These problems are typical of those that will be on the next exams in 3720. You should be comfortable with each reaction in the forward direction, how to think about each reaction in a retrosynthetic manner, and then be able to complete multi-step syntheses.

1. Give the major organic product(s) for each of the following sets of reaction conditions and then a detailed mechanism for each reaction. Be careful with any regiochemical issues.

a. 

b. 

**Carb. acid gives ester**
c. The aldehyde is much more reactive than the alkene under these conditions so the alkene survives.

d. Ester could also react but overall there would be no net change (OCH$_3$ swapped for OCH$_3$).
c. the bromide is completely unreactive under these reaction conditions.

f. the ester would not change overall even if it did react under these conditions.
2. Give the major organic product(s) from each step of the following synthetic scheme.

1. CH₃COCl, AlCl₃
2. Br₂, Fe
3. HOCH₂CH₂OH, cat. TsOH
4. Mg, ether
5. H₂C=O, ether
6. aq. NH₄Cl (quench)
7. PCC, CH₂Cl₂
8. (CH₃)₂CHLi, THF
9. aq. NH₄Cl (quench)
10. PDC, CH₂Cl₂
11. PhMgBr, THF
12. aq. NH₄Cl (quench)
13. NaH, ether
14. PhCH₂Br, ether
15. 5% HCl, 3 h, RT
16. NaBH₄, CH₃OH
17. HBr
18. NaOCH₃, CH₃OH
19. m-CPBA, CH₂Cl₂
20. PhMgBr, ether
21. aq. NH₄Cl (quench)
3. In the boxes provided, give the products from each step in the following “road-map” scheme.

4. Give retrosynthetic analyses for the following molecules that go back to the given starting materials, and then provide the synthesis in the forward direction. Assume you have access to the usual other reagents (HBr, HNO₃, NaBH₄, etc.) in the lab.
Synthesis

\[ \text{OH} \xrightarrow{\text{HBr}} \text{Br} \xrightarrow{\text{Mg, ether}} \text{MgBr} \]

\[ \text{Cl} \xrightarrow{\text{AlCl}_3} \text{C} \xrightarrow{\text{HNO}_3, \text{H}_2\text{SO}_4} \text{NO}_2 \xrightarrow{\text{NaBH}_4, \text{CH}_3\text{OH}} \text{OH} \]

\[ \text{H}_3\text{PO}_4, \text{heat} \]

\[ \text{NO}_2 \xrightarrow{\text{m-CPBA, CH}_2\text{Cl}_2} \text{O} \xrightarrow{\text{MgBr, ether}} \text{OMgBr} \xrightarrow{\text{aq. NH}_4\text{Cl}} \text{OH} \]

\[ \text{NO}_2 \xrightarrow{\text{NaH, THF}} \text{ONa} \xrightarrow{\text{Br, THF}} \text{ONa} \xrightarrow{\text{Sn, HCl}} \text{NH}_2 \]
Synthesis

HBr → HBr → Br → BrMg → BrMg

H3PO4 → heat → m-CPBA → ether → ether

PCC → CH2Cl2 → cat. H+ → cat. H+ → NH2

NH2
Synthesis

\[ \text{Cyclohexene} \xrightarrow{\text{Br}_2/\text{Fe}} \text{Bromocyclohexene} \xrightarrow{\text{Mg}/\text{ether}} \text{MgBr\_cyclohexene} \xrightarrow{\text{ether}} \text{MgBr\_cyclohexene} \]

\[ \text{Acetone} \xrightarrow{\text{NaBH}_4/\text{CH}_3\text{OH}} \text{OH} \xrightarrow{\text{aq. NH}_4\text{Cl}/(quench)} \text{OH} \xrightarrow{\text{cat. H}^+} \text{Cyclohexene carboxylic acid} \xrightarrow{\text{Na}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4} \text{Cyclohexene carboxylate} \]