Chemistry Department

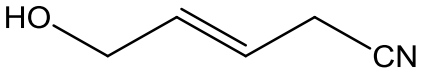
University of Alberta

CHEM 263
Final Exam

June 18, 2010

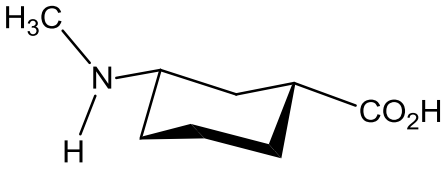
1. Name <u>five</u> (5) of the following structures: (15 points)

a.



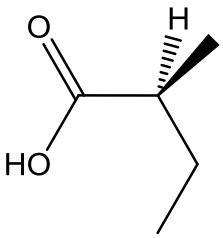
(E)-5-hydroxy-3-pentenenitrile

b.



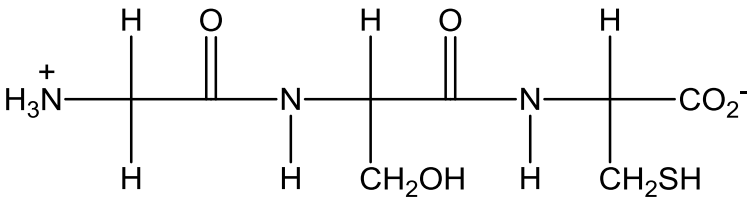
cis-3-methylaminocyclohexanecarboxylic acid

c.



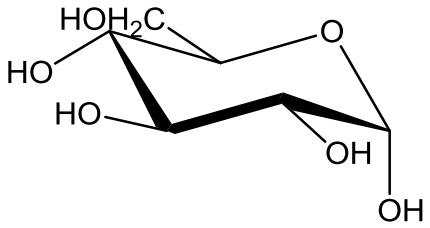
(S)-2-methylbutanoic acid

d.



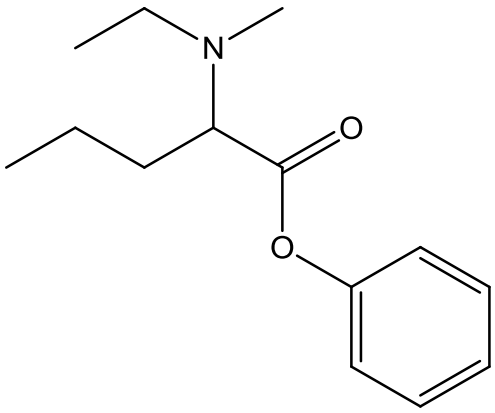
glycylserylcysteine

e.



α-D-glucopyranose

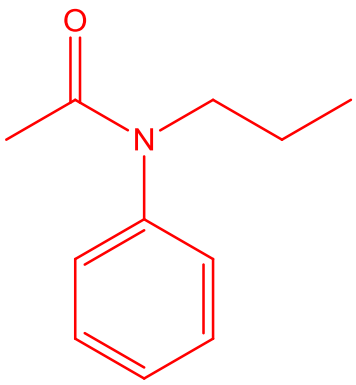
f.



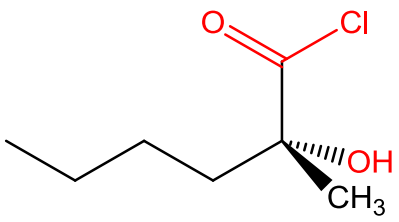
phenyl 2-ethylmethylaminopentanoate

2. Give the structural formula of <u>five</u> (5) of the following compounds. Where given, complete the partial structures: (15 points)

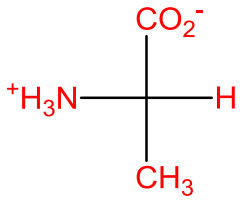
   a. *N*-phenyl-*N*-propylethanamide



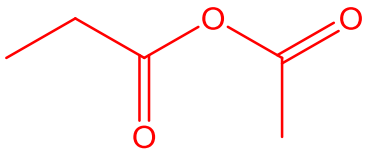
b. (R)-2-hydroxy-2-methylhexanoyl chloride



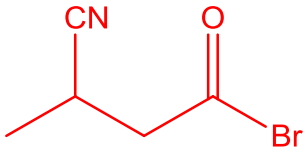
c. L-alanine (as a zwitterion)



d. ethanoic propanoic anhydride



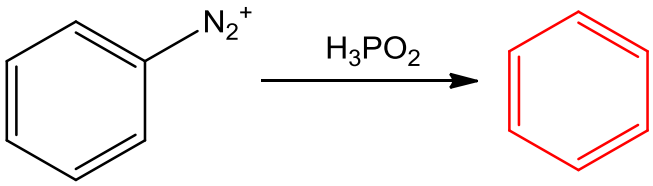
e. 3-cyanobutanoyl bromide



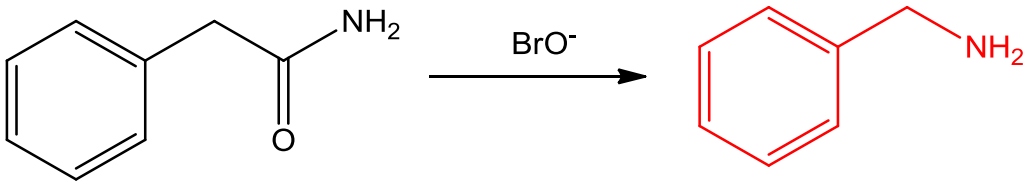
f. glycerol

3. Give the structure(s) of the principle organic products of ten (10) of the following reactions: (30 points)

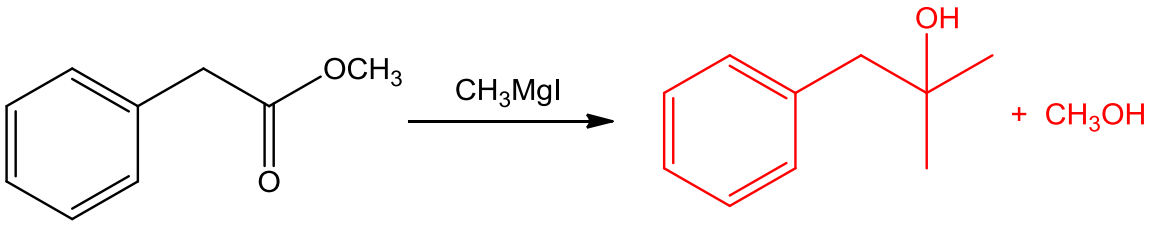
a.



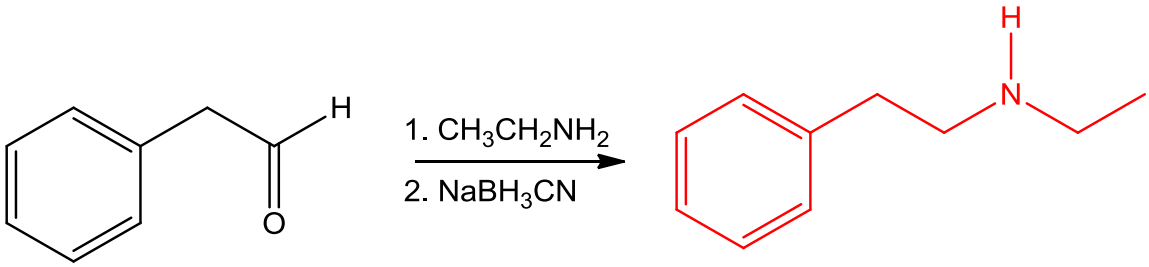
b.



