\ominus}$ + RBr (S_N2)
RCOCl + ROH (acyl substitution)

13 

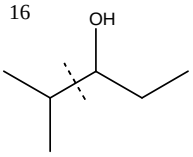
(lots of ways)
2 + CrO_3/H_2O (Jones)
2 + CrO_3/py (PCC)
33 + H_3O^+/H_2O
...and more

14 

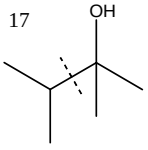
a. 1 + Mg (or Li)
b. methanal
c. WK

15 

a. 1 + Mg (or Li)
b. ethanal
c. WK

16 

a. 1 + Mg (or Li)
b. propanal
c. WK

17 

a. 1 + Mg (or Li)
b. propanone
c. WK

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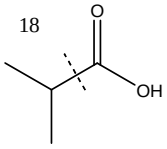
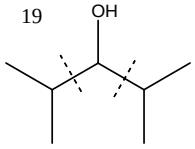
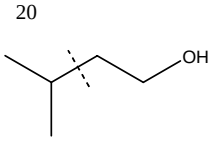
18 

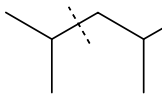
a. 1 + Mg (or Li)
b. CO_2
c. WK
5 + H_2SO_4/H_2O

19 

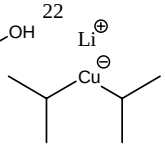
a. 1 + Mg (or Li)
b. alkyl methanoate
c. WK

20 

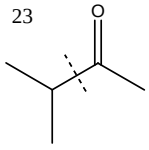
a. 1 + Mg (or Li)
b. 2C epoxide
c. WK

21 

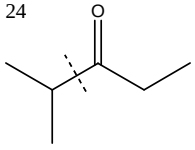
a. 1 + Mg (or Li)
b.3C epoxide
c. WK

22 

cuprate
2RLi + CuBr

23 

acid chloride + cuprate
a. 1 + Mg (or Li)
b. ethanenitrile
ethanoic acid +
2 eqs propyl lithium

24 

acid chloride + cuprate
a. 1 + Mg (or Li)
b. propanenitrile
ethanoic acid +
2 eqs propyl lithium

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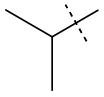
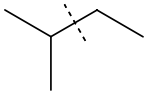
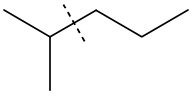
25 

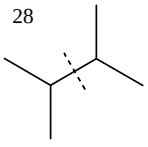
(2 ways)
cuprate + RBr

26 

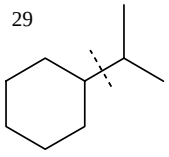
(2 ways)
cuprate + RBr

27 

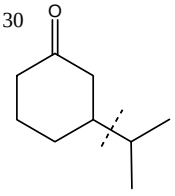
(2 ways)
cuprate + RBr

28 

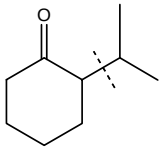
(2 ways)
cuprate + RBr

29 

(2 ways)
cuprate + RBr

30 

cuprate + enone
(conjugate addition)

31 

1. ketone + LDA
2. RBr (compound 1)

a. enamine + 1
b. H_2O (hydrolysis)

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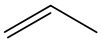
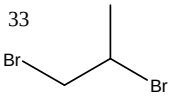
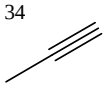
32 

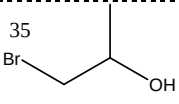
1 + K^+ t-butoxide

33 

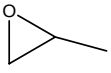
31 + Br_2

34 

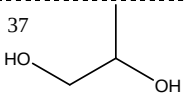
a. 32 + $NaNR_2$
b. WK

35 

31 + Br_2/H_2O

36 

31 + mCPBA
34 + NaOH

37 

31 + H_2O_2 / $HO^{\ominus}$

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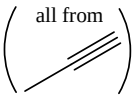
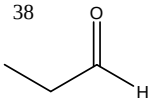
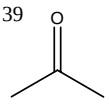
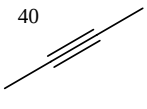
all from 

38 

1. R_2BH
b. H_2O_2 / $HO^{\ominus}$

39 

(lots of ways)
2 + CrO_3/H_2O (Jones)
2 + CrO_3/py (PCC)
33 + H_3O^+/H_2O
...and more

