Show all of your work clearly in the space provided or on the additional page at the end of the exam. Be sure to **read each problem carefully**. Note that the exam is double sided. You are not required to provide comments in your code or include `import` statements.

1. (7 points) What will the following code display?

```
String word = "Exam";
char letter = word.charAt(0);
System.out.println(letter);
System.out.println(letter+3);
System.out.println(word+1);
```

2. (7 points) Complete the code snippet that displays the length of the string returned only if the string has at least one space in it. Treat a `null` string as a string with no spaces.

```
String sentence = JOptionPane.showInputDiaglog(null, "Enter a sentence.");

if (                                                                    ) {

    JOptionPane.showMessageDialog("That sentence has " + sentence.length() + "letters.");
}
```

3. (10 points) Circle TRUE or FALSE

TRUE | FALSE If Java encounters an `int` but needs a `long`, it will automatically convert the `int` to a `long`.

TRUE | FALSE The EventHandler interface declares only one method: handle() that accepts one argument.

TRUE | FALSE In a JavaFX program, the class containing main() must extend the Application class.

TRUE | FALSE In a JavaFX program, the class containing main() must override the start() method.

TRUE | FALSE A Button class in JavaFX is considered a listener since it "listens" for the user to press the button.

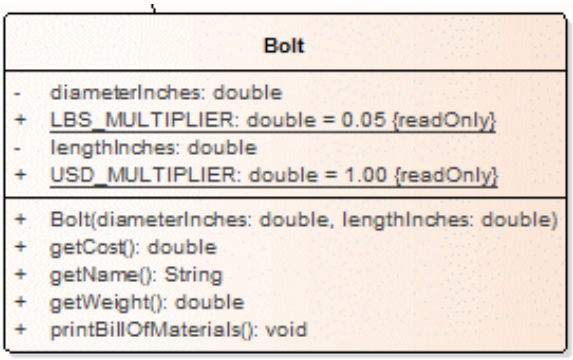
4. (7 points) Explain how aggregation promotes code reuse.

5. (7 points) Explain how inheritance promotes code reuse.

6. (6 points) Give an example of when to use an interface instead of an abstract class. Justify your answer.

7. (6 points) Give an example of when to use an abstract class instead of an interface. Justify your answer.

8. (5 points) Suppose a parent class has only one constructor that requires a String to be passed to it. Explain why a child of this class must have a constructor implemented within it.



9. (10 points)
Recall the Bolt class from lab 3. Override the .equals() method for the class so that two bolts with the same dimensions are considered equivalent.

10. (10 points) Draw a UML class diagram that includes the following interface and classes. Be sure to show the relationships between all entities.

- Trainable inteface which has one method: train() which accepts nothing and returns a `boolean` value indicating whether or not the object was trained successfully.
- Mammal class which includes a String to keep track of the mammal's hair color, a constructor that accepts the hair color as an argument, and the appropriate accessor method.
- Dog class which is a specific type of Mammal that implements the `Trainable` interface. Dogs need to keep track of their dog tag number (an integer).
- Human class which is a specific type of Mammal. Humans need to keep track of their social security number (an integer larger than what can be stored in an `int`).

11. (10 points) Implement the Trainable interface described above. Include all text found in the Trainable.java file.

12. (15 points) Implement the Dog class described in the problem on the previous page. Include all text found in the Dog.java file.