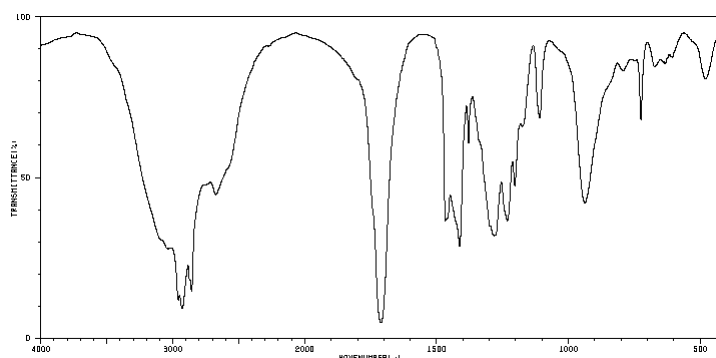


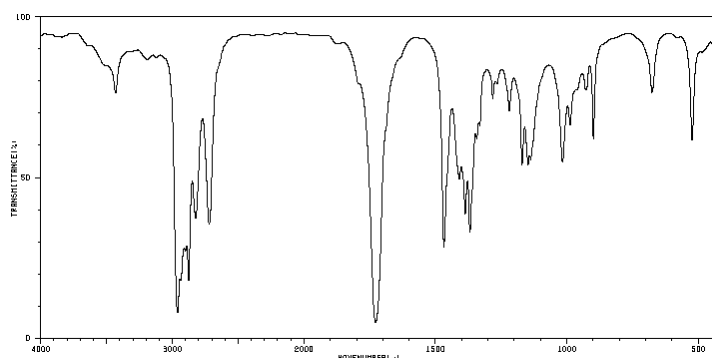
1. For the following spectra (a-e), there is a choice of three possible functional groups for each. For each spectrum, choose the most appropriate class of compound, and explain your reasoning by noting the presence or absence of characteristic peaks.



a. Alcohol, **carboxylic acid** or ether

Reasoning:

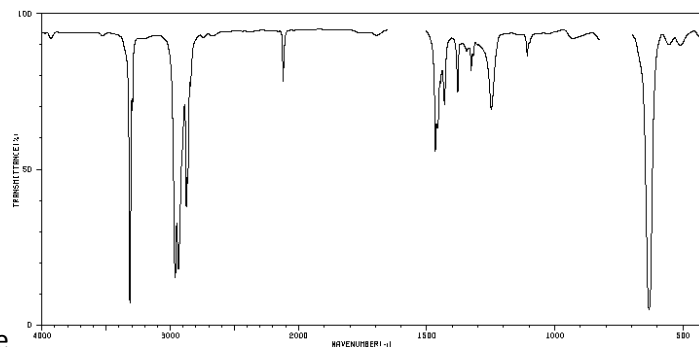
This compound has a C=O stretch at ca. 1720 cm^{-1} whereas alcohols or ethers would not have this peak. Additionally, this spectrum has an O-H stretch that overlaps with the $\text{sp}^3\text{ C-H}$ stretches at $3000\text{-}2900\text{ cm}^{-1}$, characteristic of an acid. Usually alcohols have a distinct and clear/separate O-H stretch.



b. **Aldehyde**, ester or ketone

Reasoning:

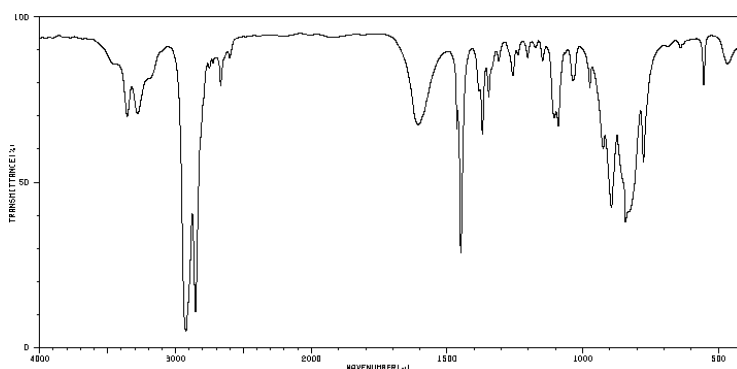
The C=O stretch at 1720 cm^{-1} does not help to distinguish but the spectrum has an aldehydic C-H absorbance at $2800\text{ and }2700\text{ cm}^{-1}$.



