

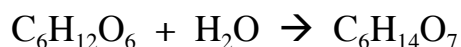
**Instructions:**

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Please write your answers on other sheets of paper as needed. Before composing your final answers, you might first make notes on this page about the components of your answer, then write out clearly those points on the pages you will hand in.

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1. My husband teaches high school chemistry in a school system nearby. While talking with his class about solutions, he asked them to give a description of glucose,  $C_6H_{12}O_6$ , dissolved in water. One student wrote this:



What is wrong with this description of glucose in water? How would you explain to the student why his answer is incorrect?

2. More paint pigment chemistry!

Cadmium yellow is a simple binary compound CdS. Let's imagine that you wish to make your own cadmium yellow paint. It's pretty easy! There are two ways to make cadmium yellow. The first is to combine a water-soluble salt of  $Cd^{2+}$  with an aqueous solution of sodium sulfide,  $Na_2S$ . The second method is to combine a water-soluble salt of  $Cd^{2+}$  with a solution of the dissolved gas hydrogen sulfide,  $H_2S$ .

- a) So, first you need to choose a soluble cadmium salt. You go to the stock room in Dr. B.'s lab and find the cadmium salts listed below:

cadmium sulfate      cadmium nitrate      cadmium oxide      cadmium carbonate

Which salt would be good choice? Why?

- b). Now, before doing new reactions, it's a good idea to write the balanced equations.

Write the balanced equations for each of the two methods for making cadmium yellow, using your choice of cadmium salt from part (a).

- c) You have a vague memory that hydrogen sulfide has some acid/base character. Which is it? Write the reaction of  $H_2S$  in water.

- d) What luck!!! You also found a bottle of aqueous hydrogen sulfide,  $H_2S_{(aq)}$ , in Dr. B.'s lab. It is marked as having a density of  $1.2 \text{ g/cm}^3$ . What is the concentration of hydrogen sulfide in this bottle?

e) Unfortunately, you discover that there is only 50 mL left in the bottle of  $\text{H}_2\text{S}$ . How many grams of the cadmium salt that you have chosen to use in the reaction can react with all the remaining hydrogen sulfide?

f) Now you have found some sodium sulfide, and there's 25 g left in the bottle. If you want to only do ONE synthesis of cadmium sulfide, which method (using the 50 mL of  $\text{H}_2\text{S}$  solution you found or the 25 g of  $\text{Na}_2\text{S}$ ) will give you the most cadmium yellow pigment for making paint? What mass of dry cadmium pigment will you get for all your work?

3. On Wednesday I described for you how sulfate dissolved in water can increase the dissolution of  $\text{CaCO}_3$  in a fresco. One way sulfate can appear in moisture in contact with a fresco painting is from car exhaust emissions, a mixture of gases including sulfur trioxide,  $\text{SO}_3$ .

(a) Show the reactions of sulfur trioxide in water that leads to formation of dissolved sulfate ion.

(b) What will the pH of a solution of sulfur trioxide be? ( $\text{pH} < 7$ ,  $\text{pH} > 7$ ,  $\text{pH} \sim 7$ )

(c) From your answer above in 3(b), can you identify yet another reaction that will cause the deterioration of  $\text{CaCO}_3$  in a fresco? Write the reaction and explain.