▶ Video explanation (YouTube Short)

Physical Properties of Aldehydes and Ketones

Molecules of the same mass can boil 100 °C apart. What decides it is the **attraction between molecules**: aldehydes and ketones have a polar C=O (dipole-dipole attraction) but no O–H (no hydrogen bonding among themselves).

1. State and smell (NCERT 8.3)

Methanal is a gas at room temperature; ethanal is a volatile liquid; the other aldehydes and ketones are liquids or solids. Lower aldehydes have sharp, pungent smells; as the molecules get bigger the smell becomes less pungent and more fragrant (many are used in perfumes and flavours).

2. Boiling points: compounds of similar mass (NCERT 8.3)

Compound (family)	Molar mass	Boiling point	Attraction between molecules
n-butane (alkane)	58	273 K (0 °C)	only weak dispersion forces; no polar bond
methoxyethane (ether)	60	281 K (8 °C)	weak dipole (slightly polar C–O–C)
propanal (aldehyde)	58	322 K (49 °C)	dipole-dipole (polar C=O)
acetone (ketone)	58	329 K (56 °C)	dipole-dipole (polar C=O)
propan-1-ol (alcohol)	60	370 K (97 °C)	intermolecular hydrogen bonds (O–H)

Order: hydrocarbons, ethers < aldehydes, ketones < alcohols (similar molar mass). The C=O is polar: carbon δ+, oxygen δ−, so the δ+ end of one molecule attracts the δ− end of the next. Aldehydes and ketones have no H on oxygen, so they cannot hydrogen-bond with each other.

3. Solubility in water

Water's H forms hydrogen bonds with the carbonyl oxygen (C=O···H–O). So **methanal, ethanal and propanone mix with water in all proportions**. As the alkyl chain gets longer, the non-polar part grows and **solubility falls rapidly**. All aldehydes and ketones dissolve well in organic solvents such as benzene, ether, methanol and chloroform.

Solved example

Q. Arrange in increasing order of boiling point: propane, ethanal (acetaldehyde), ethanol (molar masses 44, 44, 46).
A. Propane (only dispersion forces, −42 °C) < ethanal (dipole-dipole, 20 °C) < ethanol (hydrogen bonding, 78 °C).

Key takeaways

- Same mass, different boiling points: the attraction between molecules decides.
- Aldehydes and ketones boil above hydrocarbons and ethers (polar C=O, dipole-dipole) and below alcohols (no O–H, no H-bonds among themselves).
- Small aldehydes and ketones mix with water (H-bonds to the C=O oxygen); longer chains are less soluble.

Practice questions

1. (MCQ) Which has the highest boiling point? (a) n-butane (b) propanal (c) propan-1-ol (d) methoxyethane
2. (MCQ) Aldehydes boil higher than hydrocarbons of similar mass because of: (a) hydrogen bonding (b) dipole-dipole attraction (c) ionic bonds (d) higher molar mass
3. (MCQ) Which mixes with water in all proportions? (a) propanone (b) hexanal (c) benzophenone (d) decanal
4. (Very short) Why can't aldehydes form hydrogen bonds with each other?
5. (Very short) What is the physical state of methanal at room temperature?
6. (Short) Why does the solubility of aldehydes and ketones in water fall as the chain gets longer?
7. (Short) Acetone (58) boils at 56 °C but n-butane (58) at 0 °C. Explain.
8. (Application) Arrange in increasing order of boiling point: CH_3CHO, CH_3CH_2OH, CH_3OCH_3, $CH_3CH_2CH_3$.

Answer key

1. (c) propan-1-ol.
2. (b) dipole-dipole attraction.
3. (a) propanone.
4. They have no hydrogen attached to oxygen (no O–H), so there is no H to bond to another molecule's oxygen.
5. A gas.
6. The carbonyl group can H-bond with water, but the growing non-polar alkyl chain cannot, so the molecule as a whole mixes less.
7. Acetone's polar C=O gives dipole-dipole attraction between molecules; butane has only weak dispersion forces, so it needs much less energy to boil.
8. $CH_3CH_2CH_3 < CH_3OCH_3 < CH_3CHO < CH_3CH_2OH$.

▶ Watch the video explanation