Practice Questions, Final Review

1. Give the type and value of each of the following Java expressions. If an expression will not compile, write Illegal under type and put an X in value. You must fill in every entry. Entries left blank will be marked incorrect.

   (a) \((7 / 2) * 2.0\)
   
   (b) \((7 / 2.0) * 2\)
   
   (c) \(!(!false && !!true)\)
   
   (d) "1.1" + "2.2"
   
   (e) \((1 < 2 < 3)\)
   
   (f) \(1 + 2.2 + "1.1" + "a"\)
   
   (g) `Integer.valueOf("123")`
   
   (h) \(11 * 0.2\)
   
   (i) \((int) 11 * 0.2\)
   
   (j) \(11 * (int) 0.2\)
   
   (k) \((int) (11 * 0.2)\)

2. Assume that a, b, and c are variables of type int. Which of the conditions below is (are) always true if at least two of a, b, and c are equal?

   (a) \((a == b) && (a == c) && (b == c)\)
   
   (b) \((a == b) || (a == c) || (b == c)\)
   
   (c) \((a - b) \times (b - c) \times (a - c) == 0\)

3. Among the following code fragments, circle the ones that will not cause a compile-time error.

   (a) `int[] a = int[10];`
   
   (b) `int[] a = new int[10];`
   
   (c) `int[10] a = new int[10];`
   
   (d) `int[] a = {1, 2, 3}; int b = a;`
   
   (e) `int[] a;`
   
   (f) `int a = {1, 2, 3};`
   
   (g) `nt[]] a = [{1, 2, 3}, {1, 2, 3}];`
   
   (h) `int[][] a = new int[10];`
   
   (i) `int[] a = {1, 2, 3}; int[] b = a;`

4. For the purpose of this question, assume that you are developing static methods for your own statistics library MyStats.
(a) Write a public static method threeEqual() for MyStats that takes three int values as arguments and returns true if all three numbers are equal, false otherwise.

(b) Give the signature of a public static method median() for MyStats that is to take as an argument an array of int values and return the middle value. Do not give the code, just the signature (a single line of code).

(c) Give a single Java expression that a client of MyStats could use to test whether the medians of three arrays of int values int[] a, int[] b, and int[] c are all equal.

5. Short answers

(a) Which Java data type has only two values? ____________

(b) What is the value of the Java expression (.2 * (10 / 4)) ? ____________

(c) What is the value of the Java expression (.2 * 10 / 4) ? ____________

(d) What is the value of the Java expression (.2 * (10 / 4.0)) ? ____________

6. Consider the following code.

```java
public class Ball {
    private double rx, ry;
    public Ball() {
        rx = 0.5;
        ry = 0.5;
    }
    public void move() {
        rx = rx + .001;
        ry = ry + .002;
    }
    public void move(double vx, double vy) {
        rx = rx + vx;
        ry = ry + vy;
    }
    public static void main(String[] args) {
        private double vx, vy;
        Ball b1 = new Ball();
        Ball b2 = new Ball();
        b1.move();
        ... b2.move(vx, vy);
        ...
    }
}
```

In the blanks at left, give all line numbers that contain each of the entities described at right.
(a) instance variable declaration
(b) constructor signature
(c) object creation
(d) overloaded method signature
(e) method invocation or call
(f) primitive type variable declaration
(g) reference type variable declaration

7. Consider the following program.

```java
public class Conditionals {
    public static void main(String[] args) {
        java.util.Scanner in = new java.util.Scanner(System.in);
        int N = in.nextInt();
        String s = "a";
        String t = "b";
        if (N >= 10 && N <= 20)
            s = s + t;
        else if (N <= 5 || N >= 25)
            s = t + s;
        else if (N >= 30)
            s = s + s;
        else
            s = t + t;
        if (N % 3 == 0) {
            t = s + t;
        } else if (N % 5 != 0) {
            t = t + s;
        }
        System.out.println(s + t);
    }
}
```

(a) Give the result of executing this program user enters 15.
(b) What value of N corresponds to the following outputs
   i. abb
   ii. bababba
   iii. bab
   iv. bbb
   v. bbbbbbb
   vi. babab

8. Consider the following program.

```java
public class Mystery {
    public static void main(String[] args) {
        int N = args.length;
```
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#### 4

```java
String[] a = new String[N * 2];
for (int i = 0; i < N; i++) {
    a[i] = args[i];
    a[i + N] = args[N - i - 1];
}
for (int i = 0; i < a.length; i++)
    System.out.println(a[i] + " ");
System.out.println();
```

