

Effectiveness of multimedia laboratory instruction

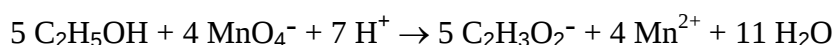
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Appendix

Empirical equations of the kinetics of a reaction

Laboratory experiment instruction

The oxidation of ethanol by potassium (VII) permanganate in acidic medium serves as an example of investigation of the rate of chemical reaction.



From the reaction equation it can be seen stoichiometrically that 5 moles of ethyl alcohol reacts with 4 moles of manganate(VII) ions producing 5 moles of acetate ions and 4 moles of manganese(IV) ions. We will be investigating the effect of changes in concentration of the reactants on the rate of a reaction. When reactant are mixed, reaction occurs, manganese (IV) is produced and the solution gradually becomes darker, which is measured by the colorimeter. The reaction will be monitored by using a colorimeter to measure the change in optical density (absorbance) at 635 nm (wavelength of red light).

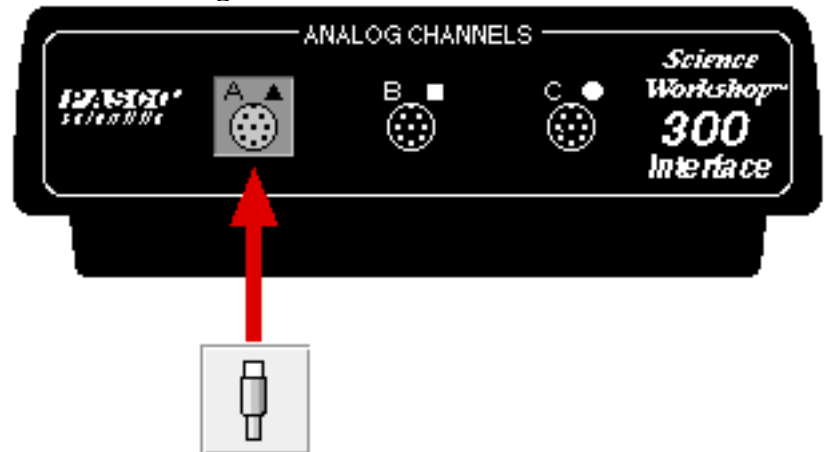
Preparation of laboratory apparatus:

- 1) Connect the *Science Workshop* interface to the computer.



- 2) Turn on the interface.
- 3) Turn on the computer.

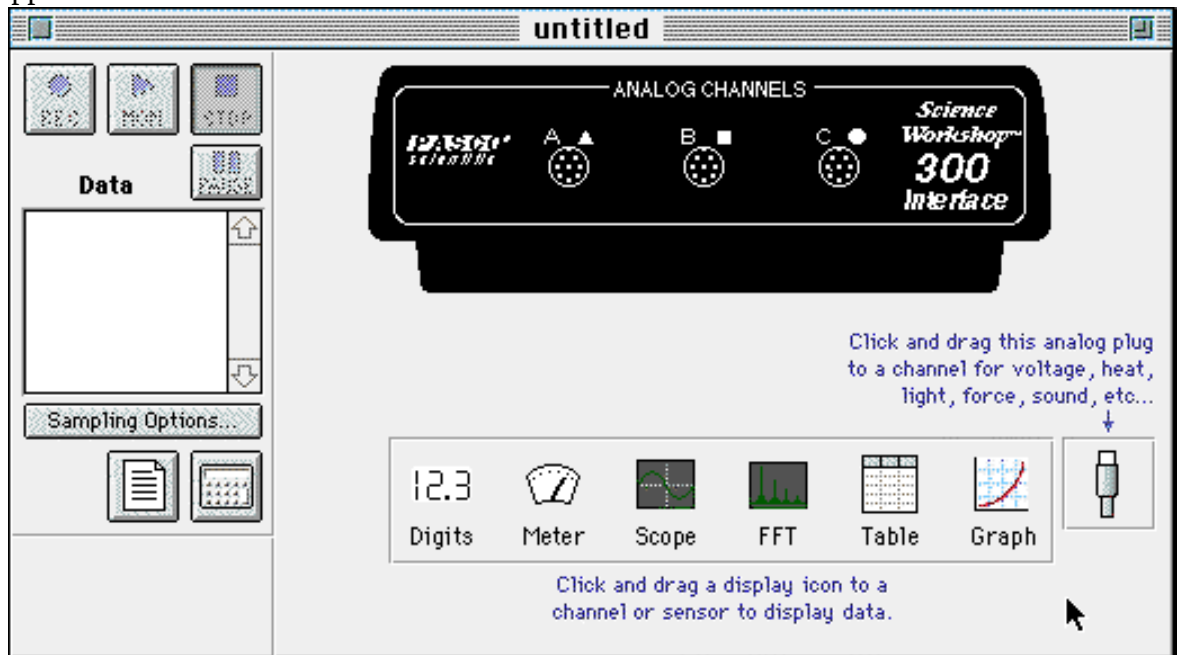
- 4) Connect the plug of the colorimeter to Analog Channel A on the interface.

