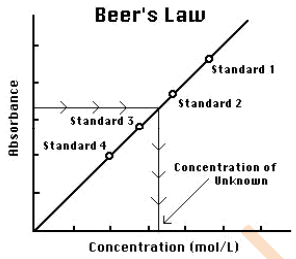
EXPERIMENT 1

AIM: To verify Lambert – beer 's law for $KMnO_4$colorimetrically.

THEORY

The primary objective of this experiment is to determine the concentration of an unknown $KMnO_4$ solution. The $KMnO_4$ solution used in this experiment has a blue color, so Colorimeter users will be instructed to use the red LED. A higher concentration of the colored solution absorbs more light (and transmits less) than a solution of lower concentration.



You will prepare five of known concentration (standard solutions).
Each solution is transferred to a small, rectangular cuvette that is placed into the Colorimeter or Spectrometer. The amount of light hat pene ra es the s lution and strikes the photocell is used to compute the absorbance of each solu on. When you graph absorbance *vs.* concentration for the standard solutions, a direct relationship should result. The direct relationship between absorbance
and concentration for a solution is known s *Beer's law.*

You will determine the concentr tion of n unknown $KMnO_4$ solution by measuring its absorbance. By locating the absorba nce of the unknown on the vertical axis of the graph, the
corresponding concentration can be found on the horizontal axis. The concentration of the unknown can a so be found using the slope of the Beer's law curve.

REQUIREMENTS
Colorimeter cuvette
five 20 × 150 mm test tubes
two 10 mL pipets or graduated cylinders two 100 mL beakers
0. 01M $KMnO_4$ solution
distilled water test tube rack stirring rod
tissues (preferably lint-free)

PROCEDURE

1. Obtain small volumes o0. 01M $KMnO_4$f solution and distilled water in separate beakers.

2. Label five clean, dry, test tubes 1–5. Use pipets to prepare five standard solutions according to the chart below. Thoroughly mix each solution with a stirring rod. Clean and dry the stirring rod between uses.

Test Tube	0.01M KMnO4. (mL)	Distilled H2O (mL)	Concentration (M)
1	2	8	0.002
2	4	6	0.004
3	6	4	0.006
4	8	2	0.008
5	~10	0	0.0100

4. Prepare a *blank* by filling a cuvette 3/4 full with distilled water. To correctly use cuvettes, remember:
   - Wipe the outside of each cuvette with a lint-free tissue.
   - Handle cuvettes only by the top edge of the ribbed sides.
   - Dislodge any bubbles by gently tapping the cuvette on a hard surface.
   - Always position the cuvette so the light passes through the clear sides.

   You are now ready to collect absorbance-concentration data for the five standard solutions.

   a. Using the solution in Test Tube 1, rinse the cuvette twice with ~1 mL amounts and then fill it 3/4 full. Wipe the outside with a tissue and place it in the device (Colorimeter or Spectrometer). Close the lid on the Colorimeter.
   b. [illegible]
   d. Repeat the procedure for Test Tubes 3 and 4. Trial 5 is the original 0.01M $KMnO_4$solution.
   e. When you have finished testing the standard solutions **Note:** Do not test the unknown solution until Step 9.

   f.

10. Determine the absorbance value of the unknown KMnO4 solution.

    a. Obtain about 5 mL of the *unknown* $KMnO_4$ in another clean, dry, test tube. Record the number of the unknown in your data table.
    b. Rinse a cuvette with the unknown solution and fill it about 3/4 full. Wipe the outside of the cuvette, place it into the device. (Close the lid of the colorimeter)
    c. Read the absorbance value displayed in the meter. When the displayed absorbance value stabilizes, record its value as Trial 6 in your data table.
    d. Select Interpolate from the Analyze menu. Find the absorbance value that is closest to the absorbance reading you obtained in Step c above. Determine the concentration of your unknown $KMnO_4$ solution and record the concentration in your data table.
    e. Dispose of any of the remaining solutions as directed.

