

Math Class Puzzles

The Math class



Which tool for which job?

PAUSE AND TRY

Each job needs one Math method. Which one? Use the Quick Reference.

1 How far apart are 4 and 19 on a number line?

2 A square has area 64. How long is one side?

3 What is 2 to the 10th power?

4 Flip a coin: heads or tails, a different answer each run.

By the end of class you can...

- 1 Explain why Math needs no import and no object.
- 2 Use abs, pow and sqrt, and predict the type of each result.
- 3 Explain the range of values Math.random() can return.
- 4 Turn Math.random() into a random int or double in a chosen range.

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PART 1

Meet the Math class

Math: always available, only class methods



Math is in the **java.lang** package, which every program gets by default. No import, no object: call each method through the class name.

Header on the Quick Reference	What it returns
<code>static int abs(int x)</code>	the absolute value of an int
<code>static double abs(double x)</code>	the absolute value of a double
<code>static double pow(double base, double exponent)</code>	base raised to the power exponent
<code>static double sqrt(double x)</code>	the nonnegative square root of x
<code>static double random()</code>	a double ≥ 0.0 and < 1.0

abs: two versions, one name

PREDICT, THEN CHECK

```
System.out.println(Math.abs(-15));  
System.out.println(Math.abs(-0.75));  
System.out.println(Math.abs(9 - 20));
```

OUTPUT

```
15  
0.75  
11
```

Call	Argument type	Version that runs	Returns
Math.abs(-15)	int	int abs(int x)	int 15
Math.abs(-0.75)	double	double abs(double x)	double 0.75
Math.abs(9 - 20)	int (-11)	int abs(int x)	int 11

pow and sqrt always return a double

PREDICT, THEN CHECK

```
System.out.println(Math.pow(10, 3));  
System.out.println(Math.sqrt(144));  
System.out.println(Math.sqrt(2));  
System.out.println((int) Math.pow(10, 3));
```

OUTPUT

```
1000.0  
12.0  
1.4142135623730951  
1000
```



`Math.pow(a, b)` is `a` to the power `b`. `Math.sqrt(x)` is the nonnegative square root of `x`. Both come back as a **double**, whatever the arguments look like. A cast to **int** drops the decimal part.

A double result will not fit in an int



Storing the result of `pow` or `sqrt` in an **int** variable does not compile without a cast.

DOESN'T COMPILE

```
int big = Math.pow(10, 3);
```

```
error: incompatible types: possible  
lossy conversion from double to int
```

FIXED WITH A CAST

```
int big = (int) Math.pow(10, 3);
```

Now `big` holds **1000**.

Predict all three

PAUSE AND TRY

Write exactly what each line prints. Watch for .0.

```
System.out.println(Math.abs(-3) + Math.pow(4, 2));  
System.out.println(Math.sqrt(Math.abs(-81)));  
System.out.println((int) Math.sqrt(50));
```

1 _____
2 _____
3 _____

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PART 2

Math.random

KEY IDEA

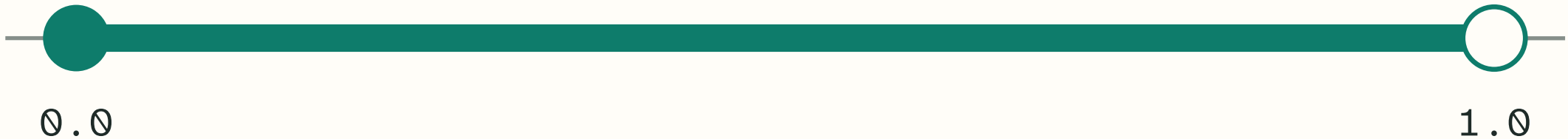
Math.random() is in [0.0, 1.0)



`Math.random()` returns a **double** that is **at least 0.0** and **less than 1.0**. Each call gives a different value.

