CS102: Week 2

February 7, 2014

Temperature Conversions

The formula to convert Fahrenheit to Kelvin is:

$$K = ((F - 32) * 5)/9 + 273.15 \tag{1}$$

1. Write a program that converts 100° F to Kelvins. It should print out the following:

   100 degrees Fahrenheit is equivalent to K degrees Kelvin

   Note: replace K with the converted temperature.

2. Modify the program to convert arbitrary Fahrenheit temperatures to Kelvin and change the printout accordingly.

Heat Transfer

The time it takes for a spherical object to cool from an initial temperature of T_{init} to a final temperature of T_{fin}, caused entirely by radiation, is provided by Kelvins cooling equation:

$$t = \frac{Nk}{2e\sigma A}\left[\frac{1}{T_{fin}^3} - \frac{1}{T_{init}^3}\right] \tag{2}$$

t is the cooling time in years

N is the number of atoms

k is Boltzmanns constant = $1.38 \times 10^{-23} m^2 kg/s^2 K$ (note that 1 Joule = $1 m^2 kg/s^2$).

e is emissivity of the object.

σ is Stephan-Boltzmanns constant = $5.6703 \times 10^{-8} Watts/m^2 K^4$.

A is the surface area.

T_{fin} is the final temperature.

T_{init} is the initial temperature.

Assuming an infinitely hot initial temperature, this formula reduces to:

$$t = \frac{Nk}{2e\sigma A T_{fin}^3} \tag{3}$$

Using this second formula, write a C++ program to determine the time it took Earth to cool to its current surface temperature of 300° K from its initial infinitely hot state, assuming the cooling is caused only by radiation. Use the information that the area of the Earths surface is $5.15 \times 10^{14} m^2$, its emissivity is 1, the number of atoms contained in the Earth is 1.1×10^{50}, and the radius of the Earth is 6.4×10^6 meters. Additionally, use the relationship that a spheres surface area is given by this formula:

$$A = 4\pi r^2 \tag{4}$$

Your program should print out:

> It took t years for the earth to cool to 300K.

Where t is replaced by the computed years.

Average Temperature

A thermometer is placed in various parts of the van and records the following temperatures: 99.9, 98.7, 100.3, 100.2, 99.5 The average temperature in the van can be calculated as:

$$van_t = \frac{1}{N} \sum_{i=1}^{i=N} t_i \tag{5}$$

i = current record
N = total number of temperature records

Write a program that computes the average temperature and prints out: (Use an accumulator)

> The average temperature in the van is van_t

Extra Credit

The error in the temperature reading can be estimated by calculating the variation in the temperature reading. The variation can be computed using the formula for standard deviation:

$$var_t = \sqrt{\frac{1}{N} \sum_{i=1}^{i=N} (t_i - van_t)^2} \tag{6}$$

Write a program that computers the variation and prints out: (Use an accumulator)

> The average variation in the van records is var_t

Note: Replace van_t and var_t with the numbers you computed.