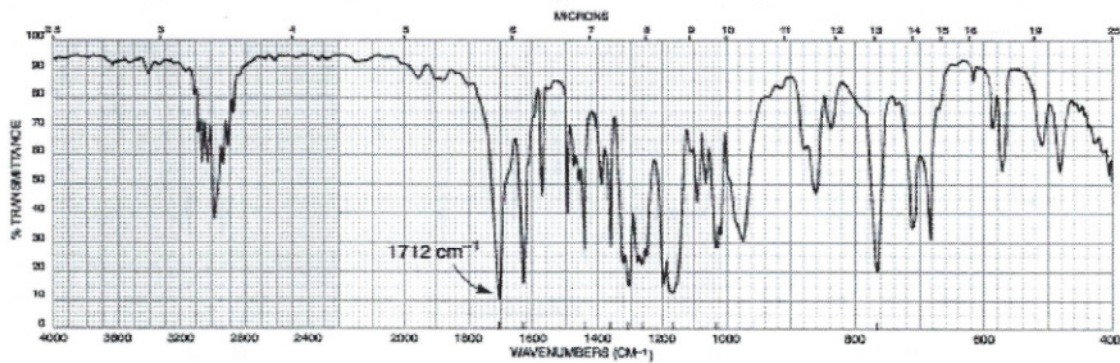
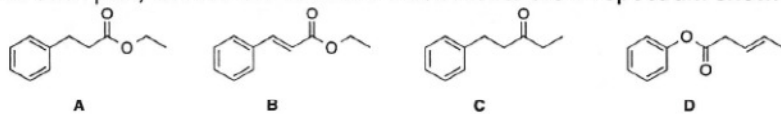
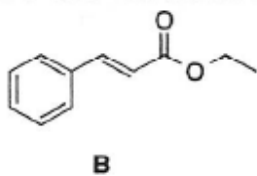


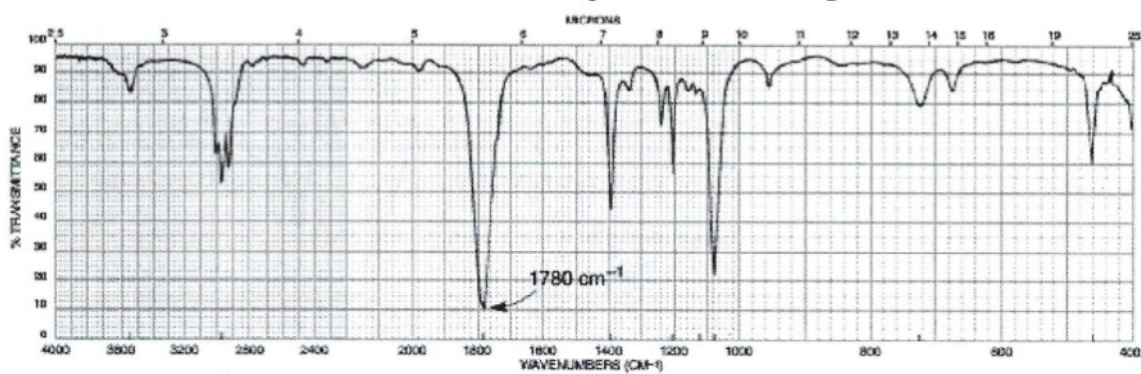
1. In each part, choose the structure that best fits the IR spectrum shown: (18 pts)



Ans:



C=O,  $1712\text{ cm}^{-1}$  for ester (due to conjugation absorption moves to lower frequency from  $1745\text{ cm}^{-1}$ ),  
C=C,  $1620\text{ cm}^{-1}$  for alkene conjugation

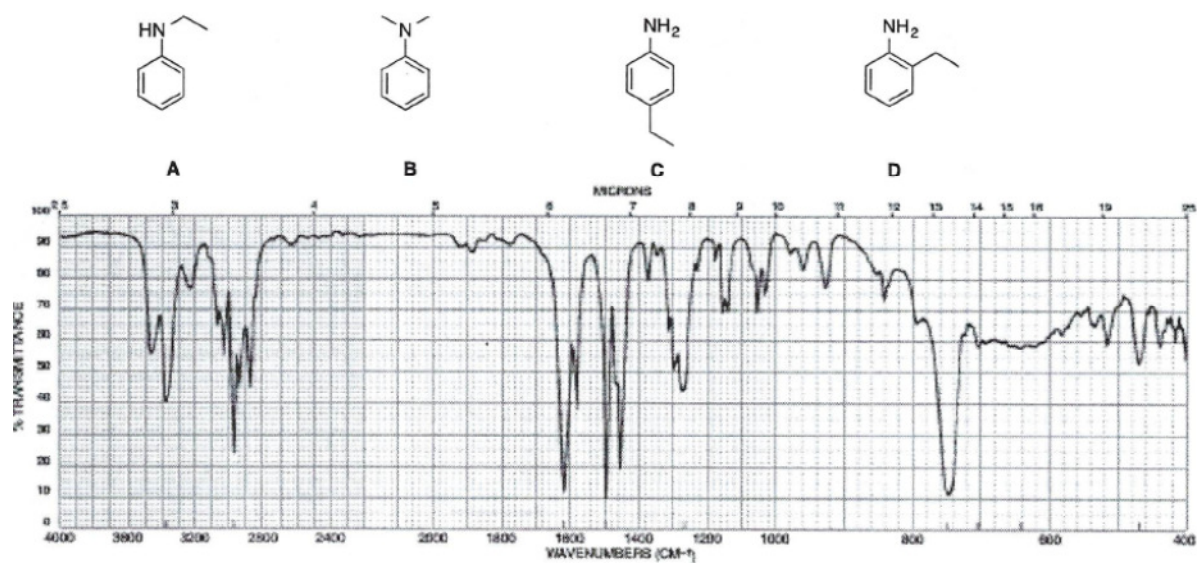


Ans:

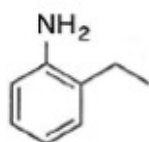


C

C=O at  $1780\text{ cm}^{-1}$ ; Ring strain increased the C=O frequency from  $1715\text{ cm}^{-1}$ .

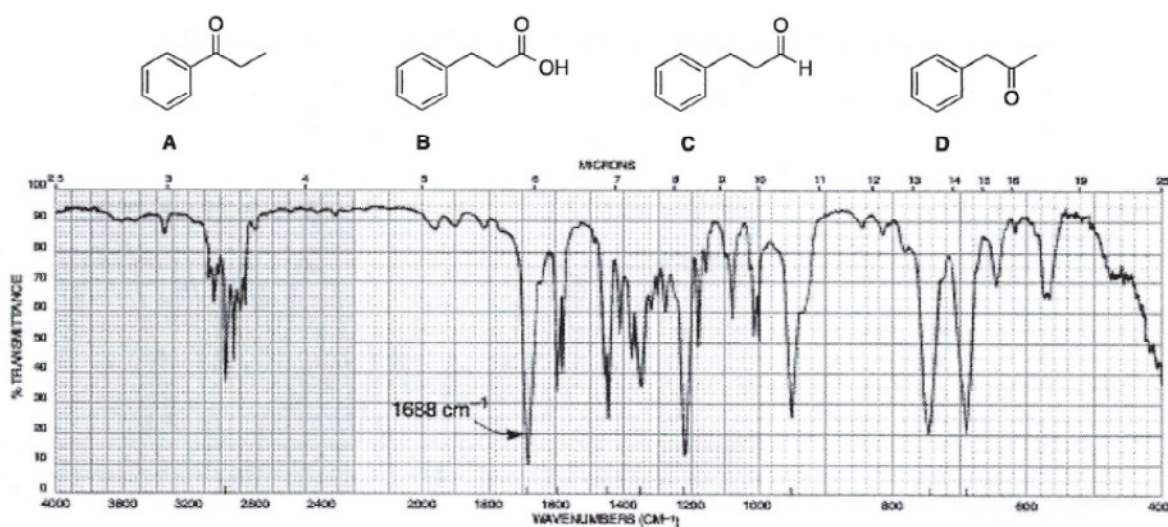


Ans:

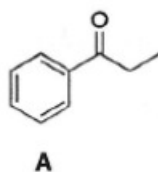


D

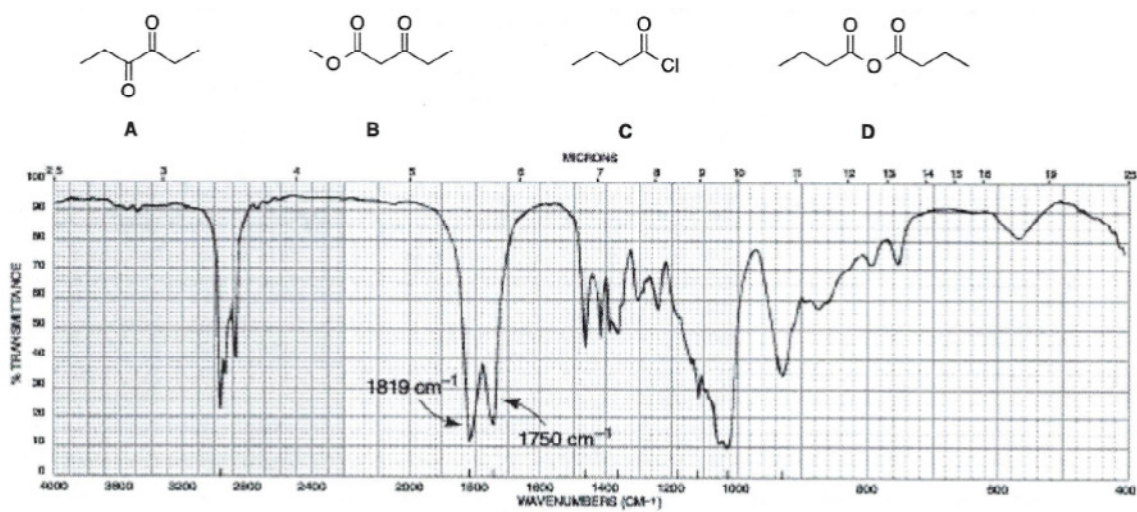
Two NH peak at  $3400\text{-}3500\text{ cm}^{-1}$ , ortho substitution oop at  $750\text{ cm}^{-1}$  (differ from para oop which has peak at  $850\text{ cm}^{-1}$ )



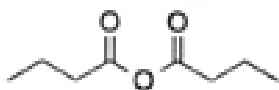
Ans:



Aromatic ketone C=O at 1688 cm<sup>-1</sup> (due to conjugation effect of aromatic ring, lowers the carbonyl frequency from 1715 cm<sup>-1</sup>)



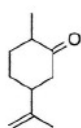
Ans:



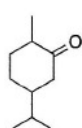
**D**

Two carbonyl peak of anhydride at  $1819\text{ cm}^{-1}$ ;  $1750\text{ cm}^{-1}$  (asymmetric and symmetric stretching)

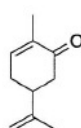
C-O strong stretching at  $1100\text{ cm}^{-1}$ .