40 

a. $NaNR_2$
b. CH_3-Br

41

39 + Na / NH_3

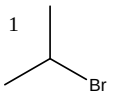
42

39 + Pd / H_2
quinoline

43

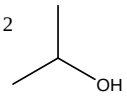
39 + Pd / H_2

1



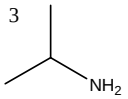
2 + HBr
2 + PBr_3
2 + $SOBr_2$
2 + a. TsCl/py
b. NaBr

2

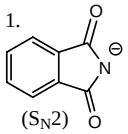


a. 1 + ester (S_N2)
b. ester + NaOH
31 + H_3O^+, H_2O
a. 13 + $NaBH_4$
b. WK

3

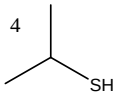


1.



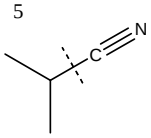
(S_N2)
2. NaOH

4



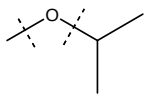
1 + NaSH (S_N2)

5



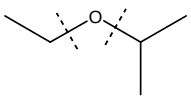
1 + NaCN (S_N2)

8



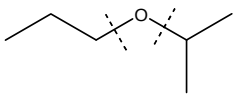
(2 ways)
$RO^{\ominus}$ + RBr (S_N2)
ROH + RBr (S_N1)

9



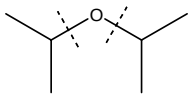
(2 ways)
RO + RBr (S_N2)
ROH + RBr (S_N1)

10



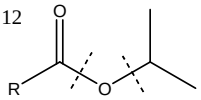
(2 ways)
RO + RBr (S_N2)
ROH + RBr (S_N1)

11



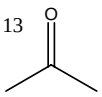
ROH + RBr (S_N1)

12



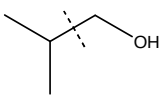
(2 ways)
$RCO_2^{\ominus}$ + RBr (S_N2)
RCOCl + ROH (acyl substitution)

13



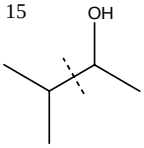
(lots of ways)
2 + CrO_3/H_2O (Jones)
2 + CrO_3/py (PCC)
33 + H_3O^+/H_2O
...and more

14



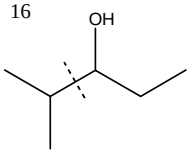
a. 1 + Mg (or Li)
b. methanal
c. WK

15



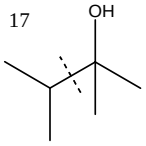
a. 1 + Mg (or Li)
b. ethanal
c. WK

16



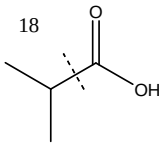
a. 1 + Mg (or Li)
b. propanal
c. WK

17



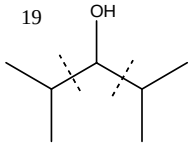
a. 1 + Mg (or Li)
b. propanone
c. WK

18



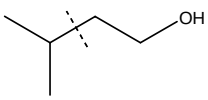
a. 1 + Mg (or Li)
b. CO_2
c. WK
5 + H_2SO_4/H_2O

19



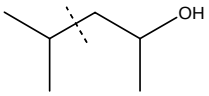
a. 1 + Mg (or Li)
b. alkyl methanoate
c. WK

20



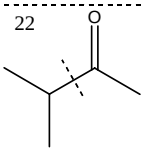
a. 1 + Mg (or Li)
b. 2C epoxide
c. WK

21



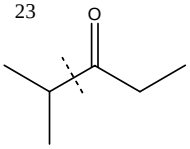
a. 1 + Mg (or Li)
b.3C epoxide
c. WK

22



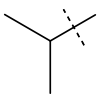
acid chloride + cuprate
a. 1 + Mg (or Li)
b. ethanenitrile
ethanoic acid + 2 eqs propyl lithium

23



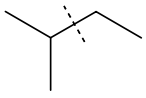
acid chloride + cuprate
a. 1 + Mg (or Li)
b. propanenitrile
ethanoic acid + 2 eqs propyl lithium