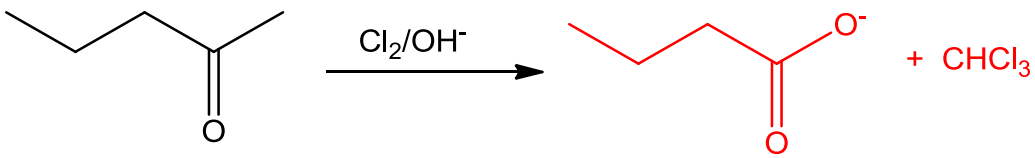
c.



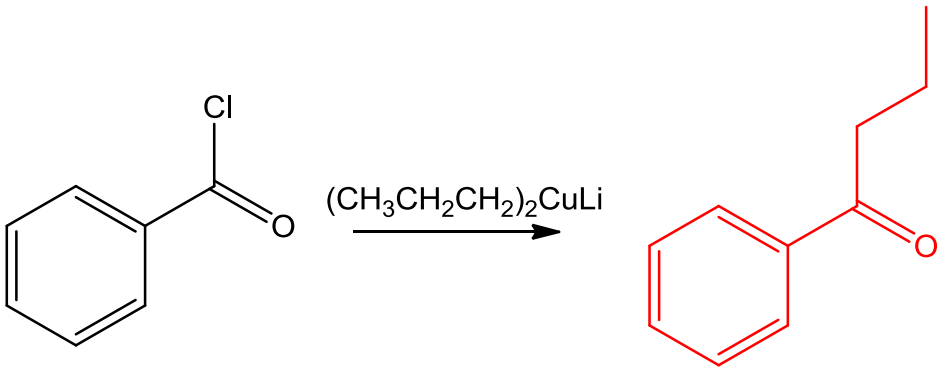
d.



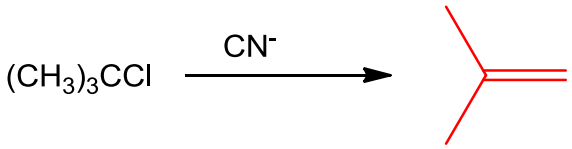
e.



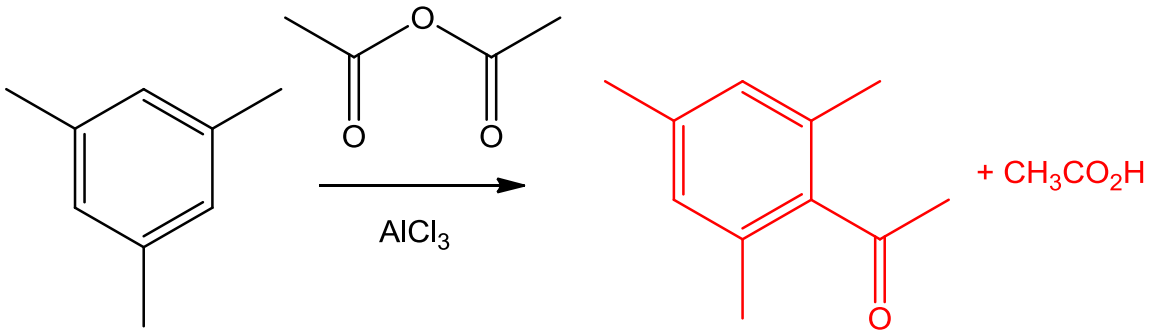
f.


Cl
O
$(CH_3CH_2CH_2)_2CuLi$
O

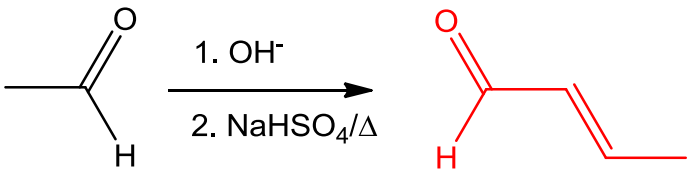
g.


$(CH_3)_3CCl$
CN^-

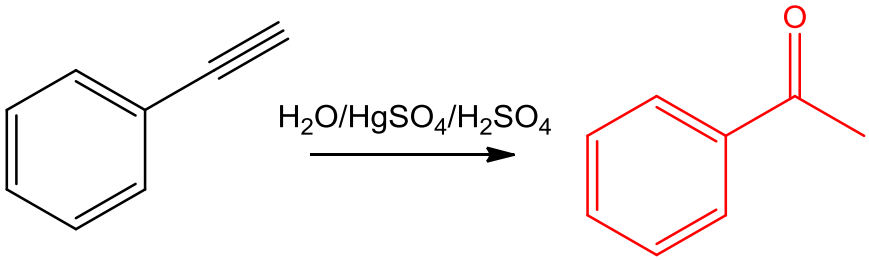
h.


O
O
O
$AlCl_3$
O
+ CH_3CO_2H

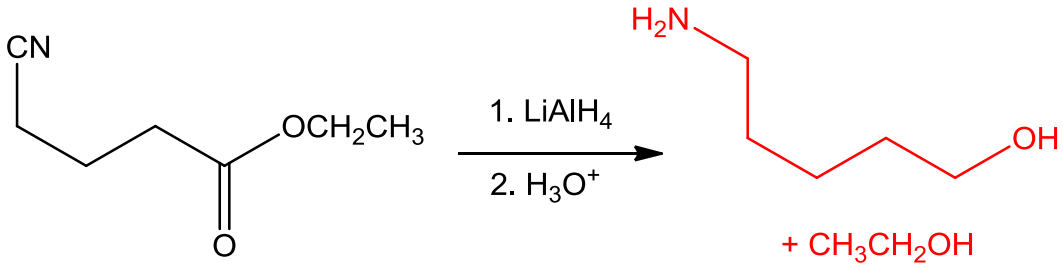
i.


O
H
1. OH^-
2. $NaHSO_4/\Delta$
O
H

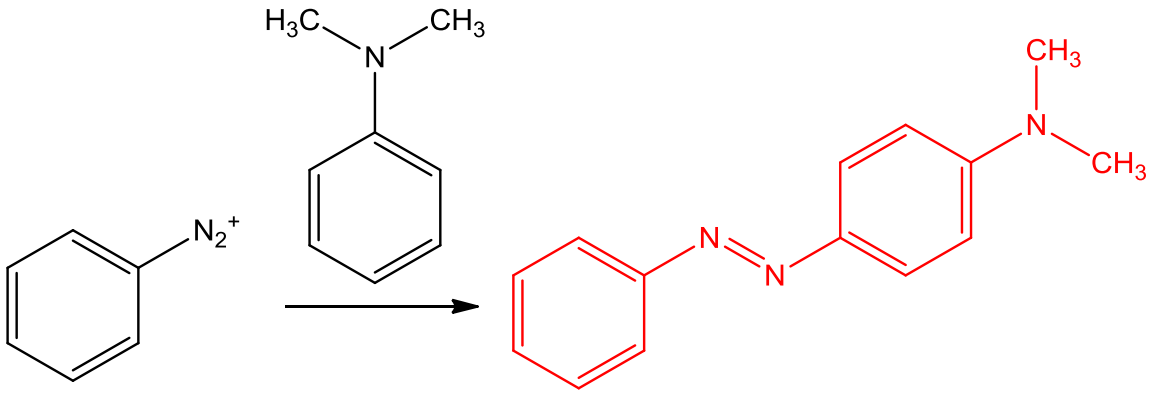
j.


H2O/HgSO4/H2SO4
O

k.