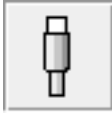


- 5) Start the *Science Workshop* controlling program pointing on program's icon



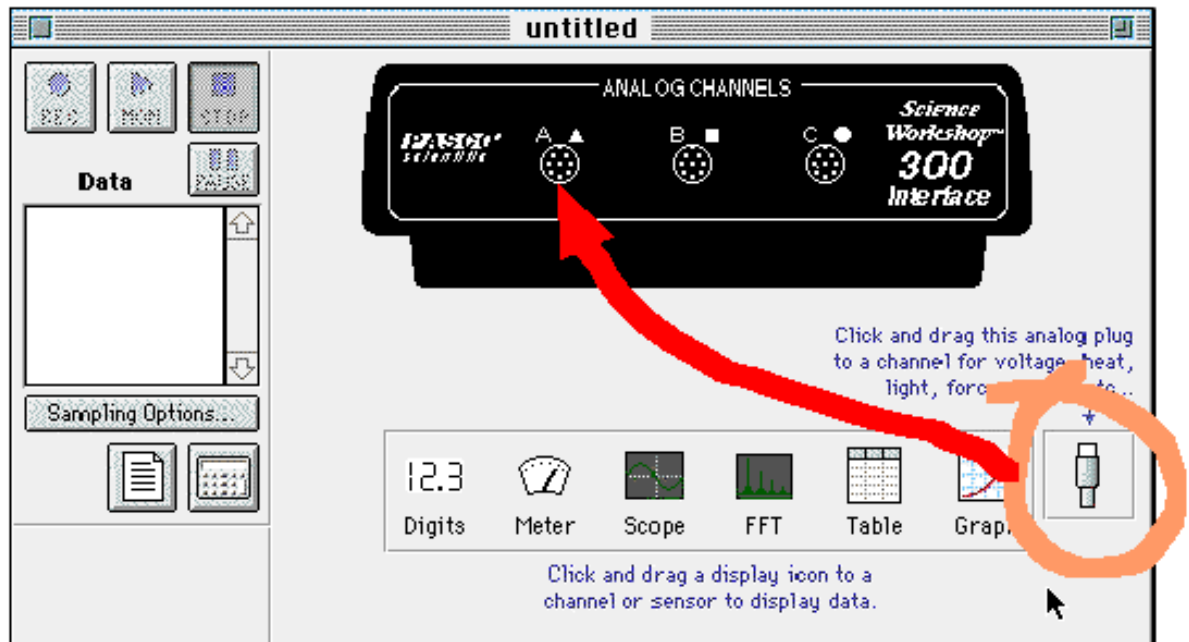
Science Workshop™ and double-clicking mouse button. Program's environment will appear:



