Statement of integrity: I did not, and will not, break the rules of academic integrity on this exam:

(Signature)

Circle Your Section:

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Instructions:

- Read all instructions carefully, and read each problem completely before starting it!
- This test is closed book – no calculators, reference sheets, or any other material allowed.
- Conciseness, clarity, and style all count. Show all work to receive partial credit, especially box diagrams.
- Carefully comment each loop and major variable.
- If you use `break` or `System.exit` to exit any control structure (except `switch`), you will lose points!
- You may not use Java arrays or any MATLAB code.
- You may not alter, add, or remove any code that surrounds the blanks and boxes.
- Only one statement, expression, modifier, type, or comment per blank!
- Use the backs of pages if you need more space or scrap. You may request additional sheets from a proctor.
- If you supply multiple answers, we will grade only one.

Core Points:

1. ________ (17 points) ________
2. ________ (43 points) ________
3. ________ (40 points) ________

Total: ________/(100 points) ________

Bonus Points:

_______/(5 bonus points) _______
Problem 1  [17 points] Code tracing, box scope diagrams

Complete the box scope diagrams up to the point indicated inside the following code that contains classes Problem1, Trewl, and Flurp. To help you out, do the following:

• Assume that all three classes belong to the same project.
• Use only the boxes we’ve drawn for you, including one box for the activation of the yalpu method.
• Do not draw boxes for constructor activations.
• Make sure that you fill in all initial values for instance and class variables.

See the next page for spare boxes, in case you need to redraw your solution. You must indicate which diagram we should grade! Otherwise, we will choose the first marked diagram for grading.

```java
class Problem1 {
    public static void main(String[] args) {
        Trewl t1 = new Trewl();
        Trewl t2 = new Trewl();
        t1.yalpu(t2).w = 10;
        Flurp f = new Flurp();
        f.w = t2.y;
        f.z = t2;

        // Complete diagrams up to this point.
    }
}
class Trewl {
    int y;
    Flurp yalpu(Trewl x) {
        x.y = 2;
        x = new Trewl();
        x.y = 3;
        return new Flurp();
    }
}
class Flurp {
    static int w;
    Trewl z;
}
```

---

You must indicate which diagram we should grade! Otherwise, we will choose the first marked diagram for grading.
Problem 2  [43 points] OOP, encapsulation, this, methods, conditions

Complete the following code in class Length by filling in the blanks and boxes. Length represents a measurement of length in inches (in) or centimeters (cm). This class has the following members:

• instance variable numlen that stores the numerical length.
• instance variable units that stores the unit label as a String, which may be "in" or "cm".
• constructor Length that sets numlen and units.
• instance method convert that takes as input a Length and a supplied unit label, compares the input Length’s units with the supplied unit label (using Java’s `equals` method), and does the following, if necessary:
  - sets the input Length’s numlen to the numerical length in terms of the supplied unit label
  - sets the input Length’s units to the supplied unit label
You do not need to account for illegal units. Hint: 1 in = 2.54 cm.
• instance method add that takes as input a Length and a supplied unit label and returns the sum of the input Length and current Length as a new Length in the units specified by the supplied unit label. Method add must call convert to perform any necessary unit conversions.
• instance method toString that returns a String containing the current numlen and units.

Note: In the box for convert, you must supply brief comments. We have supplied a Main Class that uses Length to add two measurements and convert the result to "cm". The output for method main is 2.0 in + 3.0 cm = 8.08 cm.

```java
public class Problem2 {
    public static void main(String[] args) {
        // Create two Lengths:
        Length x1 = new Length(2,"in"); // 2 inches
        Length x2 = new Length(3,"cm"); // 3 centimeters
        // Add $x1$ and $x2$ together and report result in cm:
        System.out.println( x1 + " + " + x2 + " = " + x1.add(x2,"cm") );
    }
} // Class Problem2

class Length {
    ______________ double numlen; // numerical length
    ______________ String units; // units of length
    // Construct a Length and set values of $numlen$ and $units$:
    ______________ Length(double numlen, String units) {
        ______________ = ______________ ;
        ______________ = ______________ ;
    }
    // Add current Length to another Length $x$. Return the sum as a new Length:
    ______________ Length add( ______________ x , ______________ choice ) {
        convert( ______________ , ______________ ) ;
        convert( ______________ , ______________ ) ;
        ______________ ____________________________ ;
    }
}
```
// Convert input Length's $numlen$ to the supplied unit label $choice$ and
// update instance variables, if necessary.