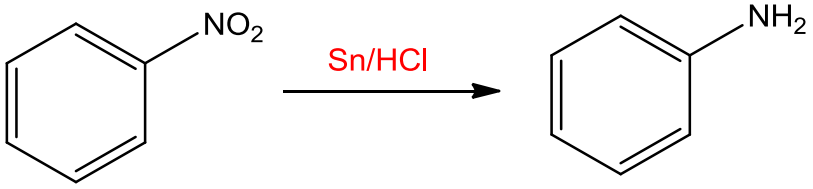

CN
OCH2CH3
O
1. LiAlH4
2. H3O+
H2N
OH
+ CH3CH2OH

l.

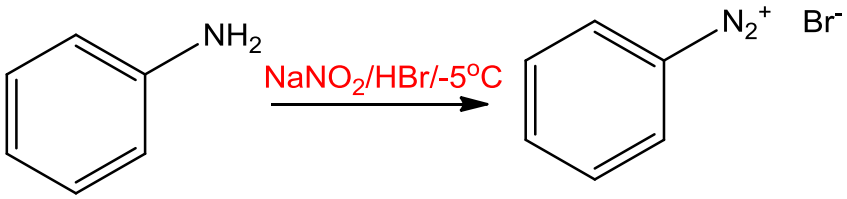

H3C
N
CH3
N2+
CH3
N
CH3
N
N

4. What reagent(s) would you use to effect ten (10) of the following conversions? (30 points)

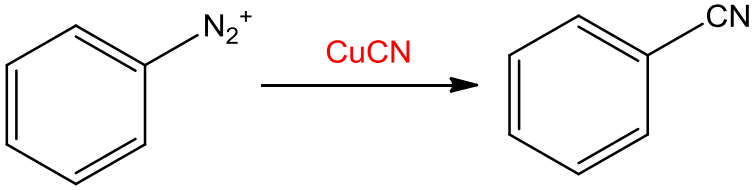
a.



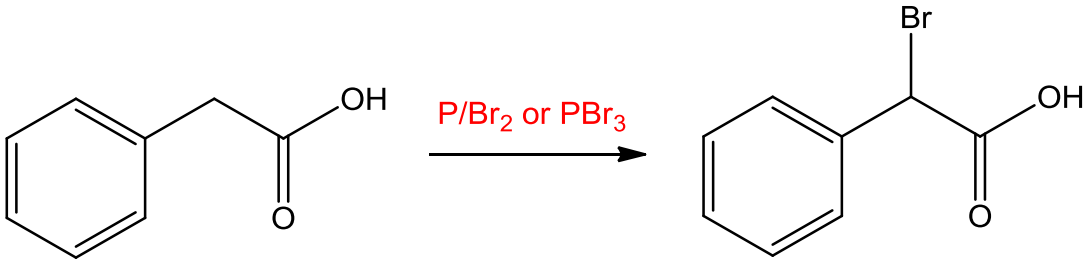
b.



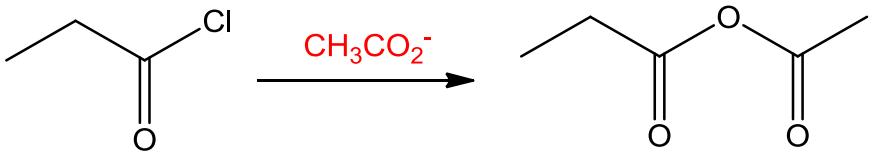
c.



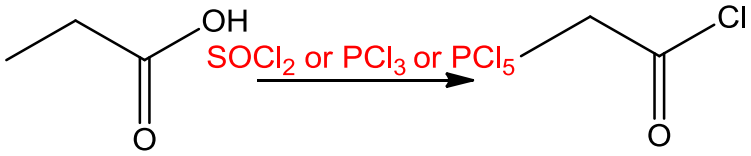
d.



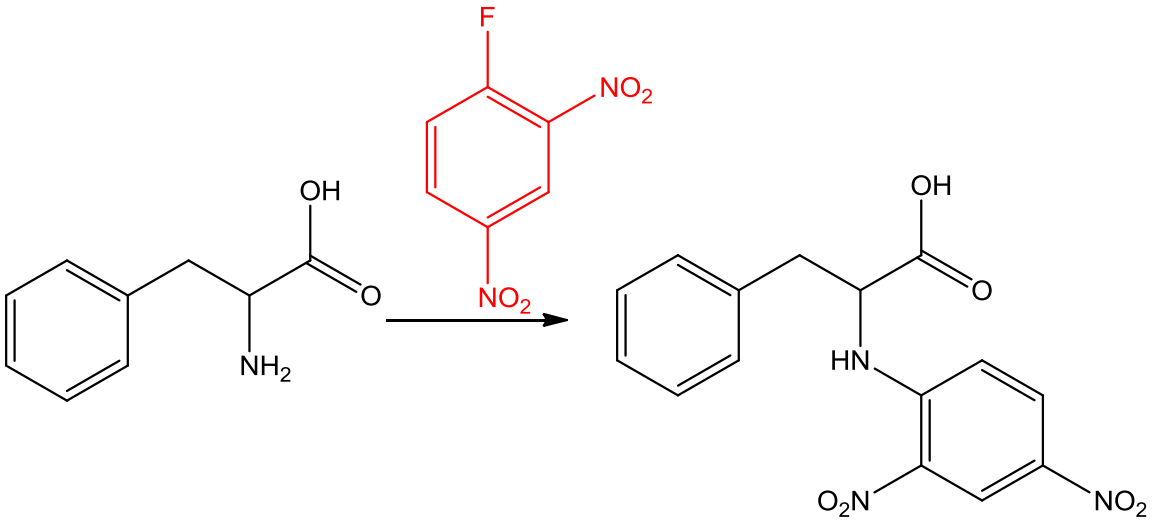
e.



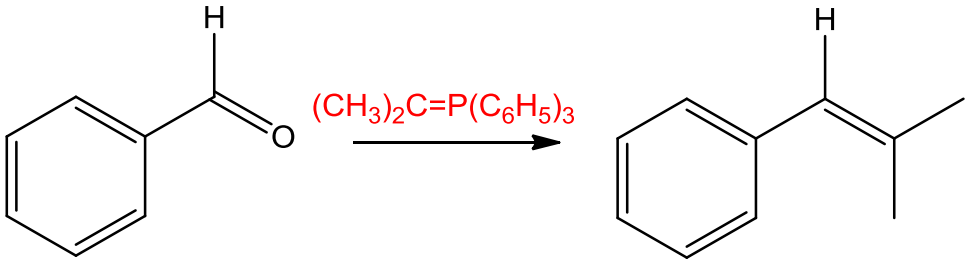
f.


OH
O
SOCl2 or PCl3 or PCl5
Cl
O

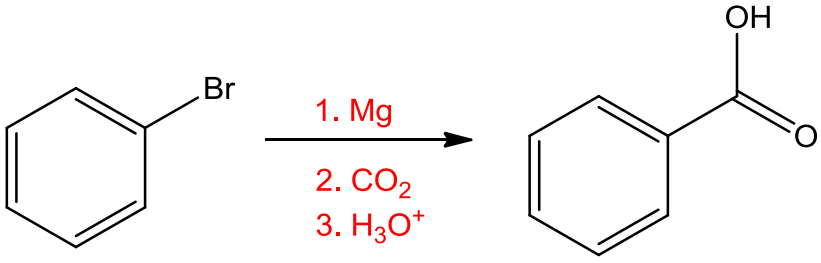
g.


