



# FORCES BETWEEN MOLECULES

*Why are  $H_2O$ ,  $HF$  and  $NH_3$  so much higher?*

They have hydrogen bonds between their molecules but the other molecules do not. Hydrogen bonds are significantly stronger than other intermolecular forces.

*Why is the effect greater for  $H_2O$  than for  $HF$  and  $NH_3$ ?*

Each water molecule is involved in attractions through hydrogen bonds to four other molecules, but  $HF$  and  $NH_3$  to only two each.

*Why do bpts increase down a group generally?*

Molecules have more electrons and so van der Waals' forces between molecules increase.

*Why are bpts of Group 4 hydrides lower than hydrides of Groups 5, 6 and 7?*

Group hydrides are non-polar and so only have van der Waals' forces between molecules, whereas hydrides of Groups 5, 6 and 7 are polar and so have dipole-dipole attractions between molecules

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| 1) $Br_2$ & $I_2$             | $I_2$        | both have van der Waals' forces only, but $I_2$ has more electrons so has greater van der Waals' forces  |
| 2) $H_2O$ & $H_2S$            | $H_2O$       | $H_2O$ has hydrogen bonds between molecules (as well as van der Waals' forces) whereas $H_2S$ has weaker dipole-dipole forces (as well as van der Waals' forces)   |
| 3) $CH_4$ & $C_4H_{10}$       | $C_4H_{10}$  | both have van der Waals' forces only, but $C_4H_{10}$ has more electrons so has greater van der Waals' forces  |
| 4) $CH_3OCH_3$ & $CH_3CH_2OH$ | $CH_3CH_2OH$ | $CH_3CH_2OH$ has hydrogen bonds between molecules (as well as van der Waals' forces) whereas $CH_3OCH_3$ has weaker dipole-dipole forces (as well as van der Waals' forces)  |
| 5) $(CH_3)_3N$ & $(CH_3)_2NH$ | $(CH_3)_2NH$ | $(CH_3)_2NH$ has hydrogen bonds between molecules (as well as van der Waals' forces) whereas $(CH_3)_3N$ has weaker dipole-dipole forces (as well as van der Waals' forces)  |
| 6) $Br_2$ & $HBr$             | $Br_2$       | although $Br_2$ has only van der Waals' forces but $HBr$ has van der Waals' and dipole-dipole forces, the $Br_2$ molecule has significantly more electrons than $HBr$ and the van der Waals' forces of $Br_2$ are greater than the combined van der Waals' and dipole-dipole forces of $HBr$   |
| 7) $CCl_4$ & $CHCl_3$         | $CCl_4$      | although $CCl_4$ has only van der Waals' forces (molecule is not polar even though its bonds are) but $CHCl_3$ has van der Waals' and dipole-dipole forces, the $CCl_4$ molecule has significantly more electrons than $CHCl_3$ and the van der Waals' forces of $CCl_4$ are greater than the combined van der Waals' and dipole-dipole forces of $CHCl_3$ |