**A**



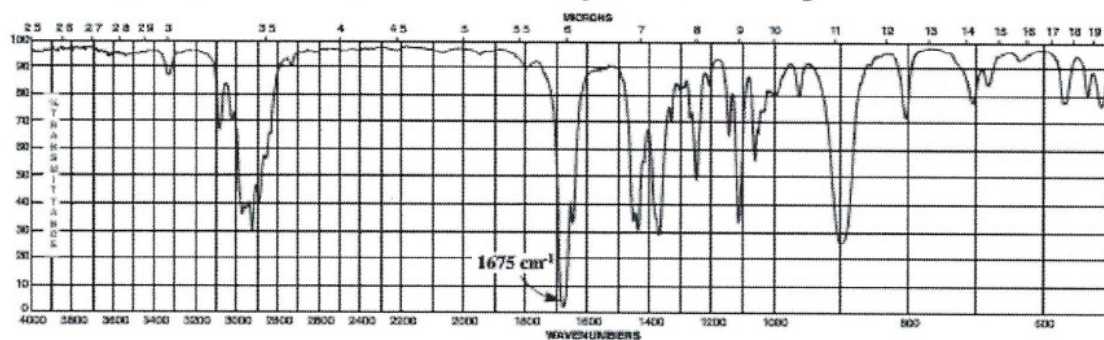
**B**



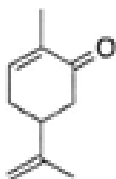
**C**



**D**

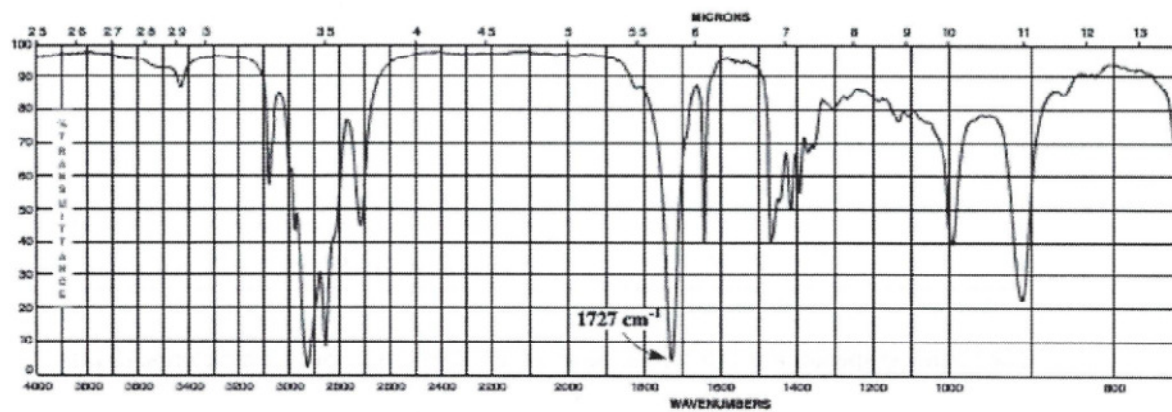
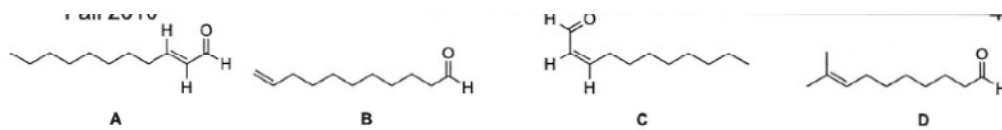


Ans:

