

Coefficient of Linear Expansion

Name: _____

Class: _____

Roster# _____

Instructor: _____

Pre-Lab Questions Page

1. What is the symbolic representation for the coefficient of thermal linear expansion and its unit?

symbol = _____ unit: _____

2. A 10.0 cm french-fry temperature changes by 37°C . If the final length of the fry is 50.03 cm, calculate the coefficient of thermal linear expansion of the fry.

3. Why are gaps or spaces placed between cement sidewalks, instead of laying them so that each side touch?

4. What is the coefficient of thermal linear expansion for the following materials:

aluminum = α_{Al} = _____

brass = α_{br} = _____

steel = α_{st} = _____

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Name: _____
Date of Lab: _____
Lab Partners: _____

Roster# _____

Coefficient of Linear Expansion

OBJECTIVE: The purpose of this lab is to measure the coefficient of thermal linear expansion for a selection of metals and compare the results to the theoretical values.

APPARATUS:

Coefficient of linear expansion apparatus
Boiler and plastic tubing
Centigrade thermometer
Meter stick
Two metal rods
Paper towels and pot holders
Cup to catch run off

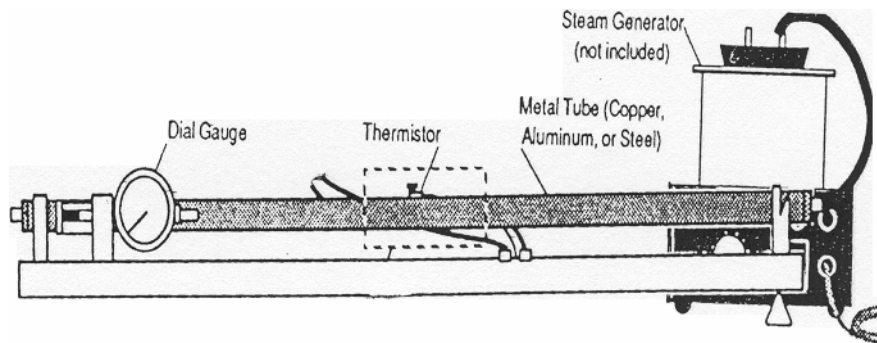


Figure 1: Linear Expansion apparatus

INTRODUCTION: Almost all matter expands when it is heated. A solid of cylindrical cross-section where the length is by far the largest dimension will expand according to the law;

$$\Delta L = L_0 \alpha \Delta T \quad \text{equation 1.}$$

where;

ΔL is the change in length,

L_0 is the initial length,

α is the coefficient of linear thermal expansion for various materials,

ΔT is the change in temperature.

The theoretical value for the coefficient of linear expansion for various substances is given in your textbook.

PROCEDURE:

1. Using the hot plate, heat the water to boiling. While the water is being heated work on the rest of the procedures.
2. Using a meter stick, measure the initial length of the **steel** rod at room temperature. Avoid excessive handling of the rod because your body will transfer heat into the rod, causing it to expand. **Record** the initial length in centimeters.
3. Record the room temperature on your data sheet, this is the initial temperature of the rod.
4. Assemble the apparatus. Insert the rod into the metal jacket. Hold the rod by its ends to avoid heating it. Align the dial pin with the metal rod. **Do not** attach the plastic tubing from the boiler yet.
5. Record the initial reading of the gauge. The gauge reads in inches and each division on the gauge is 0.001 inch.
6. Insert the thermometer into the hole in the center of the metal jacket. Attach the hose from the boiler to the metal jacket. Allow steam to pass through the apparatus until the internal temperature stabilizes to about 100 °C, due to energy losses you probably will not be able to get to 100 degrees. Allow steam to pass through the system for five minutes and observe the expansion of the rod on the gauge by checking the reading every two minutes. Observe and **record** the final gauge reading. The change in length of the rod is the difference between the final gauge reading and the initial gauge reading. Be sure to convert your units from inches to centimeters.
7. Using a potholder (insulated glove), remove the plastic tubing and tilt the apparatus to drain the hot water. **Be very careful, steam DOES burn skin!! The whole apparatus is HOT!!** Cool the steam shield in the sink to prepare for the next measurement.
8. For the second measurement repeat the previous steps using the brass, copper **or** steel rod.

DATA: Construct a data table that looks like this.

	Steel	Aluminum	Brass	Copper
Initial length of the rod (L_o)				
Initial micrometer setting				
Final micrometer setting				
Change in Length (ΔL)				
Initial temperature				
Final Temperature				
Change in temperature (ΔT)				

CALCULATIONS/ANALYSIS:

1. Use equation 1 to determine the coefficient of linear expansion for each of the (2) rods that were used during the experiment.

2. Compute the percent error between your experimental value and the theoretical value of the coefficient of linear expansion found in the textbook using the following equation:

$$\% \text{ error} = \frac{|Theoretical - Experimental|}{Theoretical} \times 100$$

Make a table of your results like the one below.

	Steel	Brass	Aluminum	Copper
Experimental Coefficient of Linear Expansion (α)				
Theoretical value of the coefficient (from the book)				
Percent Error				

QUESTIONS:

1. What is the relationship between the coefficient of thermal linear expansion and the change in length?

