is another way of writing

```
total = total * 2
```

Many programmers find this a convenient shortcut especially when incrementing or decrementing by 1:

```
count += 1
```

If you like it, go ahead and use it in your own code. For simplicity, we won't use it in this book.

Special Topic 2.3

Line Joining

If you have an expression that is too long to fit on a single line, you can continue it on another line *provided the line break occurs inside parentheses*. For example,

```
x1 = ((-b + sqrt(b ** 2 - 4 * a * c))
   / (2 * a))    # Ok
```

However, if you omit the outermost parentheses, you get an error:

```
x1 = (-b + sqrt(b ** 2 - 4 * a * c))
   / (2 * a)    # Error
```

The first line is a complete statement, which the Python interpreter processes. The next line, `/ (2 * a)`, makes no sense by itself.

There is a second form of joining long lines. If the *last* character of a line is a backslash, the line is joined with the one following it:

```
x1 = (-b + sqrt(b ** 2 - 4 * a * c)) \
   / (2 * a)    # Ok
```

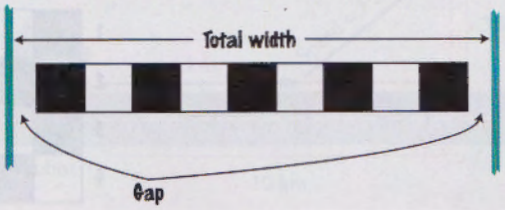
You must be very careful not to put any spaces or tabs after the backslash. In this book, we only use the first form of line joining.

2.3 Problem Solving: First Do It By Hand

In the preceding section, you learned how to express computations in Python. When you are asked to write a program for solving a problem, you may naturally think about the Python syntax for the computations. However, before you start programming, you should first take a very important step: carry out the computations *by hand*. If you can't compute a solution yourself, it's unlikely that you'll be able to write a program that automates the computation.

To illustrate the use of hand calculations, consider the following problem: A row of black and white tiles needs to be placed along a wall. For aesthetic reasons, the architect has specified that the first and last tile shall be black.

Your task is to compute the number of tiles needed and the gap at each end, given the space available and the width of each tile.



Pick concrete values for a typical situation to use in a hand calculation.

To make the problem more concrete, let's assume the following dimensions:

- Total width: 100 inches
- Tile width: 5 inches

The obvious solution would be to fill the space with 20 tiles, hut that would not work—the last tile would be white.

Instead, look at the problem this way: The first tile must always be black, and then we add some number of white/black pairs:

The first tile takes up 5 inches, leaving 95 inches to be covered by pairs. Each pair is 10 inches wide. Therefore the number of pairs is 95 / 10 = 9.5. However, we need to discard the fractional part since we can't have fractions of tile pairs.

Therefore, we will use 9 tile pairs or 18 tiles, plus the initial black tile. Altogether, we require 19 tiles.

The tiles span 19 × 5 = 95 inches, leaving a total gap of 100 – 19 × 5 = 5 inches.

The gap should be evenly distributed at both ends. At each end, the gap is (100 – 19 × 5) / 2 = 2.5 inches.

This computation gives us enough information to devise an algorithm with arbitrary values for the total width and tile width.

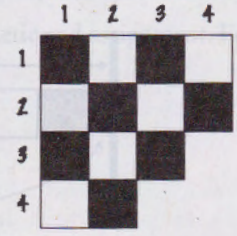
```
number of pairs = integer part of (total width - tile width) / (2 x tile width)
number of tiles = 1 + 2 x number of pairs
gap at each end = (total width - number of tiles x tile width) / 2
```

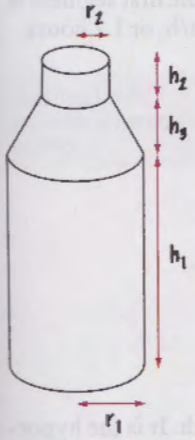
As you can see, doing a hand calculation gives enough insight into the problem that it becomes easy to develop an algorithm.

13. Translate the pseudocode for computing the number of tiles and the gap width into Python.
14. Suppose the architect specifies a pattern with black, gray, and white tiles, like this:

Again, the first and last tile should be black. How do you need to modify the algorithm?

15. A robot needs to tile a floor with alternating black and white tiles. Develop an algorithm that yields the color (0 for black, 1 for white), given the row and column number. Start with specific values for the row and column, and then generalize.





16. For a particular car, repair and maintenance costs in year 1 are estimated at $100; in year 10, at $1,500. Assuming that the repair cost increases by the same amount every year, develop pseudocode to compute the repair cost in year 3 and then generalize to year n.

17. The shape of a bottle is approximated by two cylinders of radius r_1 and r_2 and heights h_1 and h_2, joined by a cone section of height h_3.

Using the formulas for the volume of a cylinder, $V = \pi r^2 h$, and a cone section,

$$V = \pi \frac{\left(r_1^2 + r_1 r_2 + r_2^2\right) h}{3},$$

develop pseudocode to compute the volume of the bottle. Using an actual bottle with known volume as a sample, make a hand calculation of your pseudocode.

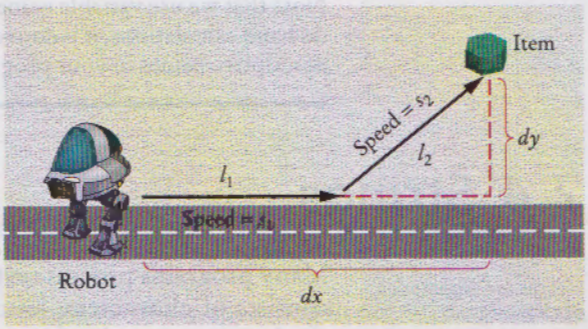
Practice It Now you can try these exercises at the end of the chapter: R2.15, R2.17, R2.18.

