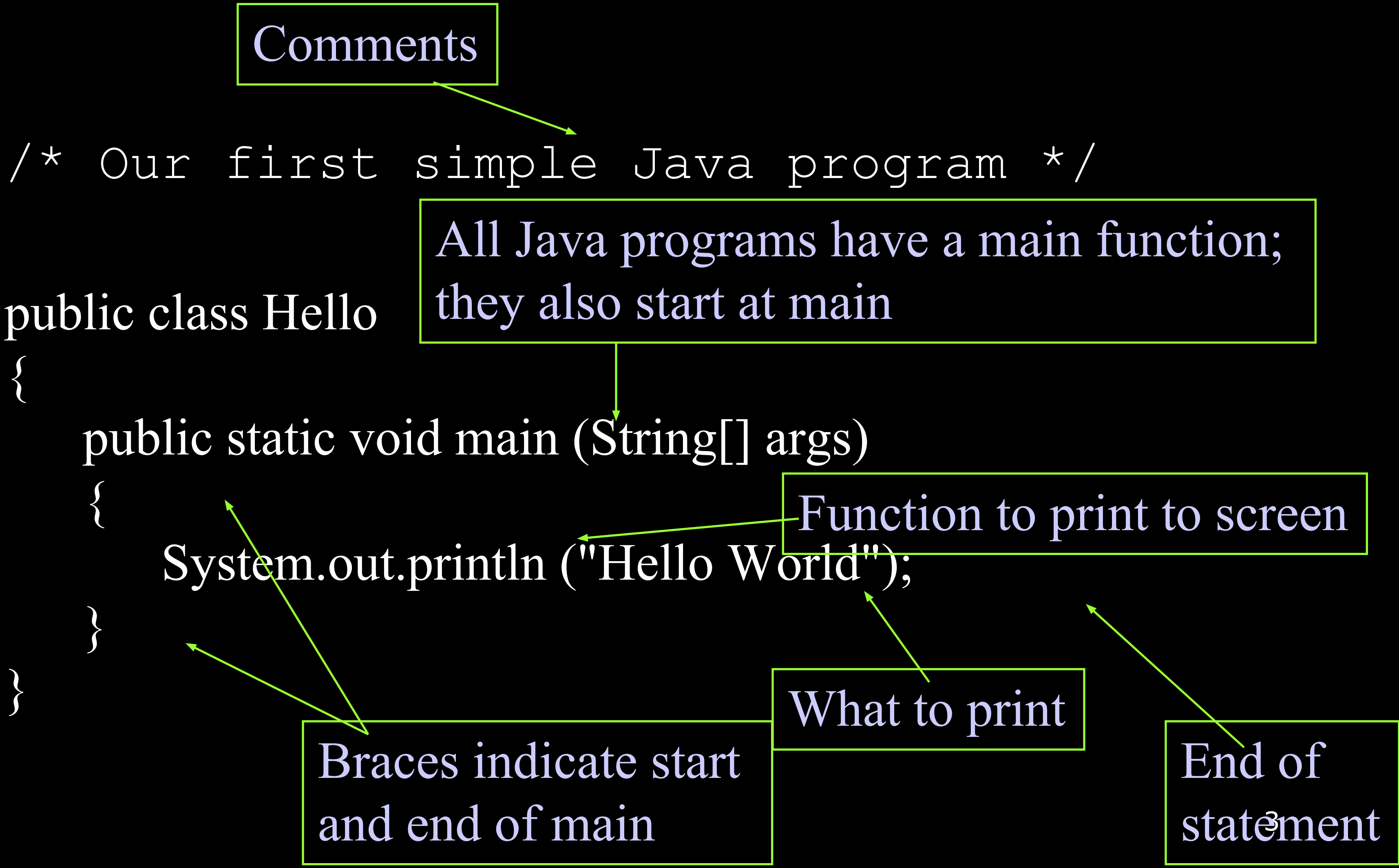
Java –
Data Types, Variables, Expression

SE 206

Simple Java Program

First Java Program



Comments

```
/* Our first simple Java program */

public class Hello
{
    public static void main (String[] args)
    {
        System.out.println ("Hello World");
    }
}
```

All Java programs have a main function; they also start at main

Function to print to screen

What to print

Braces indicate start and end of main

End of statement

Identifiers, Keyword, Statements

Identifiers

- Identifiers are names for variables, classes, methods etc.