DATA TABLE

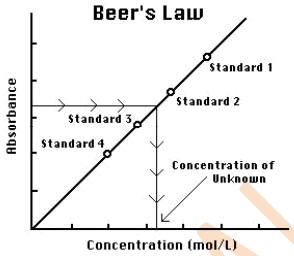
Trial	Concentration (mol/L)	Absorbance
1	0.002	
2	0.004	
3	0.006	
4	0.008	
5	0.010	
6	Unknown number ____	

EXPERIMENT 4

AIM: Toverify Lambert – beer 's law for $K_2Cr_2O_7$ colorimetrically.

THEORY

The primary objective of this experiment is to determine the concentration of an unknown $K_2Cr_2O_7$ solution. The $K_2Cr_2O_7$ solution used in this experiment has a blue color, so Colorimeter users will be instructed to use the red LED. A higher concentration of the colored solution absorbs more light (and transmits less) than a solution of lower concentration.



You will prepare five of known concentration (standard solutions).

Each solution is transferred to a small, rectangular cuvette that is placed into the Colorimeter or Spectrometer. The amount of light hat pene ra es the s lution and strikes the photocell is used to compute the absorbance of each solu on. When you graph absorbance *vs*. concentration for the standard solutions, a direct relationship should result. The direct relationship between absorbance

and concentration for a solution is known s *Beer's law*.

You will determine the concentr tion of n unknown $K_2Cr_2O_7$ solution by measuring its absorbance. By locating the absorba nce of the unknown on the vertical axis of the graph, the

corresponding concentration can be found on the horizontal axis. The concentration of the unknown can a so be found using the slope of the Beer's law curve.

REQUIREMENTS

Colorimeter cuvette

five 20 × 150 mm test tubes

two 10 mL pipets or graduated cylinders two 100 mL beakers

0. 01M $K_2 Cr_2 O_7$ solution

distilled water test tube rack stirring rod

tissues (preferably lint-free)

PROCEDURE

1. Obtain small volumes of 0. 01M $K_2 Cr_2 O_7$ solution and distilled water in separate beakers.

2. Label five clean, dry, test tubes 1–5. Use pipets to prepare five standard solutions according to the chart below. Thoroughly mix each solution with a stirring rod. Clean and dry the stirring rod between uses.

Test Tube	0.01M $K_2 Cr_2 O_7$. (mL)	Distilled H2O (mL)	Concentration (M)
1	2	8	0.002
2	4	6	0.004
3	6	4	0.006
4	8	2	0.008
5	~10	0	0.0100

4. Prepare a *blank* by filling a cuvette 3/4 full with distilled water. To correctly use cuvettes, remember:

   - Wipe the outside of each cuvette with a lint-free tissue.
   - Handle cuvettes only by the top edge of the ribbed sides.
   - Dislodge any bubbles by gently tapping the cuvette on a hard surface.
   - Always position the cuvette so the light passes through the clear sides.

You are now ready to collect absorbance-concentration data for the five standard solutions.

a. Using the solution in Test Tube 1, rinse the cuvette twice with ~1 mL amounts and then fill it 3/4 full. Wipe the outside with a tissue and place it in the device (Colorimeter or Spectrometer). Close the lid on the
b. [illegible]
d. Repeat the procedure for Test Tubes 3 and 4. Trial 5 is the original 0.01M $K_2 Cr_2 O_7$ solution. **Note:** Do not test the unknown solution until Step 9.
e. When you have finished testing the standard solutions

f.

10. Determine the absorbance value of the unknown $K_2Cr_2O_7$ solution.

a. Obtain about 5 mL of the *unknown* $K_2Cr_2O_7$ in another clean, dry, test tube. Record the number of the unknown in your data table.

b. Rinse the cuvette with the unknown solution and fill it (about 3/4

c. Read the absorbance value displayed in the meter. When the displayed absorbance value stabilizes, record its value as Trial 6 in your data table.

d. Select Interpolate from the Analyze menu. Find the absorbance value that is closest to the absorbance reading you obtained in Step c above. Determine the concentration of your unknown $K_2Cr_2O_7$ solution and record the concentration in your data table.

e. Dispose of any of the remaining solutions as directed.

DATA TABLE

Trial	Concentration (mol/L)	Absorbance
1	0.002	
2	0.004	
3	0.006	
4	0.008	
5	0.010	

6	Unknown number ____	