Stoichiometry and Quantities in Reactions Review

1. White phosphorus (see **Fig. 1**), $P_{4(s)}$, is one of the most common allotropes of the element in which each phosphorus atom is bound to three other atoms. When it is exposed to air, white phosphorus undergoes combustion producing $P_4O_{10(s)}$. For a visual of this, go to http://www.youtube.com/watch?v=Oke8GinWDG8.
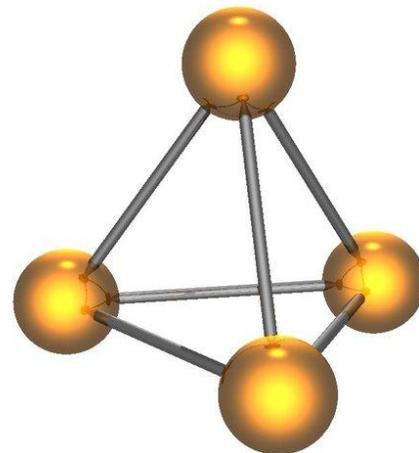
   a. Write the balanced chemical equation for the combustion of white phosphorus.

   b. How much oxygen would react when 2.5 mol of white phosphorus is completely combusted?

   c. If 10.0 mol of oxygen were available, how much white phosphorus would be combusted?

   d. How many moles of $P_4O_{10(s)}$ would be produced by the reaction of 2.5 mol of white phosphorus and 10.0 mol of oxygen?
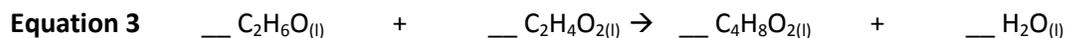
Figure 1. White phosphorus

2. The most common mineral form of mercury is cinnabar, $HgS_{(s)}$, a reddish ore located in the earth's crust at or near the surface. In a process called roasting, the ore is crushed and heated (**Eq. 1**), releasing mercury as a vapour that can be trapped and condensed (at about $350^{\circ}C$) to produce the pure form of the element.

   Equation 1   __ $HgS_{(s)}$ +   __ $O_{2(g)}$ →   __ $Hg_{(g)}$ +   __ $SO_{2(g)}$

   a. When 2.5 kg of cinnabar is roasted in excess oxygen, what mass of mercury should be produced?

   b. How many molecules of sulfur dioxide would be released to the atmosphere in this process?

   c. If the actual yield of the process was 2.0 kg of mercury, what is the percent yield?

   d. Explain how this procedure might cause a reduced yield in mercury.

3. When silver jewellery or cutlery is exposed to the air, the small amount of hydrogen sulfide, $H_2S_{(g)}$, in the air reacts with silver to produce a layer of silver sulfide, resulting in a tarnish on the silver (**Eq. 2**).

   Equation 2 $4\ Ag_{(s)}$ + $2\ H_2S_{(g)}$ + $O_{2(g)}$ → $2\ Ag_2S_{(s)}$ + $2\ H_2O_{(g)}$
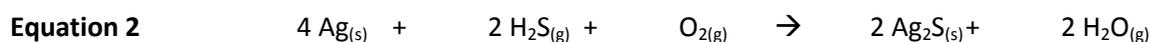
   a. Assuming hydrogen sulfide is the limiting reagent, what mass of silver sulfide is formed from the reaction of 0.015 g of $H_2S_{(g)}$?

   b. How many atoms of silver are reacted in the same process?

4. A common ingredient in many nail polish removers is ethyl acetate, $C_4H_8O_{2(l)}$, a colourless liquid with a sweet smell. This liquid is prepared through the reaction of ethanol, $C_2H_6O_{(l)}$, and acetic acid, $C_2H_4O_{2(l)}$, releasing water molecules in the process (**Eq. 3**).

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SO, THE NAIL SEMINAR WASN'T WHAT YOU EXPECTED?

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   Equation 3   __ $C_2H_6O_{(l)}$ +   __ $C_2H_4O_{2(l)}$ → __ $C_4H_8O_{2(l)}$ +   __ $H_2O_{(l)}$

   A procedure requires that 25.0 g of ethanol are reacted with 30.0 g of acetic acid.

   a. Which reactant will get used up first by this reaction?

   b. What is the term for this reactant?

   c. How much of the excess reagent will remain unreacted?

   d. What mass of ethyl acetate will be produced by the reaction?