Solving Stoichiometry Problems

1. Write out the given information and starting conditions.
2. Determine what is being asked for in the problem.
3. Formulate a plan to get (i.e. convert) from the starting conditions to the desired answer

Some Hints for Conversions:
(a) Molar Mass is the conversion between the mass and the number of moles of a compound.
(b) The balanced equation is the conversion for relative molar amounts of reactants and products.
(c) If a solution is involved with the given conditions, use the volume and concentration to determine the number of moles.
(d) If a gas is involved, use the ideal gas law (PV=nRT) to determine the number of moles.
(e) For ionic compounds that are added to produce the ions seen in the net ionic equation, the chemical formula can be used to relate moles of compound to moles of an ion in that compound.
4. Implement plan using numbers and calculate, remembering to record answer with the correct number of significant figures.

Example: Using the Strategy

Given the chemical equation:

\[
2 \text{ Mn}^{2+} \text{ (aq)} + 10 \text{ HOCl (aq)} \rightarrow 2 \text{ MnO}_4^- \text{ (aq)} + 5 \text{ Cl}_2 \text{ (g)} + \text{ H}_2\text{O (l)}
\]

Calculate what volume of chlorine gas at 1.00 atm pressure and 25 °C can be produced by 25.0 g of manganese(II) chloride dissolved in a sufficient amount of HOCl.

1. The reaction starts with 25.0 g of manganese(II) chloride with excess HOCl
2. What volume of chlorine gas at 1.00 atm and 25°C is produced?
3. To solve the problem, we must convert 25.0 g of MnCl\(_2\) to a volume of chlorine gas using the following scheme:
   - grams of MnCl\(_2\) \rightarrow (using molar mass, see (a)) mol of MnCl\(_2\) \rightarrow (using chemical formula, see (e)) moles of Mn\(^{2+}\) ions \rightarrow (using balanced equation, see (b)) moles of Cl\(_2\) \rightarrow (using PV=nRT, see (d)) volume of Cl\(_2\)
4. Carry out calculation: (molar mass of MnCl\(_2\) = 54.94 + 2(35.45) = 125.84 g/mol
   \[
   \frac{25.0 \text{ g MnCl}_2}{1 \text{ mol MnCl}_2/125.84 \text{ g}} \cdot \frac{1 \text{ mol Mn}^{2+}/1 \text{ mol MnCl}_2}{5 \text{ mol Cl}_2/2 \text{ mol Mn}^{2+}} = 0.49666 \text{ mol Cl}_2
   \]
   \[
   PV = nRT \rightarrow R \text{ (gas constant)} = 0.0821 \text{ L-atm/K-mol}, P = 1.00 \text{ atm}, T(\text{must be in K}) = 25 + 273 = 298 \text{ K},
   \]
   \[
   n = 0.49666 \text{ mol}
   \]
   \[
   V = nRT/P = \left(0.49666 \text{ mol}\right) \left(0.0821 \text{ L-atm/K-mol}\left(298 \text{ K}\right)/1.00 \text{ atm}\right) = 12.2 \text{ L (only 3 significant figures allowed)}
   \]