c. **terminal alkyne**, alkene, or nitrile

Reasoning:

The spectrum shows a sharp sp C-H stretch at 3300 cm^{-1} with a concomitant CC stretch at $2100\text{-}2200\text{ cm}^{-1}$. Neither the nitrile nor the alkene would not show the sp C-H stretch.

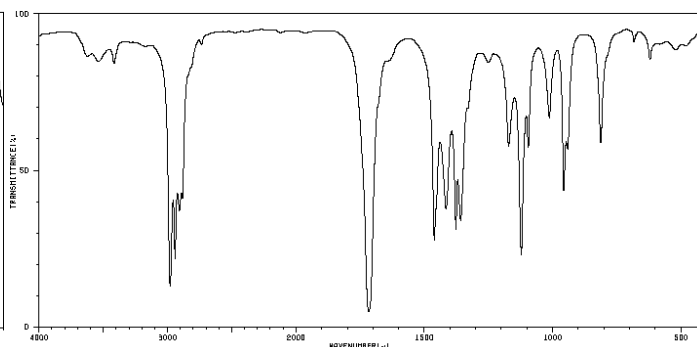
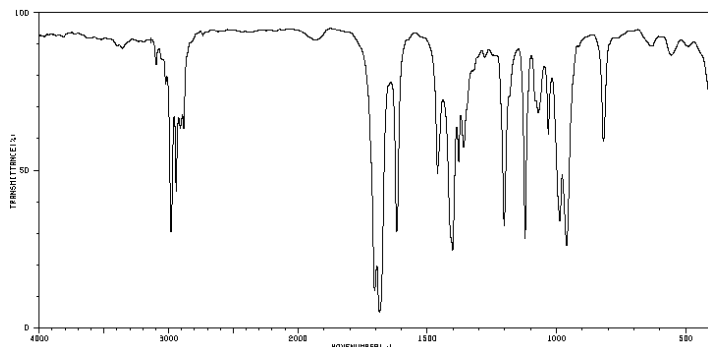
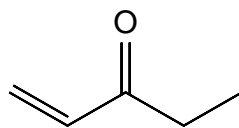
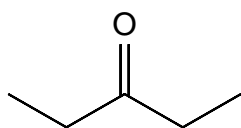


d. Primary amide, **primary amine** or nitro

Reasoning:

The nitro stretches would be evident at just above 1500 and just above 1300 cm^{-1} and they are absent here; a primary amide would show a C=O stretch ca. 1670 cm^{-1} which is also absent. The two stretches at $3300\text{-}3400\text{ cm}^{-1}$ indicate the primary nitrogen and the absence of the C=O indicate it is an amine. The broad stretch at 1600 cm^{-1} is indicative of an N-H bend of an amine.

