1. From Table 2, for the O–H bond, $v = 3400 \text{ cm}^{-1}$.

$$v = \left(3400 \ \frac{1}{cm} \right) \left(\frac{100 \ cm}{1 \ m} \right) \left(3.0 \times 10^8 \ \frac{m}{s} \right) = 1.0 \times 10^{14} \ s^{-1}$$

$$\lambda = \frac{c}{\nu} = \frac{3.0 \times 10^8 \text{ m/s}}{1.0 \times 10^{14} \text{ s}^{-1}} = 3.0 \times 10^{-6} \text{ m} = 3000 \text{ nm}$$

$$E = hv = (6.626 \times 10^{-34} \text{ J s})(1.0 \times 10^{14} \text{ s}^{-1}) = 6.6 \times 10^{-20} \text{ J}$$

- 2. A. C=O
 - В. С—О
 - $C. \qquad C{\equiv}C$
 - D. C—C
 - E. O-H (This does not follow the prediction based on mass of O vs mass of C. The reason is that the O-H bond is so much stronger than the C-H bond that it overrides the mass effect.)
- 3. A. three absorptions: 4x, 3x, 4x
 - B. two absorptions: 4x, 1x
 - C. two absorptions: 4x, 1x
 - D. three absorptions: 3x, 2x, 4x
 - E. three absorptions: 3x, 1x, 4x
 - F. two absorptions: 4x, 2x

4. B is ethanol (O–H at 3320 cm^{-1}) C is butanone (C=O at 1750 cm⁻¹) A is dimethyl ether (no C=O, no O–H)

| 5. | $\begin{array}{cccc} Cl & H & H \\ & & & & \\ Cl - C - C - C - C - H \\ & & & \\ H & H & H \end{array}$ | 3 different C – 2x, 3x, 4x 2 Cl on one C makes 2x the highest E absorbtion in the spectrum. Therefore, spectrum D. |
|----|---|---|
| | $\begin{array}{cccc} H & Cl & H \\ I & I & I \\ Cl - C - C - C - C - H \\ H & H & H \end{array}$ | 3 different C – 3x, 2x, 4x 2 C, each with one Cl, so 3x and 2x close tegether at higher E than 4x. Therefore, spectrum C. |



6. The molar mass indicates that the molecular formula is $C_5H_{10}O$.

The IR absorbance at 1700 cm–1 indicates that the molecule contains a C=O double bond.

The nmr shows three different carbon atoms. The single absorption at 4200 Hz, which is high energy, corresponds to the C of the C=O. (Oxygen is very electronegative, drawing electrons away from the C, exposing it to the external magnetic field.)

At low energy, the 3x absorption corresponds to CH_2 , and the 4x absorption corresponds to CH_3 . To account for all of the carbon atoms there must be two of each of these.

