CHEM1611 Worksheet 4 – Answers to Critical Thinking Questions

The worksheets are available in the tutorials and form an integral part of the learning outcomes and experience for this unit.

Model 1: Boiling Points Change Down a Group of the Periodic Table

1. The boiling point increases.
2. They are all tetrahedral.
3. No – they do not possess dipole moments.
4. No – they do not have δ+ H atoms or lone pairs.
5. Dispersion.
6. The strength of dispersion forces increases with the number of electrons.

Model 2: Boiling Points Change Across a Row of the Periodic Table

1. SiH_4: 14 + 4 × 1. PH_3: 15 + 3 × 1. H_2S: 16 + 2 × 1. HCl: 17 + 1.
2. It increases as the dispersion forces become stronger.
3. PH_3: pyramidal. H_2S: bent. HCl: linear.
4. Yes.
5. Dipole – dipole interactions are present in PH_3, H_2S and HCl alongside dispersion forces of similar strength.
6. Higher.
7. Dispersion forces are stronger in SnH_4 as it has more electrons and this leads to a higher boiling point, *despite* the lack of dipole – dipole interactions.

Model 3: Anomalous Boiling Points of NH_3, H_2O and HF

1. The boiling point increases. See Model 1.
2. (a) 3 (b) 2 (c) 1
3. (a) 1 (b) 2 (c) 3
4. Hydrogen bonding is present.
5. Dispersion forces are stronger in SbH_3 as it has more electrons and this leads to a higher boiling point, *despite* the lack of hydrogen bonding.
6. N-H < O-H < F-H
7. $NH_3 < OH_2 <$ HF
8. Two.
9. Two.
10. Four.
11. $NH_3 <$ HF because the hydrogen bonds are stronger in the latter.

    HF $< H_2O$ because of the presence of a higher number of hydrogen bonds in the latter, *despite* each individual hydrogen bond being stronger in the former.

Model 4: pH

1.

pH	0.50	1.50	2.50	3.50	4.50	5.50	5.75
$[H_3O^+(aq)]$	3.2×10^{-1}	3.2×10^{-2}	3.2×10^{-3}	3.2×10^{-4}	3.2×10^{-5}	3.2×10^{-6}	1.8×10^{-6}

2. The part of the pH value *after* the decimal point affects the coefficient (i.e. the numerical value). The part of the pH value *before* the decimal point affects the exponent (i.e. the position of the decimal point).

Model 5: Strong and Weak Acids

1. The major species present are $H_3O^+(aq)$, $Cl^-(aq)$ and $H_2O(l)$. There is essentially no "HCl(aq)".
2. The major species present are $CH_3COOH(aq)$ and $H_2O(l)$. The percentage ionization is very small and there is *very* little $H_3O^+(aq)$, $CH_3COO^-(aq)$.
3. $CH_3COO^-(aq)$ is the *dominant* species only at high pH.
4. The *major* species present are $CH_3NH_2(aq)$ and $H_2O(l)$.
5. $CH_3NH_3^+(aq)$ is the *dominant* species only at low pH.
6. (a) Aspirin is absorbed in the stomach. In the intestine, it is deprotonated.

   (b) Amphetamine is absorbed in the intestine. In the stomach, it is protonated.