- Good ones are compact, but inidicate what they stand for
  - radius, width, height, length

- Java is case sensitive (so as identifier).

- Rules:
  - May contain upper case, lower case letters, numbers, underscore, dollar sign.
  - Must not begin with a number.

Keywords

- Some words are reserved, and can’t be used as identifiers

```
// Authors: J. P. Cohoon and J. W. Davidson
// Purpose: display a quotation in a console window

public class DisplayForecast {

  // method main(): application entry point
  public static void main(String[] args) {
    System.out.print("I think there is a world market for");
    System.out.println(" maybe five computers.");
    System.out.println("   Thomas Watson, IBM, 1943.");
  }
}
```

Capitalization

- Case matters!

- public ≠ Public ≠ PUBLIC
  - This is different that FORTRAN and BASIC
  - This is the same as C/C++

Statements

- A statement in Java is (usually) a single line
  - Example: System.out.println (“Hello world!”);

- All statements must end with a semi-colon (like C)

Data types, Variables

Data Types

- Java is a “strong typed language”
  - Each variable has a declared type.

```
float x;      //x is a variable
x = 13.2;
```

- There are two kinds of data-types in Java:
  - Primitive types.
  - Classes (will be discussed later).

Java Primitive Types

- There are 8 primitive types in Java.
- Integer types:

byte	An 8-bit signed integer.
short	A 16-bit signed integer.
int	A 32-bit signed integer.
long	A 64-bit signed integer.

Java Primitive Types (Cont.)

- Floating point types:

Float	A 32-bit IEEE floating point.
double	A 64-bit IEEE floating point.

- Other types:

boolean	Either true or false.
char	A 16-bit Unicode character.

Primitive variable types

- Java has 8 (or so) primitive types:
  - float
  - double
  - boolean
  - char
  - byte
  - short
  - int
  - long

real numbers

two values: true and false

a single character

integer numbers

- Also the “void” type

Primitive real (floating-point) types

- A float takes up 4 bytes of space
  - Has 6 decimal places of accuracy: 3.14159
- A double takes up 8 bytes of space
  - Has 15 decimal places of accuracy: 3.14159265358979
- Always use doubles
  - It will save you quite a headache!

Primitive integer types

- Consider a byte:

0	1	0	0	0	1	0	1

- A Java `byte` can have values from -128 to 127
  - From -2^7 to 2^7-1
- C/C++ has unsigned versions; Java does not
- What would be the result for the following program?

```
byte a=127;
a+=1;
System.out.println(a);
```

- The Result will be: -128

Primitive integer types

Type	Bytes	Minimum value	Maximum value
byte	1	-2^{7}=-128	2^{7}-1=127
short	2	-2^{15}= -32,768	2^{15}-1= 32,767
int	4	-2^{31}=-2,147,483,648	2^{31}-1=2,147,483,647
long	8	-2^{63}=-9,223,372,036, 854,775,808	2^{63}-1=9,223,372,036, 854,775,807

Defining and initializing variables

- Variables must be declared before use
- Initialization:
    - int a = 30;   //initialization
- Assignment:
    - long b;
    - b=-20;   //assignment

Variable initialization

- Consider the following code:

```
int x;
System.out.println(x);
```

- What happens?

- Error message:
  - variable x might not have been initialized

- Java requires you to give x a value before you use it

Printing variables

- To print a variable to the screen, put it in a System.out.println() statement:

  - int x = 5;
  - System.out.println (“The value of x is ‟ + x);

- Important points:
  - Strings are enclosed in double quotes
  - If there are multiple parts to be printed, they are separated by a plus sign

Primitive character type

- All characters have a integer equivalent
  - ‘0’ = 48
  - ‘1’ = 49
  - ‘A’ = 65
  - ‘a’ = 97
- Thus, you can refer to ‘B’ as ‘A’+1
- Example:
  - char var=‘a’;   or, char var=97;
  - var++;   //now, var=‘b’
- There are no negative char. So the range of char is 0-65536

Primitive boolean type

- The boolean type has only two values:
  - true
  - false
- Example:
  - boolean var=true;
- There are boolean-specific operators
  - && is and
  - || is or
  - ! is not
  - etc.

