**2.** Steps for solving stoichiometry problems: If the problem asks you to convert between moles of one substance and moles of another substance, you can just do the problem in one step, using a mole ratio. You can also do the problem in one step if you only need to convert between molecules of one substance and molecules of another substance. If this is not the case, follow these steps! (fill in the missing conversion factors).

**Step 1.** Convert the given substance into moles (unless it is already in moles).

**Step 2.** Use the mole ratio from the balanced equation to convert into moles of the sought substance.

**Step 3.** Convert the sought substance from moles into molecules, atoms, or grams
(unless the answer is supposed to be in moles).

---

| | | | | |
|---|---|---|---|---|
| Formula masses | 26.9815 | 36.4609 | _______ | _______ |
| Reaction | 2 $Al_{(s)}$ + | 6 $HCl_{(aq)}$ -------> | 2 $AlCl_{3\,(aq)}$ + | 3 $H_{2(g)}$ |

**3a.** Fill the blanks, above, for the formula masses.
**b.** If 10.0 grams of aluminum react with excess hydrochloric acid, how many grams of hydrogen gas can form?

**c.** If 6.02 x $10^{22}$ aluminum atoms react, how many grams of aluminum chloride can form?

**d.** What mass of aluminum is needed to produce 4.00 grams of hydrogen gas?

**e.** If 3.21 moles of hydrochloric acid (HCl) react, how many molecules of hydrogen gas can form?

**f.** How many moles of HCl are required in order to form 3.00 grams of aluminum chloride?

**4.** 3 $Cu_{(s)}$ + 8 $HNO_{3\,(aq)}$ -------> 3 $Cu(NO_3)_{2\,(aq)}$ + 4 $H_2O_{(l)}$ + 2 $NO_{(g)}$
**a.** If 15.2 grams of copper react, how many moles of water will form?

**4, continued:** $3\ Cu_{(s)} + 8\ HNO_{3\ (aq)}$ -------> $3\ Cu(NO_3)_{2\ (aq)} + 4\ H_2O_{(l)} + 2\ NO_{(g)}$

**b.** If 10.0 grams of copper react, how many molecules of NO gas could be produced?

**c**. What mass of nitric acid ($HNO_3$) must react, in order to produce 13.3 grams of NO(gas)?

**d.** How many moles of nitric acid ($HNO_3$) are needed to react with 0.111 moles of copper?

**5.** $4\ C_3H_5N_3O_{9\ (l)}$ -------> $12\ CO_{2\ (g)} + 10\ H_2O_{(g)} + 6\ N_{2\ (g)} + O_{2\ (g)}$ + heat

**a.** What mass of nitroglycerine is needed to produce 50.0 grams of oxygen gas?

**b.** How many moles of nitroglycerine must react, in order to produce 2.31 moles of nitrogen gas?

**c.** If $4.50 \times 10^{22}$ molecules of nitroglycerine decompose, how many moles of carbon dioxide gas will be produced?

---

**1.** Nitroglycerine, $C_3H_5N_3O_9$, is a yellow, oily, unstable liquid with a density of 1.6 g/mL. It is the active ingredient in dynamite and many other explosives. Alfred Nobel invented dynamite in 1860; he stabilized the nitroglycerine by adding diatomaceous earth and other clay-like substances. Nitroglycerine decomposes according to this rxn:

$4\ C_3H_5N_3O_{9\ (l)}$ -------> $12\ CO_{2\ (g)} + 10\ H_2O_{(g)} + 6\ N_{2\ (g)} + O_{2\ (g)}$ + heat

**a.** If 12 molecules of nitroglycerine decompose, how many molecules of water will be produced?

**b.** If 0.100 moles of nitroglycerine decompose, how many moles of carbon dioxide will form?

**c.** How many moles of nitroglycerine are needed to produce 0.745 moles of nitrogen gas?

**d.** How many moles of water will be produced if 0.214 moles of nitroglycerine decompose?