F
NO2
OH
O
NH2
NO2
OH
O
HN
O2N
NO2

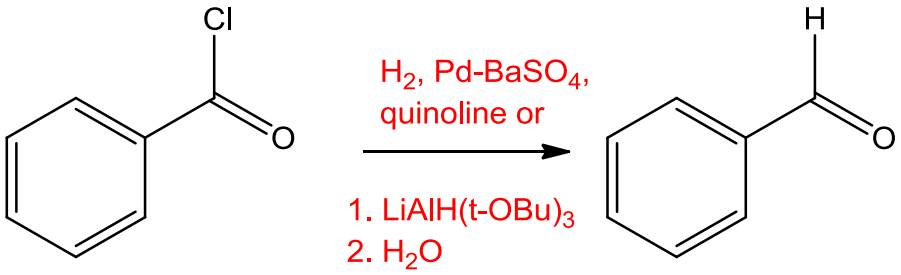
h.


H
O
(CH3)2C=P(C6H5)3
H

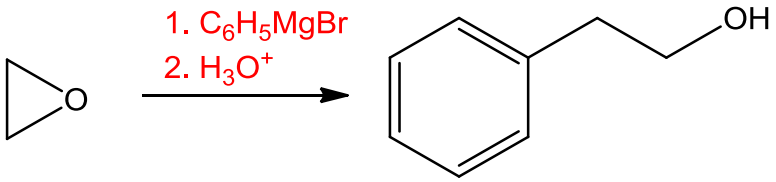
i.


Br
1. Mg
2. CO2
3. H3O+
OH
O

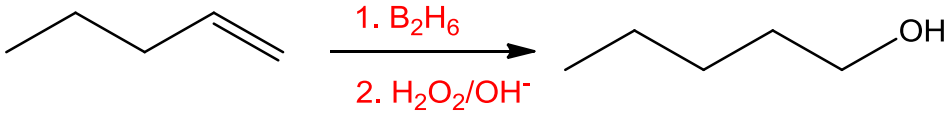
j.


Cl
O
H2, Pd-BaSO4,
quinoline or
1. LiAlH(t-OBu)3
2. H2O
H
O

k.

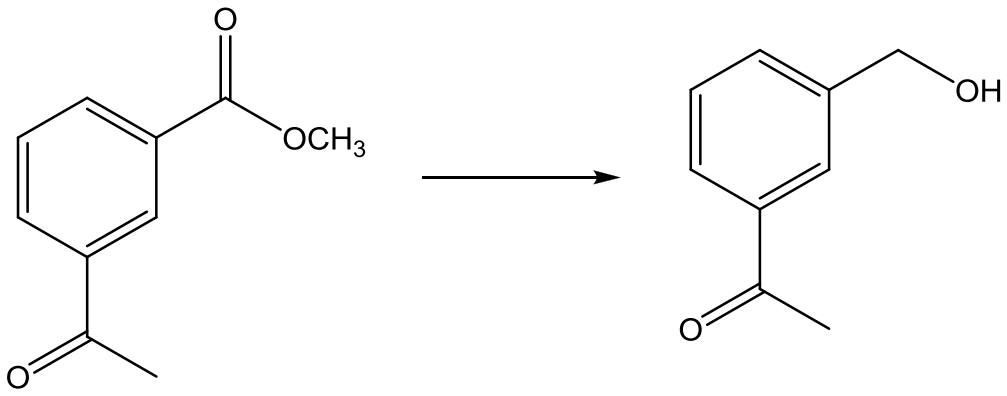

O
1. C6H5MgBr
2. H3O+
OH

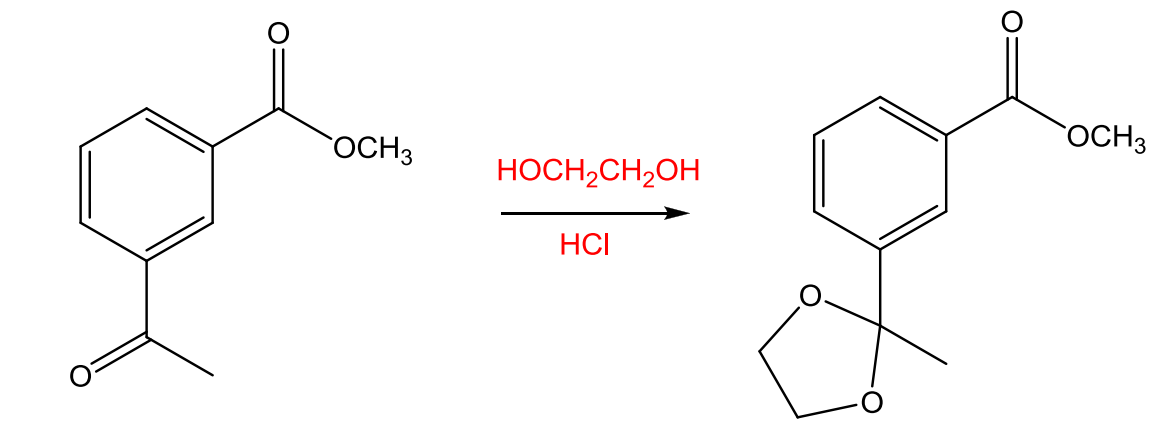
l.

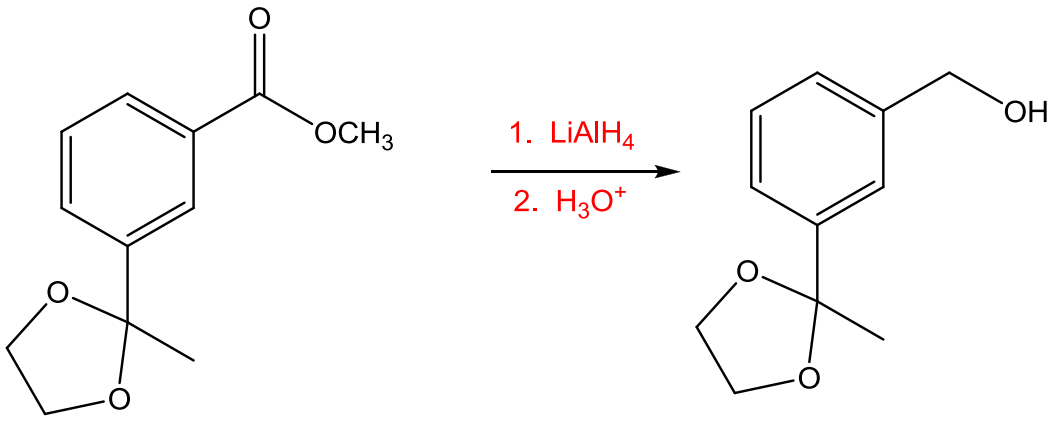

1. B2H6
2. H2O2/OH-
OH

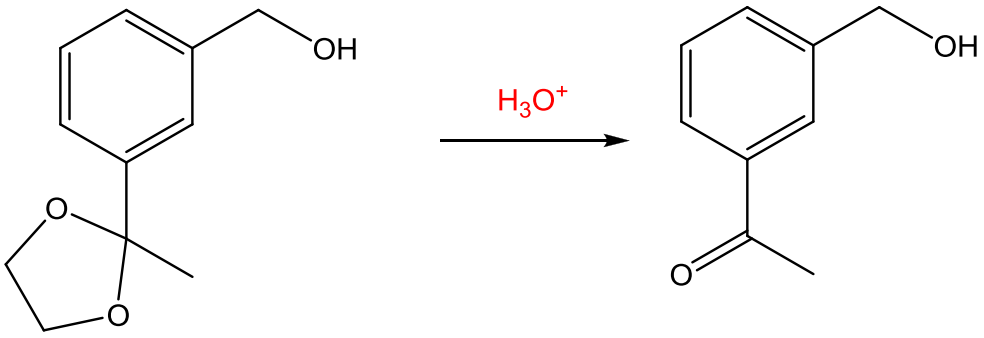
5. Provide synthetic pathways for <u>three</u> (3) of the following transformations (30 points):

   a.