WORKED EXAMPLE 2.1 Computing Travel Time

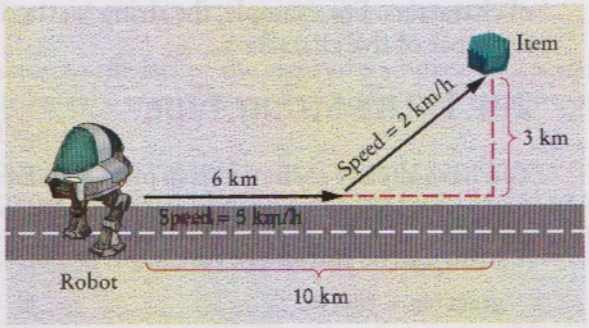
Problem Statement A robot needs to retrieve an item that is located in rocky terrain next to a road. The robot can travel at a faster speed on the road than on the rocky terrain, so it will want to do so for a certain distance before moving in a straight line to the item. Calculate by hand how much time it takes to reach the item.

Your task is to compute the total time taken by the robot to reach its goal, given the following inputs:

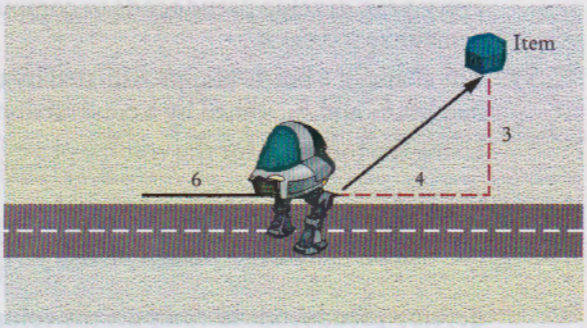
- The distance between the robot and the item in the x- and y-direction (dx and dy)
- The speed of the robot on the road and the rocky terrain (s_1 and s_2)
- The length l_1 of the first segment (on the road)



To make the problem more concrete, let's assume the following dimensions:



The total time is the time for traversing both segments. The time to traverse the first segment is simply the length of the segment divided by the speed: 6 km divided by 5 km/h, or 1.2 hours.



To compute the time for the second segment, we first need to know its length. It is the hypotenuse of a right triangle with side lengths 3 and 4.

Therefore, its length is $\sqrt{3^2 + 4^2} = 5$. At 2 km/h, it takes 2.5 hours to traverse it. That makes the total travel time 3.7 hours.

This computation gives us enough information to devise an algorithm for the total travel time with arbitrary arguments:

Time for segment 1 = l_1 / s_1
Length of segment 2 = square root of $(dx - l_1)^2 + dy^2$
Time for segment 2 = length of segment 2 / s_2
Total time = time for segment 1 + time for segment 2

Translated into Python, the computations are

```
segment1Time = segment1Length / segment1Speed
segment2Length = sqrt((xDistance - segment1Length) ** 2 + yDistance ** 2)
segment2Time = segment2Length / segment2Speed
totalTime = segment1Time + segment2Time
```

Note that we use variable names that are longer and more descriptive than dx or s_1. When you do hand calculations, it is convenient to use the shorter names, but you should change them to descriptive names in your program.

2.4 Strings

Strings are sequences of characters.

Many programs process text, not numbers. Text consists of **characters**: letters, numbers, punctuation, spaces, and so on. A **string** is a sequence of characters. For example, the string `"Hello"` is a sequence of five characters.

2.4.1 The String Type

You have already seen strings in print statements such as

```
print("Hello")
```

A string can be stored in a variable

```
greeting = "Hello"
```

and later accessed when needed just as numerical values can be:

```
print(greeting)
```

A string literal denotes a particular string.

A **string literal** denotes a particular string (such as `"Hello"`), just as a number literal (such as 2) denotes a particular number. In Python, string literals are specified by enclosing a sequence of characters within a matching pair of either single or double quotes.

```
print("This is a string.", 'So is this.')
```

By allowing both types of delimiters, Python makes it easy to include an apostrophe or quotation mark within a string.

```
message = 'He said "Hello"'
```

In this book, we use double quotation marks around strings because this is a common convention in many other programming languages. However, the interactive Python interpreter always displays strings with single quotation marks.

The `len` function returns the number of characters in a string.

The number of characters in a string is called the *length* of the string. For example, the length of `"Harry"` is 5. You can compute the length of a string using Python's `len` function:

```
length = len("World!")   # length is 6
```

A string of length 0 is called the *empty string*. It contains no characters and is written as `""` or `''`.

2.4.2 Concatenation and Repetition

Use the + operator to *concatenate* strings; that is, to put them together to yield a longer string.

Given two strings, such as `"Harry"` and `"Morgan"`, you can **concatenate** them to one long string. The result consists of all characters in the first string, followed by all characters in the second string. In Python, you use the + operator to concatenate two strings. For example,

```
firstName = "Harry"
lastName = "Morgan"
name = firstName + lastName
```

results in the string

```
"HarryMorgan"
```

What if you'd like the first and last name separated by a space? No problem:

```
name = firstName + " " + lastName
```

This statement concatenates three strings: `firstName`, the string literal `" "`, and `lastName`. The result is

```
"Harry Morgan"
```

When the expression to the left or the right of a + operator is a string, the other one must also be a string or a syntax error will occur. You cannot concatenate a string with a numerical value.

You can also produce a string that is the result of repeating a string multiple times. For example, suppose you need to print a dashed line. Instead of specifying a literal string with 50 dashes, you can use the * operator to create a string that is comprised of the string `"-"` repeated 50 times. For example,

```
dashes = "-" * 50
```