24



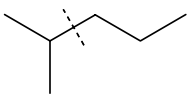
(2 ways)
cuprate + RBr

25



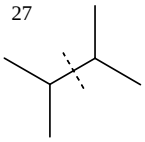
(2 ways)
cuprate + RBr

26



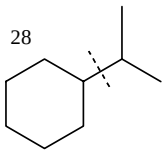
(2 ways)
cuprate + RBr

27



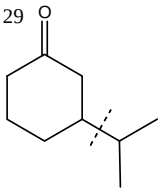
(2 ways)
cuprate + RBr

28



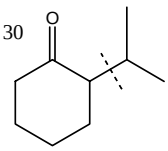
(2 ways)
cuprate + RBr

29



cuprate + enone
(conjugate addition)

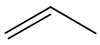
30



1. ketone + LDA
2. RBr (compound 1)

a. enamine + 1
b. H_2O (hydrolysis)

31



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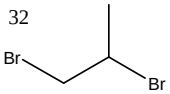

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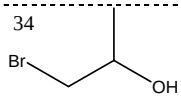
34



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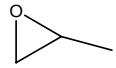

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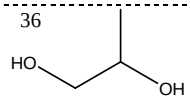
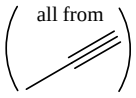


all from



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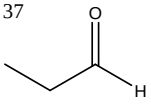

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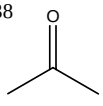

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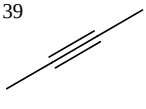

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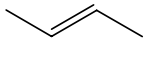


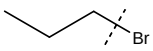
41

42

43

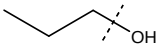
b.

1



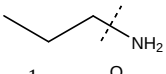
2 + HBr
2 + PBr_3
2 + $SOBr_2$
2 + a. TsCl/py
b. NaBr

2

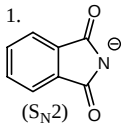


1 + NaOH (S_N2)
31 + a. BH_3
b. H_2O_2, $HO^{\ominus}$

3

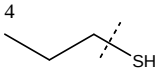


1.



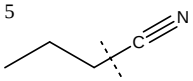
(S_N2)
2. NaOH

4



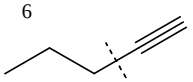
1 + NaSH (S_N2)

5



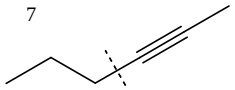
1 + NaCN (S_N2)

6



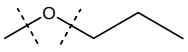
1 + NaCCH (S_N2)

7



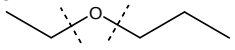
1 + $NaCCCH_3$ (S_N2)

8



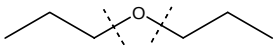
(2 ways)
$RO^{\ominus}$ + RBr
(both S_N2)

9



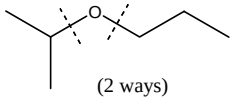
(2 ways)
$RO^{\ominus}$ + RBr
(both S_N2)

10



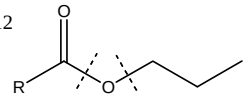
(2 ways)
$RO^{\ominus}$ + RBr
(both S_N2)

11



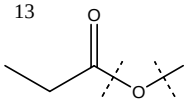
(2 ways)
$RO^{\ominus}$ + RBr
(both S_N2)

12



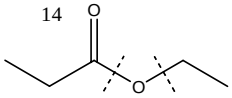
(2 ways)
$RCO_2^{\ominus}$ + RBr
(S_N2)
RCOCl + ROH
(acyl substitution)

13



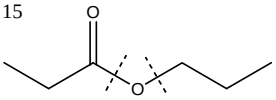
(2 ways)
$RCO_2^{\ominus}$ + RBr
(S_N2)
RCOCl + ROH
(acyl substitution)

14



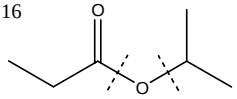
(2 ways)
$RCO_2^{\ominus}$ + RBr
(S_N2)
RCOCl + ROH
(acyl substitution)

15



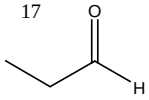
(2 ways)
$RCO_2^{\ominus}$ + RBr
(S_N2)
RCOCl + ROH
(acyl substitution)

16



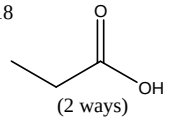
(2 ways)
$RCO_2^{\ominus}$ + RBr
(S_N2)
RCOCl + ROH
(acyl substitution)

