

Heat Transfer Workshop 2 Body Metabolism Introduction

Name _____

Assignment: Watch the introductory videos on Heat and Temperature

The human body is a sophisticated chemical reactor using metabolism for all of its activities. The energy that it produces and uses must eventually leave the body and go into the environment either as heat or work. The net work that is produced is usually small in comparison to the total energy produced. Therefore, one direct measure of the “calories burned” is the net heat transfer from the body to the environment.

Your challenge in this workshop is to estimate the calories that you burn in a day by measuring the heat transfer from your body with your heat flux sensor system. The human body has a typical surface area of 1.5 to 2.5 m², depending on the person’s size. A common equation to estimate surface area is

$$A_s = \sqrt{\frac{H m}{C_1}} \quad \text{where } C_1 = 36 \text{ kg/m}^3$$

This gives the area A_s in units of m² when the height H is in meters and body weight m is in kilograms.

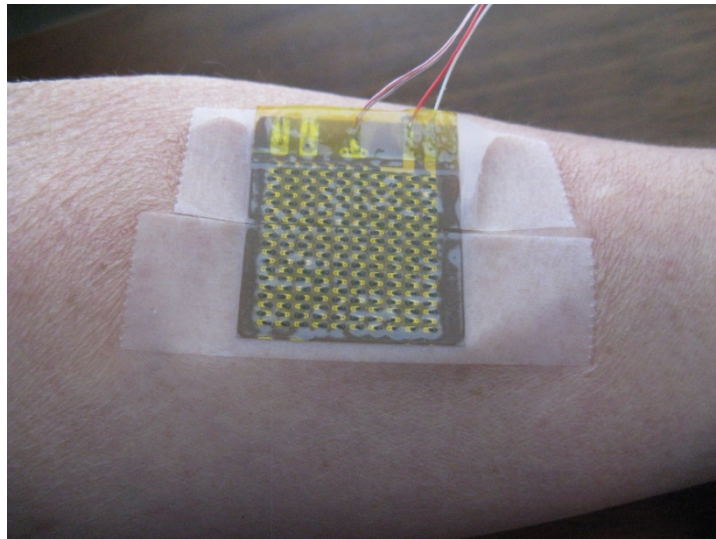
To make the measurements simply tape the heat flux sensor to different parts of your body on both exposed skin and underneath clothing. Single-sided tape can be used over top of the sensor or double-sided tape can be used between the sensor and the skin. In either case the goal is to create good contact between the entire sensor surface and the skin to give a good pathway for the heat transfer through the sensor, as illustrated in the figure. The heat flux should read positive if the leads are facing out. Check that you are measuring positive heat flux. If not, flip the sensor over.

Show the values on the worksheet and indicate where they were taken. Then average the temperature and heat flux values and use your estimated body area to find the total heat lost in both watts and calories per day. Show all of your work and equations used.

Note: One calorie is the equivalent of about 4.2 kJ.

1 inch = 0.0254 m.

1 pound = 0.454 kg



Heat Transfer Workshop 2 Body Metabolism Results

Name _____

Your challenge is to estimate the calories that you burn in a day by measuring the heat transfer from your body with your heat flux sensor system. Tape the heat flux sensor to different parts of your body on both exposed skin and underneath clothing. (Make sure to enter the proper heat flux sensor sensitivity each time the GUI is opened.) Record the average steady-state values below and indicate where they were taken. Then average the temperatures and heat flux and use your estimated body area to find the total heat lost in both watts and calories per day. Show all of your work and equations used.

	Location	Exposed/Unexposed	Surface Temp. (°C)	q" (W/m ²)
1.				
2.				
3.				
4.				
Average				

Estimated body surface area, $A_s =$

H =

m =

Total q (based on average heat flux) =

Calories per day =

How does this value compare with your usual caloric intake?

Why is there a discrepancy if any?

Why is the heat flux higher when the skin is exposed (not covered)?

Why is the surface temperature lower when the skin is exposed (not covered)?