

51. Because nitrogen, phosphorus, and arsenic are all in the same group, students will assume their hydrogen compounds have the same shape. Students know that ammonia is a polar molecule. The bonds in phosphine and arsine, however, have very small electronegativity values, so the molecules will be almost non-polar. Therefore, you would expect phosphine and arsine to have lower boiling points than ammonia, since the intermolecular forces due to dipole attractions would be significantly weaker. (Arsine has a boiling point of  $-55^{\circ}\text{C}$ , phosphine has a boiling point of  $-88^{\circ}\text{C}$ , and ammonia has a boiling point of  $-33^{\circ}\text{C}$ .)
52. The molecule  $\text{BF}_3$  is trigonal planar (you will probably need to give students this information). Because the polar bonds balance each other, the molecule is non-polar.

### Answers to Making Connections Questions

53. Students will probably work with the idea that a defense lawyer tries to establish reasonable doubt when arguing a case. If expert witnesses for the prosecution provide scientific evidence that can be shown to have a significant degree of uncertainty, the evidence will be effectively worthless to the prosecution. The argument can work the other way, of course. If counterevidence is provided by the defense, the prosecution will try to find out whether the science behind it is inaccurate, is incomplete, or has a significant margin of error.
54. In ancient times, the known metals were the least reactive ones that occurred naturally (such as silver), or were easily extracted from their ores (such as iron). The most reactive metals were unknown since no extraction methods were known to decompose their compounds. Theories of matter at the time did not predict new metals so no one was looking for them.