

1. Matching [5 pts]

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

1. _____ Recursion
 2. _____ Public method
 3. _____ Private method
 4. _____ Array
 5. _____ Polymorphism
- 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 int num;
    TraceSuper() {
        this(4);
        showNum("super-default");
    }
    TraceSuper(int n){
        num = n;
        showNum("super-int");
    }
    void showNum(String s) {
        System.out.println(s + num);
    }
}
//-----
public class TraceA extends TraceSuper {
    public TraceA(int n) {
        showNum("child-int");
    }
    void showNum(String s) {
        System.out.println("Child " + s + " " + num);
    }
}

public static void main(String[] args) {
    TraceSuper ar[] = new TraceSuper[2];

    ar[0] = new TraceA(2);
    ar[1] = new TraceSuper(1);
    for(int i = 0; i < 2; i++ ) {
        ar[i].showNum("index " + i + ": ");
    }
} // end of main(String[] args)

} // end of class TraceA
```

3. Polymorphism [12 pts]

Given the following class hierarchy:

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

Consider code inside a method with the header

```
public void someMethod(Object o, Number a, Comparable b, Integer 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) `Integer[] arr4=new Integer[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 (b) `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>

3 (c) `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 (d) `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>

4. Parameter Passing [12 pts]

Given the following code:

```
public class Test2 {  
  
    public static void product( int x, Integer result ) {  
        result.setValue(result.getValue() + x);  
    }  
  
    public static void main(String[] args) {  
        Integer result = new Integer(1);  
        product(5, result);  
        product(-3, result);  
        product(2, result);  
        System.out.println("The product is " + result);  
    } // end of main(String[] args)  
} // end of class Test2
```

The programmer expected the output to say `The product is -30`.

- 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 countWords(String s)` which returns a count of how many words there are in `s`. Words are delimited by spaces, tabs, and newlines (the default delimiter for `StringTokenizer`, which you may use).. 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 countWords(String s) {
```

```
}
```

6. Recursion [13 pts]

Write the method **public int factorial(int n)** which returns the factorial of **n**. Remember that **n** factorial is the product of all numbers from 1 to **n** and that the factorial of 0 is 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 factorial(int n) {
```

```
}
```

7. Arrays [16 pts]

Write the method **public double multiplyArray(double[] data)** which multiplies the elements of **data**. You may use iteration and/or recursion, as you see fit for this problem. You may assume that **data** is non-null, and has at least one element.

```
public double multiplyArray(double[] data) {
```

```
}
```

8. **Vectors** [**16 pts**]

Write the method **public int sumVector(Vector data)** which takes a Vector containing Integers and returns the sum of the elements of it. You may use iteration and/or recursion, as you see fit for this problem. You may assume that **data** is non-null, and has at least one element.

```
public int sumVector(Vector data) {
```

```
}
```