# 10.5: Solutions to Selected Problems

a) graphite is between 1 & 2 b) stishovite is between 9 & 10 c) opal is between 6 & 7

d) obsidian is about 5 e) ruby is about 9 f) emerald is between 7 & 8

a. forsterite: $Mg_2SiO_4$: If each nesosilicate unit has a charge of $4^-$ because of the formal charges on the four oxygens, then the two magnesiums must combine to balance that charge with a $4^+$ charge. Each magnesium must have a $2^+$ charge of its own. That seems reasonable, since magnesium is two atoms from the left edge of the periodic table; it would have a $2^+$ charge in a noble gas configuration.
b. fayalite: $Fe_2SiO_4$: In order for this to work, each iron would have to have a $2^+$ charge. Transition metal charges are harder to predict than alkali and alkaline earth metals because they are farther from the edge of the periodic table, but it turns out that the two most common charges on an iron ion are $2^+$ and $3^+$, so this charge seems reasonable.

a. If each nesosilicate has a charge of $4^-$, then the total negative charge is 100 x $4^-$ = $400^-$. If there are 25 magnesium ions, each with a $2^+$ charge, the total positive charge is 25 x $2^+$ = $50^+$. That leaves a net negative charge of $400^-$ + $50^+$ = $350^-$. The irons would balance that charge with an equal positive charge. The number of iron ions would be 350+/3+ = 150.
b. If we divide these ratios by 100 to arrive at the one nesosilicate in the formula, we get $Mg_{0.25}Fe_{1.5}SiO_4$. It does not mean there is a quarter of a magnesium ion anywhere; this formula is just the overall ratio of atoms.

So far we have $Al_2Fe_3$. The positive charge = 2 x $3^+$ + 3 x $2^+$ = $12^+$. That charge must be balanced by the nesosilicate anions, which are each $4^-$. So the number of silicates is $12^-/4^-$ = 3. The formula is $Al_2Fe_3(SiO_4)_3$.

The anions are nesosilicate ($4^-$) + sorosilicate ($6^-$) + oxide ($2^-$) + hydroxide ($1^-$). The total charge is $13^-$.

Calcium is an alkaline earth metal, two atoms from the left edge of the periodic table. The two calciums would partially balance that charge with 2 x $2^+$ = $4^+$ charge; the net charge is now $13^-$ + $4^+$ = $9^-$.

If each Al or Fe has charge $3^+$, then the number needed to balance the charge is $9^+/3^+$ = 3 Fe/Al ions.