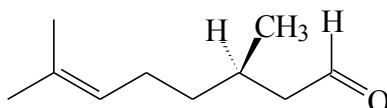


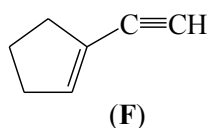
Work through the ChemCAL modules "Nucleophilic Addition to Carbonyl Groups" and "Organic Acids and Bases".

1. (+)-Citronellal is a widely occurring natural product, present in citronella oil, lemon and lemon grass. It is used as a soap perfume and in insect repellents.

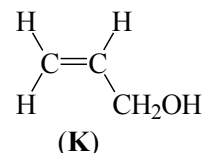
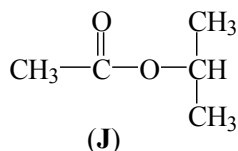
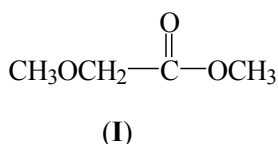
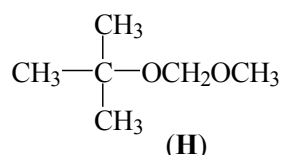


- (a) Give the molecular formula for citronellal.
 - (b) List the functional groups present in citronellal.
 - (c) Give the constitutional formula of the major product(s) formed when citronellal is treated with each of the following reagents.
 - (i) $\text{Cr}_2\text{O}_7^{2-} / \text{H}^+$
 - (ii) excess CH_3OH / catalytic amount H_2SO_4
 - (iii) NaBH_4 in CH_3OH followed by $\text{H}^+/\text{H}_2\text{O}$
 - (iv) H_2/Pd in ethanol
 - (v) 3 M H_2SO_4
 - (vi) HCl in CCl_4 solvent
2. Predict the products for the following reactions.
- (a) acetone heated in excess methanol with a catalytic amount of H_2SO_4
 - (b) ethylammonium chloride with dilute sodium hydroxide

3. Consider the compounds **F**, **G**, **H**, **I**, **J** and **K**.

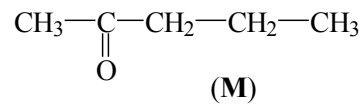
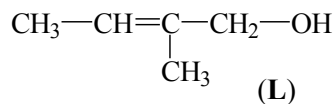
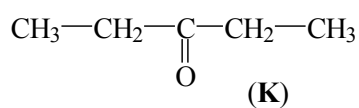
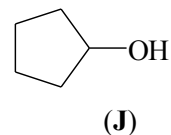
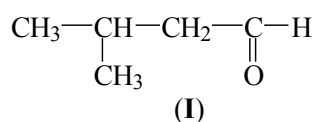
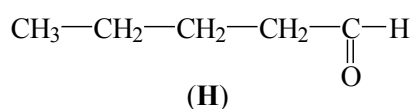


(G)

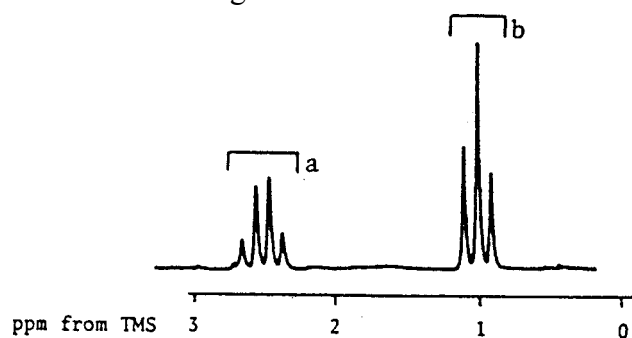


- (a) Which of the compounds strongly absorb IR in the range $1650\text{-}1800\text{ cm}^{-1}$?
- (b) Which of the compounds strongly absorb IR in the range $3200\text{-}3700\text{ cm}^{-1}$?
- (c) Which of the compounds strongly absorb UV radiation?
- (d) Which of the compounds have a ^1H NMR spectrum consisting of only three singlets?
- (e) Which of the compounds will show peaks of approximately equal intensity at m/z 168 and 170 in its mass spectrum?

