If the input stream from the keyboard contained the two lines

```
a
1
```

the objects `ch1`, `ch2`, and `ch3` would be assigned values as shown in the following memory snapshot:

`char ch1` ['a']   `char ch2` ['\n']   `char ch3` ['1']

The output would be

```
a
1
```

The `get()` function treats whitespace as valid character data; thus, the newline character was input from the keyboard and stored in the object `ch2`.

2.5 Numerical Technique: Linear Interpolation

The collection of data from an experiment or from observing a physical phenomenon is an important step in developing a problem solution. These data points can generally be considered to be coordinates of points of a function $f(x)$. We would often like to use these data points to determine estimates of the function $f(x)$ for values of x that were not part of the original set of data. For example, suppose that we have data points $(a, f(a))$ and $(c, f(c))$. If we want to estimate the value of $f(b)$, where $a < b < c$, we could assume that a straight line joined $f(a)$ and $f(c)$ and then use linear interpolation to obtain the value of $f(b)$. If we assume that the points $f(a)$ and $f(c)$ are joined by a cubic (third-degree) polynomial, we could use a cubic-spline interpolation method to obtain the value of $f(b)$. Most interpolation problems can be solved using one of these two methods. Figure 2.1 contains a set of six data points that have been connected with straight-line segments and that have been connected with cubic degree polynomial segments. It should be clear that the values determined for the function between sample points depend on the type of interpolation that we select. In this section, we discuss linear interpolation.

A graph with two arbitrary data points $f(a)$ and $f(c)$ is shown in Figure 2.2. If we assume that the function between the two points can be estimated by a straight line, we can then compute the function value at any point $f(b)$ using an equation derived from similar triangles:

$$f(b) = f(a) + \frac{b-a}{c-a}[f(c) - f(a)].$$

Recall that we are also assuming that $a < b < c$.

To illustrate using this interpolation equation, assume that we have a set of temperature measurements taken from the cylinder head in a new engine that is being tested for possible

