1 Sorting

1.1 Fill in the missing code. The number of lines corresponds to the answer key. Your code may vary.

```java
public class Bug implements Comparable {
    int num_legs; // sort by this first
    int num_eyes; // sort by this if num_legs is equal
    @Override
    public int compareTo(Object o) {
        Bug that = (Bug) o;
        ..........
        int diff = this.num_legs - that.num_legs;
        ..........
        if (diff != 0) return diff;
        ..........
        return this.num_eyes - that.num_eyes;
        ..........
    }
    public static void main(String[] args) {}
}
```

1.2 What kind of sort is this? Rewrite it to use ArrayList.

```java
static void sort(int start, int[] values) {
    if (values.length - start < 2)
        return;
    int m = start;
    for (int i = start + 1; i < values.length; i++)
        if (values[i] < values[m])
            m = i;
    int tmp = values[m];
    values[m] = values[start];
    values[start] = tmp;
    sort(start + 1, values);
}
```

This is a selection sort because it keeps finding the minimum and moving it to the start.

```java
static void sort(int start, ArrayList<Integer> values) {
    if (values.size() - start < 2)
        return;
    int m = start;
    for (int i = start + 1; i < values.size(); i++)
        if (values.get(i) < values.get(m))
            m = i;
    int tmp = values.get(m);
    values.set(m, values.get(start));
    values.set(start, tmp);
    sort(start + 1, values);
}
```
2 Anonymous Inner Classes

2.1
Given the interface defined like this:

```java
public interface KeyListener {
    void keyPressed(char key);
    void keyReleased(char key);
}
```

Write a complete program that uses an anonymous inner class that implements this interface, then calls keyPressed() to print the key character to the screen.

```java
public class Test {
    public static void main(String[] args) {
        KeyListener kl = new KeyListener() {
            public void keyPressed(char c) {
                System.out.println(c);
            }
            public void keyReleased(char c) {
                System.out.println(c);
            }
        };
        kl.keyPressed('A');
    }
}
```

3 Recursion

3.1
You want to implement combat within a role playing game on a computer. Specifically, the game rules for damage inflicted by a hit are:

- In order to figure out damage from one hit, you throw a N-sided die.
- The result of one throw will be between 1 and N (including both, e.g., a 6-sided die has six sides, labeled 1 to 6).
- If the result is 1 to N-1, that is the resulting damage from the hit.
- If the result in N, however, you hit critically, and you throw again, adding the results.
- If you throw again, the same rules apply, potentially resulting in doubly or more critical hits.

For example, if you use a 4-sided die and throw a 3, the damage is 3. If you throw a 4 instead, you throw again. If that results in a 3, the total damage is 7. If you happen to throw two 4s after each other and then a 2, the total damage is 10.

Fill in the missing code. The number of lines corresponds to the answer key. Your code may vary.

```java
final static Random rand = new Random();
public static int damage(int n) {
    int result = rand.nextInt(n) + 1;
    ...........
    if (result < n) return result;
    ...........
    return result + damage(n);
    ...........
}
```
3.2
What is wrong with the following program, what happens when you run it? If this method would have been implemented using a loop, and would have a similar error, what would happen then if run?

```java
public class JavaIsToJavascriptWhatCarIsToCarpet {
    public static int factorial(int n) {
        return (n * factorial(n - 1));
    }
    public static void main(String args[]) {
        factorial(4);
    }
}
```

There is an exit-condition missing in the recursive function. When run, you get a stack overflow. This is similar to infinite loops, so the same in an iterative program would result in a hang during execution.

4 Big O

4.1
What is the Big-O notation for the following function?

\[ T(N) = 100000 + 10N + N^{-2} \]

The leading term as N gets large is N, so...

\[ O(N) \]

4.2
What is the Big O speed for a binary search? For a bubble sort? For a quick sort?

For binary search it’s \( O(\log N) \).

For bubble sort it’s \( O(N \log N) \).

For quick sort it’s \( O(N^2) \).