

1. Matching [5 pts]

. Choose the **best** definition for each of the words below.

1. _____ Array
 2. _____ Iteration
 3. _____ Polymorphism
 4. _____ Private method
 5. _____ Vector
- A.** The process by which method calls are resolved at runtime based on the actual type of the object on which the method is invoked.
 - B.** A fixed length data structure that has elements of a specific type
 - C.** A programming technique in which loops are used to allow an action to be taken multiple times.
 - D.** A method that returns a boolean value.
 - E.** A method that is accessible by all classes
 - F.** A programming technique whereby a method calls itself.
 - G.** The ability of an instance of a subclass to be treated as if it were an instance of its super class
 - H.** A dynamic data structure that stores a collection of objects.
 - I.** The case in a recursive method in which no recursion is required, as the answer is immediately known.
 - J.** A method that is accesible only by a class and its inner classes.
 - K.** The process by which method calls are resolved at compile time based on the declared type of the object on which the method is invoked.

2. Tracing [15 pts]

What is the output when the main method in the code below is run?

```
class TraceSuper {
    public String name;
    public int value;
    TraceSuper() {
        this("Parent", 4);
        showScore("default-super");
    }
    TraceSuper(String s, int v){
        value = v;
        name = s;
        showScore("2param-super");
    }
    void showScore(String s) {
        System.out.println(s + name + "(parent): " + value);
    }
}
//-----
public class TraceC extends TraceSuper {
    public TraceC(String n, int v ) {
        showScore(n);
    }
    void showScore(String s) {
        System.out.println(s + name + "(child): " + value);
    }
    public static void main(String[] args) {
        TraceSuper ar[] = new TraceSuper[2];

        ar[0] = new TraceC("Alpha", 3);
        ar[1] = new TraceSuper("Omega", 6);
        for(int i = 0; i < 2; i++ ) {
            ar[i].showScore("Team " + i + ": ");
        }
    }
} // end of main(String[] args)

} // end of class TraceC
```

3. Polymorphism [12 pts]

Given the following class hierarchy:

- Number is abstract.
- Comparable is an interface
- Double extends Number and implements Comparable

Consider code inside a method with the header

```
public void someMethod(Object o, Number a, Comparable b, Double c)
```

For each of the following array declarations, circle **all** assignments that are legal (as written, with no extra casts). Be sure to circle **all** that are legal.

3 (a) `Object[] arr1=new Object [5];`

<code>arr1[0]=o;</code>	<code>arr1[0]=a;</code>	<code>arr1[0]=b;</code>	<code>arr1[0]=c;</code>
<code>o=arr1[0];</code>	<code>a=arr1[0];</code>	<code>b=arr1[0];</code>	<code>c=arr1[0];</code>

3 (b) `Number[] arr2=new Number[5];`

<code>arr2[0]=o;</code>	<code>arr2[0]=a;</code>	<code>arr2[0]=b;</code>	<code>arr2[0]=c;</code>
<code>o=arr2[0];</code>	<code>a=arr2[0];</code>	<code>b=arr2[0];</code>	<code>c=arr2[0];</code>

3 (c) `Double[] arr4=new Double[5];`

<code>arr4[0]=o;</code>	<code>arr4[0]=a;</code>	<code>arr4[0]=b;</code>	<code>arr4[0]=c;</code>
<code>o=arr4[0];</code>	<code>a=arr4[0];</code>	<code>b=arr4[0];</code>	<code>c=arr4[0];</code>

3 (d) `Comparable[] arr3=new Comparable[5];`

<code>arr3[0]=o;</code>	<code>arr3[0]=a;</code>	<code>arr3[0]=b;</code>	<code>arr3[0]=c;</code>
<code>o=arr3[0];</code>	<code>a=arr3[0];</code>	<code>b=arr3[0];</code>	<code>c=arr3[0];</code>

4. Parameter Passing [12 pts]

Given the following code:

```
public class Test5 {  
  
    public static void total( int x, Integer sum ) {  
        sum.setValue(sum.getValue() + x);  
    }  
  
    public static void main(String[] args) {  
        Integer sum = new Integer(0);  
        total(5, sum);  
        total(-3, sum);  
        total(2, sum);  
        System.out.println("The total is " + sum);  
    } // end of main(String[] args)  
} // end of class Test5
```

The programmer expected the output to say `The total is 4`.

- 4 (a) Which of the following actually occurs with the code above:
- The code compiles without error and produces the expected output.
 - The code compiles without error, but produces some other output.
 - The code causes a compiler error.
- 4 (b) Explain your answer from (a). If the program works correctly, explain why it does so, with specific reference to the concept of parameter passing. If the program produces the incorrect output, include the actual output in your explanation. If the program will not compile, include why in your explanation.
- 4 (c) If the program does not work properly, fix the code so that it works properly by clearly marking your changes above. Your fix may not be superficial, i.e. you may not simply cross out all of the code and simply print the expected output. Your fix should address the issues explained in (b).

5. Iteration [11 pts]

Write the method `public int countDigitsMatching(int x, int num)` which returns the number of digits in `x` which match `num`. You may assume that $0 \leq \text{num} \leq 9$. You **must use iteration only** for this method. If you do not use iteration, or if you use any recursion, you will receive no credit.

```
public int countDigitsMatching(int x, int num) {
```

```
}
```

6. Recursion [13 pts]

Write the method `public int fibonacci(int n)` which the n^{th} fibonacci number. Remember that the a fibonacci number is obtained by summing the previous two fibonacci numbers, and that the 0^{th} and 1^{st} terms are 1. You **must use recursion only** for this method. If you do not use recursion, or if you use any iteration, you will receive no credit.

```
public int fibonacci(int n) {
```

```
}
```

7. Arrays [16 pts]

Write the method **public int countEvens(int[] data)** which returns the number of even elements in **data**. You may use iteration and/or recursion, as you see fit for this problem. You may assume that **data** is non-null.

```
public int countEvens(int[] data) {
```

```
}
```

8. **Vectors [16 pts]**

Write the method **public int countGreaterThan(Vector data, int x)** which takes a Vector of Integers and returns a count of the number of even Integers in that Vector. You may use iteration and/or recursion, as you see fit for this problem. You may assume that **data** is non-null.

```
public int countGreaterThan(Vector data, int x) {
```

```
}
```