

Exercise walk-through

Solubility ■ 3.10

eXercise

You must be able to

- apply the rule **like dissolves like** (polar dissolves polar, nonpolar dissolves nonpolar)
- predict whether a solute dissolves in a given solvent
- explain solubility with intermolecular forces

Method — Like dissolves like

A solute dissolves best in a solvent with **similar** intermolecular forces:

- **polar/ionic** solutes dissolve in **polar** solvents (water);
- **nonpolar** solutes dissolve in **nonpolar** solvents (oil, hexane).

Method — Why it works

Dissolving requires the solute-solvent attractions to be comparable to the attractions being broken. Water can hydrate ions and hydrogen-bond to polar molecules, but has nothing to offer a nonpolar molecule.

Method — A worked prediction

Will NaCl dissolve in water? Yes — ionic solute, polar solvent, water surrounds the ions. Will oil dissolve in water? No — nonpolar solute, polar solvent (they separate).

Method — Molecules with both parts

A molecule with a polar and a nonpolar end (like soap) can bridge the two, which is why soap cleans grease.

Practice 2.1 ■ 1 mark

State the “like dissolves like” rule.

Solution 2.1

Method: Like dissolves like

Worked steps

A solute dissolves in a solvent with similar intermolecular forces (polar dissolves polar, nonpolar dissolves nonpolar) **B1**.

Practice 2.2 ■ 2 marks

Will a nonpolar substance dissolve in water? Give a reason.

Solution 2.2

Method: A worked prediction

Worked steps

No — water is polar; it cannot form favorable attractions with a nonpolar solute, so they stay separate **M1** **A1**.

Practice 2.3 ■ 1 mark

Name a good solvent for an ionic compound.

Solution 2.3

Worked steps

Water (a polar solvent) **B1**.

Exam-style 3.1 ■ 1 mark

A polar solute is most soluble in

A a nonpolar solvent

B a polar solvent

C any solvent equally

D no solvent

Solution 3.1

A a nonpolar solvent

B a polar solvent 

C any solvent equally

D no solvent

Worked steps

B — a polar solvent.

Exam-style 3.2 ■ 1 mark

Iodine (I_2 , nonpolar) is shaken with water and with hexane (nonpolar).

- (a) In which solvent does it dissolve better?
- (b) Explain using intermolecular forces.

Solution 3.2

Method: Like dissolves like

Worked steps

(a) Hexane **B1**. (b) I_2 is nonpolar, so it mixes with the nonpolar hexane (similar dispersion forces) but not with polar, hydrogen-bonded water **M1 A1**.

Exam-style 3.3 ■ 2 marks

Explain why ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) is soluble in water but hexane is not.

Solution 3.3

Worked steps

Ethanol has an —OH group that hydrogen-bonds with water, so it dissolves; hexane is entirely nonpolar and cannot form such attractions with water **M1 A1**.