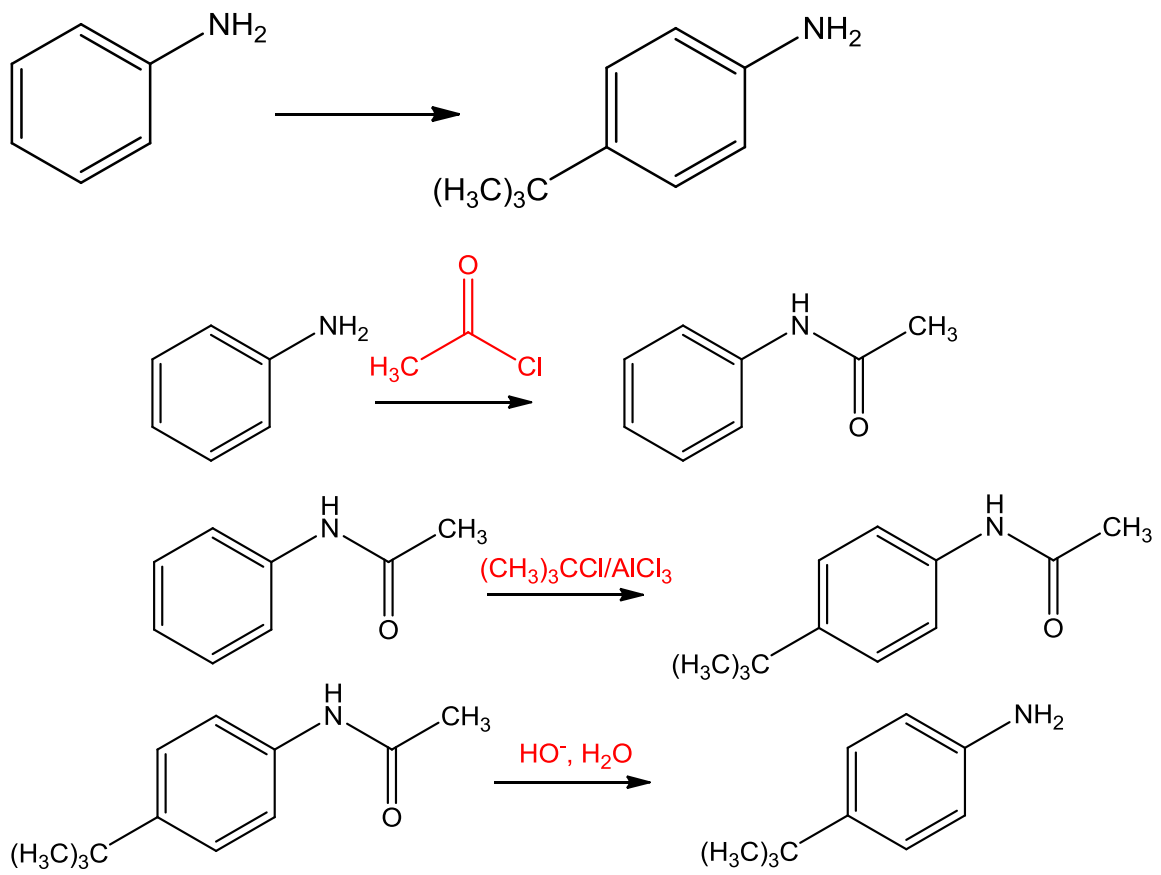



O
OCH3
O
HOCH2CH2OH
HCl
O
OCH3
O
O

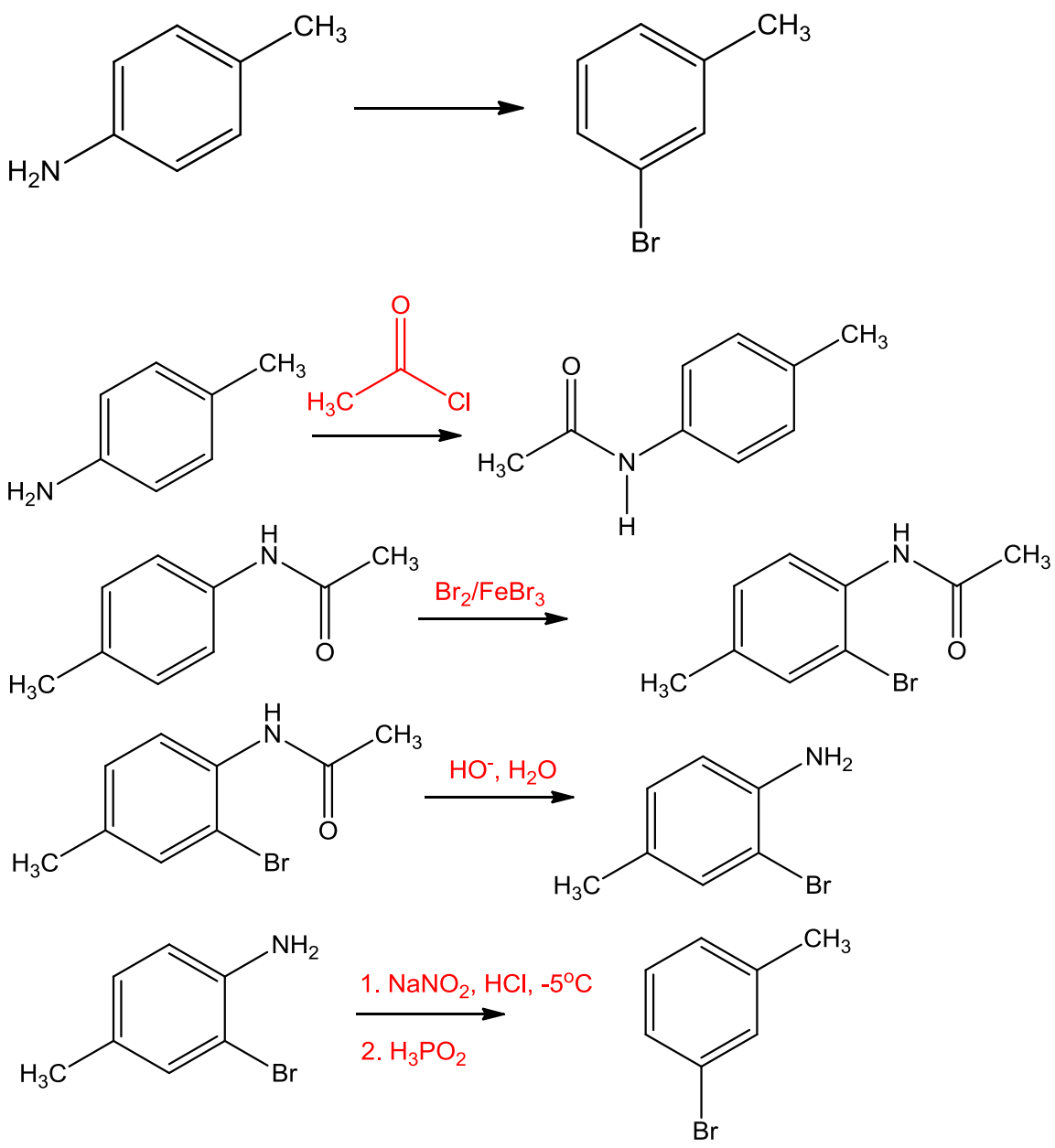

O
OCH3
O
O
1. LiAlH4
2. H3O+
OH
O
O


