What is Hydrogen Bonding?

Worksheet

Hydrogen bonding is an intermolecular force between a hydrogen bonded to a highly electronegative atom (O, N, F) and a lone pair on another molecule. It is much stronger than regular dipole-dipole forces.

Questions

1. Hydrogen bonding occurs between

A) H and H
B) H bonded to O/N/F and a lone pair on another atom
C) Any two atoms with a @delta+ and @delta@minus
D) H and a covalent bond

2. How many hydrogen bonds can one water molecule form?

A) 1
B) 2
C) 3
D) 4

3. Why is HF a liquid (bp 19.5@deg C) but HCl is a gas (bp 85@deg C)?

A) F is heavier
B) HF molecules are larger
C) HF forms hydrogen bonds; HCl does not strongly
D) Cl attracts H more strongly

4. Which molecule exhibits the strongest hydrogen bonding?

A) CH@sub{3}OH
B) H@sub{2}O
C) NH@sub{3}
D) HF

5. Explain why water has an unusually high boiling point (100@deg C).

6. Why is ammonia (NH@sub{3}) a gas at room temperature while water (H@sub{2}O) is liquid?

7. DNA's double helix is stabilised by hydrogen bonds between base pairs. Why are G-C pairs more stable than A-T pairs?

8. Define: Define hydrogen bonding.

9. Define: Why is hydrogen bonding strong compared to other intermolecular forces?

10. Define: What atoms can form hydrogen bonds?

Answer Key

1. B) H bonded to O/N/F and a lone pair on another atom - Hydrogen bonding requires H bonded to O/N/F (very polar) and a lone pair acceptor.

2. D) 4 - O has 2 lone pairs (acceptor) and 2 H atoms (donor) @rightarrow up to 4 H-bonds.

3. C) HF forms hydrogen bonds; HCl does not strongly - HF can form strong hydrogen bonds; HCl's dipole-dipole forces are much weaker.

4. D) HF - HF has the most electronegative atom (F), creating the strongest H-bond.

5. Water molecules contain O-H bonds (hydrogen bonding donors) Each O also has 2 lone pairs (hydrogen bonding acceptors) Each water molecule can form up to 4 hydrogen bonds: 2 as donor, 2 as acceptor This extensive hydrogen bonding network requires a lot of energy to break Result: water boils at 100@deg C, much higher than similar-mass molecules like CH@sub{4} (164@deg C)

6. Both have hydrogen bonding capability Water: O has 2 lone pairs; each H can donate @rightarrow up to 4 H-bonds per molecule Ammonia: N has 1 lone pair; each H can donate, but fewer H-bonds form Water's hydrogen bonding network is more extensive than ammonia's Result: water remains liquid; ammonia is a gas (boiling point 33@deg C)

7. Adenine (A)-Thymine (T): 2 hydrogen bonds Guanine (G)-Cytosine (C): 3 hydrogen bonds More hydrogen bonds = stronger interaction Result: G-C pairs are more stable and require more energy to denature

8. An intermolecular force between H bonded to O/N/F and a lone pair on another molecule.

9. The large electronegativity difference (especially with F) creates a very polar bond.

10. A donor: H bonded to O, N or F. An acceptor: a lone pair on O, N or F.