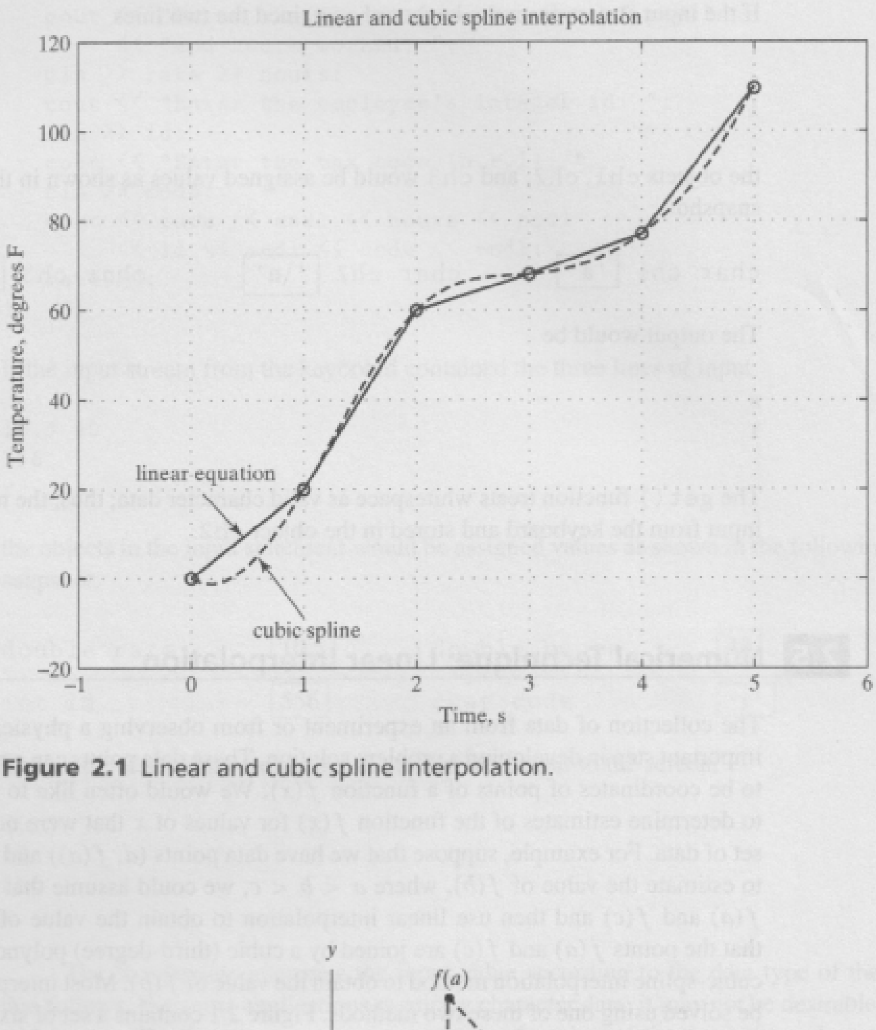

Figure 2.1 Linear and cubic spline interpolation.

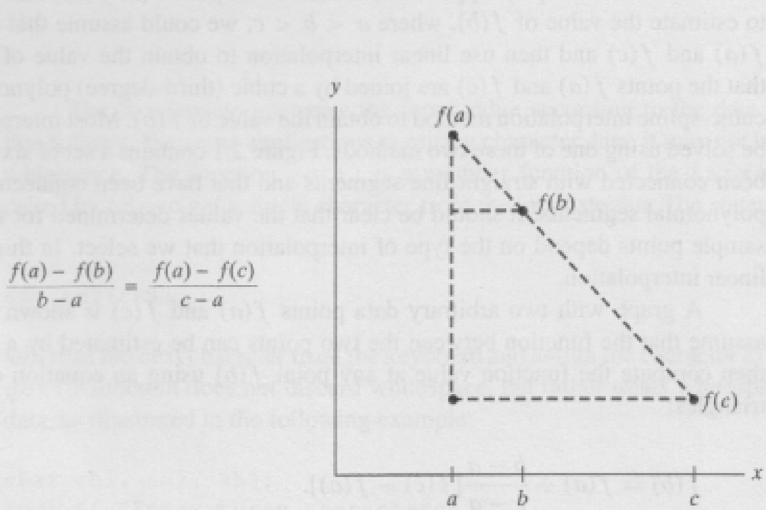

Figure 2.2 Similar triangles.

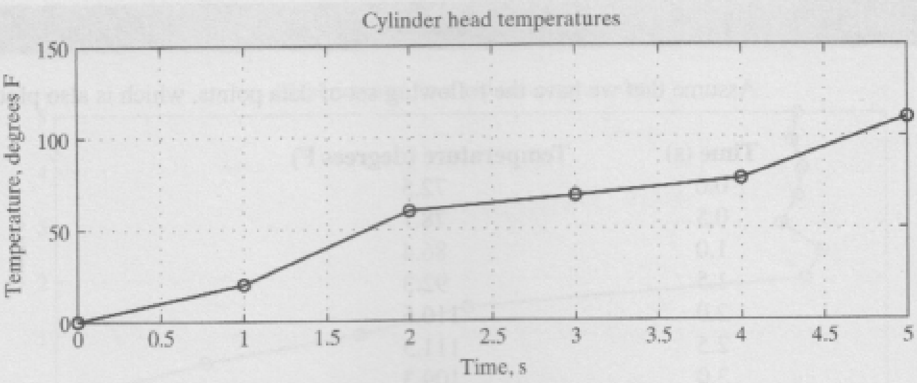

Figure 2.3 Cylinder head temperatures.

use in a race car. These data are plotted with straight lines connecting the points in Figure 2.3, and they are also listed here:

Time, s	Temperature, degrees F
0.0	0.0
1.0	20.0
2.0	60.0
3.0	68.0
4.0	77.0
5.0	110.0

Assume that we want to interpolate a temperature to correspond to the value 2.6 seconds. We then have the following situation:

a	2.0	f(a)	60.0
b	2.6	f(b)	?
c	3.0	f(c)	68.0

Using the interpolation formula, we have

$$f(b) = f(a) + \frac{b-a}{c-a}[f(c) - f(a)]$$

$$= 60.0 + \frac{2.6-2.0}{3.0-2.0}[68.0 - 60.0]$$

$$= 64.8.$$

In this example, we used linear interpolation to find the temperature that corresponds to a specified time. We could also interchange the roles of temperature and time, so that we plot temperature on the x-axis and time on the y-axis. In this case, we can use the same process to compute the time that a specified temperature occurred, assuming that we have a pair of data points with temperatures below and above the specified temperature.