2. Identify which compound corresponds to each spectrum below. Briefly explain your reasoning.

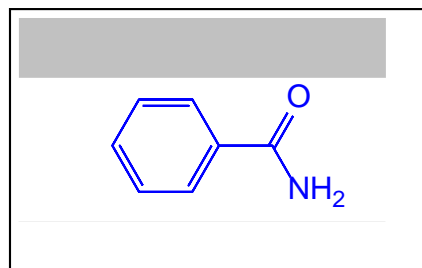
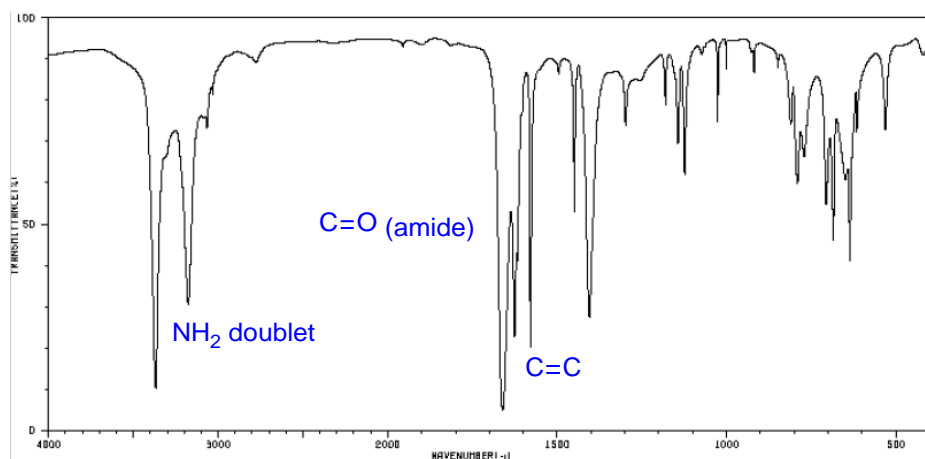
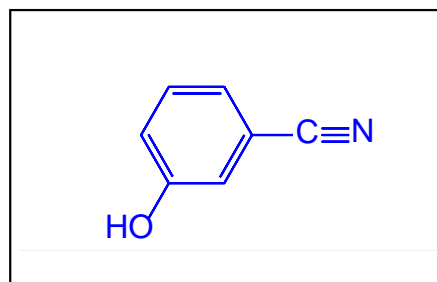
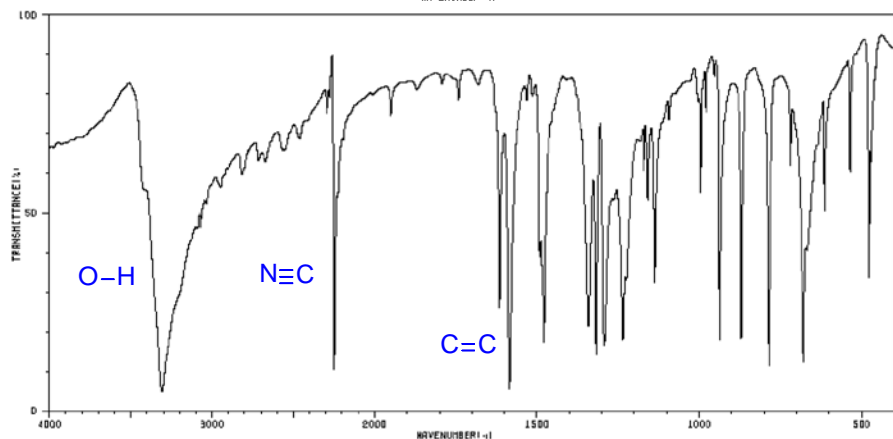
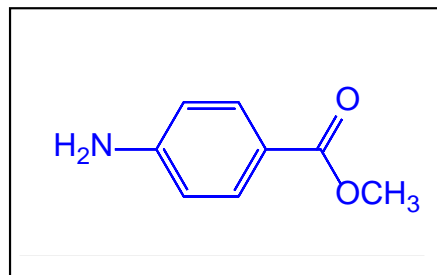
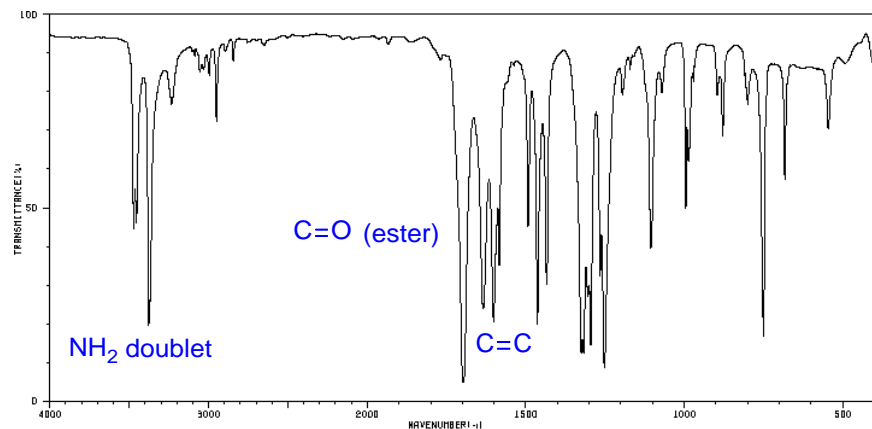
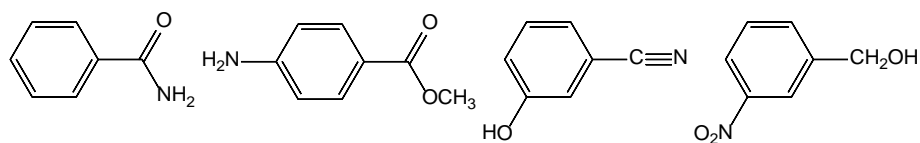