Literals

- Integer literals:
  - Octal base: 034
  - Hexadecimal base: 0x3A
- Floating point literals:
  - Standard notation: 42.4362
  - Scientific notation: 424362E-4
- Boolean Literals:
  - The values of true and false do not convert into any numerical representation. (so, true ≠ 1)
- Character Literals:
  - \n – New line, \t – tab, \" – double quote, \' – single quote.
  - Enclosed by a single quote. 'a', '\n'
- String Literals:
  - Enclosing by a pair of double quotes.
    - "hello world"

Constants

- Consider the following:

```
final int x = 5;
```

- The value of x can NEVER be changed!
  - The value assigned to it is "final"

- This is how Java defines constants

Type Conversion & Casting

Type Conversion

- Automatic Type Conversion
- Casting Incompatible types

Automatic Type Conversion

- Automatic Type Conversion:
  - When two types are compatible
  - The destination type is larger that the source type.
  - Example:
    - int type is larger than byte value
    - The numeric types are compatible with each other.
  - The numeric types are not compatible with character or boolean
  - char and boolean are not compatible with each other.

Automatic Type Conversion

- short’s variable = byte’s variable → ok
- int’s variable = byte’s variable → ok
- byte’s variable = int’s variable → Error
- float’s variable = int’s variable → ok
- int’s variable = float’s variable → Error
- double’s variable = float’s variable → ok
- float’s variable = double’s variable → Error
- char’s variable = any other variable → Error
- int’s variable = char’s variable → ok
- short’s variable = char’s variable → Error
- boolean variable = any other variable → Error
- Any other variable = boolean variable → Error

Casting Incompatible Types:

- Casting Incompatible Types:
  - When narrowing conversion is occurred.
- Way:
  - (target-type) value
- Example:
  - int a=20;
  - byte b;
  - b=(byte) a;

Casting

- Consider the following code

```
double d = 3.6;
int x = Math.round(d);
```

- Java complains (about loss of precision). Why?

- Math.round() returns a long, not an int
  - So this is forcing a long value into an int variable

- How to fix this

```
double d = 3.6;
int x = (int) Math.round(d);
```

- You are telling Java that it is okay to do this
  - This is called "casting"
  - The type name is in parenthesis

More casting examples

- Consider

```
double d = 3.6;
int x = (int) d;
```

- At this point, x holds 3 (not 4!)
  - This truncates the value!

- Consider

```
int x = 300;
byte b = (byte) x;
System.out.println (b);
```

- What gets printed?
  - Recall that a byte can hold values -128 to 127
  - 44!
  - This is the “loss of precision”

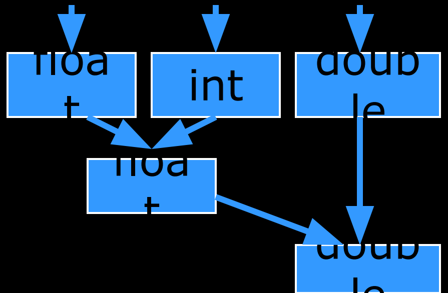
Automatic Type Promotion in Expressions

- Java automatically promotes each byte or short operand to int when evaluating an expression.
- Example:
  - byte a=40, b=50,c=60;
  - int d=a*b+c;   // here, d will be 2060
- Problem:
  - byte b=20;
  - b=b*2;   //Error: Can’t assign an int to a byte
- Solution:
  - b=(byte)(b*2);

The Type Promotion Rules

- All byte and short values are promoted to int
- If one operand is a long, the whole expression is promoted to long.
- If one operand is a double, the whole expression is promoted to double.
- How it works:

```
byte b=34;
char c = ‘a’;
short s=1023;
int i = 343;
float f=34.46f
double d = .23
double result = (f*b) + (i/c) - (d*s);
```



Expressions

- What is the value used to initialize expression

  ```
  int expression = 4 + 2 * 5;
  ```

- What value is displayed

  ```
  System.out.println(5 / 2.0);
  ```

- Java rules in a nutshell
  - Each operator has a precedence level and an associativity
    - Operators with higher precedence are done first
      - * and / have higher precedence than + and -
    - Associativity indicates how to handle ties
  - When floating-point is used the result is floating point

Question on expressions

- Does the following statement compute the average of double variables a, b, and c? Why or why not?

