

BIO 480/680 Lab Exercise 8

Lizard Energy Budget Model

Due date: 11 April 2025

This exercise involves developing a program to solve the lizard energy budget using Newton's method. You should be able to modify your previous program (root finding) to solve the energy budget. See the lizard budget handout for the relevant energy equations. The lizard data are as follows:

Insulation resistance	$0.002 \text{ m}^2 \text{ }^\circ\text{C W}^{-1}$
Mass	0.067 kg
Surface area	0.018 m^2
Animal emissivity	0.95
Lizard diameter	0.01 m
k_1	$3.49 \text{ W m}^{-2} \text{ }^\circ\text{C}^{-1} \text{ s}^{1/2}$

We will consider a sunny summer day during which lizards can come out of their underground burrow to hunt for food – but only if they will not overheat!

Radiation absorbed	800 W m^{-2}
Wind speed	1.5 m/s
Air temperature	$35.0 \text{ }^\circ\text{C}$
Maximum body core temp.	$45 \text{ }^\circ\text{C}$

The default air temperature will be $35.0 \text{ }^\circ\text{C}$. If your program is setup correctly, this should give a body temperature of about $41.4 \text{ }^\circ\text{C}$, given the environmental conditions shown above. Use that result to test your program!

Use your animal energy budget model to determine how high the wind speed must be to allow the lizard to be out in the sun without overheating under these conditions. So you should try various wind speeds until you can figure out how wind speed affects body temperature and therefore the minimum wind speed that will keep the body temperature from exceeding $45 \text{ }^\circ\text{C}$. Your results should be presented in the form of a graph showing lizard body temperature as a function of wind speed.

Programming notes: If you wrote a good program for the previous project, you should only have to modify the actual function that is being solved. So instead of that function containing $x^2 - 7$, it will contain the complete lizard energy budget as described in class and in the handout summarizing the lizard energy budget. (1) Remember that the function you want to solve is the last one on the aforementioned handout, where we have eliminated the surface temperature as a term and now the outgoing radiation and convection terms include metabolic and evaporation energies. Of course, this will mean that your program will have to calculate the metabolic and evaporation energies before they need to be used in calculating the outgoing radiation and convection terms. (2) Also remember that the metabolism and evaporation energies have to be multiplied by the animal's mass to surface area ratio to convert the energy per mass units into per area units.