OH
O
O
H3O+
OH
O

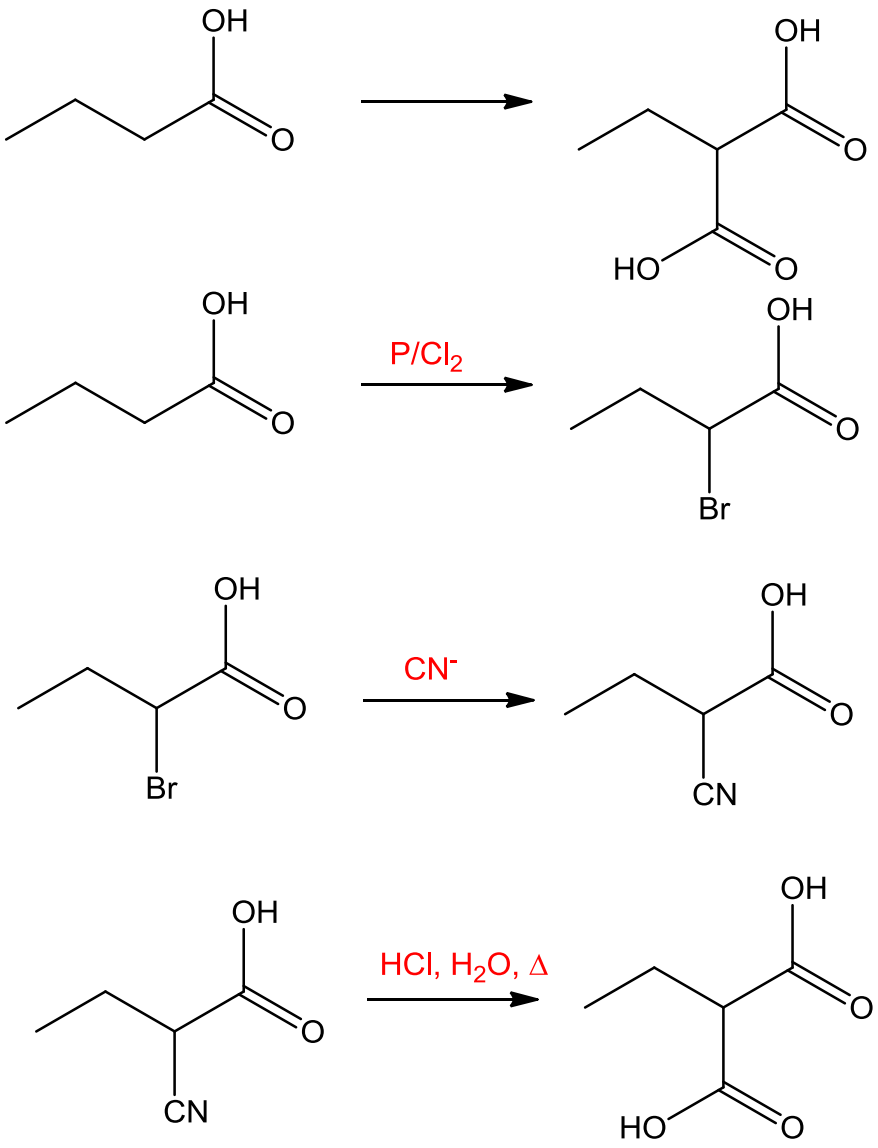
b.



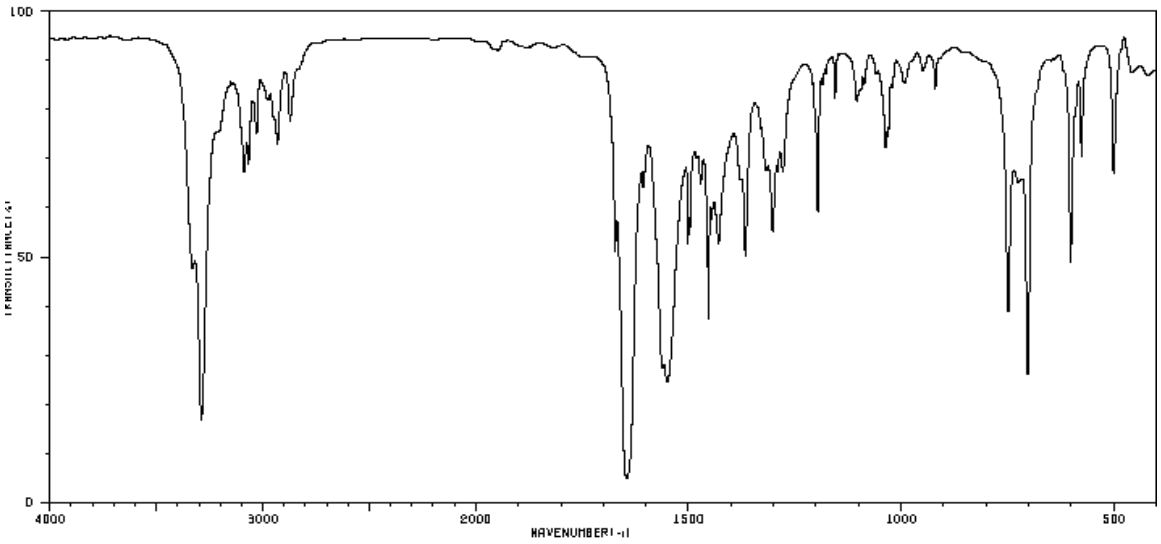
c.



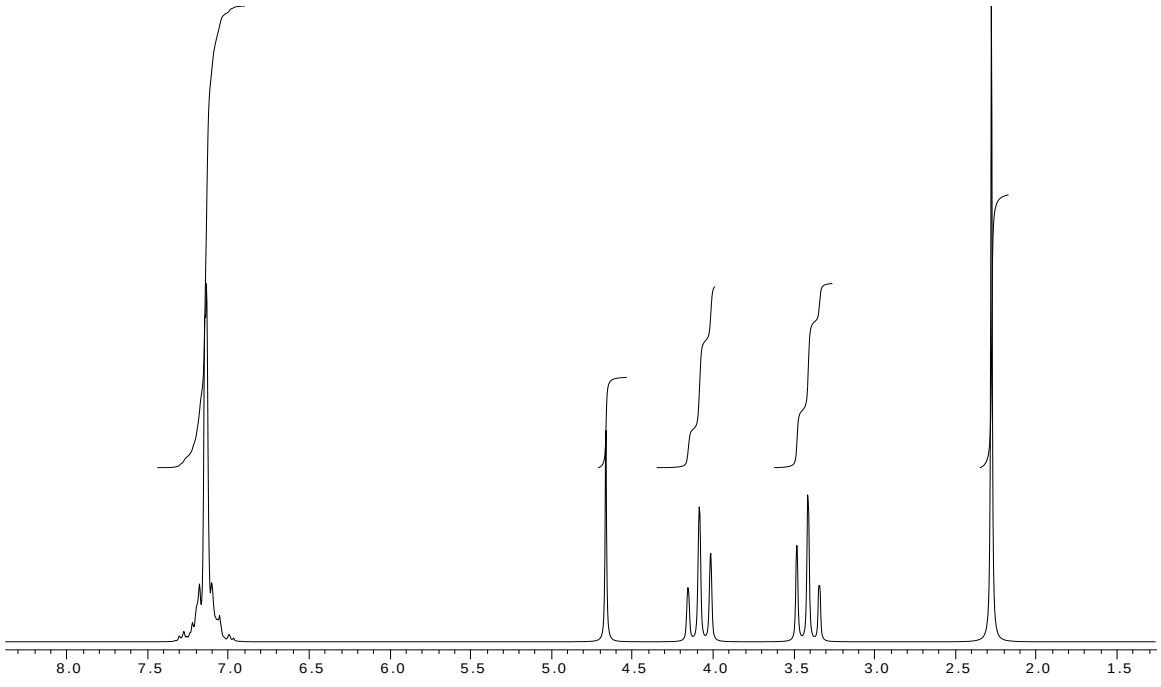
d.


