Practice with variables and types

1. Types. For each literal or expression, state its type (String, int, double, or boolean).

<table>
<thead>
<tr>
<th>Expression</th>
<th>Type</th>
<th>Expression</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>387</td>
<td>int</td>
<td>&quot;pancakes&quot;</td>
<td>String</td>
</tr>
<tr>
<td>true</td>
<td>boolean</td>
<td>45.0</td>
<td>double</td>
</tr>
<tr>
<td>&quot;14&quot;</td>
<td>String</td>
<td>87.98515</td>
<td>double</td>
</tr>
<tr>
<td>&quot;false&quot;</td>
<td>String</td>
<td>15 &gt;= 71</td>
<td>boolean</td>
</tr>
<tr>
<td>31.6 + 7</td>
<td>double</td>
<td>(double)(int)93.2</td>
<td>double</td>
</tr>
</tbody>
</table>

2. Declaring and using variables. Only one of the following code snippets is valid (i.e., will compile without errors). Which is it, and what’s wrong with each of the others?

**Code snippet A:**
```java
int x = 3;
int y = 17;
int x = x + y;
```
Variable x is declared twice.

**Code snippet B:**
```java
int num = 42;
double anotherNum = 81;
num = anotherNum - num;
```
anotherNum - num has type double, which cannot be stored in num, an int.

**Code snippet C:**
```java
int years = 18;
int months = 7;
double totalAge = years + months/12.0;
```
This one works!

**Code snippet D:**
```java
int p = 5;
int q = 43.7;
p = q;
```
Can’t assign a double (q) to an int (p).
3. **Casting.** For each of the following, add a cast to fix the type error.

```java
int i = 5;
double j = 21.3;
i = i + (int)j;
```

```java
int totalLabScore = 84;
int numLabs = 10;
double averageScore = (double)totalLabScore/numLabs;
```

Note: this doesn’t cause a compiler error, but it didn’t achieve the intended behavior of computing the average score, which should include the decimal places.

4. **Using variables.** Write a piece of code that asks the user to enter their height (as a number of feet and a number of inches, i.e., 5 7) and tells them their height in meters (i.e., 1.7018). (Note: there are 12 inches in a foot, and there are 3.28 feet in a meter.)

```java
System.out.println("Enter the number of feet");
int feet = keyboard.nextInt();
System.out.println("Enter the number of inches");
int inches = keyboard.nextInt();
System.out.println("Your height is: " + (feet + inches/12.0)/3.28);
```
Practice with if statements

1. Are they equivalent? Which of the following snippets of code do the same thing? That is, which print the same message(s) on every single input value for num?

**Code snippet A:**
```java
int num = keyboard.nextInt();
if(num > 54) {
    if(num > 82) {
        System.out.println("one");
    } else {
        System.out.println("two");
    }
} else {
    System.out.println("three");
}
```
When num > 82, prints “one”
When 82 ≥ num > 54, prints “two”
When num ≤ 54, prints “three”

**Code snippet B:**
```java
int num = keyboard.nextInt();
if(num > 82) {
    System.out.println("one");
} else if(num > 54) {
    System.out.println("two");
} else {
    System.out.println("three");
}
```
When num > 82, prints “one”
When 82 ≥ num > 54, prints “two”
When num ≤ 54, prints “three”

**Code snippet C:**
```java
int num = keyboard.nextInt();
if(num < 54) {
    System.out.println("three");
} else if(num > 82) {
    System.out.println("one");
} else {
    System.out.println("two");
}
```
When num > 82, prints “one”
When 82 ≥ num ≥ 54, prints “two”
When num < 54, prints “three” and “two”

**Code snippet D:**
```java
int num = keyboard.nextInt();
if(num > 54) {
    if(num < 82) {
        System.out.println("two");
    }
} else if(num > 82) {
    System.out.println("one");
} else {
    System.out.println("three");
}
```
When num > 82, prints nothing
When 82 > num > 54, prints “two”
When num ≤ 54, prints “three”

A and B do the same thing.
2. Old enough? Write some code that asks the user for their age and then prints out whether they are old enough to:

1. Vote (age 18)
2. Get a driver’s license in MA (age 16)
3. Rent a car (age 25)
4. Drink legally (age 21)

```java
System.out.println("How old are you?");
int age = keyboard.nextInt();

if(age >= 16) {
    System.out.println("You can drive");
    if(age >= 18) {
        System.out.println("You can vote");
        if(age >= 21) {
            System.out.println("You can drink");
            if(age >= 25) {
                System.out.println("You can rent a car");
            }
        }
    }
}

Other solutions are also possible.
3. Scope. Determine whether each of the following code snippets will compile successfully. If not, correct the error. Then determine what prints.

**Code snippet A:**
```java
int i = 5;
if(i > 2) {
    i = i * 7;
}
System.out.println(i);
```
Compiles and prints 35

**Code snippet B:**
```java
int i = 8;
int j = 0;
if(i % 2 == 0) {
    j = 4;
}
System.out.println(i + j);
```
The scope of $j$ is only inside the if statement. Can fix this by declaring and initializing $j$ before the if statement. With the above correction, 12 will print.

**Code snippet C:**
```java
int x = -3;
int y = -2;
if(x * y > 0) {
    int z = x + y;
    y = z * 2;
}
System.out.println(x + " " + y);
```
Compiles and prints "-3 -10"

**Code snippet D:**
```java
int num1 = 42;
int num2 = 0;
if(num1 < 10) {
    num2 = 3;
}
System.out.println(num2);
```
The compiler doesn’t know whether $num2$ will be initialized before the print statement. We can fix this by initializing $num2$ before the if statement. This prints 0.

4. Seasons. Write some code that asks the user to enter the current month (as an int, 1=January and 12=December) and then prints the season (Winter for Dec-Feb, Spring for Mar-May, Summer for June-Aug, Fall for Sep-Nov).

```java
System.out.println("What month is it?");
int month = keyboard.nextInt();
if(month == 12 || month <= 2) {
    System.out.println("Winter");
} else if(month <= 5) {
    System.out.println("Spring");
} else if(month <= 8) {
    System.out.println("Summer");
} else {
    System.out.println("Fall");
}
```
Practice with boolean expressions and order of operations

1. true or false? Evaluate each of the following boolean expressions when int x = 4 and int y = 6.

\[ x \leq 5 \text{ } || \text{ } y + x > 12 \text{ } && \text{ } !(x \% 3 == 1) \]

true. We have \( x \leq 5 \) is true, \( y + x > 12 \) is false, and \( x \% 3 == 1 \) is true, so \( !(x \% 3 == 1) \) is false. So our expression becomes \( true || false \text{ } && \text{ } false \), and the AND gets evaluated first, so \( true || false \), which is true.

\[ y/x > 1 \text{ } && \text{ } x != 17 \]

false. Since \( x \) and \( y \) are both ints, the quotient \( y/x \) is also an int, so it has value 1. We then have \( false \text{ } && \text{ } true \), which is false.

\[ !(y \% 4 \% 2 == 0 \text{ } || \text{ } !((x + y / 3) >= y)) \]

false. Simplifying this one step at a time, we have:

\[ !(6 \% 4 \% 2 == 0 \text{ } || \text{ } !((4 + 6 / 3) <= 6)) \]

\[ !(2 \% 2 == 0 \text{ } || \text{ } !((4 + 2 <= 6)) \]

\[ !(true \text{ } || \text{ } true) \]

\[ !true \text{ } || \text{ } false \]

\[ !true \]

false

2. What prints? What prints when each of the following pieces of code runs?

```java
int month = 2;
int day = 20;
System.out.println("Tomorrow is " + month/day);

Tomorrow is 0
```

```java
int month = 2;
int day = 20;
System.out.println("Tomorrow is " + month + "/" + day);

Tomorrow is 2/20
```

```java
int age = 19;
System.out.println("In three years your age will be: " + age + 3);
System.out.println("Your age in three years is: " + (age + 3));
System.out.println(age + 3 + " is your age in three years");

In three years your age will be 193
Your age in three years is: 22
22 is your age in three years
```
3. **Broken code.** Assume that the declaration and initialization `int x = 7;` appears somewhere earlier in the code. None of the following pieces of code will compile without error. Make a small change to fix the error without changing the intended meaning of the code.

