Lab 1: Sunsets

This lab is intended to show you the basics of writing programs in Python. It presumes that you have Python installed on your computer, or are using a lab computer with Python already installed.

The program

Take a look at the idea in this blog post:

http://blag.xkcd.com/2009/04/06/a-date-idea-analyzed/

All the equations in the post assume that the cherry picker is at the equator, which given the large radius of the Earth at that point, is a most unfavorable location. For this lab, you will write a program which will allow the user to enter their latitude, and respond with information about how fast the cherry picker will have to move. The Earth's radius at any latitude is given by the formula $r = R_{equator} \cos(latitude)$

The formula the program is based upon is:

$$v = \frac{2\pi h}{day * arcsec(\frac{h}{r_e} + 1)}$$

Python's math library does not have an `arcsec` function. However, $arcsec(\theta) = arccos(\frac{1}{\theta})$, so we can use this instead. Instead of writing the entire formula on a single line, I will break it into several smaller formulas for the algorithm below. `arccos` in Python is called `acos`.

Input: Latitude (l), height (h)

1. Re = 6378100 * cos(latitude_in_radians)
2. asec_angle = $\frac{h}{Re} + 1$
3. asec_result = $acos(\frac{1}{asec\_angle})$
4. day = 24 * 60 * 60
5. v = $\frac{2*\pi*h}{day*asec\_result}$
6. t = $\frac{h}{v}$

Output: Speed to reach h (v), time to reach h (t)

Remember, you'll need to import the contents of Python's math library, like this:

```
from math import *
```

You'll also need to collect input and convert it to floating-point numbers. Example:

```
l = float(input("Enter your latitude:  "))
```

Latitude is generally specified in decrees, but Python's `cos` function expects radians. To convert this, use the `radians` function, like this (the following does NOT comprise a complete line of code): `radians(l)`

It's up to you to figure out how to put these pieces together into a working program! When it works, for a lattitude of 49 and height of 10, v should be 0.3326, and t should be 30.06.

Using Python

Your TA will give a demonstration of how to use Python. However, I recommend you arrive with Python already installed on your laptop. Python is also available on the lab machines, but most students prefer to use their own laptops. There is no requirement that you do this, and it is certainly possible to do all your work in the lab.

For the over-achiever

If this lab seems to easy (perhaps you have previous programming experience, or are simply smart), here are a couple ways to greatly improve the program:

- Modify the program so that it outputs the maximum reachable height given a latitude and cherry picker speed. You don't have to solve the last equation for h (although, that would certainly be the optimal way!). The less mathematical way is to set up a loop which will try various values for h until an appropriate value is reached.
- A table of how many seconds the sunlight will take to reach various altitudes would be convenient for the user, and isn't that hard to write. You'll need a loop which uses t as a counter, and the equation for h in terms of t (from the blog). Python doesn't have a `sec` function, but $sec(\theta) = \frac{1}{cos(\theta)}$.

Turning in the assignment

When you have finished the assignment, ask your TA to check your work. If the program is satisfactory, you will receive full credit. If there is enough time remaining and your assignment is not complete, you will be given time to finish it.