A10 · Polar and non-polar molecules · 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 · Decide whether a molecule with a lone pair is polar

Use the four steps on phosphorus tribromide, PBr_3. It has 1 lone pair on phosphorus.

1. Find the shape around the centre atom: 3 bonds and 1 lone pair make it trigonal pyramidal.
2. Draw a bond dipole on each polar bond: each arrow points from phosphorus to bromine.
3. Ask if the arrows cancel: all 3 lean the same way, so they do not cancel.
4. State polar or non-polar, with the reason: polar, because of the lone pair on the centre atom.

Answer: PBr_3 is a polar molecule.

Example 2 · Decide whether a symmetrical molecule is polar

Use the four steps on silicon tetrabromide, $SiBr_4$. It has no lone pairs on silicon.

1. Find the shape around the centre atom: 4 bonds and no lone pairs make it tetrahedral.
2. Draw a bond dipole on each polar bond: each arrow points from silicon to bromine.
3. Ask if the arrows cancel: the 4 arrows are equal and evenly spread, so they cancel.
4. State polar or non-polar, with the reason: non-polar, because the outer atoms match and there is no lone pair.

Answer: $SiBr_4$ is a non-polar molecule.

Practice

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

EASY

1. Is hydrogen fluoride, HF, a polar molecule? Say why.

1. HF has two different atoms, so its one bond is polar.
2. Nothing can cancel it, so HF is polar.

EASY

2. Is iodine, I_2, a polar molecule? Say why.

1. I_2 has two atoms of the same element.
2. Its bond is non-polar, so I_2 is non-polar.

EASY

3. What does "symmetrical" mean? Say what else must be true for the bond dipoles to cancel.

1. "Symmetrical" means the same on every side.
2. The outer atoms must match too.

EASY

4. Name the two shapes that are polar whenever their bonds are polar. Say why.

1. They are trigonal pyramidal and angular.
2. Each has a lone pair on the centre atom, so the arrows do not cancel.

MEDIUM

5. Phosphorus trifluoride, PF_3, is trigonal pyramidal. Is it polar? Say why.

1. Each arrow points from phosphorus to fluorine.
2. All 3 arrows lean the same way, so they do not cancel.
3. So PF_3 is polar.

MEDIUM

6. Fluoromethane, CH_3F, is tetrahedral. Is it polar? Say why.

1. The outer atoms are 3 hydrogen and 1 fluorine.
2. They do not match, so the arrows are not equal.
3. They do not cancel, so CH_3F is polar.

MEDIUM

7. Ethane, C_2H_6, is made of only carbon and hydrogen. Is it polar? Say why.

1. A molecule made of only carbon and hydrogen is non-polar.
2. So ethane is non-polar.

MEDIUM

8. CO_2 is linear and SF_2 is angular. Each has 2 polar bonds. Explain why CO_2 is non-polar but SF_2 is polar.

1. In CO_2 the 2 arrows are equal and point in opposite directions, so they cancel.
2. In SF_2 the 2 arrows are not opposite, so they do not cancel.

HARDER

9. Sort these three molecules as polar or non-polar, with a reason for each. $SiCl_4$ is tetrahedral. SF_2 is angular. CHF_3 is tetrahedral.

1. $SiCl_4$ is symmetrical with matching outer atoms. It is non-polar.
2. SF_2 has lone pairs on the centre atom. It is polar.
3. CHF_3 has outer atoms that differ. It is polar.

HARDER

10. A student says CCl_4 must be polar, because it has 4 polar bonds. Explain the mistake.

1. Each bond is polar, so each has an arrow.
2. CCl_4 is tetrahedral, with 4 outer atoms the same.
3. The 4 arrows are equal and evenly spread, so they cancel. CCl_4 is non-polar.