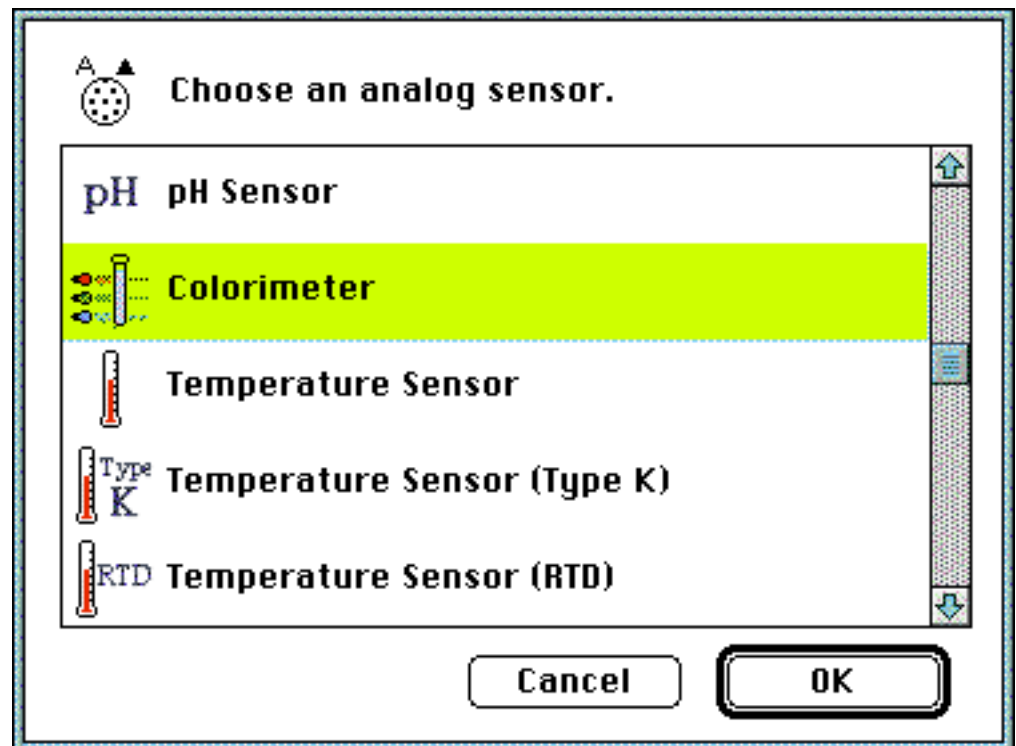
- 6) With the mouse drag the analog plug icon  on to the icon of Analog Channel A



at the interface picture. That way the logical connection of sensor to the interface is defined.