```java
if(!x < 17) {
    System.out.println("yes");
}
```

```java
if(!(x < 17)) {
    System.out.println("yes");
}
```

*Needs parenthesis around `x < 17` because `!` has higher precedence than `<.`*

```java
int y = 4;
if(x < -1 || < y) {
    System.out.println("yes");
}
```

```java
int y = 4;
if(x < -1 || x < y) {
    System.out.println("yes");
}
```

*Needs a complete boolean expression on either side of the OR.*

```java
if(10 >= x > 2) {
    System.out.println("yes");
}
```

```java
if(10 >= x && x > 2) {
    System.out.println("yes");
}
```

*Can’t chain inequalities.*
Practice with loops

1. What prints? Consider the following while loop. What is the output?

```java
int i = 0;
while(i < 5) {
    int j = 0;
    while(j < 3) {
        System.out.print(i + j);
        j++;
    }
    System.out.println();
    i++;
}
```

```
012
123
234
345
456
```

2. while and for. Translate the following while loop into a for loop that does the same thing.

```java
int i = 0;
while(i < 100) {  
    System.out.println(i * 7);
    i++;
}
```

```java
for(int i = 0; i < 100; i++) {
    System.out.println(i * 7);
}
```

3. Pretty patterns. Write some nested while loops that print the following pattern:

```
*****
*  *
*  *
*  *
*  *
*****
```
int i = 0;
while(i < 6) {
    if(i == 0 || i == 5) {
        System.out.println("*****");
    } else {
        System.out.println("* * ");
    }
    i++;
}

Another solution that prints an n by n border for any int n:

int i = 0;
while(i < n) {
    if(i == 0 || i == n - 1) {
        int j = 0;
        while(j < n) {
            System.out.print("*");
            j++;
        }
        System.out.println();
    } else {
        System.out.print("*");
        int j = 0;
        while(j < n - 2) {
            System.out.print(" ");
            j++;
        }
        System.out.println("*");
    }
    i++;
}

And yet another solution:

for(int row = 0; row < n; row++) {
    for(int col = 0; col < n; col++) {
        if(row == 0 || row == n-1 || col == 0 || col == n-1) {
            System.out.print("*");
        } else {
            System.out.print(" ");
        }
    }
}
Other solutions are also possible.

4. Comparing code. Do the following two pieces of code do the same thing? If so, what do they both do? If not, change the second in some small way so that they do the same thing.

**Code snippet A:**

```java
for(int i = 1; i <= 10; i++) {
    System.out.println(i);
}

Prints 1 2 3 4 5 6 7 8 9 10
```

**Code snippet B:**

```java
for(int i = 10; i > 0; i--) {
    System.out.println(10 - i);
}

Prints 0 1 2 3 4 5 6 7 8 9
```

We can get them to do the same thing by making the second loop counter i start at 9.

5. Improving code that already works. What is stylistically not so great about the following piece of code? Fix it to improve the code style without changing what it does.

