## WORKED EXAMPLE 2.1 Computing the Cost of Stamps

You are asked to simulate a postage stamp vending machine. A customer inserts dollar bills into the vending machine and then pushes a "purchase" button. The vending machine gives out as many first-class stamps as the customer paid for, and returns the change in penny (one-cent) stamps. A first-class stamp cost 44 cents at the time this book was written.

**Step 1** Understand the problem: What are the inputs? What are the desired outputs?

In this problem, there is one input:

- The amount of money the customer inserts

There are two desired outputs:

- The number of first-class stamps the machine returns
- The number of penny stamps the machine returns

**Step 2** Work out examples by hand.

Let's assume that a first-class stamp costs 44 cents and the customer inserts $1.00. That's enough for two stamps (88 cents) but not enough for three stamps ($1.32). Therefore, the machine returns two first-class stamps and 12 penny stamps.

**Step 3** Write pseudocode for computing the answers.

Given an amount of money and the price of a first-class stamp, how can you compute how many first-class stamps can be purchased with the money? Clearly, the answer is related to the quotient

$$\frac{\text{amount of money}}{\text{price of first-class stamp}}$$

For example, suppose the customer paid $1.00. Use a pocket calculator to compute the quotient: $1.00/$0.44 ≈ 2.27.

How do you get "2 stamps" out of 2.27? It's the quotient without the remainder. In Java, this is easy to compute if both arguments are integers. Therefore, let's switch our computation to pennies. Then we have

```
number of first-class stamps = 100 / 44 (integer division, without remainder)
```

What if the user inputs two dollar? Then the numerator becomes 200. What if the price of a stamp goes up? A more general equation is

```
number of first-class stamps = 100 x dollars / price of first-class stamps in cents
```

How about the change? Here is one way of computing it. When the customer gets the stamps, the change is the customer payment, reduced by the value of the stamps purchased. In our example, the change is 12 cents—the difference between 100 and $2 \cdot 44$. Here is the general formula:

```
change = 100 x dollars – number of first-class stamps x price of first-class stamp
```

**Step 4** Declare the variables and constants that you need, and specify their types.

Here, we have three variables:

- `dollars`
- `firstClassStamps`
- `change`

There is one constant, `FIRST_CLASS_STAMP_PRICE`.

The variable `dollars` and constant `FIRST_CLASS_STAMP_PRICE` must be of type `int` because the computation of `firstClassStamps` uses integer division. The remaining variables are also integers, counting the number of first-class and penny stamps. Thus, we have

```
final int FIRST_CLASS_STAMP_PRICE = 44; // Price in pennies
int dollars; // Filled through input statement

int firstClassStamps = 100 * dollars / FIRST_CLASS_STAMP_PRICE;
int change = 100 * dollars - firstClassStamps * FIRST_CLASS_STAMP_PRICE;
```

**Step 5** Turn the pseudocode into Java statements.

Our computation depends on the number of dollars that the user provides. Translating the math into Java yields the following statements:

```
firstClassStamps = 100 * dollars / FIRST_CLASS_STAMP_PRICE;
change = 100 * dollars - firstClassStamps * FIRST_CLASS_STAMP_PRICE;
```

**Step 6** Provide input and output.

Before starting the computation, we prompt the user for the number of dollars:

```
System.out.print("Enter number of dollars: ");
dollars = in.nextInt();
```

When the computation is finished, we display the result.

```
System.out.printf("First class stamps: %6d\n", firstClassStamps);
System.out.printf("Penny stamps:       %6d\n", change);
```

**Step 7** Provide a class with a `main` method.

Here is the complete program, `ch02/stamp/StampMachine.java`:

```
import java.util.Scanner;

/**
   This program simulates a stamp machine that receives dollar bills and dispenses
   first class and penny stamps.
*/
public class StampMachine
{
   public static void main(String[] args)
   {
      Scanner in = new Scanner(System.in);

      final int FIRST_CLASS_STAMP_PRICE = 44; // Price in pennies

      System.out.print("Enter number of dollars: ");
      int dollars = in.nextInt();

      // Compute and print the number of stamps to dispense

      int firstClassStamps = 100 * dollars / FIRST_CLASS_STAMP_PRICE;
      int change = 100 * dollars - firstClassStamps * FIRST_CLASS_STAMP_PRICE;
      System.out.printf("First class stamps: %6d\n", firstClassStamps);
      System.out.printf("Penny stamps:       %6d\n", change);
   }
}
```

### Program Run

```
Enter number of dollars: 4
First class stamps:      9
Penny stamps:            4
```