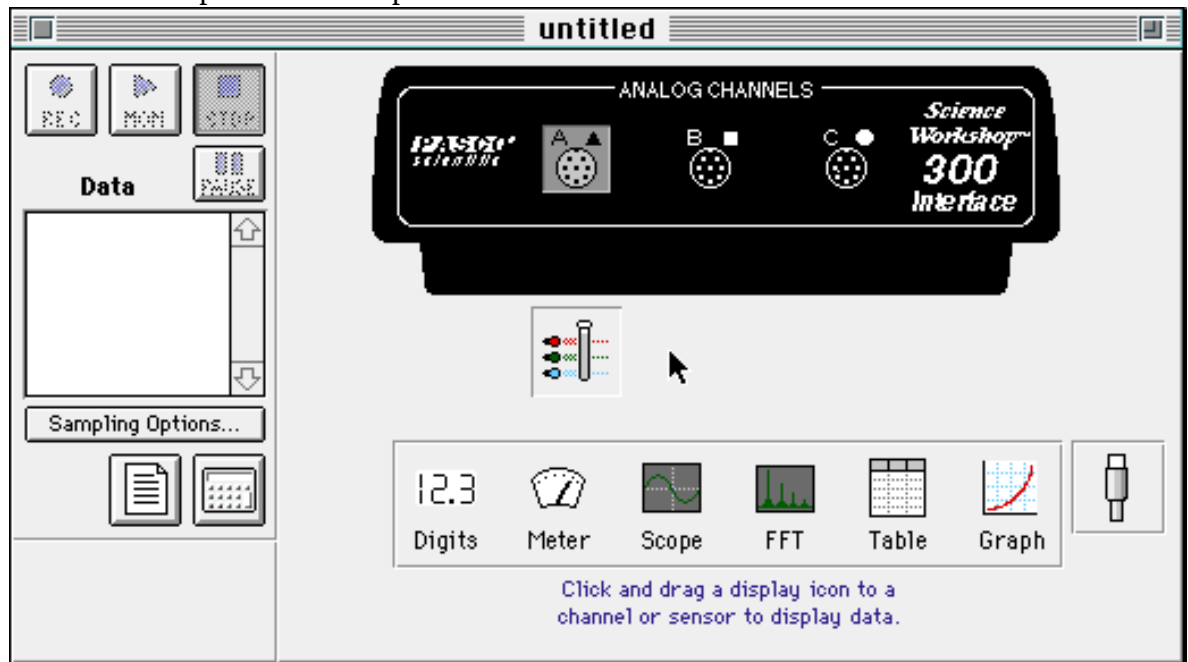


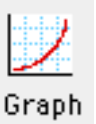
- 7) Next the menu 'Choose an analog sensor' will appear. With the mouse and the left side slider choose 'Colorimeter':

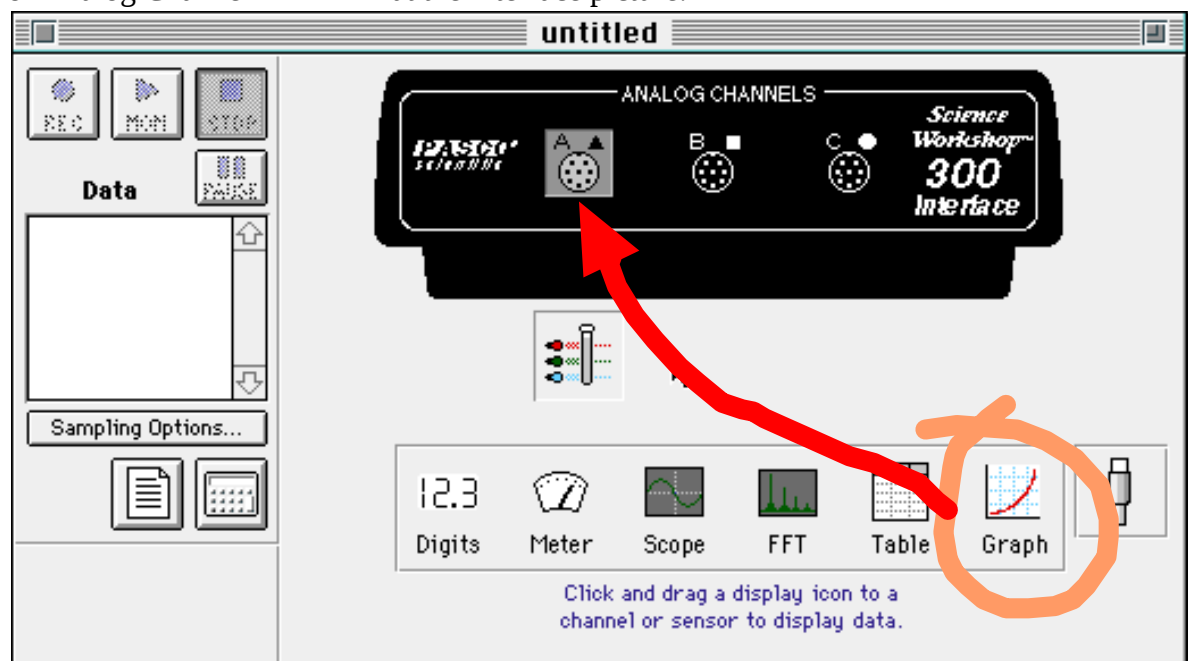


Choose  to confirm your choice.

