

## Chemistry – Unit 12 Worksheet 2

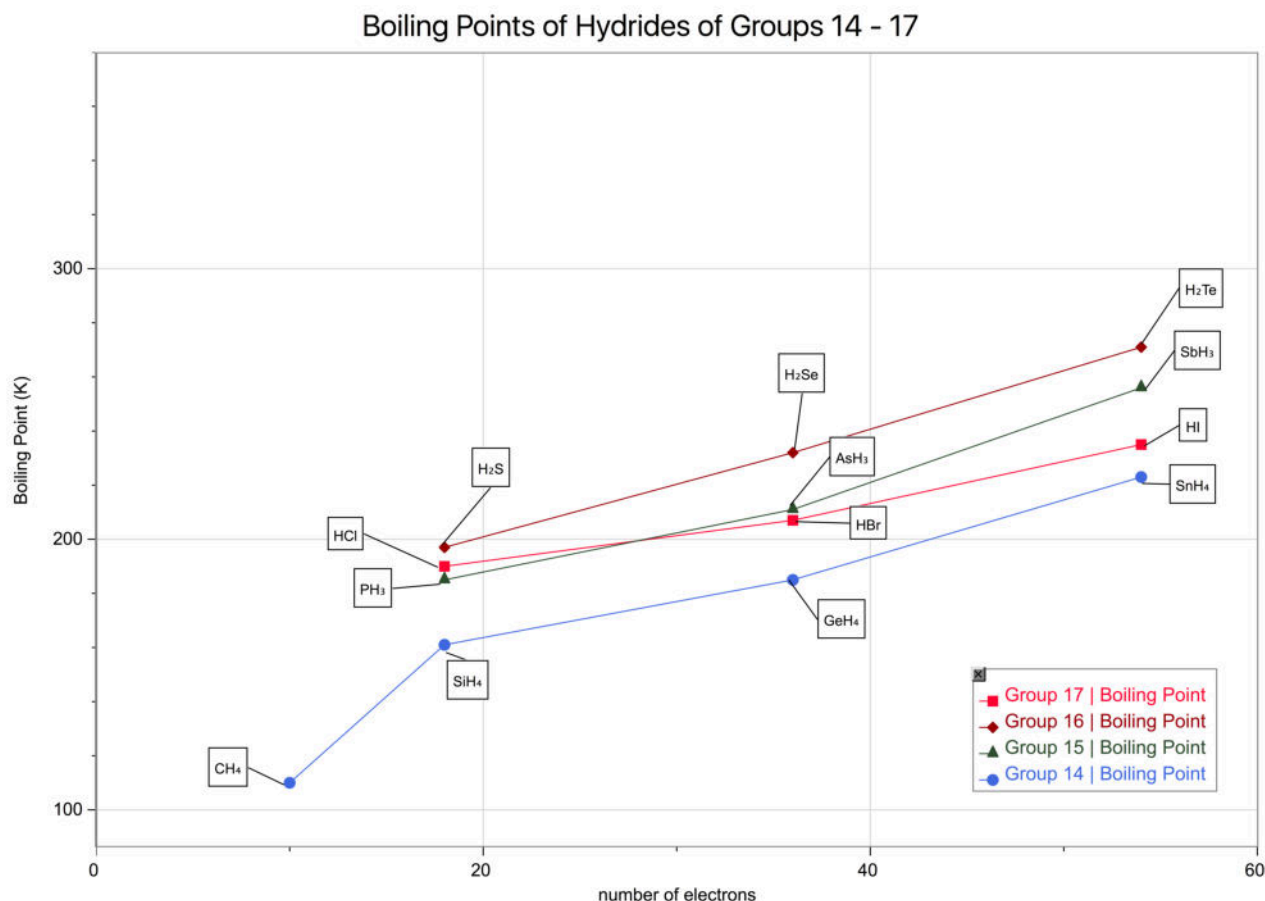
Use the PhET simulation "molecular-polarity" to help you answer the following.<sup>1</sup>  
Be sure to sketch diagrams to support your explanations.

1. Under the Real Molecules tab, view the electron density diagram for HF. How does it differ from the one for F<sub>2</sub>?
2. Examine the diagrams for HF and H<sub>2</sub>O. Explain why the distribution of electron density for molecules like HF and H<sub>2</sub>O is not symmetrical. What is meant by the term "electronegativity"?
3. Use the electrostatic potential diagrams for HF and H<sub>2</sub>O to explain why these molecules are said to be polar. How does this representation help explain the stronger attractions between these molecules?
4. How does the polar nature of water explain how ionic substances dissolve in water? The Flash animation found at this site may help.  
<http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/molvie1.swf>

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<sup>1</sup> <http://phet.colorado.edu/en/simulation/molecule-polarity>

5. Examine the graph of the boiling pts of the hydrides of groups 14 - 17. Estimate the b.p.'s of  $\text{NH}_3$ ,  $\text{H}_2\text{O}$  and  $\text{HF}$  if these compounds followed the same trend as  $\text{CH}_4$  does in group 14. Label the graph with your predicted b.p.'s for these three molecules.



Now, examine the graph of the b.p.'s of groups 15 - 17 found at <http://www.chemguide.co.uk/atoms/bonding/hbond.html#top>.

From the classroom discussion, account for the fact that these molecules do *not* follow the same trend as the hydrides of group 14.

6. Draw two molecules of water interacting by hydrogen bonding. Label the locations of the covalent bonds and the hydrogen bond. How is a hydrogen bond different from a covalent bond?

7. Were it not for hydrogen-bonding, in what phase would water exist on our planet? Explain.
8. How do hydrogen bonds between molecules of  $\text{NH}_3$  and  $\text{H}_2\text{O}$  differ from dipole-dipole attractions between molecules of  $\text{CH}_3\text{Cl}$ ? Why are hydrogen bonds called *bonds*, rather than attractions?
9. Describe the role hydrogen bonding plays in the structure of ice. Why is ice less dense than liquid water? Draw water molecules in the liquid phase and then in the solid phase to support your explanation.
10. Both ethanol,  $\text{CH}_3\text{CH}_2\text{OH}$  and dimethyl ether,  $\text{CH}_3\text{OCH}_3$  have the same molecular formula, but one of these substances has a much higher b.p. than the other. Predict which has the higher b.p. and explain. Draw diagrams of each molecule to support your explanation.