

**2013 AP<sup>®</sup> CHEMISTRY FREE-RESPONSE QUESTIONS**

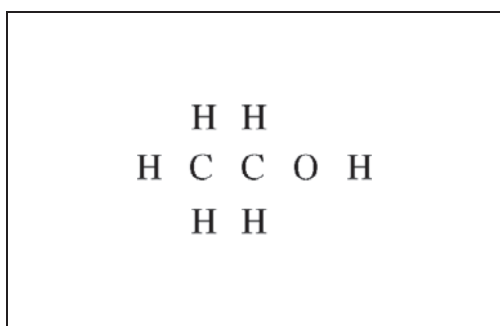
6. Answer the following questions using principles of molecular structure and intermolecular forces.

Compound	Empirical Formula	Solubility in Water	Boiling Point (°C)
1	C <sub>2</sub> H <sub>6</sub> O	Slightly soluble	-24
2	C <sub>2</sub> H <sub>6</sub> O	Soluble	78

Compounds 1 and 2 in the data table above have the same empirical formula, but they have different physical properties.

(a) The skeletal structure for one of the two compounds is shown below in Box X.

(i) Complete the Lewis electron-dot diagram of the molecule in Box X. Include any lone (nonbonding) pairs of electrons.



Box X



Box Y

(ii) In Box Y above, draw the complete Lewis electron-dot diagram for the other compound, which is a structural isomer of the compound represented in Box X. Include any lone (nonbonding) pairs of electrons.

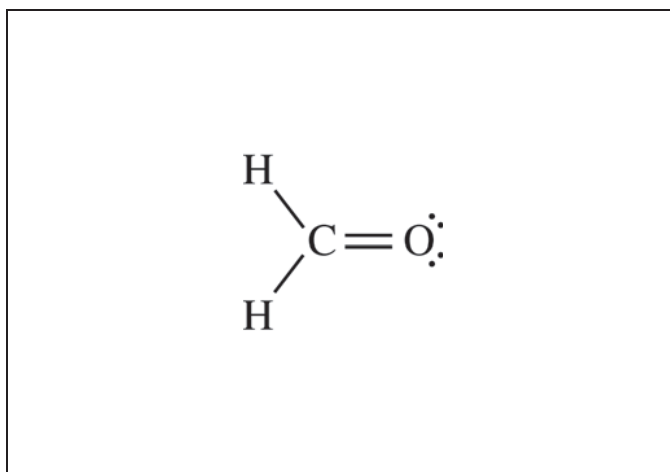
(b) On the basis of the complete Lewis electron-dot diagrams you drew in part (a) and the information in the data table above, identify which compound, 1 or 2, has the structure represented in Box X. Justify your answer in terms of the intermolecular forces present in each compound.

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Use the information in the following table to answer parts (c) and (d).

Name	Lewis Electron-Dot Diagram	Boiling Point (°C)	Vapor Pressure at 20°C (mm Hg)
Dichloromethane	$  \begin{array}{c}  \text{H} \\    \\  \text{:}\ddot{\text{C}}\text{:}\ddot{\text{C}}\text{:}\text{H} \\    \\  \text{:}\ddot{\text{C}}\text{:}  \end{array}  $	39.6	353
Carbon tetrachloride	$  \begin{array}{c}  \text{:}\ddot{\text{C}}\text{:} \\    \\  \text{:}\ddot{\text{C}}\text{:}\ddot{\text{C}}\text{:}\ddot{\text{C}}\text{:} \\    \\  \text{:}\ddot{\text{C}}\text{:}  \end{array}  $	76.7	89

- (c) Dichloromethane has a greater solubility in water than carbon tetrachloride has. Account for this observation in terms of the intermolecular forces between each of the solutes and water.
- (d) In terms of intermolecular forces, explain why dichloromethane has a higher vapor pressure than carbon tetrachloride.
- (e) The complete Lewis electron-dot diagram of methanal (formaldehyde) is shown in the box below. Molecules of methanal can form hydrogen bonds with water. In the box below, draw a water molecule in a correct orientation to illustrate a hydrogen bond between a molecule of water and the molecule of methanal. Use a dashed line to represent the hydrogen bond.



**STOP**

**END OF EXAM**