**Do First:** Choose a recorder \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and a computer technician \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

(Name) (Name)

**Sign in one student into the chromebook (**[**firstlast@wfsd.k12.ny.us**](mailto:firstlast@wfsd.k12.ny.us) **and password) and google search phet. While waiting to sign in and find the website, answer the following questions:**

1. Calculate the concentration of 0.00500 mole of NaCl in 10.0L of water. Show work.
2. Report your answer to millimolar (mM) and to micromolar (uM).
3. Are the solutions we are working with dilute or concentrated?

**Go to the “Beers Law Lab” simulation under the “Chemistry simulations”. Click the “Beer’s Law” simulation. In this simulation, we are assuming that the temperature is set constantly at 25oC. During this simulation, you are going learn how a spectrophotometer works to determine concentration of a solution. Choose the Cobalt (II) Nitrate solution to start. Set the concentration to 0 mM. Use the ruler and the double headed arrow to make sure the width of the tube is 1.0cm. The wavelength of the light on the left should be at a preset wavelength of 549nm and if you click the red button to turn it on the color will shine green through your solution.**

1. Record the transmittance and absorbance reported by the meter on the right.
2. Change the concentration of the Cobalt (II) Nitrate to 100mM. Record the transmittance and absorbance.
3. Using you previous answers, what do you think transmittance and absorbance means in this simulation?



1. Hypothesize what you think will happen to the transmittance and absorbance if you change the concentration to 200mM. Then change the concentration and record the actual values. Did the transmittance increase, decrease, or remain the same? Did the absorbance increase, decrease, or remain the same?
2. Choose another salt, potassium dichromate, from the drop down list. What happened to the wavelength and color of light coming from the device on the left?
3. At 0 mM are the transmittance and absorbance values the same as cobalt (II) nitrate?
4. At 100uM are the values the same as cobalt (II) nitrate?
5. Play around with more salts and concentrations. What is the relationship between:
   1. Concentration and absorbance?
   2. Concentration and transmittance?



1. Use the ruler provided on the simulation to change the width of the container. Does this change the values of transmittance and absorbance?
2. The Beer’s Law formula is A=abc. Use your reference table to define each letter in the formula.
3. Choose copper sulfate at 100mM with a path length of 1.0cm and a wavelength of 780nm. Record the absorbance. Calculate the molar absorptivity (with units) of copper sulfate using the concentration and path length. (The A has no units.)
4. Verify Beer’s Law works by choosing a new concentration of copper sulfate, using the same path length and molar absorptivity, Calculate the absorbance. Then check the absorbance on the meter. Show work below.
5. In an experiment where a student is changing the concentration of a solution for multiple trials, what numbers should be held constant for a specific solution in Beer’s Law, A=abc?
6. Will those numbers be constant for a new solute? You can check with other solutes on the simulation.
7. In a lab, a student used the formula A1/A2 = c1/c2. Why can he use this as long as the solute stays the same? (Hint think about the previous two questions.)
8. Record the absorptivity of potassium chromate at 100uM with a wavelength of 411nm and a path length of 1.5cm. Then calculate the absorbance if the concentration is changed to 350uM. Show you work. Then check it on the simulation.
9. Why is Beer’s Law useful?

