Name: Key Key Key Section: __________

Instructions:

1. There are test questions on the front and the back of each sheet.

2. This is a closed book exam. Do not use any notes, books, or neighbors except your one page, two side, handwritten, cheat sheet which MUST be turned in with your exam.

3. Show your work. Partial credit will be given. Grading will be based on correctness and clarity.

4. You have 75 minutes to complete the exam. Watch your time appropriately. You should take about 15 minutes per question section.

Integrity: The University of Richmond’s Honor Code is “We, the students of the University of Richmond, shall promote and uphold a community of integrity and trust.” Upon accepting admission to University of Richmond, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning, and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the Richmond community from the requirements or the processes of the Honor System.

I agree to uphold this commitment and produce original work in this exam, i.e., I will not cheat nor will I consciously let anyone cheat.

Signature: ________________________________

DO NOT BEGIN THE EXAM UNTIL INSTRUCTED TO DO SO. GOOD LUCK!

<table>
<thead>
<tr>
<th>Question</th>
<th>Points</th>
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<tbody>
<tr>
<td></td>
<td>received</td>
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<td>5</td>
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<td>Bonus</td>
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<td>Total</td>
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1. Definitions (20 points, 2 points each). For each of the following, fill in the blanks with the most accurate term.

(a) Computer science is the study of computer architecture, problem solving, and interaction with computing devices.

(b) Computer programs typically run as a layer interacting directly with the operating system.

(c) The data type defines both the possible values of the data and the operations on the data.

(d) An expression is any combination of variables, operators, and function calls that generates a new value.

(e) Type conversion is the process of reinterpreting the value of a variable as a new data type. It can happen in two ways, explicitly with a cast or implicitly by the compiler.

(f) The sequence of statements that the program executes is called the control flow, also referring to the possible paths the program could take.

(g) When a control structure is located within another control structure, this is referred to as nesting.

(h) Scope is the lifetime of a variable. In other words, it defines where in a program you are allowed to use a variable.

(i) Creating two or more functions with the same name but different argument lists is referred to as overloading.

(j) Methods are useful for providing organization to code and reducing the amount of duplicated code segments.
2. **Syntax** (20 points). The following question deal specifically with Java syntax. Always write snippets of code in valid Java. Don’t forget your semicolons (where appropriate).

(a) Write the signature of function `main` (2 points):

```java
public static void main(String[] args)
```

(b) Given the code: `String hello = "Hello";`. Write the snippets for the following (6 points):

<table>
<thead>
<tr>
<th>Type</th>
<th>String</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declaration</td>
<td>String hello</td>
</tr>
<tr>
<td>Variable</td>
<td>hello</td>
</tr>
<tr>
<td>Literal</td>
<td>&quot;Hello&quot;</td>
</tr>
<tr>
<td>Assignment</td>
<td>hello = &quot;Hello&quot;</td>
</tr>
<tr>
<td>Initialization</td>
<td>hello = &quot;Hello&quot;</td>
</tr>
</tbody>
</table>

(c) Given that `a` is a `double`, `b` is an `int`, and `c` is a `String`, what is the type of the expression `a*b + c`? (2 points)

```
String
```

(d) Write a snippet of code to convert a `String s` to a `double d` (2 points).

```java
double d = Double.parseDouble(s);
```

(e) Write a snippet of code to randomly generate an integer `c` in the range `[a, b]` where `a` is an integer and `b` is an integer (2 points). You must use `Math.random()`.

```java
int c = (int)(Math.random()*(b - a + 1)) + a;
```

(f) What is the Java keyword to immediately skip to the condition check of a loop (2 points)?

```
continue
```

(g) Given the function signature: `public static float foo(String s)`. Write snippets for the following (4 points):

<table>
<thead>
<tr>
<th>Privacy and memory context:</th>
<th>public static</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return type:</td>
<td>float</td>
</tr>
<tr>
<td>Method name:</td>
<td>foo</td>
</tr>
<tr>
<td>Parameter list:</td>
<td>String s</td>
</tr>
</tbody>
</table>
3. **Tracing** (30 points, 5 points each). For each of the following pieces of pseudocode or Java, determine the final output. No partial credit will be given in this section. You should assume there are no compiler errors and no runtime exceptions. Carefully, work through each example one step at a time.

