Name: ______________________________ **Date:** ______________

Complete the following problems individually and completely without the use of any external materials.

1. What is the range of an `int` in Java?

2. What would be the output of the following code?

```
public class UACat {
    public String name;
}

UACat c1 = new UACat();
UACat c2 = new UACat();
UACat c3 = new UACat();
UACat c4 = new UACat();
UACat c5 = new UACat();

c1 = c2;
c2 = c3;
c3 = c1;
c4 = c5;
c5 = c1;

c1.name = "Mackey";
c2.name = "Sophia";
c3.name = "Rex";
c4.name = "Minho";
c5.name = "Sue";


System.out.println(c1.name);
System.out.println(c2.name);
System.out.println(c3.name);
System.out.println(c4.name);
System.out.println(c5.name);
```

3. Define a class named UAExam with a method named hash that accepts one parameters of type PARM1. The method should return an ABC object. The method should be accessible by objects only within the same package, but not globally. The class should contain a field of type NG1 named NG1PARM that is unique per instance of UAExam. The class should contain a field that is the same for **all** instances of type G1 named G1PARM.

4. Create a class named UAChild that is a child class of UAParent. It should also utilize the following interface:

```
public interface MyInterface {
     ABC XYZ(VAR1 TYPE1);
}
```

The method implemented in the interface accepts one parameter. Create a field within the UAChild class that corresponds to the same variable name and type as presented in the interface method parameter. Implement any methods that are required for this class to compile. Write the accessor and mutator methods for any fields created in the UAChild class. Set the field within the method as indicated in the interface (in other words, add the functionality in your UAChild class to assign the parameters of the method to the field you defined).

5. State the tightest asymptotic complexity for the following algorithm. Be sure to show your work.

```
for ( int a = 0; a < Math.pow(n,2); a++ ) {
   for ( int i = 0; i < a; i++ ) {
      int j = 1;

      while ( j <= n ) {
         System.out.println("Mackey");
         j <<= 1;    // you should know what this operator does
      }
   }
}
```

6. Write an algorithm that will find a key within a sorted array of integers A that runs in $\mathcal{O}(lg\, n)$ time. The method should be named `int find(int[] A, int x)` and it should return the index within the array of the value x. For example, assume that $A = \{10, 20, 30, 40\}$ and we called `find(A, 20)`, the result would be 1 as $A[1] = 20$.

7. Create a class named `UAStudent` that contains a single field of type `int` named `empId`, a field named `next` of type `UAStudent`, and a field named `prev` of type `UAStudent` that should only be accessible within the same package. The class should be a child class of `UAFS`. Write the appropriate get and set methods for these fields. The class should utilize the `UAFS1` and `UAFS2` interfaces.

8. Create a class named `UATest` that is executable. Create three nodes of type `UAStudent` from the previous problem. Build a doubly-linked list of these nodes with employee IDs of 10, 20, and 30. (Hint: you only have to populate and connect them.) Write a loop that will iterate through this linked list (do not create an infinite loop).

9. Solve the following problem *mathematically*. Be sure to show your work to receive **any** credit.

$$gcd(275, 150)$$

10. Write a **recursive** algorithm that will iterate through an array A and calculate the sum of every three numbers (starting with the first number). For example, $A = \{1, 2, 3, 4, 5, 6, 7\}$, you would find the sum of $1 + 4 + 7 = 12$.

11. Explain why calculating the Fibonacci sequence as $fib(i) = fib(i-1) + fib(i-2)$ results in a runtime of $\mathcal{O}(2^n)$.

12. State the asymptotic complexity of an algorithm that demonstrates the following number of iterations:

$$1 + 2 + 3 + 4 + ... + n = \sum_{i}^{n} i$$

13. State the following equation in $\mathcal{O}(\cdot)$ notation. Use the tightest asymptotic bounds.

$$T(n) = \sqrt{n + 175} - \frac{(n^2 - 6n - 9)^2}{(n - 3)}$$