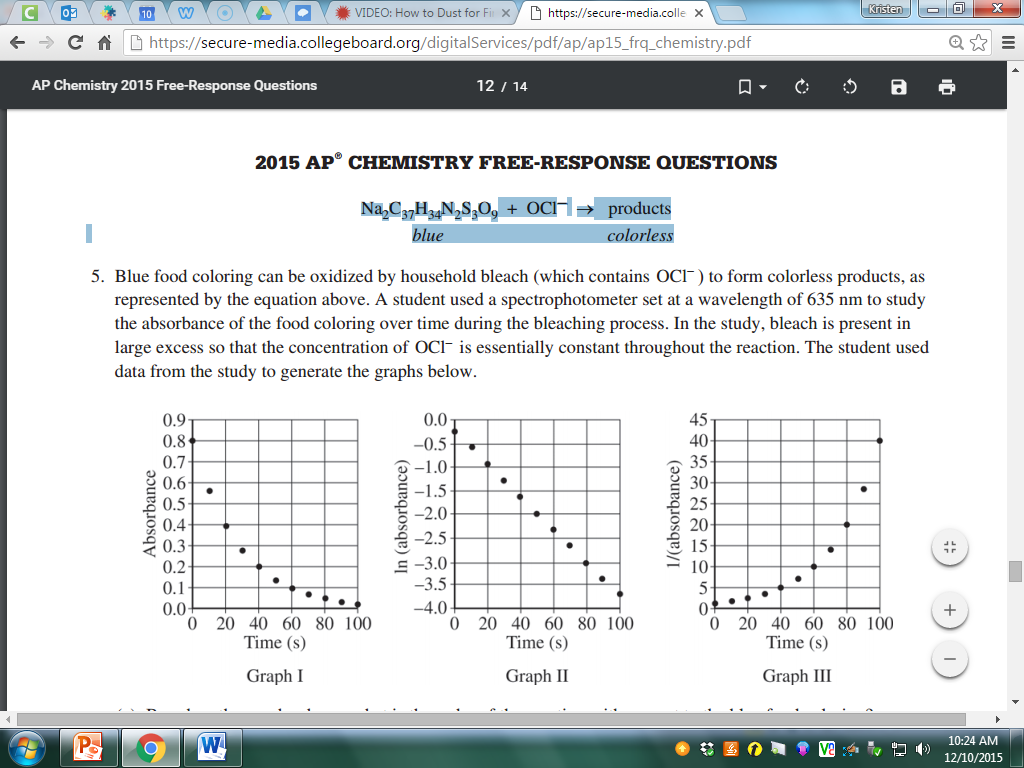


**AP Question 2015:**

Na2C37H34N2S3O9 + OCl− → products

blue colorless

Blue food coloring can be oxidized by household bleach (which contains OCl− ) to form colorless products, as represented by the equation above. A student used a spectrophotometer set at a wavelength of 635 nm to study the absorbance of the food coloring over time during the bleaching process. In the study, bleach is present in large excess so that the concentration of OCl− is essentially constant throughout the reaction. The student used data from the study to generate the graphs below.



1. Based on the graphs above, what is the order of the reaction with respect to the blue food coloring?
2. The reaction is known to be first order with respect to bleach. In a second experiment, the student prepares solutions of food coloring and bleach with concentrations that differ from those used in the first experiment. When the solutions are combined, the student observes that the reaction mixture reaches an absorbance near zero too rapidly. In order to correct the problem, the student proposes the following three possible modifications to the experiment.

• Increasing the temperature

• Increasing the concentration of the food coloring

• Increasing the concentration of the bleach

Circle the one proposed modification above that could correct the problem, and explain how that modification increases the time for the reaction mixture to reach an absorbance near zero.

1. In another experiment, a student wishes to study the oxidation of red food coloring with bleach. How would the student need to modify the original experimental procedure to determine the order of the reaction with respect to the red food coloring?

**AP Multiple Choice**

**1994**

Concentrations of colored substances are commonly measured by means of a spectrophotometer. Which of the following would ensure that correct values are obtained for the measured absorbance?

I. There must be enough sample in the tube to cover the entire light path.

II. The instrument must be periodically reset using a standard.

III. The solution must be saturated.

(A) I only (B)II only (C) I and II only (D) II and III only (E) I, II, and III

**1999**

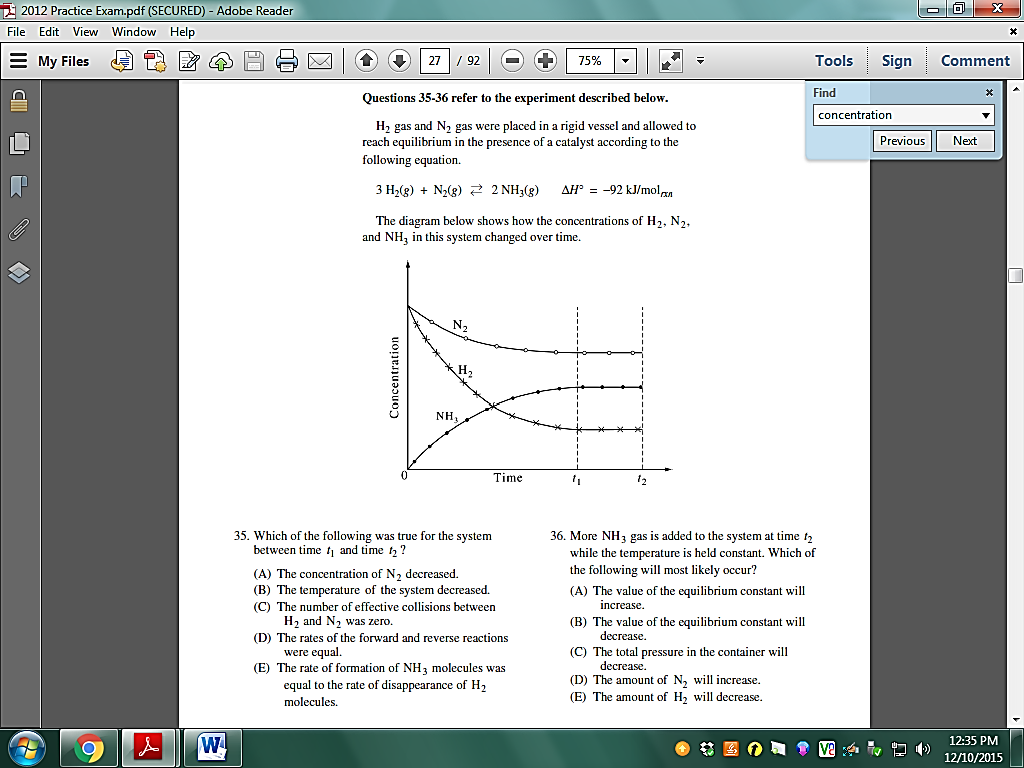
Appropriate uses of a visible-light spectrophotometer include which of the following?

I. Determining the concentration of a solution of Cu(NO3)2

II. Measuring the conductivity of a solution of KMnO4

III. Determining which ions are present in a solution that may contain Na+, Mg2+, Al3+

(A) I only (B) II only (C) III only (D) I and II only (E) I and III only

**2012**