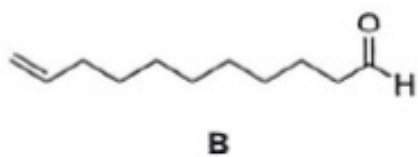


**C**

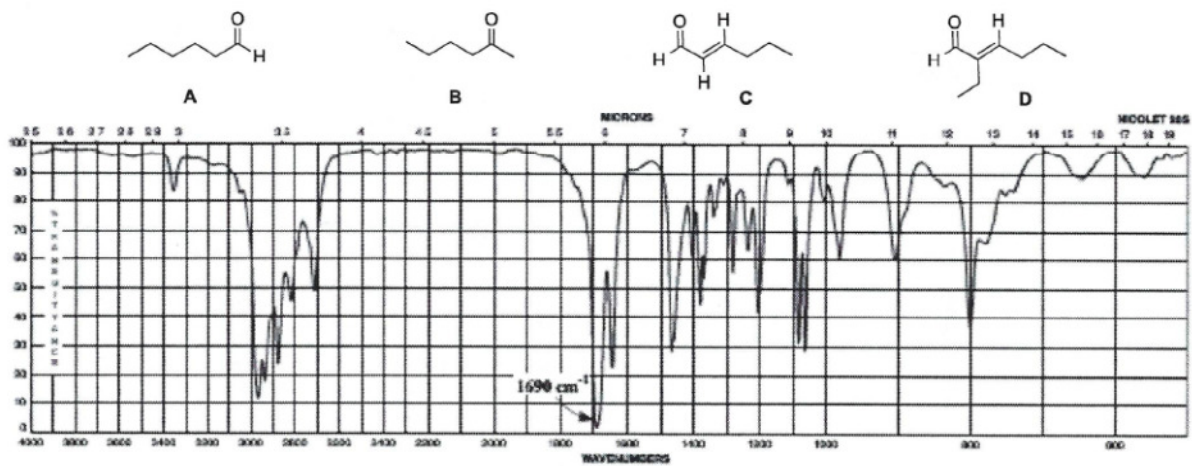
Carbonyl at conjugation, so  $\text{C}=\text{O}$  at  $1675\text{ cm}^{-1}$  due to conjugation, also  $\text{C}=\text{C}$  observed



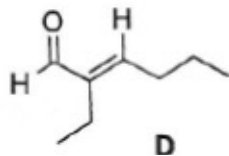
Ans:



1727 cm<sup>-1</sup> for CHO; vinyl oop is observed at 900-1000 cm<sup>-1</sup>.

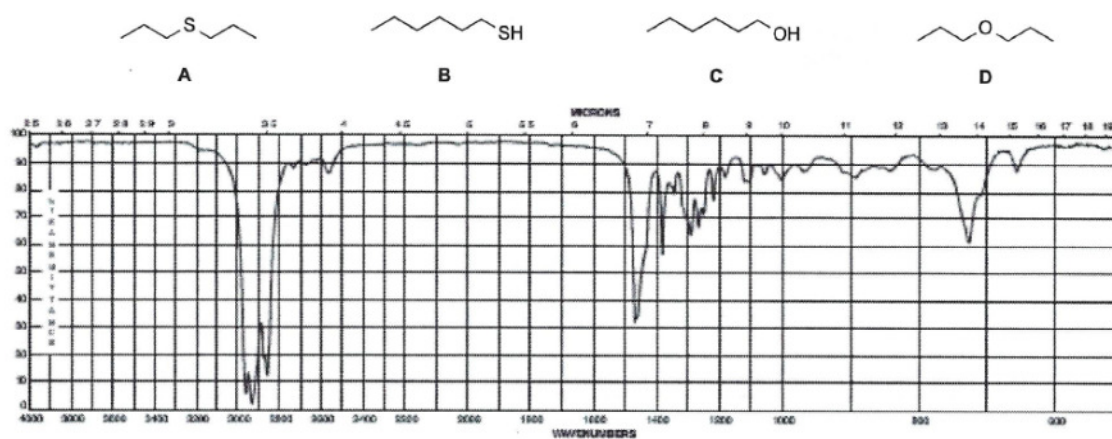


Ans:

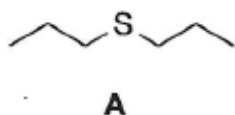


1690  $\text{cm}^{-1}$  CHO conjugated (due to conjugation absorption moves to lower frequency from 1725  $\text{cm}^{-1}$ )

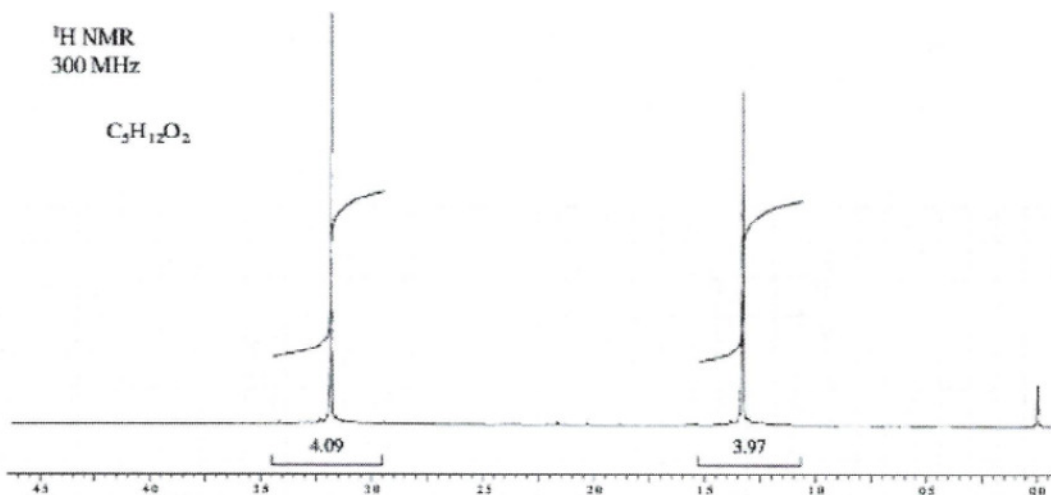
Trisubstituted alkene due to oop at 800  $\text{cm}^{-1}$



