Special Molarities

Molarities of ions:

define: $[\ Pb^{2+}] \equiv$ molarity of Pb^{2+} ion = moles Pb^{2+} ion per liter of solution = $\dfrac{\text{mol } Pb^{2+}}{1\text{ L soln}}$

A 0.200 M $Pb(NO_3)_2$ solution has ions $\quad Pb(NO_3)_2 \longrightarrow Pb^{2+} + 2\ NO_3^-$

$$\text{so } [\ Pb^{2+}] = \frac{0.200\text{ mol } Pb(NO_3)_2}{1\text{ L soln}} \times \frac{1\text{ mol } Pb^{2+}}{1\text{ mol } Pb(NO_3)_2} = \frac{0.200\text{ mol } Pb^{2+}}{1\text{ L soln}} = 0.200\text{ M } Pb^{2+}$$

$$\text{and } [NO_3^-] = \frac{0.200\text{ mol } Pb(NO_3)_2}{1\text{ L soln}} \times \frac{2\text{ mol } NO_3^-}{1\text{ mol } Pb(NO_3)_2} = \frac{0.400\text{ mol } NO_3^-}{1\text{ L soln}} = 0.400\text{ M } NO_3^-$$

Millimoles of ions:

notice: $\quad \text{molarity} = M = \dfrac{n}{V} = \dfrac{\text{moles solute}}{\text{liters solution}}$ so $n = M \times V$

moles $Pb^{2+} = M \times V = 0.200\text{ M } Pb^{2+} \times 70.0\text{ mL soln} = 14.0\text{ mmol } Pb^{2+} = 14.0\text{ millimoles } Pb^{2+}$

Because:

$$V \times M = 70.0\text{ mL soln} \times \frac{0.200\text{ mol } Pb^{2+}}{1\text{ L soln}} \times \left\{ \frac{1\text{ L soln}}{1000\text{ mL soln}} \times \frac{1000\text{ mmol } Pb^{2+}}{1\text{ mol } Pb^{2+}} \right\} = 14.0\text{ mmol } Pb^{2+}$$

where the terms in { } are the same as multiplying by 1 (one) (This is true for every solution.)

Molarity from millimoles and milliliters:

$$[NO_3^-] = \frac{28.0\text{ mmol } NO_3^-}{70.0\text{ mL soln}} \times \left\{ \frac{1000\text{ mL soln}}{1\text{ L soln}} \times \frac{1\text{ mol } NO_3^-}{1000\text{ mmol } NO_3^-} \right\} = \frac{0.0280\text{ mol } NO_3^-}{0.070\text{ L soln}} = 0.400\text{ M } NO_3^-$$

where the terms in { } are the same as multiplying by 1 (one) and this is the same factor for all ions.