OH
O
OH
O
HO
O
OH
O
P/Cl2
OH
O
Br
OH
O
Br
CN-
OH
O
CN
OH
O
CN
HCl, H2O, Δ
OH
O
HO
O

6. The IR and ^{1}H NMR spectra of a compound of molecular formula $C_{10}H_{13}NO$ are given below.



SDBSWeb : http://riodb01.ibase.aist.go.jp/sdbs/ (National Institute of Advanced Industrial Science and Technology, 16-06-10)



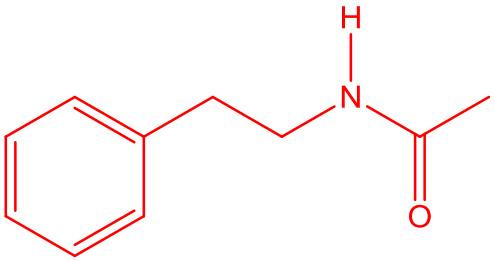
a. Calculate the degree of unsaturation. (1 point)

(2 x 10 + 1 – 13 + 2) = 5

b. What is the functional in the unknown? (2 point)

amide

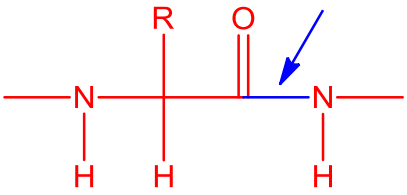
c. Draw a table that lists chemical shifts and multiplicity. Then propose a structure for this compound. (12 points)



7.

a. Explain what is meant by the term peptide bond. (2 points)

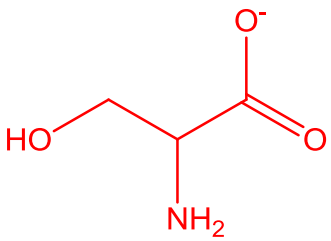
The amide linkage joining amino acids



b. Explain the term isoelectric point. (2 points)

The pH at which the zwitterion predominates.

c. The isoelectric point of serine is 5.7. What is the structure of this acid at pH 10.0? (You do not need to specify any stereochemistry about C-2) (2 points)



d. Secreted by the pituitary gland, corticotrophin is a hormone that stimulates the adrenal cortex. Determine its structure from the following information: (6 points)

Trypsin, a digestive enzyme of intestinal liquids, cleaves polypeptides only at the carboxy (acid) end of arginine (Arg) and Lysine (Lys). Chymotrypsin which is also found in mammalian intestines, cleaves the carboxy end of phenylalanine (Phe), tryptophan (Trp) and tyrosine (Tyr).

Hydrolysis by trypsin produces free lysine, free arginine, Trp-Gly-Lys, Pro-Val-Lys, Pro-Val-Gly-Lys, Ser-Tyr-Ser-Met-Glu-His-Phe-Arg, and Val-Tyr-Pro-Asp-Ala-Gly-Glu-Asp-Gln-Ser-Ala-Glu-Ala-Phe-Pro-Leu-Glu-Phe.

Hydrolysis by chymotrypsin produces Arg-Trp, Ser-Tyr, Pro-Leu-Glu-Phe, Ser-Met-Glu-His-Phe, Pro-Asp-Ala-Gly-Glu-Asp-Gln-Ser-Ala-Glu-Ala-Phe, and Gly-Lys-Pro-Val-Gly-Lys-Lys-Arg-Arg-Pro-Val-Lys-Val-Tyr.

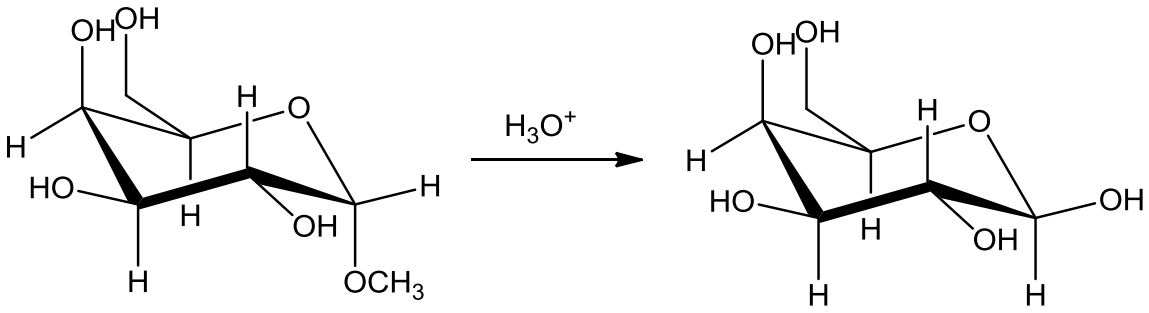
Ser-Tyr-Ser-Met-Glu-His-Phe-Arg-Arg-Trp-Gly-Lys-Pro-Val-Gly-Lys-Lys-Arg-Arg-Pro-Val-Lys-Val-Tyr-Pro-Asp-Ala-Gly-Glu-Asp-Gln-Ser-Ala-Glu-Ala-Phe-Pro-Leu-Glu-Phe

8.

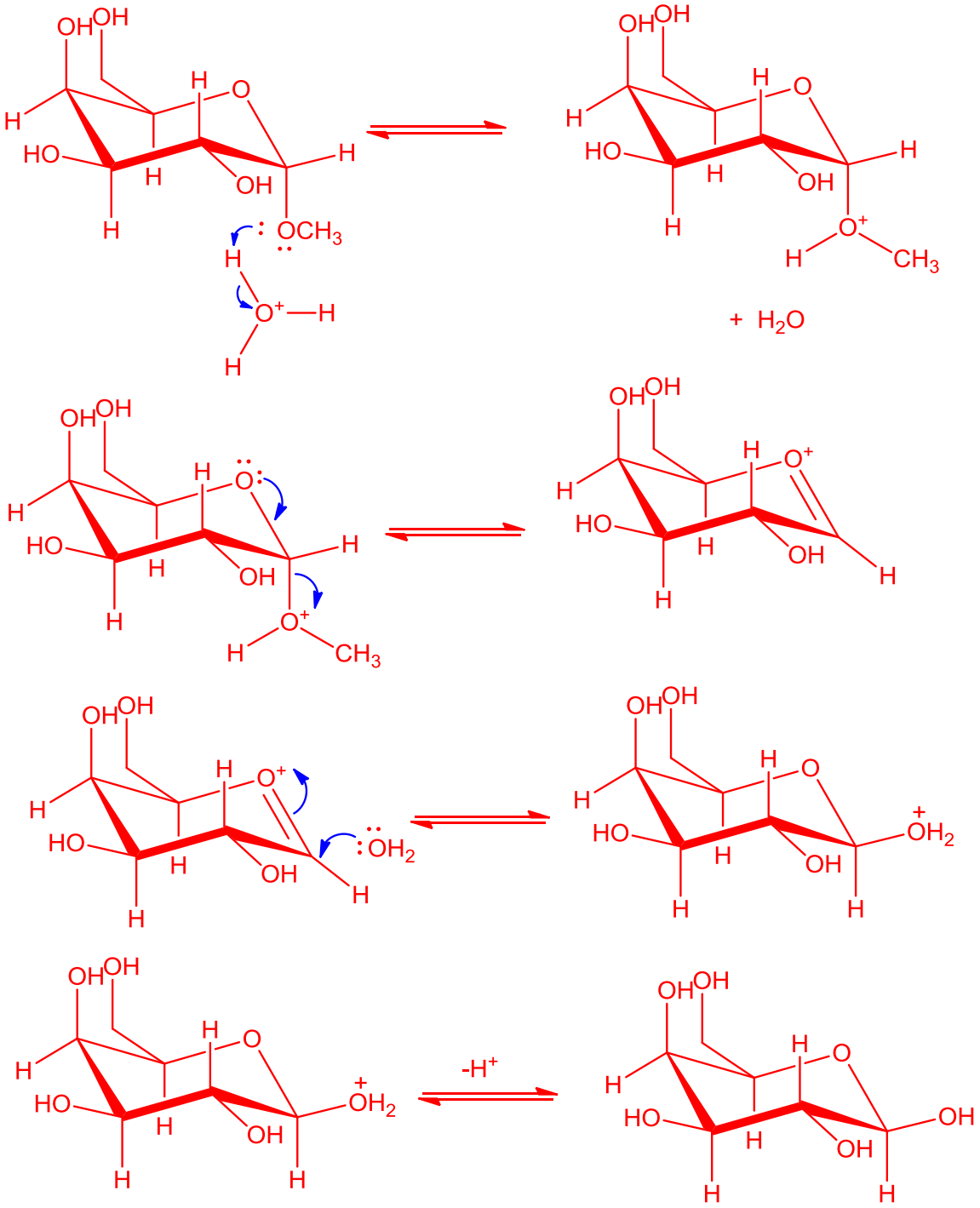
a. What is meant by the term “epimers”? (2 points)