Ans



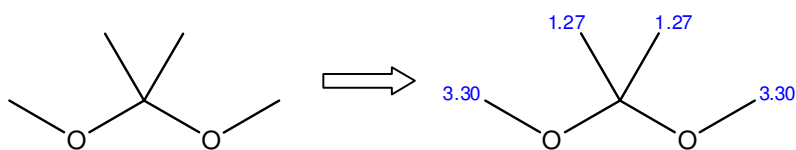
2800-2900  $\text{cm}^{-1}$   $\text{sp}^2$  C-H stretching ; C-H bending 1450  $\text{cm}^{-1}$  (no S-H observed at 2500  $\text{cm}^{-1}$ , and no broad O-H at 3600  $\text{cm}^{-1}$ ; no C-O at 1100  $\text{cm}^{-1}$ )



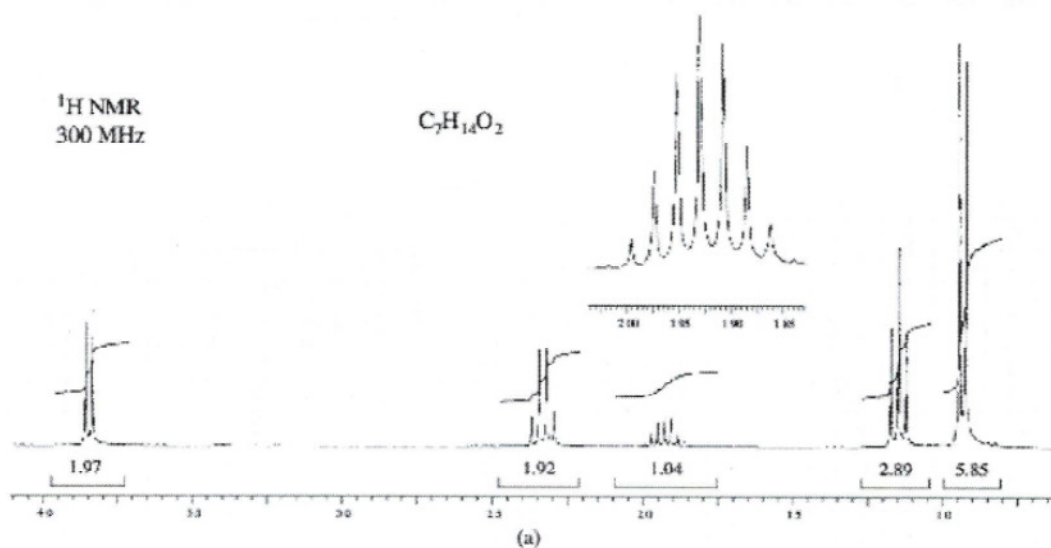
C<sub>5</sub>H<sub>12</sub>O<sub>2</sub>

Peak from 1-1.5 for alkyl, 3-3.5 for alkyl ester/ether

Only two singlet and saturation (C<sub>n</sub>H<sub>2n+2</sub>) will indicate of symmetrical ether (eliminate ester)



3. The following spectra are of three isomeric esters, C<sub>7</sub>H<sub>14</sub>O<sub>2</sub>. Draw the structures. (2 pts)

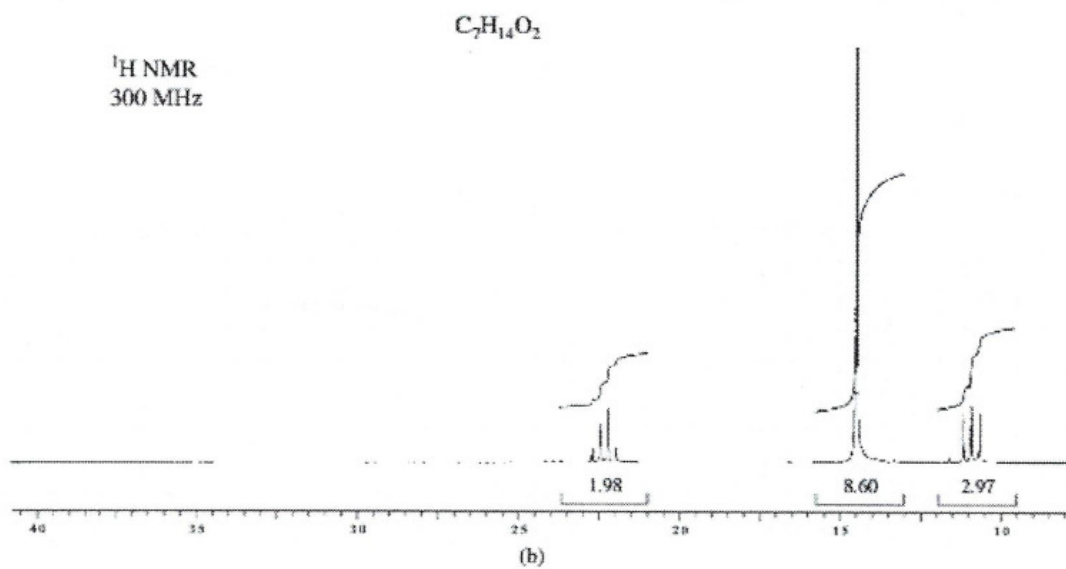
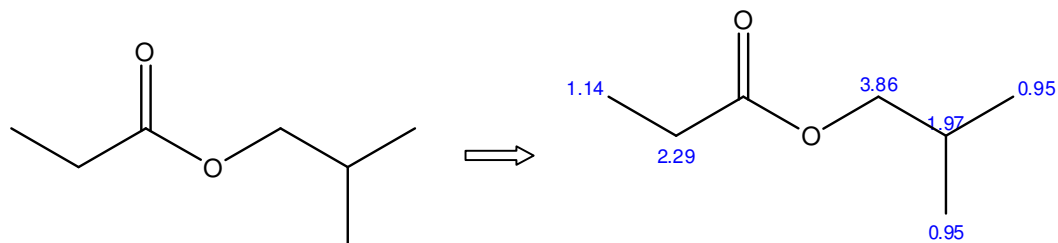


