

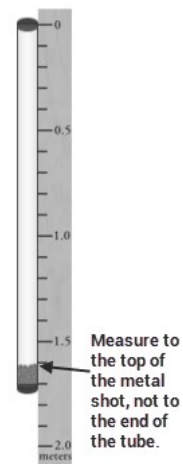
## Mechanical Equivalent of Heat

### Part I: Open the Lab

In your web browser (mobile phones not recommended), navigate to [www.gigaphysics.com](http://www.gigaphysics.com), then click Virtual Labs in the heading bar and Mechanical Equivalent of Heat from the list of labs. If you're using a computer that someone else just used for this lab, then also click the Reset Experiment button to obtain your own random data.

### Part II: Proof of Concept

From the Choose a metal menu, select copper. To find the amount of gravitational potential energy that will be converted to heat, you will need the mass of the shot and the distance it falls. To find the distance that the copper shot will fall, use your mouse to drag the ruler next to the tube and measure the distance from the top of the tube to the top of the copper shot (not from end to end of the tube since the shot actually takes up room). Record your length in the table below.



You will also need the mass of the shot. Click the Open Tube button to remove the shot from the tube, then use the mouse to drag the shot to the pan of the electronic balance. The balance will read the mass of the shot in grams. After converting to SI units, add this number to your data table.

You will also need the initial temperature of the copper shot when it comes time to calculate its increase in thermal energy. Next, drag the shot onto the red laser dot in front of the infrared thermometer. That's the instrument right under the electronic balance. The thermometer will read the temperature in °C; add this value to your data table as well.

Length of tube	Mass of copper shot	Initial temperature of shot

Now it's time to start flipping the tube over so the shot can fall, turning gravitational potential energy into heat. Click the Close Tube button to put the shot back in the tube, then click the Flip Tube button about 30-40 times. The readout in the upper left of the lab will keep track of how many times the tube has flipped. When you have finished, click Open Tube again and drag the shot back to the red dot near the infrared thermometer to find the final temperature. Add your data to the table below.

Number of times flipped	Final temperature of shot

Now calculate the amount of gravitational potential energy that was available for conversion using the formula  $E_g = mgh$ . Be sure to take into account the number of times the tube was flipped to get the total distance that the shot fell in the experiment.

Total distance fallen	Total gravitational potential energy transformed

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Now use the formula  $Q = mc\Delta T$  to determine the heat energy generated in this transformation. The specific heat capacity of copper is 390 J/kg·°C.

Change in temperature	Heat energy gained by shot

If you have performed these steps correctly, the total gravitational energy lost by the copper shot should be equal to the heat energy gained by the shot (at least to within rounding and measurement errors).

### Part III: Specific Heat Capacity of Lead

Now it's time to use the fact that mechanical energy can be transformed to an equal amount of heat energy in order to calculate the specific heat capacity of lead. Use the Choose a metal menu to select lead, then click Open Tube and drag the shot to the thermometer again for an initial temperature measurement. You may also drag the shot to the balance for a mass measurement if you wish. The length of the tube should not have changed unless you have hit the Reset Experiment button since completing part II.

Length of tube	Mass of lead shot (optional)	Initial temperature of shot

This time, you will probably need to flip the tube only about 20-30 times for good results. Then you can take and record a new temperature reading.

Number of times flipped	Final temperature of shot

Now that you know that the gravitational potential energy at the beginning is equal to the heat gained at the end, you should be able to calculate the specific heat capacity of lead. Show your work in the space provided.

	Specific heat capacity of lead
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If you have done this calculation correctly, you should find that the specific heat capacity of lead is about one third that of copper.

**Part IV: Specific Heat Capacity of Aluminum**

Change the shot to aluminum using the Choose a metal menu, then repeat the above procedure. This time, however, you will probably need to flip the tube about 40-50 times to get a better result.

Length of tube	Mass of aluminum shot (optional)	Initial temperature of shot
Number of times flipped	Final temperature of shot	

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Use the space below to complete your calculations of the specific heat capacity of aluminum. If you do this calculation correctly, you should find the specific heat capacity of aluminum to be somewhat more than double that of copper.

	Specific heat capacity of aluminum

**Part V: Additional Questions**

In parts III and IV, it wasn't truly necessary to measure the mass of the metal shot in order to find its specific heat capacity. Can you explain why not?

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Iron has a specific heat capacity of 450 J/kg-°C. Would an iron nail heat up more or less than an aluminum nail while being pounded into a board with a hammer? Explain your answer.

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