

Repetition using Java – Simple `for` Statements

The following is a practical example to illustrate the `while` statement. Depending upon the condition at the beginning of the `while` loop, the code inside the loop may be executed zero, once, or many times.

```
while (there are lumps in the gravy)
    give the gravy a stir
end while
```

We have compared this to the `do` statement, where the code inside the loop will be executed *at least* once, and possibly many times.

```
start
    give the gravy a stir
while (there are lumps in the gravy)
```

The third, and last, type of loop in Java uses the `for` statement, and it is a counted loop. In terms of our gravy example, it might look something like

```
stir the gravy 100 times
```

The For Statement – A Counted Loop

In a more Java-like form, we might write

```
int count;
for (count = 0; count < 100; count++)
{
    <stir the sauce>;
}
```

It is always possible to rewrite the `for` statement using a `while` statement, as follows.

```
int count;
count = 0;
while (count < 100)
{
    <stir the sauce>;
    count++;
}
```

The `for` statement actually contains three very important components, which are hopefully illustrated by the equivalent `while` statement:

1. **Initialization** – the variable used to count the loop is set to an initial value
2. **Boolean Expression** – controls the loop by testing the variable
3. **Modifier** – changes the variable (usually up or down by one)

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Example 1 – The following fragment finds the sum of the numbers from 1 to 100,
 $1+2+3+\dots+99+100$

```
sum = 0;
for (i = 1; i <= 100; i++)
{
    sum = sum + i;
}
```

Example 2 – Similar to the example above, we allow the user to specify the ending value, giving the sum of integers from 1 to N, $1+2+3+\dots+N$

```
sum = 0;
n = In.getInt();
for (i = 1; i <= n; i++)
{
    sum = sum + i;
}
```

Example 3 – This fragment prints the sum of squares from 1 to 100: $1^2+2^2+3^2+\dots+99^2+100^2$

```
sum = 0;
for (i = 1; i <= 100; i++)
{
    sum += i*i;
}
```

Example 4 – This program fragment prints the values of the squares ($y=x^2$), but only for every *third* integer less than 20 (i.e., 1, 4, 7, 10, 13, 16, 19). Notice that although our condition stops at 20, the last number whose square is printed is 19, as the next number, 22, would fail the condition.

```
for (x = 1; x <= 20; x += 3)
{
    System.out.println("x = " + x + "    x^2: " + x*x);
}
```

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Exercises

1. What does each statement print?
 - a)

```
for (int i = -3; i <= 3; i++)  
{  
    System.out.print("*");  
}
```
 - b)

```
for (int countDown = 5; countDown > 0; countDown--)  
{  
    System.out.println(countDown + " seconds");  
}
```
 - c)

```
for (char letter = 'P'; letter <= 'S'; letter++)  
{  
    System.out.println("Give me a " + letter);  
}
```
 - d)

```
for (int i = 2; i < 100; i *= i)  
{  
    System.out.println(i);  
}
```
2. Write statements that will print a table of values for the expression $y=2x+5$ for the indicated values of x .
 - a) $x=6,5,4,\dots,0$
 - b) $x=0,3,6,\dots,30$
 - c) $x=-15,-10,-5,\dots,15$
 - d) $x=1,2,4,8,\dots,1024$
3. Write a fragment that uses a for statement to perform the indicated action.
 - a) Set the double variable sum to the value of
$$\frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{1000}$$
 - b) Set the double variable sum to the value of
$$\sqrt{100} + \sqrt{200} + \sqrt{300} + \dots + \sqrt{5000}$$
 - c) Set the long variable product to the value of
$$1 \times 2 \times 3 \times \dots \times 20$$
 - d) Set the int variable total to the value of
$$(-12)^3 + (-11)^3 + (-10)^3 + \dots + (20)^3$$
 - e) Set the double variable sum to the value of
$$1 + \sqrt{2} + \sqrt[3]{3} + \sqrt[4]{4} + \dots + \sqrt[25]{25}$$
4. Write a program that reads a positive integer n and then prints an "n-times table" containing values up to $n \times n$. For example, if the program reads the value 5, it should print
$$\begin{array}{l} 5 \times 1 = 5 \\ 5 \times 2 = 10 \\ 5 \times 3 = 15 \\ 5 \times 4 = 20 \\ 5 \times 5 = 25 \end{array}$$

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Solutions

1. You can test these using the *interactions pane* in DrJava, or write a short program for each.

2. a) `for (int x = 6; x >= 0; x--)`

b) `for (int x = 0; x <= 30; x+=3)`

c) `for (int x = -15; x <= 15; x+=5)`

d) `for (int x = 1; x <= 1024; x*=2)`

3. a)

```
double sum = 0;
for (int i = 1; i <= 1000; i++)
{
    sum += 1.0/i;
}
```

b)

```
double sum = 0;
for (int i = 100; i <= 5000; i += 100)
{
    sum += Math.sqrt(i);
}
```

c)

```
long product = 1;
for (int i = 1; i <= 20; i++)
{
    product *= i;
}
```

d)

```
long total = 0;
for (int i = -12; i <= 20; i++)
{
    total += Math.pow(i,3);
}
```

e)

```
double sum = 0;
for (int i = 1; i <= 25; i++)
{
    sum += Math.pow(i, (1.0/i));
}
```

4.

```
class ForLoopExercise4
{
    public static void main(String [] args)
    {
        int n; // for the n-times table
        System.out.println("Which times table do you want?");
        n = In.getInt();
        for (int i = 1; i <= n; i++)
        {
            System.out.println(i + " x " + n + " = " + i*n);
        }
    }
}
```