Ans:

$C_7H_{14}O_2$

Five peaks [d (6H) t (3H), m (1H), q (2H), d (2H)]

Ester "a" will be

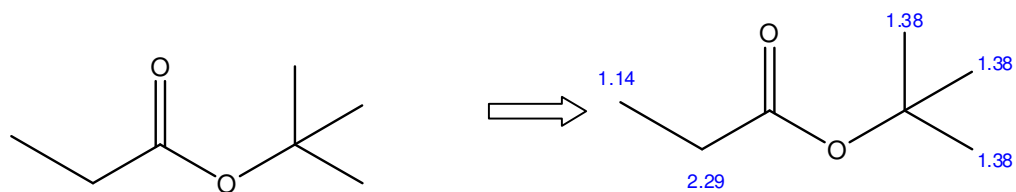


Ans:

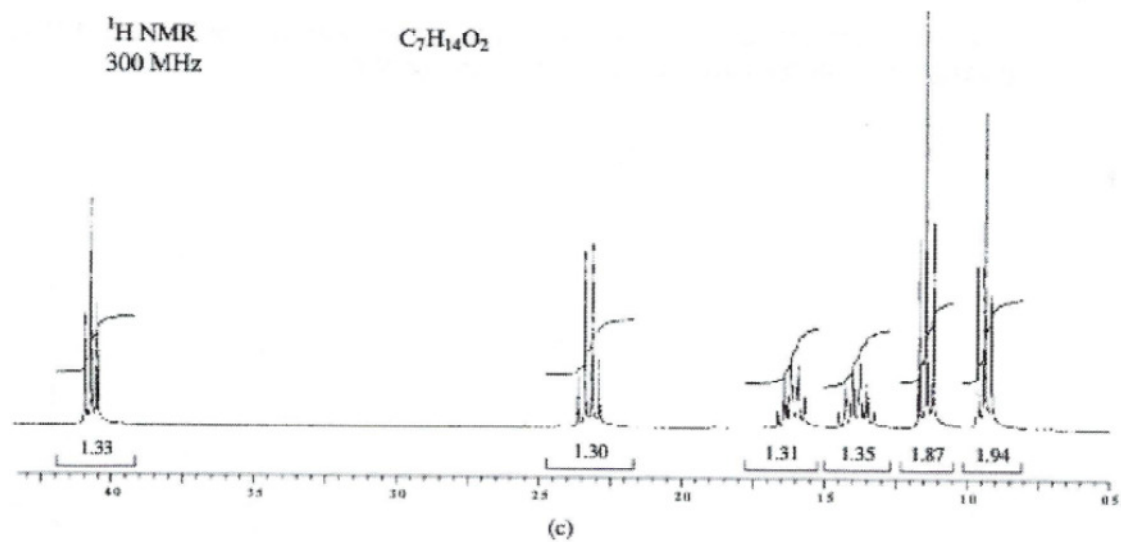
$C_7H_{14}O_2$

three peaks [t (3H), s (9H), q (2H)]

Ester "b" will be





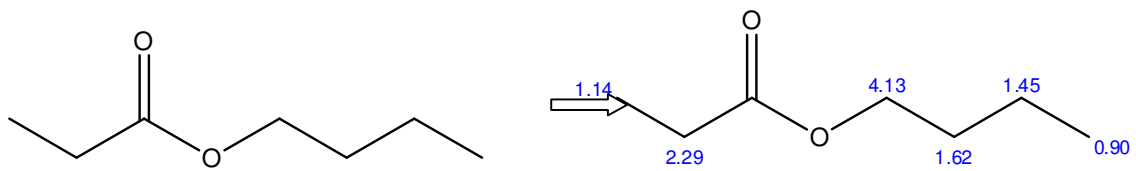


Ans:

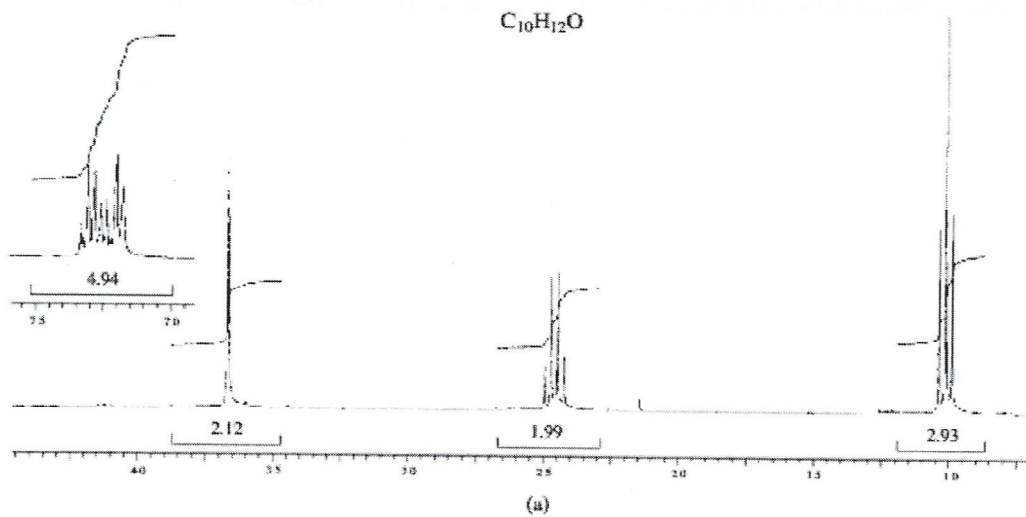
$\text{C}_7\text{H}_{14}\text{O}_2$

six peaks [t (3H), t (3H), m (2H), m (2H), q (2H), t (2H)]

Ester "c" will be



4. The following spectra are of two isomeric compounds,  $C_{10}H_{12}O$ . Their IR spectra show strong bands near  $1715\text{ cm}^{-1}$ . Draw the structures. (2 pts)

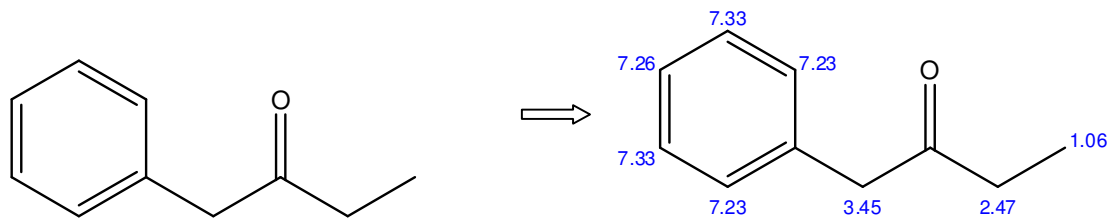


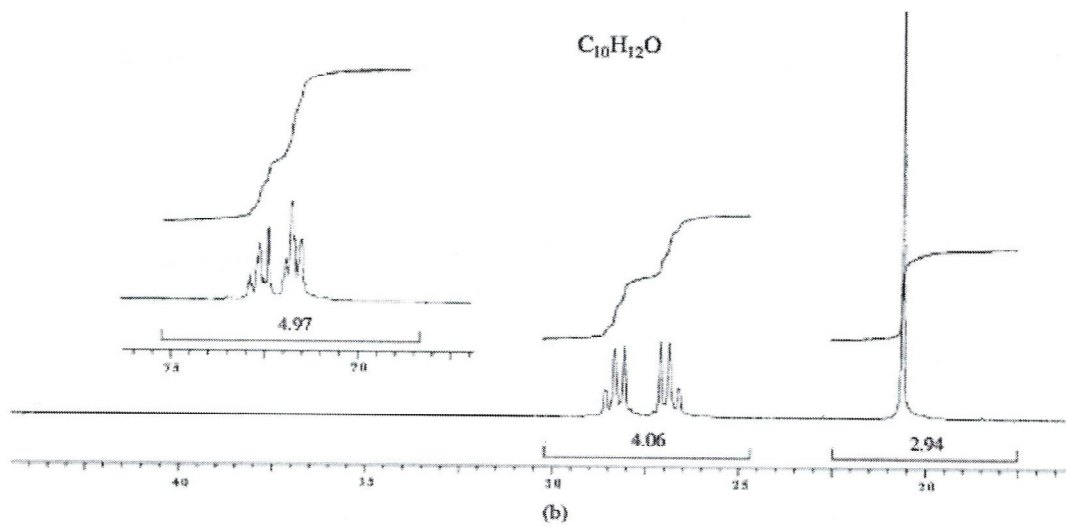
Ans:

$1715\text{ cm}^{-1}$  for ketone (IR)

Peak from 7-8 for aromatic hydrogen

Four type of hydrogen [t(3H), q(2H), s (2H), m(5H)]



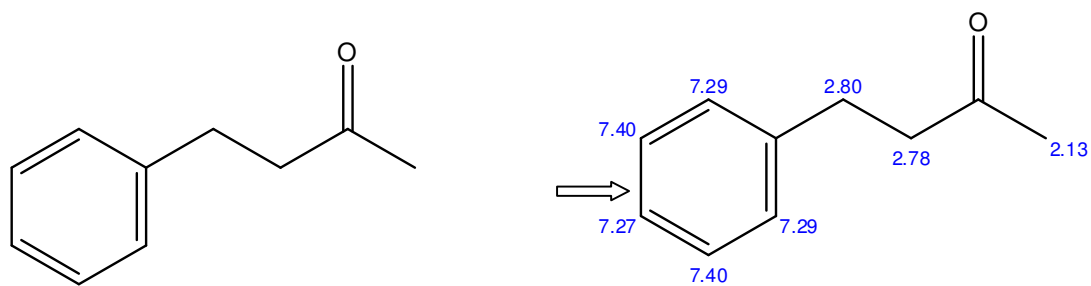


Ans:

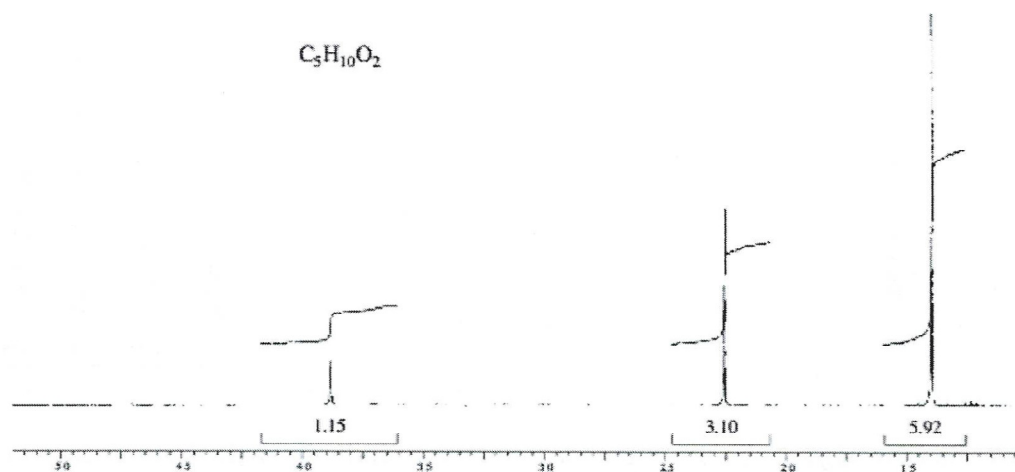
$1715\text{ cm}^{-1}$  for ketone (IR)

Peak from 7-8 for aromatic hydrogen

three type of hydrogen [s(3H), q(4H), s (s), m(5H)]



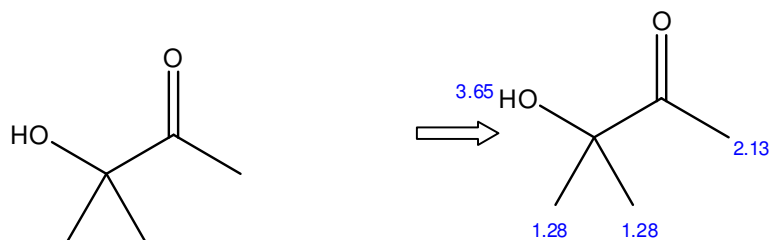
5. The following compound,  $C_5H_{10}O_2$ , shows bands at  $3450\text{ cm}^{-1}$  (broad) and  $1713\text{ cm}^{-1}$  (strong) in the IR spectrum. Draw its structure. (2 pts)



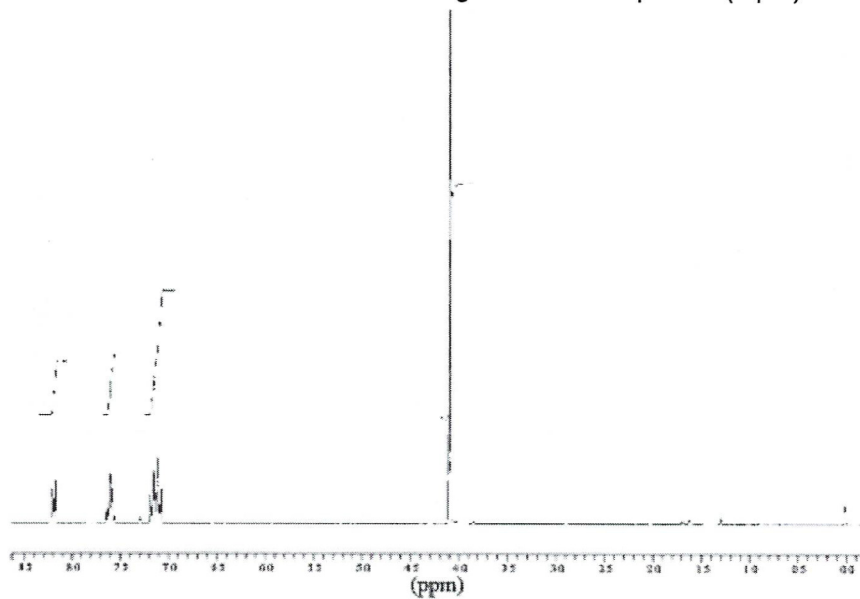
Ans:

IR  $3450\text{ cm}^{-1}$  broad peak for OH;  $1713\text{ cm}^{-1}$  for C=O ketone

Three type of proton [s(6H), s(3H), bs (1h, OH)]



6. The following compound,  $C_8H_8O_3$ , has a broad peak (1H) appearing near 12 ppm that is not shown. Draw the structure and *assign* each of the peaks. (2 pts)



Ans:

Broad peak at 12 ppm will be for carboxylic acid proton

Proton from 7-8 ppm are aromatic; four peak in aromatic region ortho substitution

Proton at 4ppm for methoxy singlet