(a) What does this program print out when the following command is executed (from the command line)?
```
java Mystery aaa bbb ccc
```

(b) What does this program print out when the following command is executed (from the command line)?
```
java Mystery aaa bbb ccc | java Mystery xxx yyy
```

#### 9

9. Consider the following program, which is supposed to read in integer N from standard input, read N strings from standard input, and print them to standard output in reverse order.

```java
public class ReverseInputBuggy {
    public static void main(String[] args) {
        java.util.Scanner in = new java.util.Scanner(Std.in);
        int N = in.nextInt();
        String s;
        for (int i = 1; i < N; i++)
            s[i] = in.next();
        for (int i = N; i >= 0; i--)
            System.out.println(s[i]);
    }
}
```

This program has three bugs.

(a) Which bug prevents the program from compiling successfully? Identify the line number where the bug appears and give a correct version of this line of code.

```
Line number ______
Correct version:
```

(b) After fixing the first bug, which bug causes the program to crash? Identify the line number where the bug appears and give a correct version of this line of code.

```
Line number ______
Correct version:
```

(c) After fixing the first two bugs, which bug causes the program to produce incorrect output? Identify the line number where the bug appears and give a correct version of this line of code.

```
Line number ______
Correct version:
```
10. Implement the Java class `Digits`, which allows you to access a number by its individual digits. Here is the complete interface:

```java
public class Digits {
    // create Digits version of num
    // assume num >= 0
    public Digits(int num) { ... }

    // gets digit i of the number,
    // such that digit 1 is the left-most digit,
    // and digit numDigits() is the right-most digit
    // assume 1 <= i <= numDigits()
    public int getDigit(int i) { ... }

    // returns the number of digits in the number
    public int numDigits() { ... }

    // returns the integer itself
    public int getInt() { ... }
}
```

Here’s an example of using the class:

```java
Digits zero(0);
System.out.println(zero.numDigits() + " + zero.getDigit(1)); // prints: 1 0

Digits digits(5207);
System.out.println(digits.numDigits()); // prints: 4
System.out.println(digits.getDigit(1) + " + digits.getDigit(3)); // prints: 5 0
System.out.println(digits.getInt()); // prints: 5207
```

Hint: the modulus (%) and integer division operators will be useful in your implementation.

11. Write the Java function `lengthOfSortedSequence` which returns the length of the longest sorted sequence in an array. For this problem a sorted sequence is a sequence of non-decreasing values. Here are some examples:

<table>
<thead>
<tr>
<th>array</th>
<th>return value from <code>lengthOfSortedSequence(array)</code></th>
</tr>
</thead>
<tbody>
<tr>
<td>[-7 3 99 -10 0 43 10 20 30 5]</td>
<td>4</td>
</tr>
<tr>
<td>[-1, 2, 3, 3]</td>
<td>4</td>
</tr>
<tr>
<td>[5, 2, 1]</td>
<td>1</td>
</tr>
<tr>
<td>[1]</td>
<td>1</td>
</tr>
<tr>
<td>[]</td>
<td>0</td>
</tr>
</tbody>
</table>

12. Write a Java class `Point` that represents (x,y) point in a plain. The class should implement `Comparable` interface. The points should be compared based on their distance from the origin (point (0,0)). The
distance from the origin can be computed using 

$$distance = \sqrt{x^2 + y^2}.$$ 

Your class should implement all methods needed for the following code to compile and run successfully:

```java
Random r = new Random;
Point[] myPoints = new Point[10];
for (int i = 0; i < myPoints.length; i++)
    myPoints[i] = new Point(r.nextDouble(), r.nextDouble());
Array.sort(myPoints);
```

You do not need to provide any additional methods.

13. Implement the static method `mode`, which returns the value that occurs most often in an array of integers. You may assume the array has at least one element, and all of the values in the array are in the range $0 \text{ to } 100$. If there is more than one value that occurs most often, return the smallest such value (See Example 2 below). Here are some examples:

Example 1: array contains 99 86 99 99 95 86, `mode(array)` returns 99
Example 2: array contains 23 15 15 74 23, `mode(array)` returns 15
Example 3: array contains 76, `mode(array)` returns 76

For full credit, your answer must only traverse the data in array once. **Hint:** you are allowed to use additional memory.