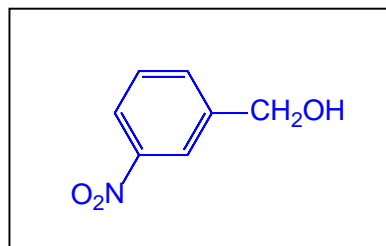
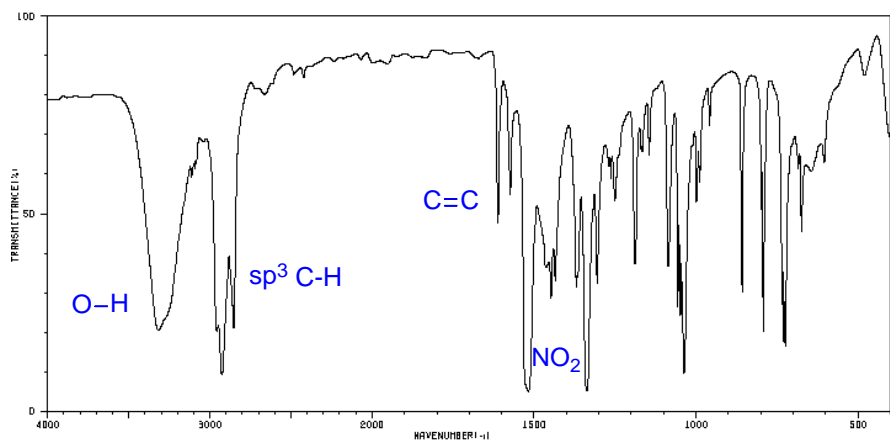
Carbonyls that are in conjugation with a double bond shift to lower frequency (due to the single bond character) and broaden due the resonance it exhibits. The spectrum on the left has a lower C=O frequency and is attributed to the 1-penten-3-one. Additionally, the spectrum on the left has an absorbance at $\sim 1600\text{ cm}^{-1}$ corresponding to the C=C bond.

3. Provide absorbances (and label them) that can be used to distinguish between the compounds in each pair.

| Compound | Peaks? | Compound | Peaks? |
|----------|---|----------|--|
| a. | O—H: $3300\text{--}3400\text{ cm}^{-1}$ C=C: 1600 cm^{-1} | | C=O: $\sim 1745\text{ cm}^{-1}$ |
| b. | Aldehydic C—H: 2750 cm^{-1} | | O—H: $3300\text{--}3400\text{ cm}^{-1}$ That is overlaps on the the $\text{sp}^3\text{ C—H}$ peak instead of being its own peak. C=O might be lower in v. |
| c. | Nitrile CN: $2260\text{--}2220\text{ cm}^{-1}$ | | CC: $2260\text{--}2100\text{ cm}^{-1}$ sp C—H str, ca. 3300 cm^{-1} |

4. Below are four IR spectra for the following compounds. Determine which IRs are for which structures. Indicate the diagnostic bands on the IRs you used to differentiate between the six compounds, draw your answer in the box on the right.





3. Determine the compounds for each spectrum, **A-D**, among compounds **1-8** and provide your reasoning by labeling the diagnostic bands on the IRs you used to differentiate between the compounds.

