Show all of your work clearly in the space provided or on the additional page at the end of the exam. If the additional page is used, clearly identify to which exam question it is related. Be sure to **read each problem carefully**. Note that the exam is double sided.

1. (20 points) True/False (**T** or **F**)

_____ If `import` java.lang.String is not present before the class declaration, all occurences of String must be replaced with java.lang.String.

_____ Math.PI is declared as a `private` attribute.

_____ If a method is overloaded, it means that there are two methods with exactly the same name that return different types (e.g., one returns String while the other returns `double`).

_____ Math.cos(30) is a call to a class method.

_____ Local variables declared in a constructor are only accessible within that constructor.

_____ A `private` attribute is accessible to all methods defined within the class.

_____ An accessor method must be declared as `static`.

_____ It is illegal to place `this` on the left side of the assignment operator. E.g.,

```
this = that;
```

_____ A constructor may call another constructor.

_____ A class may have two attributes with exactly the same name as long as they are from different types and one of them is declared with this. in front of it. E.g.,

```
private double number;
private int this.number;
```

2. (10 points) Give an example of a method implementation that makes use of the keyword: `this` to disambiguate between a local variable and an attribute.

```
public class Question2 {
  private double number;
```

}

4. (20 points) Recall the Complex class developed in lecture. The class contained two `private` attributes: real and imag (both `double`s). Implement the toString() method for the class such that it produces output consistent with the following examples:

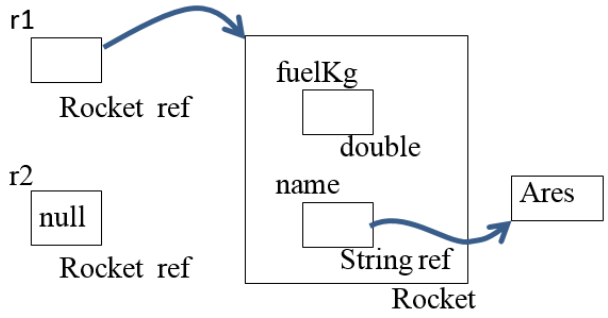
- **3.2** when the real component is 3.2 and the imaginary component is 0.0.
- **3.2 + i5.7** when the real component is 3.2 and the imaginary component is 5.7.
- **3.2 - i5.7** when the real component is 3.2 and the imaginary component is -5.7.
- **i5.7** when the real component is 0.0 and the imaginary component is 5.7.
- **-i5.7** when the real component is 0.0 and the imaginary component is -5.7.

5. (15 points) Suppose a Rocket class exists with two attributes: fuelKg (a double) and name (a String). Complete the following diagram that illustrates the state of memory at four points in the program on the right. The solution to step **(b)** is provided as an example.

(a)

```
Rocket r1 = null;
Rocket r2 = null;
// (a)
r1 = new Rocket("Ares");
// (b)
r1.setFuelKg(5000);
r2 = r1;
// (c)
r1 = new Rocket("Saturn IV");
// (d)
```

(b)



(c)

(d)

6. (15 points) Create a UML class diagram for a Fraction class that represents a fraction with a numerator and denominator and, if implemented, would allow the following code to run:

```
public static void main(String[] args) {
  Fraction f1 = new Fraction(1, 2);
  Fraction f2 = new Fraction(2, 1);
  Fraction f3 = new Fraction();
  System.out.println("Math alert: " + f1 + " + " + f2 + " = " + f1.plus(f2));
  System.out.println("Math alert: " + f1 + " - " + f3 + " = " + f1.minus(f3));
}
```

producing the following output:

```
Math alert: 1/2 + 2 = 5/2
Math alert: 1/2 - 1 = -1/2
```

7. (20 points) Partially implement the Fraction class from the previous problem. The class and the main method in the previous problem should compile without errors and all necessary constructors should be fully implemented, but any remaining methods do not need to be functional. For example, if you need a method called cabbage that returns a `double`, your implementation would look like this:

```
public double cabbage() {
  return 0.0;
}
```

Additional space — indentify which problem your work is associated with.