14. For each of the following Java definitions, fill in the question marks (???) such that the given main class always prints the number 42. If it’s not possible to do this, then explain why. Try to keep your answers as simple as possible.

```
(a) class C {
    public int foo () {
        return 10;
    }
}
class S extends C {
            ???
}
class Main {
    public static void main (String[] args) {
        S x = new S(42);
        System.out.println(x.foo());
    }
}
```
(b)  
```java
class C {
    private int x;
    public C(int x) {
        this.x = x;
    }
    public int foo() {
        return x;
    }
}
```

```java
class S extends C {
    public S() {
        ???
    }
}
```

```java
class Main {
    public static void main(String[] args) {
        S x = new S();
        System.out.println(x.foo());
    }
}
```

(c)  
```java
class C {
    ???
}
```

```java
class Main {
    public static void main(String[] args) {
        C x = new C();
        C y = new C();
        System.out.println(x.get() + y.get() + 1);
    }
}
```

15. Implement a class that represents an amount of US money in dollars and cents. It should support these operations:

```java
public class Money implements Comparable {
    // data fields
    public Money(int dollars, int cents) {
        ...
    }
    public int getDollars() {
        ...
    }
    public int getCents() {
        ...
    }
    @Override
    public String toString() {
        ...
    }
    @Override
    public int compareTo(Money m) {
        ...
    }
    public static Money add(Money m1, Money m2) {
        ...
    }
}
```

Both dollars and cents should be non-negative. The constructor should set the value of dollars and cents to zero if a negative argument is passed to it. The value of cents should be stored as an integer between zero and 99. The constructor should convert the value of cents that exceeds 99 to whole
dollars. `toString()` method should produce a string starting with the dollar sign and with exactly two digits after the decimal point, for example, "$9.37", "$0.10", "$1500.00".

16. Write the method `sumSeries` that given an integer argument `n` will return as a double the following sum:

\[
\frac{1}{n} + \frac{2}{n-1} + \frac{3}{n-2} + \ldots + \frac{n-1}{2} + \frac{n}{1}.
\]

Do not write a full program with input and output, just the method.

Hints/Notes:

- You need only a single loop.
- The return value is a `double`, make sure that as the sum is computed using double division and not integer division.
- You don’t need to check for valid values of `n`, assume it’s an integer > 0.

17. Design an abstract `Shape` class that will be used in a graphical application. `Shape` is extended by `Circle` and `Rectangle`.

The data elements of the `Shape` class are:

- Two private integer variables, `x` and `y`, representing the coordinates of the center of the object.

The methods of the `Shape` class are:

- A protected constructor that accepts two arguments: the coordinates of the center.
- Public methods to set and get the values of the coordinates of the center.
- The public abstract method `isInside`, which takes as arguments the coordinates of a point and returns the boolean value true/false if the point is inside the graphical object.

The additional data element of the `Circle` class is:

- The private integer variable `radius`.

The methods of the `Circle` class are:

- A constructor that accepts three arguments: the coordinates of the center and the radius.
- Implementation of the `isInside` method.
  Note: to see if the point is inside the circle, verify if the distance from the point to the center is less than the radius. To compute the distance, assuming that `px` and `py` represent the coordinates of the point and `cx` and `cy` represent the coordinates of the center, use the formula:
  \[
  \text{Math.pow(Math.pow(px  cx, 2) + Math.pow(py  cy, 2)), 0.5)}
  \]

The additional data elements of the `Rectangle` class are:

- Two private integer variables, `horizontal` and `vertical`, representing the horizontal and vertical size of the rectangle.

The methods of the `Rectangle` class are:

- A constructor that accepts four arguments: the coordinates of the center and the size of the sides.
- Implementation of the `isInside` method.
18. Write the definition of the abstract class `Vehicle` that contains:

- a private double variable, `maxSpeed`
- a private double variable, `currentSpeed`
- a protected constructor accepting a double used to initialize the `maxSpeed` instance variable
- an abstract method, `accelerate`, that accepts no parameters and returns nothing.
- a method `getCurrentSpeed` that returns the value of `currentSpeed`
- a method `getMaxSpeed` that returns the value of `maxSpeed`
- a method, `pedalToTheMetal`, that repeatedly calls `accelerate` until the speed of the vehicle is equal to `maxSpeed`. `pedalToTheMetal` returns nothing.

If you were to implement the class `Car` that extends `Vehicle`, which methods would you need to implement (at a minimum)?