

Mathematical Functions in Java

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Mathematical Functions in Java

- The **Math** Class: Built-in Mathematical Tools. Part of **java.lang** (automatically imported).
- Java's **Math** class simplifies complex calculations.
- Contains **methods** (reusable code blocks) and **constants**.
- Syntax:

`Math.methodName () or Math.CONSTANT`

- **Two key constants:**
 1. **Math.PI** ≈ 3.14159 (π).
 2. **Math.E** ≈ 2.71828 (base of natural logs)

```
double circumference = 2 * Math.PI * radius;  
double growth = Math.E * Math.pow(time, rate);
```



Trigonometric Methods

Core methods:

- `sin(radians)`, `cos(radians)`, `tan(radians)`.
- `toRadians(degrees)`, `toDegrees(radians)`.
- `asin(a)`, `acos(a)`, `atan(a)`.

```
Math.toDegrees(Math.PI / 2);           // → 90.0
Math.toRadians(30);                    // → 0.5236 (π/6)
Math.sin(0);                           // → 0.0
Math.sin(Math.toRadians(270));         // → -1.0
Math.cos(0);                           // → 1.0
Math.acos(0.5);                        // → 1.0472 (π/3)
Math.atan(1.0);                        // → 0.7854 (π/4)
```

Use `toRadians()` when input is in degrees.



Example

Task: create a program that:

- asks the user for an angle in degrees;
- converts it to radians;
- calculates and prints the sine, cosine, and tangent values for this angle.

```
Enter angle in degrees: 45  
Angle in radians: 0.7853981633974483  
Sine: 0.70710678118654755  
Cosine: 0.70710678118654755  
Tangent: 0.999999999999999999
```



```
import java.util.Scanner;

public class TrigonometricMethods {
    public static void main(String[] args) {
        Scanner scanner = new Scanner(System.in);

        System.out.print("Enter angle in degrees: ");
        double degrees = scanner.nextDouble();
        double radians = Math.toRadians(degrees);

        System.out.println("Angle in radians: " + radians);
        System.out.println("Sine: " + Math.sin(radians));
        System.out.println("Cosine: " + Math.cos(radians));
        System.out.println("Tangent: " + Math.tan(radians));

        scanner.close();
    }
}
```

```
Enter angle in degrees: 45
Angle in radians: 0.7853981633974483
Sine: 0.70710678118654755
Cosine: 0.70710678118654755
Tangent: 0.9999999999999999
```



Exponential Methods

Five key methods:

1. `exp(x)` → e^x .
2. `log(x)` → $\ln(x)$.
3. `log10(x)` → $\log_{10}(x)$.
4. `pow(a, b)` → a^b .
5. `sqrt(x)` → \sqrt{x} ($x \geq 0$).

```
Math.exp(3.5);           // → 33.11545 ( $e^{3.5}$ )
Math.log(3.5);          // → 1.25276 ( $\ln(3.5)$ )
Math.log10(3.5);       // → 0.544 ( $\log_{10}(3.5)$ )
Math.pow(2, 3);        // → 8.0 ( $2^3$ )
Math.pow(4.5, 2.5);    // → 42.9567 ( $4.5^{2.5}$ )
Math.sqrt(4);          // → 2.0 ( $\sqrt{4}$ )
Math.sqrt(10.5);       // → 3.24 ( $\sqrt{10.5}$ )
```



Rounding Methods

Four rounding tools:

1. `ceil(x)` → round **up** (double).
2. `floor(x)` → round **down** (double).
3. `rint(x)` → round to **nearest integer** (double; even if tie).
4. `round(x)` → returns int (float) or long (double).

```
Math.ceil(2.1);           // → 3.0
Math.ceil(-2.1);         // → -2.0
Math.floor(2.1);         // → 2.0
Math.floor(-2.1);        // → -3.0
Math.rint(2.1);          // → 2.0
Math.rint(2.5);          // → 2.0 (even)
Math.rint(3.5);          // → 4.0 (even)
Math.round(2.6f);        // → 3 (int)
Math.round(-2.6);        // → -3 (long)
```



Min, Max, and Absolute Value

Methods:

- `Math.max(a, b)` → larger of two values.
- `Math.min(a, b)` → smaller of two values.
- `Math.abs(x)` → absolute value ($|x|$).

```
Math.max(2, 3);           // → 3
Math.min(2.5, 4.6);      // → 2.5
Math.max(Math.max(2.5, 4.6), Math.min(3, 5.6)); // → 4.6
Math.abs(-2);            // → 2
Math.abs(-2.1);         // → 2.1
```

Example

Task: write a program that:

- takes two integers from the user;
- outputs the minimum of them;
- outputs the maximum of them;
- prints the absolute value for each number.

```
Enter first number: -5
Enter second number: 8
Minimum: -5
Maximum: 8
Absolute value of -5: 5
Absolute value of 8: 8
```

```
import java.util.Scanner;
```

```
public class BasicMathMethods {  
    public static void main(String[] args) {  
        Scanner scanner = new Scanner(System.in);  
  
        System.out.print("Enter first number: ");  
        int num1 = scanner.nextInt();  
  
        System.out.print("Enter second number: ");  
        int num2 = scanner.nextInt();  
  
        System.out.println("Minimum: " + Math.min(num1, num2));  
        System.out.println("Maximum: " + Math.max(num1, num2));  
        System.out.println("Absolute value of " + num1 + ": " + Math.abs(num1));  
        System.out.println("Absolute value of " + num2 + ": " + Math.abs(num2));  
  
        scanner.close();  
    }  
}
```

```
Enter first number: -5  
Enter second number: 8  
Minimum: -5  
Maximum: 8  
Absolute value of -5: 5  
Absolute value of 8: 8
```

Random Number Generation

Method: `Math.random()` → double in **[0.0, 1.0)**.

General formula:

`a + Math.random() * b` // random in `[a, a+b)`

```
(int)(Math.random() * 10);           // 0-9
50 + (int)(Math.random() * 50);      // 50-99
5.5 + Math.random() * 50.0;          // 5.5-55.5
```



Example

Task: create a program that:

- generates 5 random numbers in the range from 1 to 100;
- prints them to the screen in a single line, separated by commas;
- finds and prints the maximum of the generated numbers.

Random numbers: 23, 67, 12, 89, 45
Maximum random number: 89

```
public class RandomNumbersNoLoop {
    public static void main(String[] args) {
        // Generate 5 random integers in range [1; 100]
        int num1 = 1 + (int) (Math.random() * 100);
        int num2 = 1 + (int) (Math.random() * 100);
        int num3 = 1 + (int) (Math.random() * 100);
        int num4 = 1 + (int) (Math.random() * 100);
        int num5 = 1 + (int) (Math.random() * 100);

        System.out.println("Random numbers: " + num1 + ", " + num2 + ", " + num3 + ", " +
num4 + ", " + num5);
        // Find maximum using nested Math.max calls
        int max = Math.max(
            (Math.max(Math.max(num1, num2), Math.max(num3, num4)),
            num5
        );
        System.out.println("Maximum random number: " + max);
    }
}
```

Random numbers: 23, 67, 12, 89, 45
Maximum random number: 89