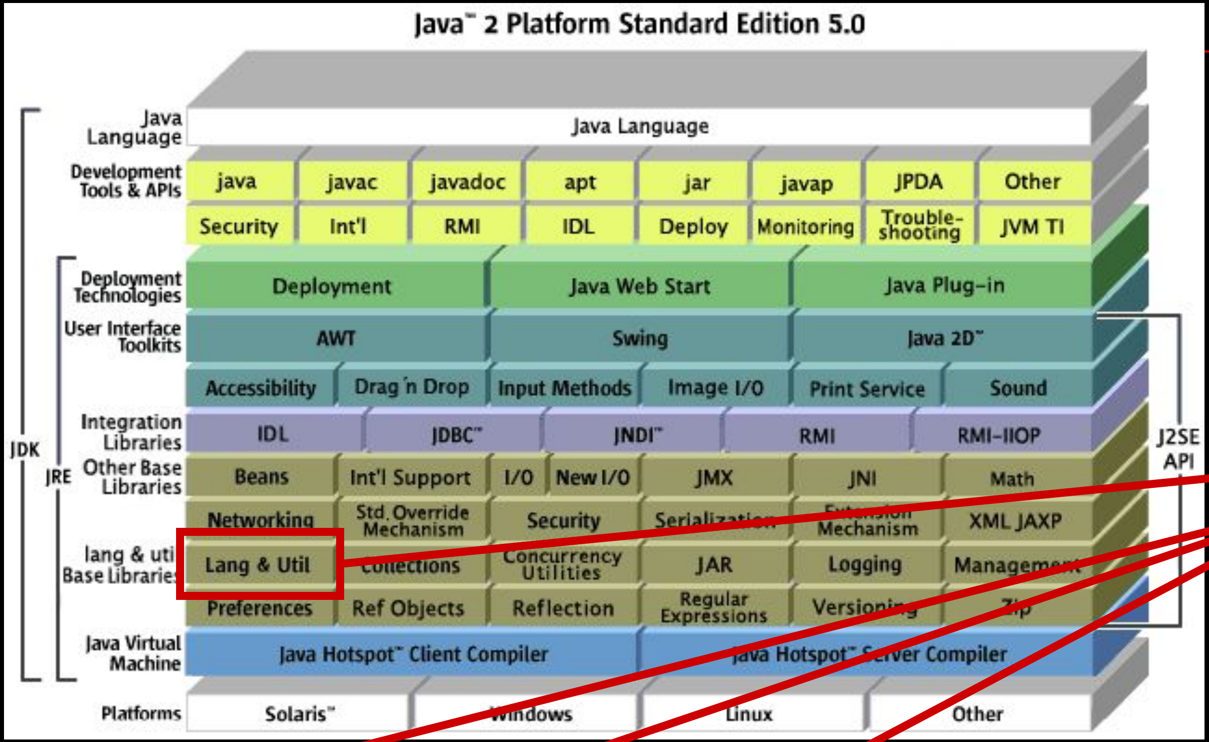
```
double average = a + b + c / 3.0;
```

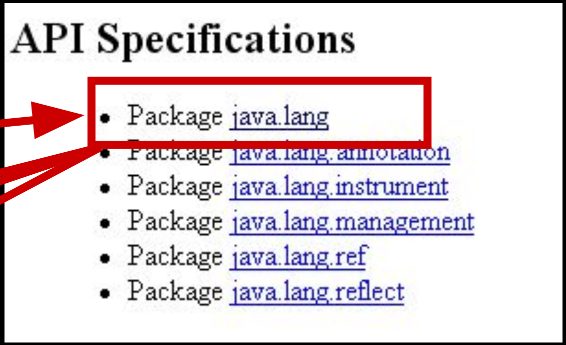
Using Math Library

About Math Library

- Math class is under the package of java.lang
- The class Math contains methods for performing basic numeric operations such as the elementary exponential, logarithm, square root, and trigonometric functions.
- How to use Math library:
  - double a=Math.round(34.64);
- Here is some homework.

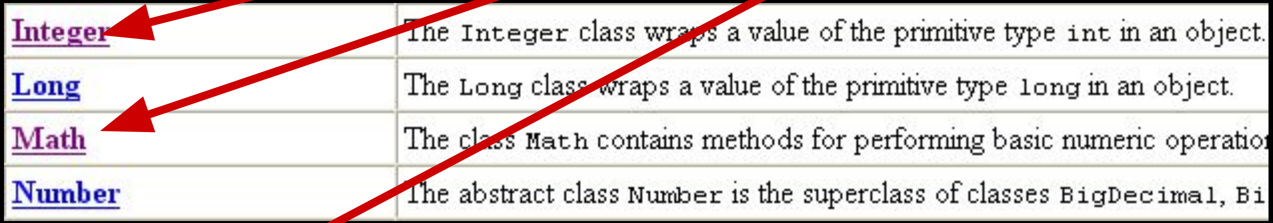
How to get help (From JDK Documentation)