included (inclusive)

never returned (exclusive)



$$0.0 \leq \text{Math.random()} < 1.0$$

WORKED EXAMPLE

From [0.0, 1.0) to 1 through 20

Expression	Smallest	Largest	What the step did
<code>Math.random()</code>	0.0	just under 1.0	start
<code>Math.random() * 20</code>	0.0	just under 20.0	stretch: 20 times as wide
<code>(int) (Math.random() * 20)</code>	0	19	cast: drop the decimal part
<code>(int) (Math.random() * 20) + 1</code>	1	20	shift: add 1 to every value



Multiply to set how many values, **cast** to make them whole, **add** to move the lowest value.

A random int from low through high

THE RECIPE

```
(int) (Math.random() * count) + low
```

```
count = high - low + 1
```

For 50 through 60

How many values?

$60 - 50 + 1 = 11$

Multiply by 11, then cast

0 through 10

Add the low end, 50

50 through 60

EXAMPLE: A RANDOM AGE FROM 50 THROUGH 60

```
int age = (int) (Math.random() * 11) + 50;
```



Both ends are included because the count includes them. Multiplying by $\text{high} - \text{low}$ (here 10) is the classic slip: then 60 can never appear.

The cast grabs only what comes right after it



A cast applies to the **one value right after it**. Put parentheses around the multiplication.

ALWAYS 1

```
(int) Math.random() * 20 + 1
```

`(int) Math.random()` is always 0, and `0 * 20 + 1` is 1.

1 THROUGH 20

```
(int) (Math.random() * 20) + 1
```

Multiply first, then cast, then add.

What values can each one produce?

PAUSE AND TRY

For each one: int or double? Smallest and largest possible value?

A `(int) (Math.random() * 8) + 3`

type ____ from ____ to ____

B `Math.random() * 8 + 3`

type ____ from ____ to ____

C `(int) (Math.random() * 8 + 3)`

type ____ from ____ to ____

Random doubles: leave out the cast

A WAIT TIME FROM 1.0 UP TO 3.5 SECONDS

```
double seconds = Math.random() * 2.5 + 1.0;
```

Expression	Smallest	Largest
Math.random()	0.0	just under 1.0
Math.random() * 2.5	0.0	just under 2.5
Math.random() * 2.5 + 1.0	1.0	just under 3.5



Each end of a range is **inclusive** (can happen) or **exclusive** (never happens). Here 1.0 is inclusive and 3.5 is exclusive.

A large, white, rounded square containing the number '3' in a bold, teal, sans-serif font.

3

PART 3

Putting Math to work

Square it, then undo it

SQUARE.JAVA

```
import java.util.Scanner;

public class Square {
    public static void main(String[] args) {
        Scanner console = new Scanner(System.in);
        double side = console.nextDouble();
        double area = Math.pow(side, 2);
        System.out.println(area);
        System.out.println(Math.sqrt(area));
    }
}
```

THE USER TYPES

2.5

OUTPUT

6.25
2.5

Scanner needs an import. **Math** does not: it is in java.lang.

Write the expression

PAUSE AND TRY

A card game needs a random card value from 2 through 14, both included.

```
int card = _____ ;
```

Hint: how many values are there from 2 through 14? Count both ends.

Words to know

java.lang

The package every program gets by default. Math lives here, so it needs no import.

Absolute value

A number without its minus sign. `Math.abs(-7)` is 7.

Overloaded

Same name, different parameter lists, like the `int` and `double` versions of `abs`.

Math.random()

Returns a double that is at least 0.0 and less than 1.0.

Inclusive

An end of a range that can happen, like 0.0 for `Math.random()`.

Exclusive

An end of a range that never happens, like 1.0 for `Math.random()`.

Count, multiply, cast, add



Explain to your partner how to build a random int from 10 through 30, both included.

SENTENCE STARTER

First I count ____ values. I multiply `Math.random()` by ____, cast with ____, and then add ____.

Next: the Math Class Puzzles worksheet.