1. Use principles of molecular structure, intermolecular forces, and kinetic molecular theory to answer the following questions.

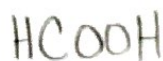   a. A complete Lewis electron-dot diagram of a molecule of ethyl methanoate is given below.
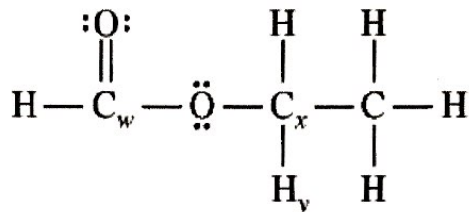


   i. Identify the hybridization of the valence electrons of the carbon atom labeled $C_w$. (1 point)

   ii. Estimate the numerical value of the $H_y$–$C_x$–O bond angle in an ethyl methanoate molecule. Explain the basis of your estimate. (1 point)

   b. Ethyl methanoate, $CH_3CH_2OCHO$, is synthesized in the laboratory from ethanol, $C_2H_5OH$, and methanoic acid, $HCOOH$, as represented by the following equation.

   $$C_2H_5OH(l) + HCOOH(l) \rightleftarrows CH_3CH_2OCHO(l) + H_2O(l)$$
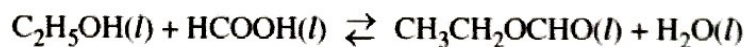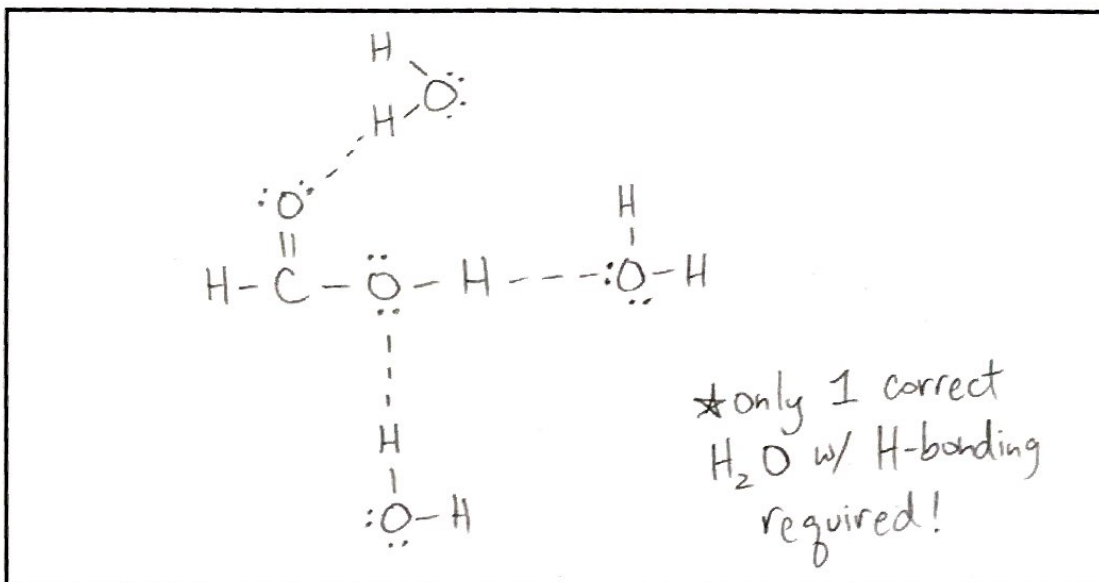
   i. In the box below, draw the complete Lewis electron-dot diagram of a methanoic acid molecule. (1 point)



**Methanoic Acid**

HCOOH
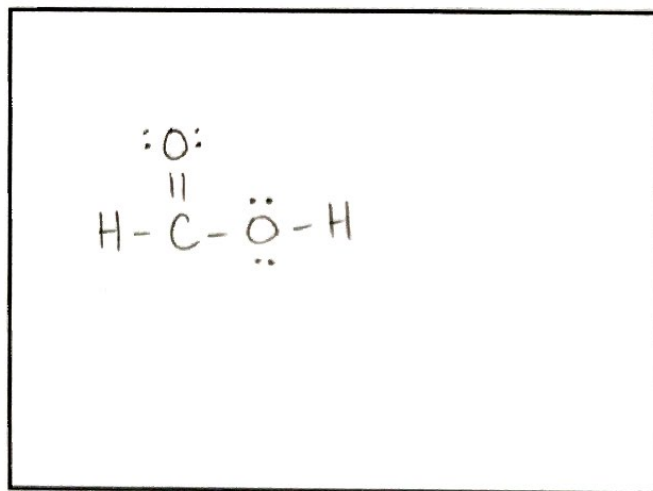
ii. In the box below, draw the complete Lewis electron-dot diagrams of a methanoic acid molecule and a water molecule in an orientation that allows a hydrogen bond to form between them. (1 point)



**Hydrogen Bonding Between Methanoic Acid and Water**

a.) (i) $sp^2$

(ii) 109.5°, by $C_x$ has a tetrahedral VSEPR shape (4 bonding domains, no lone pairs)