17



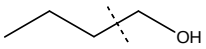
(2 ways)
2 + CrO_3/py
(PCC)
33 + a. R_2BH
b. H_2O_2, $HO^{\ominus}$

18



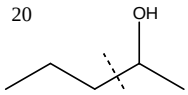
(2 ways)
2 + CrO_3/H_2O
(Jones)
nitrile + H_2SO_4/H_2O

19



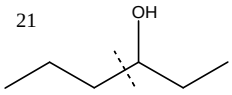
a. 1 + Mg (or Li)
b. methanal
c. WK

20



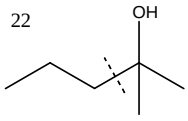
a. 1 + Mg (or Li)
b. ethanal
c. WK

21



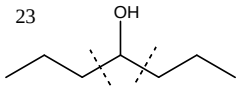
a. 1 + Mg (or Li)
b. propanal
c. WK

22



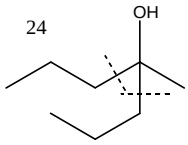
a. 1 + Mg (or Li)
b. propanone
c. WK

23



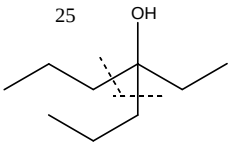
a. 1 + Mg (or Li)
b. alkyl methanoate
c. WK

24



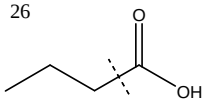
a. 1 + Mg (or Li)
b. alkyl ethanoate
c. WK

25



a. 1 + Mg (or Li)
b. alkyl propanoate
c. WK

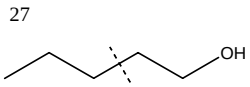
26



(2 ways)
a. 1 + Mg (or Li)
b. CO_2
c. WK

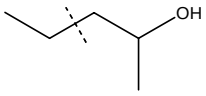
5 + H_2SO_4/H_2O

27



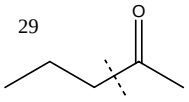
a. 1 + Mg (or Li)
b. 2C epoxide
c. WK

28



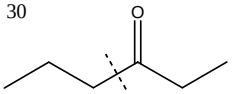
a. 1 + Mg (or Li)
b.3C epoxide
c. WK

29



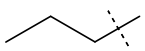
acid chloride + cuprate
a. 1 + Mg (or Li) b. ethanenitrile
ethanoic acid + 2 eqs propyl lithium

30



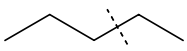
acid chloride + cuprate
a. 1 + Mg (or Li) b. propanenitrile
ethanoic acid + 2 eqs propyl lithium

31



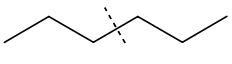
(2 ways)
cuprate + RBr

32



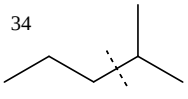
(2 ways)
cuprate + RBr

33



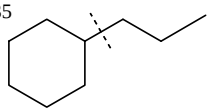
(2 ways)
cuprate + RBr

34



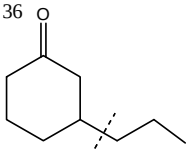
(2 ways)
cuprate + RBr

35



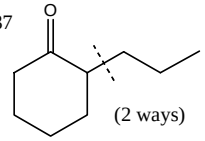
(2 ways)
cuprate + RBr

36



cuprate + enone
(conjugate addition)

37



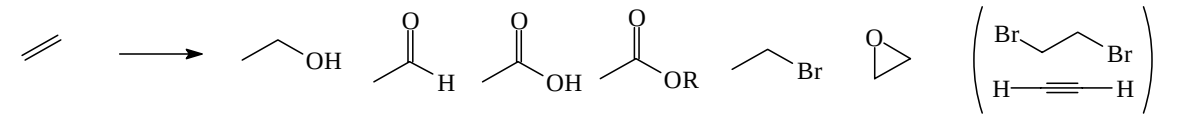
(2 ways)
1. ketone + LDA
2. RBr (compound 1)