_____________ convert(Length x, String choice) {


} // Class Length

// Return a String that contains the current object's $numlen$ and $units$:

____________ toString() {

    return ________________________________ ;

}
Problem 3 [40 points] OOP, encapsulation, static, constants, methods, flow control

Background: A program can simulate the stacking of boxes on carts. Boxes of random height between 1 and 3 ft are stored on 3 carts that each have a height of 7 ft (feet). Boxes are stacked on top of each other on each cart, one cart at a time. On each cart boxes are stacked until their total height reaches as close as possible to, without exceeding, the top of the cart.

Problem: We have supplied the Main Class Problem3 which drives the simulation, class Box which models the boxes, and some of class Cart which models the carts. You need to complete class Cart by filling in the blanks and boxes.

Approach: Complete the following methods that use the code we have provided for you:

• constructor Cart sets the current CartNumber and calls other instance methods to fill the current Cart and report the number of Boxes stored on it.
• instance method fillOneCart stores Boxes on the current Cart by instantiating new Boxes until their height exceeds MAXHEIGHT. Creating a new Box simulates the stacking of the Box on top of the current Cart. Each time a Box is created, boxes increments by one to count the number of Boxes on one Cart, so far. When no more Boxes can fit on the current Cart, totalBoxes increments by boxes to count the total number of Boxes for all Carts, so far.
• class method fillAllCarts creates Carts one at a time. When finished stacking the Boxes on each Cart, fillAllCarts reports the total number of Boxes stored on all Carts.

Hint: Sample output has the following form (except the numbers of boxes might be different):

There are 2 boxes on Cart #1
There are 4 boxes on Cart #2
There are 3 boxes on Cart #3
There are a total of 9 boxes.

Notes: Remember that you may not use arrays! Avoid redundant/unnecessary code for full credit.

```java
class Problem3 {
    public static void main(String[] args) {
        Cart.fillAllCarts(); // Determine the total number of Boxes stored on all Carts
    }
} // Class Problem3

class Box {
    private double height; // height of Box
    public double getHeight() { return height; } // return height of current Box
    // Construct a Box with a random $height$ between 1 and 3 ft:
    public Box() { height = Math.random()*2+1; }
} // Class Box

class Cart {
    private int cartNumber; // Cart number
    private int boxes; // number of boxes stored on Cart
    private static int totalBoxes; // total number of Boxes for all Carts
    private static int totalCarts; // total number of Carts
    public static final int MAXHEIGHT = 7; // max allowable height of Boxes on Carts
    public static final int MAXCARTS = 3; // maximum number of Carts

    // Construct a Cart:
    // assign Cart number, fill the current Cart with Boxes, and report contents:
    public Cart(int cartNumber) {
        _________________________________; // assign CartNumber
        _________________________________; // fill current Cart with Boxes
        _________________________________; // report number of Boxes in Cart
    }
```
// Put as many Boxes as possible in current Cart:
private void fillOneCart() {
}

// Report the final number of Boxes stored on the current Cart:
private void reportOneCart() {
    System.out.println("There are " + boxes + " boxes on Cart #" + cartNumber);
}

// Report the total number of Boxes on all Carts:
private static void reportAllCarts() {
    System.out.println("There are a total of " + totalBoxes + " boxes.");
}

// Stack Boxes on each Cart, one Cart at a time:
public static void fillAllCarts() {
}

} // Class Cart
Checklist: Congratulations! You reached the last page of Prelim 3. Make sure your name, ID, and section are CLEARLY indicated. Also, re-read all problem descriptions/code comments/instructions. If you reached this part before exhausting the allotted time, check your test! Have you done the following?
- Completed all tasks
- Filled in ALL required blanks
- Given comments when necessary
- Declared all variables
- Maintained case-sensitivity
- Handled “special cases” correctly
- Indicated which solution to grade if you wrote multiple attempts

Bonus: [5 points] Remember that bonus points do not count towards your core-point total! You will lose additional points from your entire CS100M bonus score for “inappropriate” language.

[2 Bonus points] Why does DIS use only one public class per file in many of his examples?

[3 Bonus points] Why is Java’s method $\text{main}$ modified as $\text{public static void}$?

```java
public:

static:

void:
```