A12 · Predicting boiling points and solubility · Practice key

This is the worked key. Every practice question is worked step by step.

Worked examples

Read these first. There is one for each kind of question in this lesson.

Example 1 · Compare two boiling points

Use the three steps to compare the boiling points of methane, CH_4, and silane, SiH_4. Both are non-polar.

1. List the forces of each substance: both are non-polar, so each has London forces only.
2. Compare the kinds of force: they are the same.
3. Count electrons if the kinds are the same: CH_4 has 10 and SiH_4 has 18.
4. Check: stronger forces give a higher boiling point.

Answer: Silane has more electrons, so it has stronger London forces and the higher boiling point.

Example 2 · Predict whether two liquids mix

Use the three steps on pentane, C_5H_{12}, and water. Pentane is non-polar.

1. List the forces of each liquid: pentane has London forces only. Water has London forces, dipole-dipole forces and hydrogen bonding.
2. Compare the kinds of force. Are they alike? No.
3. Predict mixing if alike, two layers if not: two layers.

Answer: Pentane and water do not mix. They stay in two layers.

Practice

Questions 1 to 4 are easy. Questions 5 to 8 are medium. Questions 9 and 10 are harder.

EASY

1. What must happen to the molecules of a liquid for it to boil? Say whether any covalent bond breaks.

1. The molecules must be pulled far apart.
2. That takes energy to overcome intermolecular forces. No covalent bond breaks.

EASY

2. Two substances have the same kinds of intermolecular force. What do you compare next to find the higher boiling point?

1. Count the electrons in one molecule of each.
2. More electrons give stronger London forces and a higher boiling point.

EASY

3. What does "like mixes with like" mean for two liquids?

1. Two liquids mix when their intermolecular forces are alike.
2. If the forces are not alike, the liquids stay apart in two layers.

EASY

4. Which melts at a higher temperature, an ionic compound or a molecular substance? Say why.

1. An ionic compound melts higher.
2. Melting it pulls ions apart, and ionic bonds are strong.
3. Melting a molecular solid overcomes only intermolecular forces, which are much weaker.

MEDIUM

5. F_2 has 18 electrons and Br_2 has 70. Both are non-polar. Which has the higher boiling point? Say why.

1. Both have London forces only.
2. Br_2 has more electrons, so its London forces are stronger.
3. So Br_2 has the higher boiling point.

MEDIUM

6. Propane, C_3H_8, and chloromethane, CH_3Cl, each have 26 electrons. Propane is non-polar. Chloromethane is polar. Which has the higher boiling point? Say why.

1. Their London forces are about equal.
2. Chloromethane is polar, so it adds dipole-dipole forces.
3. So chloromethane has the higher boiling point.

MEDIUM

7. Carbon tetrachloride, CCl_4, and hexane, C_6H_{14}, are both non-polar liquids. Will they mix? Say why.

1. Each has London forces only.
2. Their forces are alike, so they mix.

MEDIUM

8. Ammonia, NH_3, and methane, CH_4, each have 10 electrons. Ammonia has hydrogen bonding. Methane is non-polar. Which has the higher boiling point? Say why.

1. Their London forces are about equal.
2. Ammonia adds dipole-dipole forces and hydrogen bonding.
3. So ammonia has the higher boiling point.

HARDER

9. HCl has 18 electrons and HF has 10. Both are polar. Use the three steps to find which has the higher boiling point.

1. Step 1: HCl has London forces and dipole-dipole forces. HF has both of those and hydrogen bonding.
2. Step 2: the kinds are not the same. HF has one more kind, hydrogen bonding.
3. Step 3: the kinds differ, so the electron count does not decide.
4. HF has the higher boiling point.

HARDER

10. Salad dressing is made of oil and vinegar. Oil molecules are non-polar. Vinegar is mostly water. Explain why the dressing separates into two layers.

1. Oil has London forces only. Water has hydrogen bonding.
2. The forces are not alike, so the liquids do not mix.
3. Water molecules attract each other far more than they attract oil molecules.