4. Consider the compounds having constitutional formulas **H** to **M**.



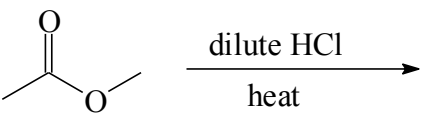
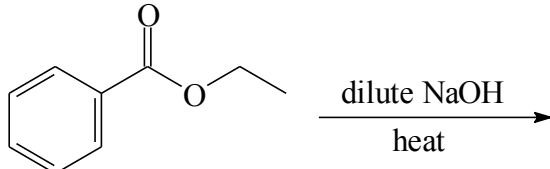
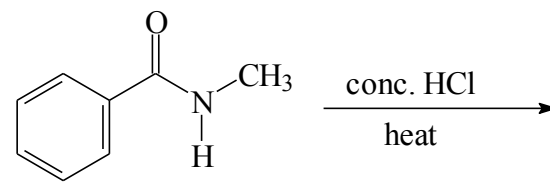
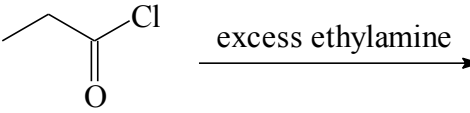
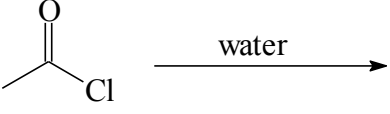
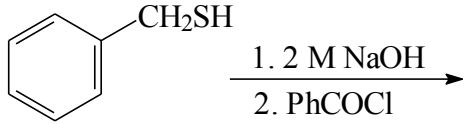
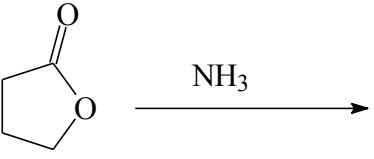
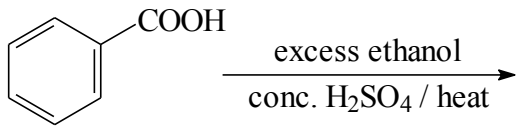
- (a) Which of the compounds **H** to **M** would have a parent ion in the mass spectrum at m/z 86?
- (b) Which one of the compounds **H** to **M** has the ^1H NMR spectrum below?
- (c) State the relative areas of signals a:b.



- (d) Which (if any) of compounds **H** to **M** strongly absorb IR in the ranges 1650-1750, 2850-2950 and 3200-3600 cm^{-1} ?

Problem sheet 8 continues on the next page.

5. Give the major organic product(s) formed in the following reactions.

reactants and reaction conditions	major organic product(s)
 <chem>CC(=O)OC</chem> $\xrightarrow[\text{heat}]{\text{dilute HCl}}$	
 <chem>CCOC(=O)c1ccccc1</chem> $\xrightarrow[\text{heat}]{\text{dilute NaOH}}$	
 <chem>CNC(=O)c1ccccc1</chem> $\xrightarrow[\text{heat}]{\text{conc. HCl}}$	
 <chem>CCC(=O)Cl</chem> $\xrightarrow{\text{excess ethylamine}}$	
 <chem>CC(=O)Cl</chem> $\xrightarrow{\text{water}}$	
 <chem>c1ccc(cc1)CS</chem> $\xrightarrow[2. \text{PhCOCl}]{1. 2 \text{ M NaOH}}$	
 <chem>O=C1OCCCC1</chem> $\xrightarrow{\text{NH}_3}$	
 <chem>c1ccc(cc1)C(=O)O</chem> $\xrightarrow[\text{conc. H}_2\text{SO}_4 / \text{heat}]{\text{excess ethanol}}$	

6. Fats and oils are triesters of glycerol.

What fat is prepared from stearic acid and what reaction conditions are required to convert it back to glycerol?