```java
int i = 0;
while(i < 1) {
    System.out.print(i + " ");
    i++;
}
System.out.println();
i = 0;
while(i < 2) {
    System.out.print(i + " ");
    i++;
}
System.out.println();
i = 0;
while(i < 3) {
    System.out.print(i + " ");
    i++;
}
System.out.println();
i = 0;
```
while(i < 4) {
    System.out.print(i + " ");
    i++;
}
System.out.println();

Since we’re repeating what is essentially the same code four times in a row, it would be better to put it in some sort of loop to make the code more concise. Here’s one way to do it:

for(int j = 1; j <= 4; j++) {
    int i = 0;
    while(i < j) {
        System.out.print(i + " ");
        i++;
    }
    System.out.println();
}

6. Finding factors. Write some code to print out all of the factors of all numbers from 1 to 100. For example, the first few lines of your code’s output should be:

1: 1
2: 1 2
3: 1 3
4: 1 2 4
5: 1 5

Do this twice, once with while loops and once with for loops.

Here’s a solution with while loops:

int i = 1;
while(i <= 100) {
    System.out.print(i + ": ");
    int j = 1;
    while(j <=i) {
        if(i % j == 0) {
            System.out.print(j + " ");
        }
        j++;
    }
    System.out.println();
    i++;
}

Here’s a solution with for loops:
for(int i = 1; i <= 100; i++) {
    System.out.print(i + ": ");
    for(int j = 1; j <= i; j++) {
        if(i % j == 0) {
            System.out.print(j + " ");
        }
    }
    System.out.println();
}
## Practice with methods

1. **Method headers.** Write the *header* for each of the following methods:

   - A method that, given a length and a width, prints out a rectangle of *s of the specified size.
     ```java
     public static void printRect(int length, int width)
     ```
   - A method that, given an integer \( n \), computes and returns \( n! \) (\( n! \), read as “\( n \) factorial,” is the product of all integers from 1 to \( n \)).
     ```java
     public static int factorial(int n)
     ```
   - A method that, given an integer \( x \), returns whether or not \( x \) is prime.
     ```java
     public static boolean isPrime(int x)
     ```
   - A method that, given an array of doubles, finds and returns the largest number stored in that array.
     ```java
     public static double findLargest(double[] theArray)
     ```
   - A method that, given a string and a character (stored in a variable of type `char`, which we haven’t talked about yet—a `char` is a single letter, number, or other symbol), returns a count of the number of times that character appears in the string.
     ```java
     public static int countChar(String str, char c)
     ```

2. **Method bodies.** Now write the *body* of the first three methods listed above. (The fourth method, which uses arrays, is something that you should be able to write at this point but is more involved than what I expect you to know about arrays on this exam. The fifth method, which involves manipulating Strings, is not something that I expect you to know how to write at this point.)

   I’ve interpreted the “length” of the rectangle to mean the number of rows, and the “width” to mean the number of columns.

   ```java
   public static void printRect(int length, int width) {
     for(int row = 0; row < length; row++) {
       for(int col = 0; col < width; col++) {
         System.out.print("*");
       }
       System.out.println();
     }
   }
   ```

   ```java
   public static int factorial(int n) {
     int result = 1;
     for(int i = n; i > 0; i--) {
       result = result * i;
     }
     return result;
   }
   ```
```java
public static boolean isPrime(int x) {
    for(int y = 2; y < x; y++) {
        if(x%y == 0) {
            return false;
        }
    }
    return true;
}
```

3. **Programs that use methods.** Write a program that asks the user to enter two prime numbers, then prints a rectangle of the dimensions specified by the user. Your program should ensure that the user behaves well (i.e., ask the user to try again until they’ve actually entered positive prime numbers). You can assume that the user will only enter integers. Your program should call the methods you wrote above, and you can feel free to write new methods if you’d like.

```java
public static void main(String [] args) {
    int firstNum = getAPrime();
    int secondNum = getAPrime();
    printRect(firstNum, secondNum);
}
```

```java
public static int getAPrime() {
    System.out.println("Enter a prime number.");
    int x = keyboard.nextInt();
    while(!isPrime(x)) {
        System.out.println("That wasn’t prime. Please try again.");
        x = keyboard.nextInt();
    }
    return x;
}
```

This program calls the isPrime and printRect methods written above.
**Practice with arrays**

1. **Creating arrays.** Write a piece of code to declare and allocate an array of size 10.

   ```java
   int[] myArray = new int[10];
   ```

   If we had wanted an array that stores values of a different type, we could have written this differently, e.g.:

   ```java
   double[] anotherArray = new double[10];
   boolean[] yetAnother = new boolean[10];
   ```

   and so forth.

2. **Storing values in arrays.** Write a piece of code to store multiples of 2 in an array.

   We'll use the array `myArray` declared above. I'm assuming that we want our multiples of 2 to start at 2.

   ```java
   for(int i = 0; i < myArray.length; i++) {
       myArray[i] = 2 * (i + 1);
   }
   ```

3. **Printing arrays.** Write a method that prints the contents of an array of ints.

   We've seen this one a few times at this point!

   ```java
   public static void printArray(int[] toPrint) {
       for(int i = 0; i < toPrint.length; i++) {
           System.out.print(toPrint[i] + " ");
       }
       System.out.println();
   }
   ```