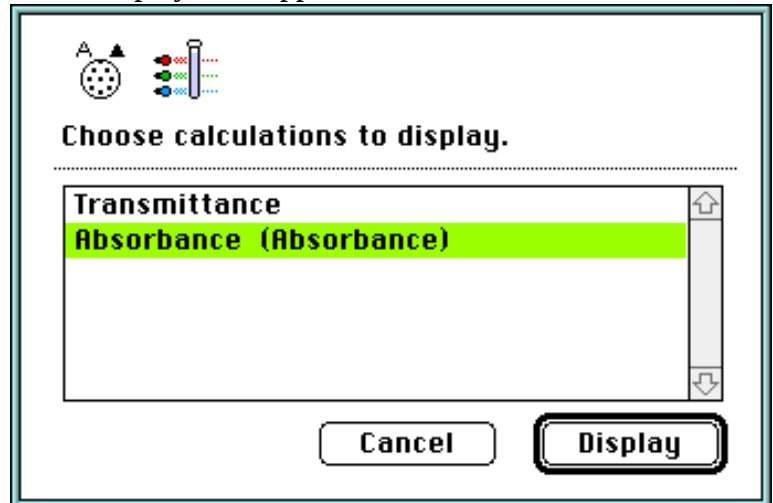
- 8) As a result the picture will be presented:



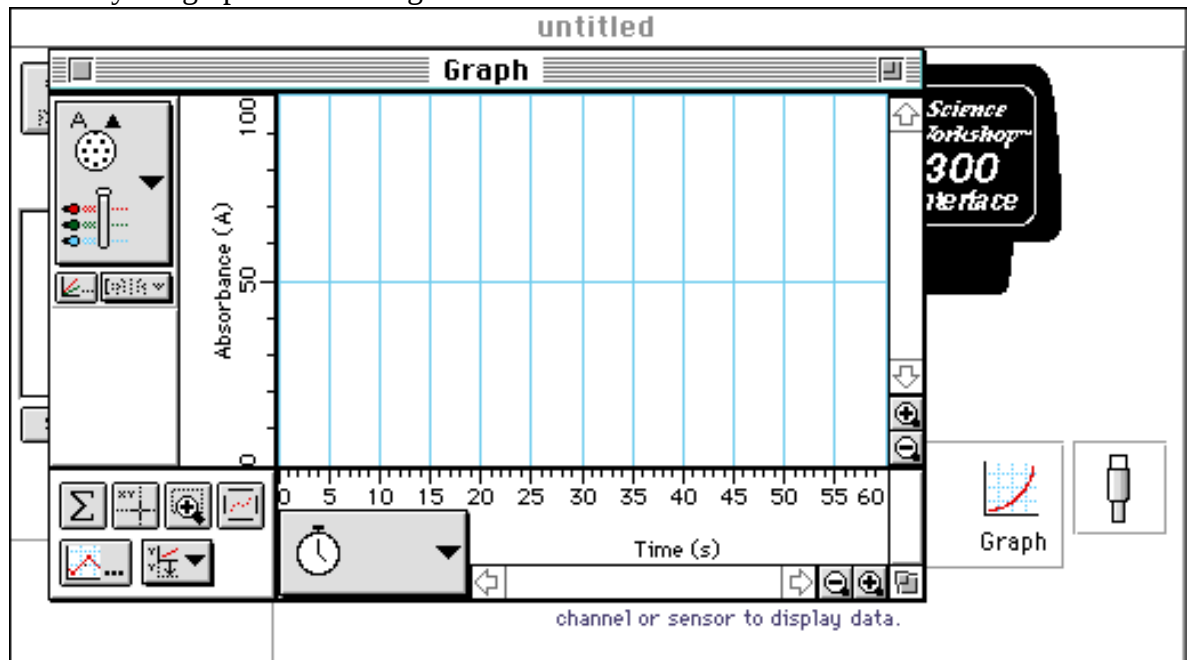
- 9) To allow registration of measurements with the mouse drag graph icon  on the icon of Analog Channel A  at the interface picture.