(a) ```java
int x = 7;
int y = x;
x = 3*y;
y = x/2;
x = x + 1;
System.out.println(y+x);
```

Output: _____________ 32 _____________

(b) ```java
integer x ← 51;
if x % 7 = 5 then
    x ← x * 2;
else if x % 4 = 3 then
    x ← x / 2;
Output(x < 100);
```

Output: _____________ true _____________

(c) ```java
Real number x ← 6
Real number y ← -6
while x > 1 do
    x ← x / 2
    y ← y + x
Output(x + y)
```

Output: _____________ 0 _____________

(d) ```java
String s = "Hello";
int c = 0;
for(int a = s.length(); a > 1; --a) {
    if(s.charAt(s.length() - a) == s.charAt(s.length() - a + 1))
        c += 5;
    else
        c += 1;
}
System.out.println(c);
```

Output: _____________ 8 _____________
(e) public static double foo(int x) {
    int j = x/2;
    return j;
}

public static void main(String[] args) {
    System.out.print(foo(5) + 2.5);
}

Output: 4.5

(f) public static int bar(int y, int n) {
    for(int x = 0; x < n; ++x)
        for(int z = n; z > x; --z)
            ++y;
    return y;
}

public static void main(String[] args) {
    System.out.print(bar(14, 7));
}

Output: 42
4. **Diagramming** (20 points, 5 points each). For each of the following create a flow chart (circles, blocks, diamonds, arrows, and labels), but do not describe the individual elements. Simply label items appropriately.

(a) General algorithmic process.

(b) Basic computer organization.

(c) Control flow of a **for** loop.

(d) Control flow of a **do-while** loop.
5. **Algorithm** (10 points). For the following question, please write pseudocode (not Java code) for a function.

Say you have a module called `Distribution` with the function `nextRandom()`. You are given an integer \( N \). Compute the standard deviation \( \text{stdev} \) of \( N \) calls to `Distribution.nextRandom()`. Use the following equation:

\[
\text{stdev} = \sqrt{\left( \frac{1}{N} \sum_{i=0}^{N-1} x_i^2 \right) - \bar{x}^2}
\]

where \( \Sigma \) means the sum, \( x_i \) is the \( i \)th element of the sequence, and \( \bar{x} \) is the mean (average) of the sequence. **Hint**: Use a single loop to simultaneously sum the numbers for the average and sum the square of the numbers.

**Function StDev**

**Input**: Integer \( N \)

**Output**: Standard deviation \( \text{stdev} \)

\[
\begin{align*}
\text{sum} & \leftarrow 0, \text{sqsum} \leftarrow 0 \\
\text{for } i \leftarrow 1 \ldots N \text{ do} & \\
& \quad v \leftarrow \text{Distribution.nextRandom()} \\
& \quad \text{sum} \leftarrow \text{sum} + v \\
& \quad \text{sqsum} \leftarrow \text{sqsum} + v^2 \\
& \text{mean} \leftarrow \text{sum}/N \\
\text{return } & \sqrt{\text{sqsum}/N - \text{mean}^2}
\end{align*}
\]
6. **Bonus** (up to 10 points, 5 points each). Answer the following conceptual or programming questions on computing and Java.

(a) What is bytecode? What generates bytecode? What runs bytecode? Why is bytecode beneficial?

Bytecode is a set of architecture independent instructions specific to the Java programming language (similar to 0s and 1s for computers). A Java compiler generates it (.class files). The Java Virtual Machine (JVM) runs it (program java at the command line). Bytecode allows Java programs to be portable between any machine (assuming they have the appropriate JVM installed).

(b) Write a valid switch statement for handling a keyboard press to move a point. Assume the key pressed is stored in a char named key and the point has an x and y value. When ‘a’, ‘s’, ‘d’, or ‘w’ is typed move the point by 1 unit in an appropriate direction. If any other key is pressed reset the point to the origin.

```java
switch(key) {
    case 'a': x -= 1; break;
    case 's': y -= 1; break;
    case 'd': x += 1; break;
    case 'w': y += 1; break;
    default: x = y = 0; break;
}
```