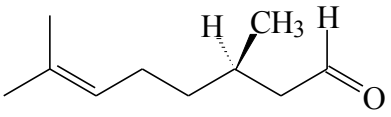
CHEM1611 Answers to Problem Sheet 8

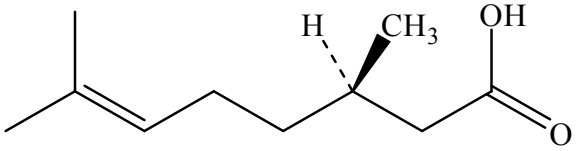
1.



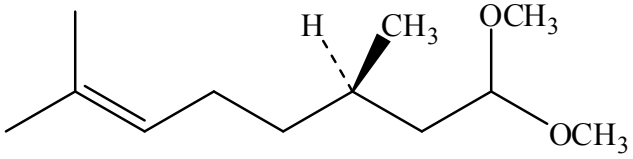
(a) **$C_{10}H_{18}O$**

(b) **Aldehyde (-CHO, carbonyl) and alkene (C=C)**

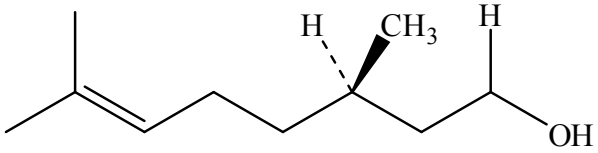
(c) (i) $Cr_2O_7^{2-}$ / H^+: **aldehyde → carboxylic acid:**



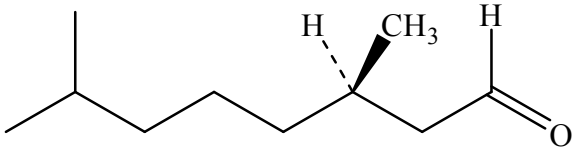
(ii) excess CH_3OH / catalytic amount H_2SO_4: **aldehyde → acetal:**



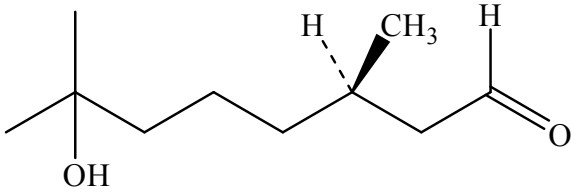
(iii) $NaBH_4$ in CH_3OH followed by H^+/H_2O: **aldehyde → primary alcohol:**



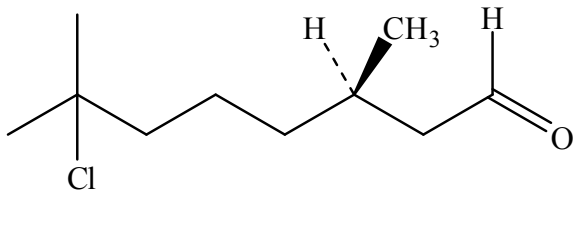
(iv) H_2/Pd in ethanol: **alkene → alkane:**



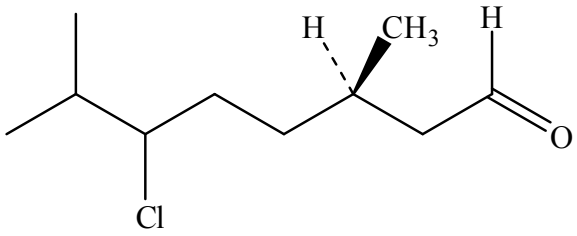
(v) 3 M H_2SO_4: **alkene → alcohol:**



(vi) HCl in CCl_4 solvent: **addition of HCl across C=C:**

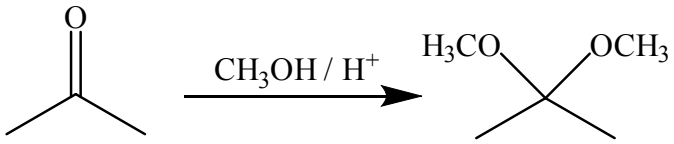


Major (Markovnikov) product



Minor (anti-Markovnikov) product

2. (a) **Acid catalysed addition of CH_3OH to ketone → acetal:**

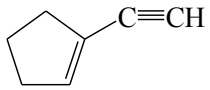


propan-2-one 2,2-dimethoxypropane

(b) **Deprotonation:**

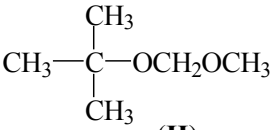
ethylammonium chloride ethylammonium chloride

3.