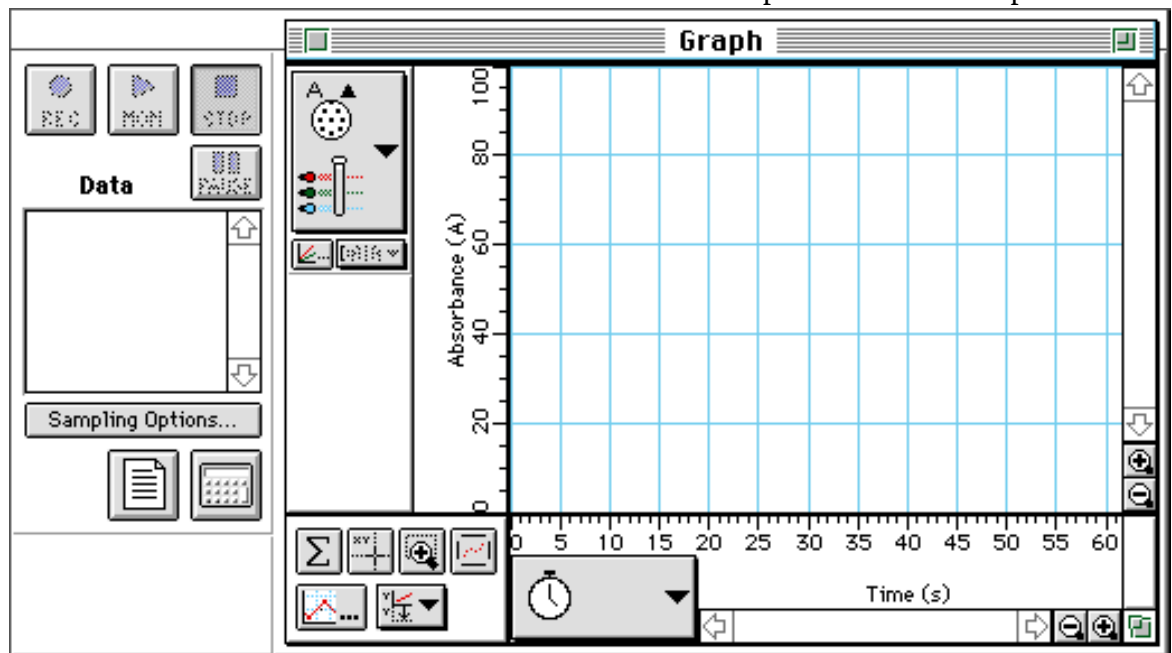
- 10) Next the menu 'Choose calculations to display' will appear. Choose 'Absorbance':



- 11) That way the graph will be assigned to the measurements:



- 12) With the mouse and elements of the program window  move the graph window to clear position of the computer screen:



- 13) Choose  and set up sampling options:

Sampling Options

Periodic Samples:
 10 Hz
☐ Slow ☒ Fast

☐ Keyboard

Start Condition: ☒ None
☐ Channel
☐ Time
☐ Samples

Stop Condition: ☒ None
☐ Channel
☐ Time
☐ Samples

Cancel **OK**

Periodic Samples:
 10 Hz
☐ Slow ☒ Fast

Periodic Samples: Fast 10Hz

Stop conditions: (option ☐ Time): 120 s

Sampling Options

Periodic Samples:
 10 Hz
☐ Slow ☒ Fast

☐ Keyboard

Start Condition:
☒ None
☐ Channel
☐ Time
☐ Samples

Stop Condition:
☐ None
☐ Channel
☒ Time
☐ Samples
 (120.00 s)

- 14) Point at vertical axis of the graph and click with the mouse.
 In the window 'Enter Plot Y Scale':

Enter Plot Y Scale

Max:

Min:

set in values Min: 0.0; Max: 2.0.

- 15) Point at horizontal axis of the graph and click with the mouse.
In the window 'Enter Plot X Scale':

Enter Graph X Scale

Minimum:  **Maximum:**

Time Units:

☐ milliseconds

☒ **seconds**

☐ minutes

☐ hours

☐ days

set in values Min: 0.0; Max: 150.

