

This exam is due on Friday, December 13, at midnight. Write up your solutions to Problems 1, 2, and 3 electronically and put them in either a PDF file or a text file. Your solution to Problem 4 will be in the file `CS590_Exam_Q4.java` from the zip file. Zip up a copy of your solution document and your version of `CS590_Exam_Q4.java` and call the zip file `CS590Exam1Surname.zip` and submit it using Blackboard.

Everyone should work on this exam individually. You should turn in your own solution to each problem. If you have any questions about these problems, please write me an email.

1. (25 points) In Java, we always make a distinction between a reference variable and the object that it refers to. For example, the type that a reference variable has need not be the same as the type that the object it refers to has.

Instances of Java's `Class` class are used at runtime to represent Java types. In particular, an instance of the `Class` class can be used at runtime to answer a question about the type of a reference variable or the type of an object.

In each part below, determine if the instance of the `Class` class is being used to represent the type of an object or the type of a reference variable or neither. In each part, explain your reason for your answer. (Remember that (non-primitive) fields of a class and (non-primitive) formal parameters of a method are reference variables.)

- (a) `Class<?> c1 = x.getClass();`
- (b) `Class<?> c2 = x.getClass().getDeclaredFields()[0].getType();`
- (c) `Class<?> c3 = x.getClass().getDeclaredFields()[0].get(x).getClass();`
- (d) `Class<?> c4 = x.getClass().getMethods()[0].getDeclaringClass();`
- (e) `Class<?> c5 = x.getClass().getMethods()[0].getParameterTypes()[0];`
- (f) `Class<?> c6 = x.getClass().getInterfaces()[0];`

2. (25 points) This Java expression checks the type of the object referred to by `x`.

```
x instanceof Shape
```

This Java expression also checks the type of the object referred to by `x`.

```
x.getClass() == Shape.class
```

- (a) Carefully explain the difference between the two expressions.
- (b) Give an example of a few lines of code in which the first expression above would evaluate to `true` but the second expression above would evaluate to `false`.

3. (25 points) (a) Carefully explain *what* the following expression would evaluate to and *why* it evaluates that way.

`String.class.getClass()`

- (b) Carefully explain *what* the following expression would evaluate to and *why* it evaluates that way.

`Class.class.getClass()`

4. (25 points) In the zip file there is a file `CS590_Exam_Q4.java`. You need to complete the implementation of the function `callMathMethod()` in that file. Follow the directions in the file and write your answer in the file.

When the program runs correctly, the output looks like this.

```
-1
1.000000000000000002
1.0000001
```