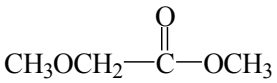


(**F**)

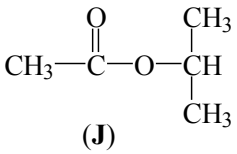
(**G**)



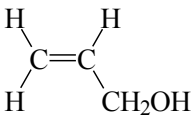
(**H**)



(**I**)



(**J**)



(**K**)

(a) **IR absorption in the range 1650-1800 cm^{-1} is associated with the presence of the C=O group: I and J**

(b) **Strong IR absorption in the range 3200-3700 cm^{-1} is associated with the presence of the O-H and N-H groups: K only**

(c) **Strong UV absorption is associated with the presence of conjugated systems (i.e. those with alternating single and multiple bonds): F only**

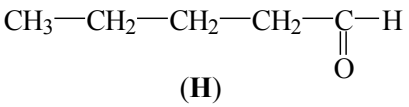
(d) **The presence of only three signals in the ^1H NMR means that three (and only three) distinct types of hydrogen – H, I and J.**

As these are singlets, there are *not* chemically different hydrogen atoms on immediately adjacent carbon atoms. This is not the case for J where the signal on hydrogen of the CH group will be split into a septet by the $2CH_3$ groups (and the signal due to hydrogen atoms on these CH_3 will be split into a doublet by the CH group).

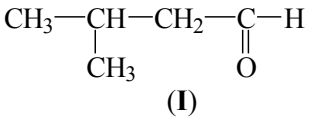
Overall, only H and I fit.

(e) **Bromine has two main isotopes ^{79}Br (51%) and ^{81}Br (49%). The mass spectrum of G therefore shows peaks with approximately equal intensity at separated by 2 mass units.**

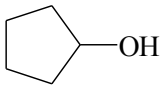
4.



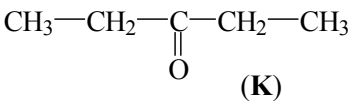
(H)



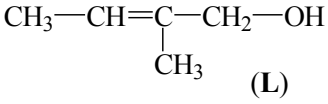
(I)



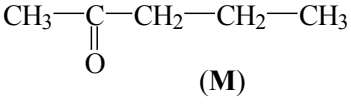
(J)



(K)



(L)



(M)

(a) **All of them have molar mass = 86**.

(b) **The number shows two signals in the ^1H NMR spectrum – a quartet ('a') and a singlet ('b'). The molecule therefore has only two types of hydrogen atom. This is only true for K.**

(c) **The signal due to the hydrogen atoms on the CH_2 group is split into a quartet by the CH_3 group. Hence signal 'a' is due to the two hydrogen atoms on the CH_2 group. The relative intensity is therefore 2.**

The signal due to the hydrogen atoms on the CH_3 group is split into a triplet by the CH_2 group. Hence signal 'b' is due to the three hydrogen atoms on the CH_3 group. The relative intensity is therefore 3.