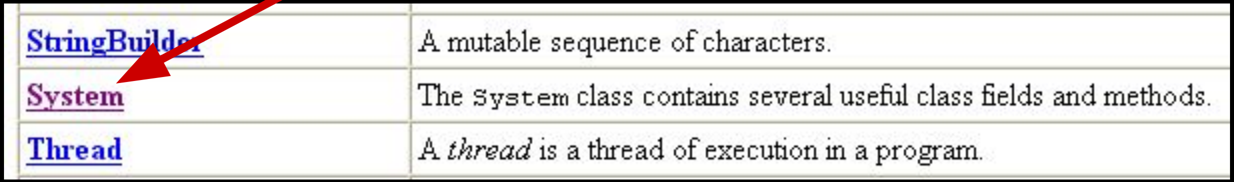


API Specifications

- Package java.lang
- Package java.lang.annotation
- Package java.lang.instrument
- Package java.lang.management
- Package java.lang.ref
- Package java.lang.reflect



Integer	The `Integer` class wraps a value of the primitive type `int` in an object.
Long	The `Long` class wraps a value of the primitive type `long` in an object.
Math	The class `Math` contains methods for performing basic numeric operatio
Number	The abstract class `Number` is the superclass of classes `BigDecimal`, `Bi`



StringBuilder	A mutable sequence of characters.
System	The `System` class contains several useful class fields and methods.
Thread	A *thread* is a thread of execution in a program.

Using Integer Class.

- Some Math functions: sin(), cos(), log(), sqrt()
- Using Integer Object:
  - int a = Integer.MAX_VALUE;
  - int b = Integer.SIZE;
  - String str=Integer.toString(123); //works as itoa()
  - int b=Integer.bitCount(10);

Take Input and Print output

I/O streams

- System.out
  - Prints to standard output
  - Equivalent to “cout” in C++, and “printf()” in C
- System.in
  - Reads from standard input
  - Equivalent to “cin” in C++, and “scanf()” in C
- System.err
  - Prints to standard error
  - Equivalent to “cerr” in C++, and “fprintf(stderr)” in C

System.out.println()

```
public static void main(String[] args) {
   System.out.print(“I want to believe that most of you");
   System.out.println(" want to be a very good programmer.”);
}
```

- Class System supplies objects that can print and read values
- System variable out references the standard printing object
  - Known as the standard output stream
- Variable out provides access to printing methods
  - print(): displays a value
  - println(): displays a value and moves cursor to the next line

Escape sequences

- Java provides escape sequences for printing special characters
  - \b backspace
  - \n newline
  - \t tab
  - \r carriage return
  - \\ backslash
  - \" double quote
  - \' single quote

