

Determining Water Solubility in Compounds

<https://gemini.google.com/app/1fa3078102e259fb>

Response: To determine which compound has the lowest water solubility, we analyze the functional groups, hydrogen bonding capabilities, and the non-polar alkyl chain lengths:

1. Hydrogen Bonding Capability:

- **Alcohols (C, D, E):** Contain an —OH group capable of acting as both a hydrogen-bond donor and acceptor with water molecules.
- **Aldehydes (A, B):** Contain a carbonyl group (—CHO) which can only act as a hydrogen-bond acceptor. They cannot form hydrogen bonds as effectively with water compared to alcohols of similar molecular weight, making aldehydes generally less soluble in water than alcohols with the same carbon count.

2. Hydrophobic (Non-Polar) Effect:

- As the non-polar alkyl chain length increases, water solubility decreases.
- **A** ($\text{CH}_3\text{CH}_2\text{CHO}$) has 3 carbons.
- **B** ($\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$) has 4 carbons.

Comparing **A** and **B**, compound **B** has a larger non-polar hydrophobic alkyl group ($\text{C}_3\text{H}_7\text{—}$) paired with the carbonyl functional group, making it significantly less soluble in water than **A**, as well as the alcohols (**C, D, E**) which form stronger hydrogen bonds.

Therefore, compound **B** has the lowest water solubility.

Correct Option: (2) B