- 16) Turn the wavelength selection knob on the top of the colorimeter to the 'RED' position.

Preparation of solutions and data recording

In the second series of measurements vary the concentration of potassium manganate(VII).

- 17) When you are ready to begin data recording, place distilled water, ethyl alcohol, and sulfuric acid in the cuvette in the amounts specified below for the first trial.

- | | |
|------------------|---------|
| a. water | 0.00 ml |
| b. ethyl alcohol | 1.00 ml |
| c. sulfuric acid | 1.00 ml |

Add specified amount of potassium manganate(VII) last.

- | | |
|-----------------------------|----------|
| d. potassium manganate(VII) | 1.00 ml. |
|-----------------------------|----------|

- 18) Quickly cap the cuvette and put the cuvette into the colorimeter.
- 19) Click the 'Rec' button to begin recording data. Record data for about 120 seconds.
- 20) Empty and rinse the cuvette.
- 21) In the Data list in the Experiment Setup window 'Run no.1' will appear.
- 22) Repeat the procedure for trial 2 using the amounts of reactants shown below.
- | | |
|-------------------------------|-----------------------------------|
| a. water | 0.50 ml |
| b. ethyl alcohol | 1.00 ml |
| c. sulfuric acid | 1.00 ml |
| d. potassium manganate(VII) | 0.50 ml - Add specified amount of |
| potassium manganate(VII) last | |

- 23) Repeat the procedure for trial 3 using the amounts of reactants shown below.
- | | |
|-------------------------------|-----------------------------------|
| a. water | 0.75 ml |
| b. ethyl alcohol | 1.00 ml |
| c. sulfuric acid | 1.00 ml |
| d. potassium manganate(VII) | 0.25 ml - Add specified amount of |
| potassium manganate(VII) last | |

In the second series of measurements vary the concentration of alcohol:

- 24) trial 1
- | | |
|-------------------------------|-----------------------------------|
| a. water | 0.00 ml |
| b. ethyl alcohol | 1.00 ml |
| c. sulfuric acid | 1.00 ml |
| d. potassium manganate(VII) | 0.00 ml - Add specified amount of |
| potassium manganate(VII) last | |
- 25) trial 2
- | | |
|-------------------------------|-----------------------------------|
| a. water | 0.50 ml |
| b. ethyl alcohol | 0.50 ml |
| c. sulfuric acid | 1.00 ml |
| d. potassium manganate(VII) | 0.50 ml - Add specified amount of |
| potassium manganate(VII) last | |
- 26) trial 3
- | | |
|-------------------------------|-----------------------------------|
| a. water | 0.75 ml |
| b. ethyl alcohol | 0.25 ml |
| c. sulfuric acid | 1.00 ml |
| d. potassium manganate(VII) | 0.50 ml - Add specified amount of |
| potassium manganate(VII) last | |

In the third series of measurements vary the concentration of acid:

- 27) trial 1
- | | |
|-------------------------------|-----------------------------------|
| a. water | 0.00 ml |
| b. ethyl alcohol | 1.00 ml |
| c. sulfuric acid | 1.00 ml |
| d. potassium manganate(VII) | 0.00 ml - Add specified amount of |
| potassium manganate(VII) last | |
- 28) trial 2
- | | |
|-------------------------------|-----------------------------------|
| a. water | 0.50 ml |
| b. ethyl alcohol | 1.00 ml |
| c. sulfuric acid | 0.50 ml |
| d. potassium manganate(VII) | 0.50 ml - Add specified amount of |
| potassium manganate(VII) last | |
- 29) trial 3
- | | |
|-------------------------------|-----------------------------------|
| a. water | 0.75 ml |
| b. ethyl alcohol | 1.00 ml |
| c. sulfuric acid | 0.25 ml |
| d. potassium manganate(VII) | 0.50 ml - Add specified amount of |
| potassium manganate(VII) last | |
- 30) Compare the results.