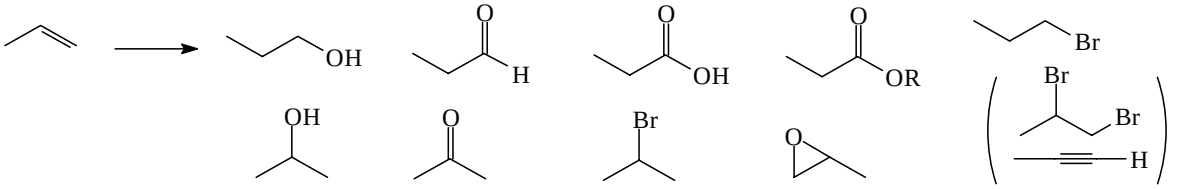
a. enamine + 1
b. H_2O (hydrolysis)

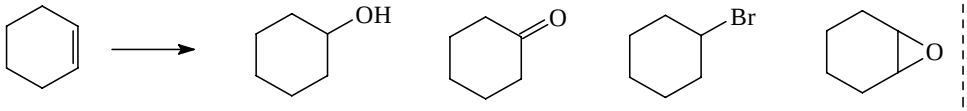
Propose a synthesis for the following compounds using only *CH_3OH, Na*CN, and *CO_2 as your source of radioactive ^{14}C isotope. Bromobenzene, methanol, ethene, propene and cyclohexene are also available. Work backwards from the target. The last step of the synthesis should be your first step. Show the reagents and reactant for each backwards step until you reach one of the ^{14}C compounds above and the other allowed starting structures. If a specific functional group or type of reaction is listed, you must use that group or reaction in your synthesis. For many of the target structures, there is more than one possible approach and for some there may be several possible approaches. Any approach is acceptable for this problem as long as the steps are reasonable and any necessary conditions are met. Do not show mechanisms.

Allowed ^{14}C precursors ★CH_3OH ★CO_2 ★NaCN Use any typical reagents from our course.

Other allowed starting structures and some possible structures that might be derived from them in a small number of steps.

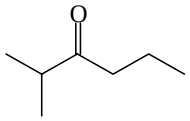




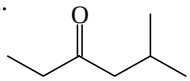


CH_3OH
CO_2
NaCN

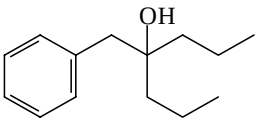
Targets

1. 

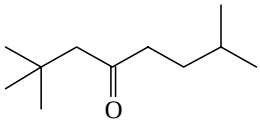
use an acid chloride

2. 

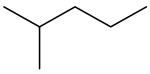
use a nitrile

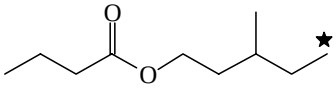
3. 

use an ester

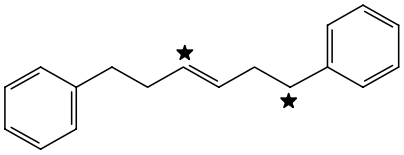
4. 

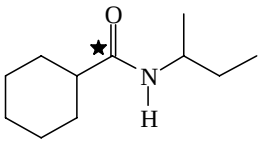
use a carboxylic acid
and a lithium reagent

5. 
use a cuprate
coupling reaction

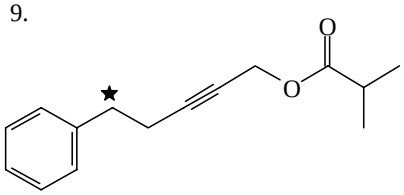
6. 

use any approach

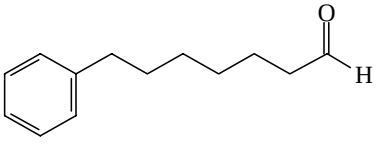
7. 
use the Wittig reaction

8. 

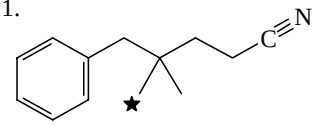
use Gabriel amine synthesis and
approach #1 use NaCN
approach #2 use CO_2
Can you make this into a secondary amine?

9. 

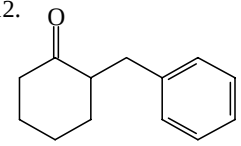
use the zipper reaction

10. 

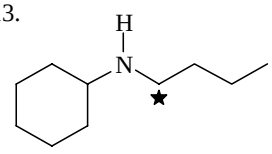
use an alkyne

11. 

use any approach

12. 

use an enamine

13. 

use an imine