

# CSCI 310, Data Structures, Summer 2009

## Assignment 4 (15 points)

Daniel Gabriel Fahrenheit (1686-1736) devoted most of his life to creating precision meteorological instruments. Fahrenheit invented the mercury thermometer in 1714. Fahrenheit sought to create a practical temperature scale in which 0 corresponded with the coldest temperature normally encountered in Western Europe and 100 corresponded to the hottest temperature. Fahrenheit initially created a temperature scale in which 0 represented the temperature of a salt and ice mixture, 30 represented the freezing point of water, and 90 represented the mean human body temperature. Fahrenheit later adjusted his temperature scale so that 32 represented the freezing point of water and 212 represented the boiling point of water. The units of the Fahrenheit temperature scale were designated *degree Fahrenheit* ( $^{\circ}\text{F}$ ). The Fahrenheit temperature scale is still used today in many countries, including the United States.

In 1742, Anders Celsius (1701-1744) created an inverted centigrade temperature scale in which 0 represented the boiling point of water and 100 represented the freezing point.

In 1744, Carl Linnaeus (1707-1778) suggested reversing the temperature scale of Anders Celsius so that 0 represented the freezing point of water and 100 represented the boiling point. The centigrade relative temperature scale gradually became popular throughout the world. The units of the centigrade temperature scale were designated *degree Celsius* ( $^{\circ}\text{C}$ ).

In 1848, William Thomson (1824-1907) proposed a thermodynamic temperature scale which assigned 0 to thermodynamic absolute zero and used the degree centigrade as its base unit. This absolute scale was later named the centigrade thermodynamic temperature scale (after Thomson's peer title) and its unit designated *degree Kelvin* ( $^{\circ}\text{K}$ ).

In 1859, William John Macquorn Rankine (1820-1872) proposed another thermodynamic temperature scale which also assigned 0 to thermodynamic absolute zero, but used the degree Fahrenheit as its base unit. This absolute scale was later named the Rankine thermodynamic temperature scale and its unit designated *degree Rankine* ( $^{\circ}\text{R}$ ).

The following table shows how to convert among these four standard temperature scales

From	To	Formula
Fahrenheit	Celsius	$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times \frac{5}{9}$
Fahrenheit	Kelvin	$^{\circ}\text{K} = (^{\circ}\text{F} + 459.67) \times \frac{5}{9}$
Fahrenheit	Rankine	$^{\circ}\text{R} = ^{\circ}\text{F} + 459.67$
Celsius	Fahrenheit	$^{\circ}\text{F} = (^{\circ}\text{C} \times \frac{9}{5}) + 32$
Celsius	Kelvin	$^{\circ}\text{K} = ^{\circ}\text{C} + 273.15$
Celsius	Rankine	$^{\circ}\text{R} = (^{\circ}\text{C} \times \frac{9}{5}) + 32 + 459.67$
Kelvin	Fahrenheit	$^{\circ}\text{F} = (^{\circ}\text{K} \times \frac{9}{5}) - 459.67$
Kelvin	Celsius	$^{\circ}\text{C} = ^{\circ}\text{K} - 273.15$
Kelvin	Rankine	$^{\circ}\text{R} = ^{\circ}\text{K} \times \frac{9}{5}$
Rankine	Fahrenheit	$^{\circ}\text{F} = ^{\circ}\text{R} - 459.67$
Rankine	Celsius	$^{\circ}\text{C} = (^{\circ}\text{R} - 459.67 - 32) \times \frac{5}{9}$
Rankine	Kelvin	$^{\circ}\text{K} = ^{\circ}\text{R} \times \frac{5}{9}$

1. (15 points) Create a class named `Temperature`. The `Temperature` class will have only one data member, degrees, which is of type `double`. This will represent the temperature in degrees Celsius.

### Constructors

There will be two constructors for the `Temperature` class:

1. The default constructor, which sets the temperature to 0° C.
2. A constructor that takes a temperature of type `double` and a scale of type `char`. The valid scale values are:
  - 'F' or 'f' Fahrenheit
  - 'C' or 'c' Celsius
  - 'R' or 'r' Rankine
  - 'K' or 'k' Kelvin

Since the temperature is stored in degrees Celsius, if the initial temperature is in a different scale it will need to be converted before it is stored.

**Public Functions** Your class should provide the following functions to allow users to interface with your class:

<code>void set(double temp, char scale)</code>	sets the temperature. You may need to convert the temperature to Celsius.
<code>double get(char scale)</code>	returns the temperature. You may need to convert to the requested scale.
<code>bool isLessThan(const Temperature t) const</code>	returns true if this temperature < t
<code>bool isLessThanOrEqual(const Temperature t) const</code>	returns true if this temperature ≤ t
<code>bool isEqual(const Temperature t) const</code>	returns true if this temperature = t
<code>bool isGreaterThanOrEqual(const Temperature t) const</code>	returns true if this temperature ≥ t
<code>bool isGreaterThan(const Temperature t) const</code>	returns true if this temperature > t
<code>bool isNotEqualTo(const Temperature) const</code>	returns true if this temperature ≠ t

Here is a sample program that uses the `Temperature` class.

```
#include <iostream>
using namespace std;
#include "Temperature.h"

const unsigned char DEG = (char)248;

int main(){
    Temperature temp1(80, 'c'), temp2(150, 'F'), absoluteZero(0, 'K');

    if(temp1.isLessThen(temp2))
        cout << temp1.get('c') << DEG << "C"
             << " is less than "
             << temp2.get('f') << DEG << "F";
    else
        cout << temp1.get('c') << DEG << "C"
             << " is greater than or equal to "
             << temp2.get('f') << DEG << "F";

    cout << "Absolute Zero is " << absoluteZero.get('f')
         << DEG << "F" << endl;

    return EXIT_SUCCESS;
}
```