Escape sequences

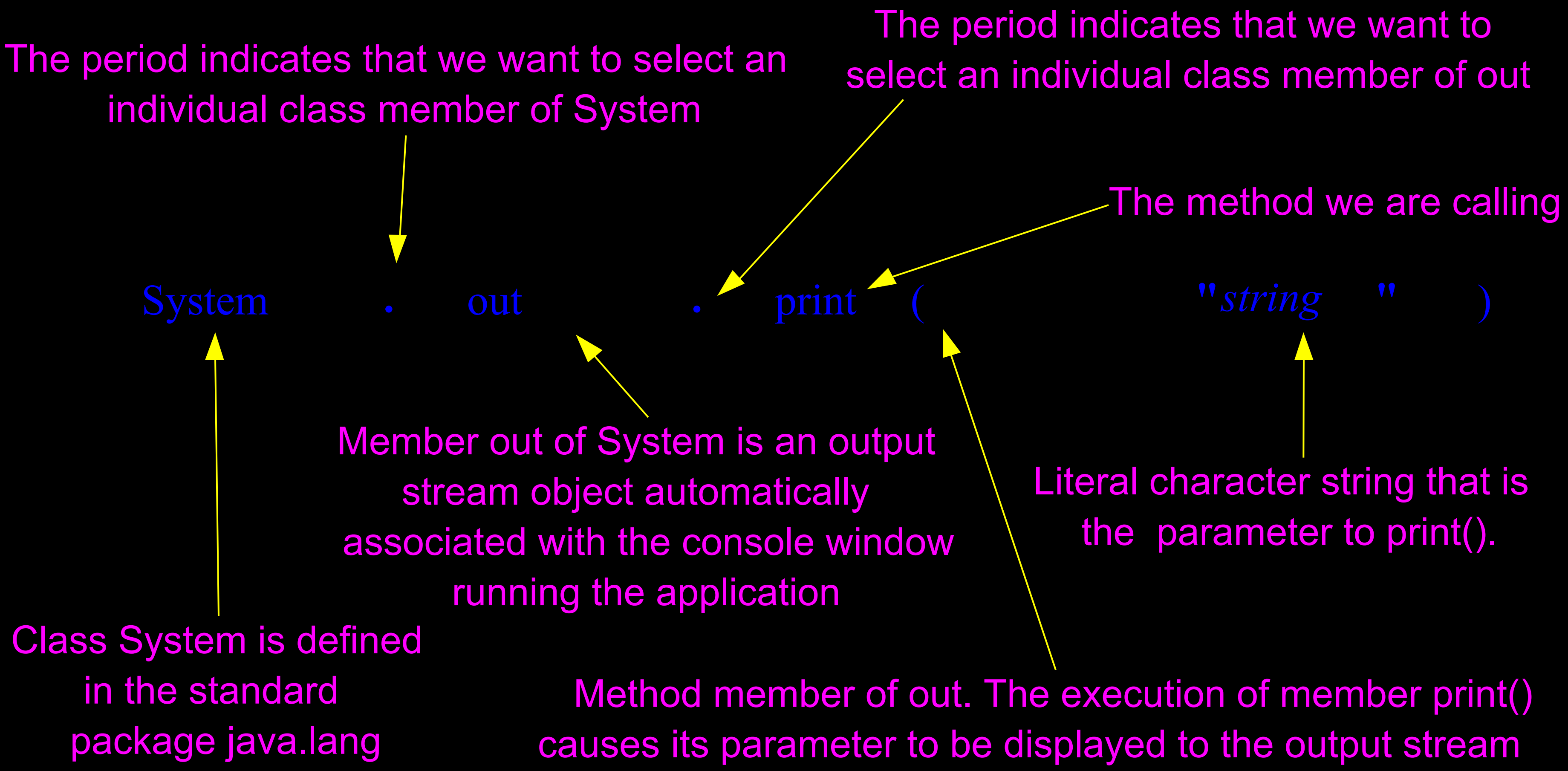
- What do these statements output?

```
System.out.println("Person\tHeight\tShoe size");
System.out.println("=============================");
System.out.println("Hannah\t5‘1\"\t7");
System.out.println("Jenna\t5'10\"\t9");
System.out.println("JJ\t6'1\"\t14");
```

- Output

```
Person  Height  Shoe size
=============================
Hannah  5‘1"    7
Jenna   5'10"   9
JJ      6'1"    14
```

Selection



The period indicates that we want to select an individual class member of System

The period indicates that we want to select an individual class member of out

The method we are calling

System . out . print ("*string* ")

Member out of System is an output stream object automatically associated with the console window running the application

Literal character string that is the parameter to print().

Class System is defined in the standard package java.lang

Method member of out. The execution of member print() causes its parameter to be displayed to the output stream

Example program: temperature conversion

```
// Purpose: Convert a Celsius temperature to Fahrenheit

public class CelsiusToFahrenheit {

      // main(): application entry point
      public static void main(String[] args) {
        // set Celsius temperature of interest
        int celsius = 28;

        // convert to Fahrenheit equivalent
        int fahrenheit = 32 + ((9 * celsius) / 5);

        // display result
        System.out.println("Celsius temperature");
        System.out.println("   " + celsius);
        System.out.println("equals Fahrenheit temperature");
        System.out.println("   " + fahrenheit);
      }
}
```

Homework (Math Library)

- Suppose you are given the following
  - double a=56.34, b=6.58334, c=-34.4265;
- Calculate the following value:
  - Print the pi’s value and e’s value
  - Print a random number.
  - Find the absolute value of the variable c
  - Find the square root of a
  - Find the maximum value between a and b
  - Calculate the value a^b
  - Round the number a
  - Calculate the value of $\sqrt{}(a^2+b^2)$
  - Find the floor, ceil and round value of b and c
  - Find the radian value of a.
  - Find the sin value of a where a represents the degree