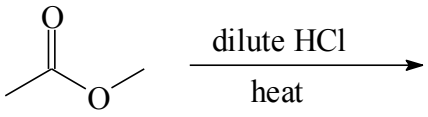
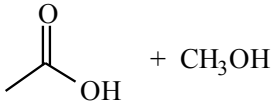
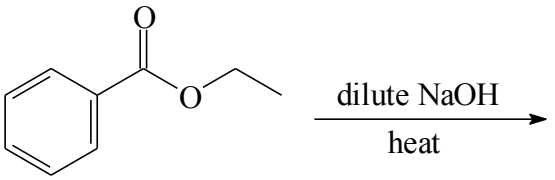
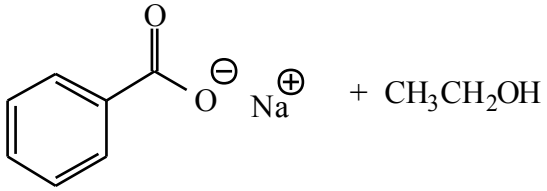
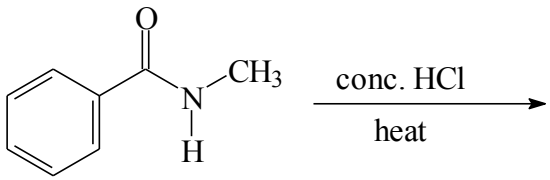
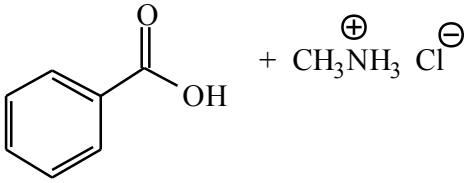
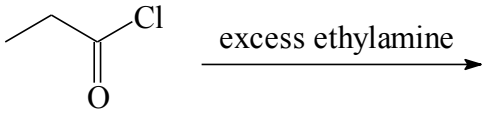
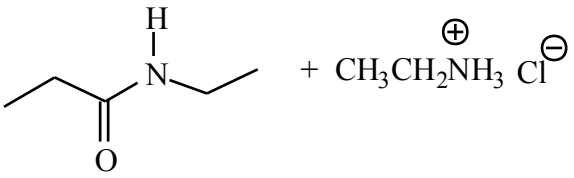
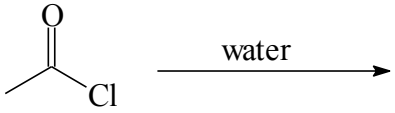
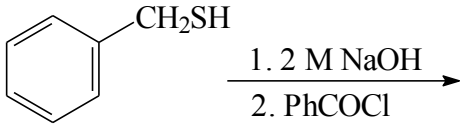
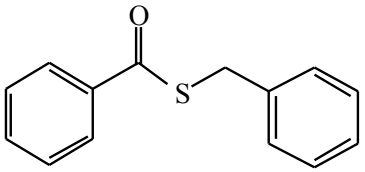
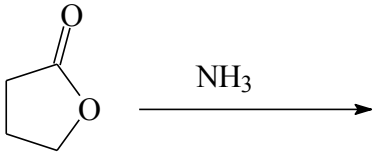
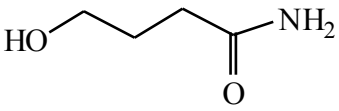
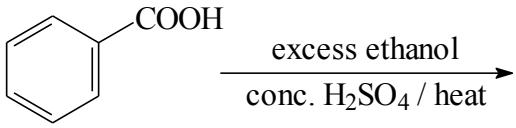
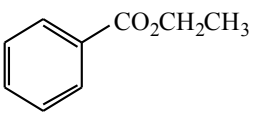
(d) **IR absorption in the ranges 1650-1750, 2850-2950 and 3200-3600 cm^{-1} are associated with vibrations of C=O, C-H and O-H groups respectively.**

1650-1750 cm^{-1}: H, I, K and M

2850-2950 cm^{-1}: all of them

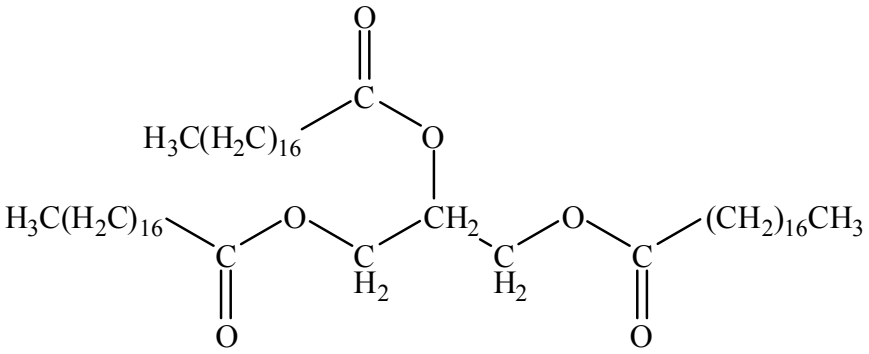
3200-3600 cm^{-1}: J and L.

5.

reactants and reaction conditions	major organic product(s)
	
	
	
	
	CH_3COOH
	
	
	

6. **Fats and oils are triesters of glycerol:**

glycerol + 3 fatty acid → triglyceride



The triglyceride can be converted back to stearic acid and glycerol using either strong aqueous acid and heat or strong aqueous base and heat.