Epimers are diastereomers that differ in the configuration about one stereogenic centre.

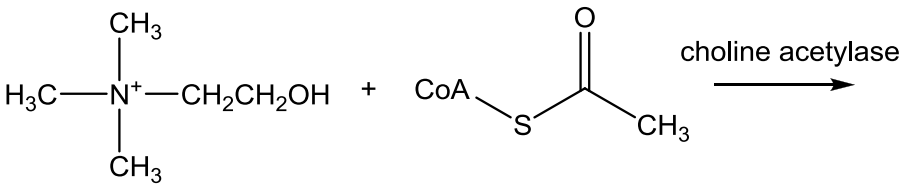
b. Methyl α-D-galactopyranoside reacts with aqueous acid to form β-D-galactose:



Propose a mechanism that accounts for this transformation. (12 points)

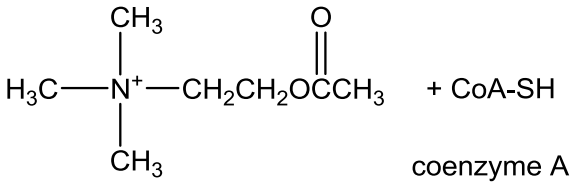

OH
OH
H
O
HO
H
OH
OCH3
O+
CH3
+ H2O
OH2
-H+

9. Thioesters are compounds in which a sulphur atom has replaced the alkoxy oxygen of an ester. Acetyl coenzyme A is an important thioester and is central to the following reaction that synthesizes acetylcholine at the nerve synapses:



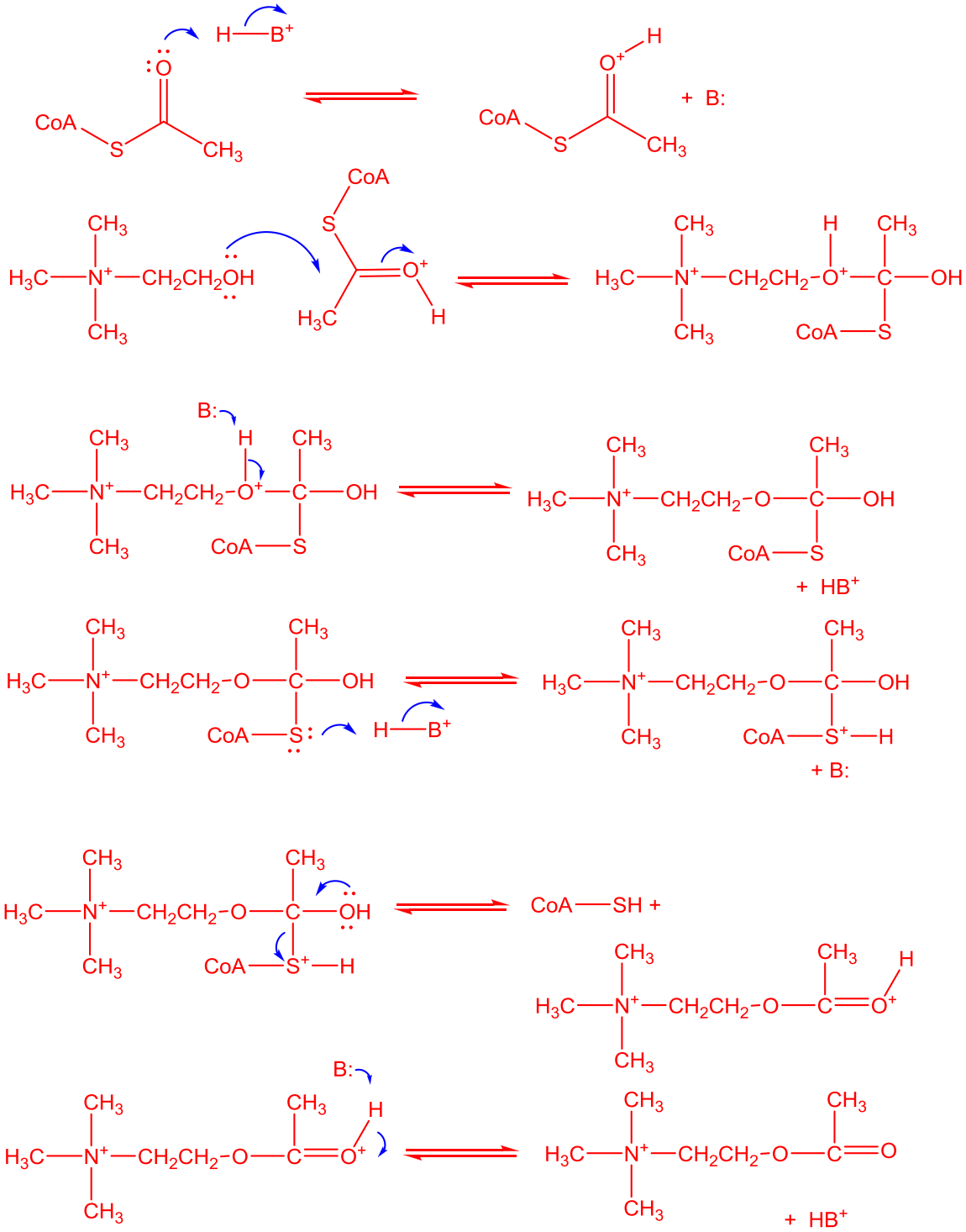
choline

acetyl coenzyme A



acetylcholine

Assuming that choline acetylase is a good source of protons, HB^+, and of bases to remove protons, B:, write a complete mechanism for this reaction. Don't forget to use curved arrows. (12 points)


H—B+
CoA
S
CH3
+ B:
H3C—N+—CH2CH2OH
CH3
CH3
CoA
S
H3C
O+
H
CH2CH2—O+—C—OH
CoA—S
B:
HB+
CH2CH2—O—C—OH
CoA—S:
CoA—SH +
CoA—S+—H
CH2CH2—O—C=O+
CH2CH2—O—C=O