CS100M **November 14, 2000**
Prelim 3 **7:30 PM – 9:00 PM**

_____ _____
(Print last name, first name, middle initial/name) (Student ID)

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

_____
(Signature)

Circle Your Section:

	Tuesday			Wednesday	
	PH 403	PH 407	UH 111	HO 306	UH 111
1:25	1 Nagarajan		2 Fan	6 Rohde	
2:30		3 Nagarajan	5 Fan		7 Fernandes
3:35		4 Fernandes		8 Rohde	

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.

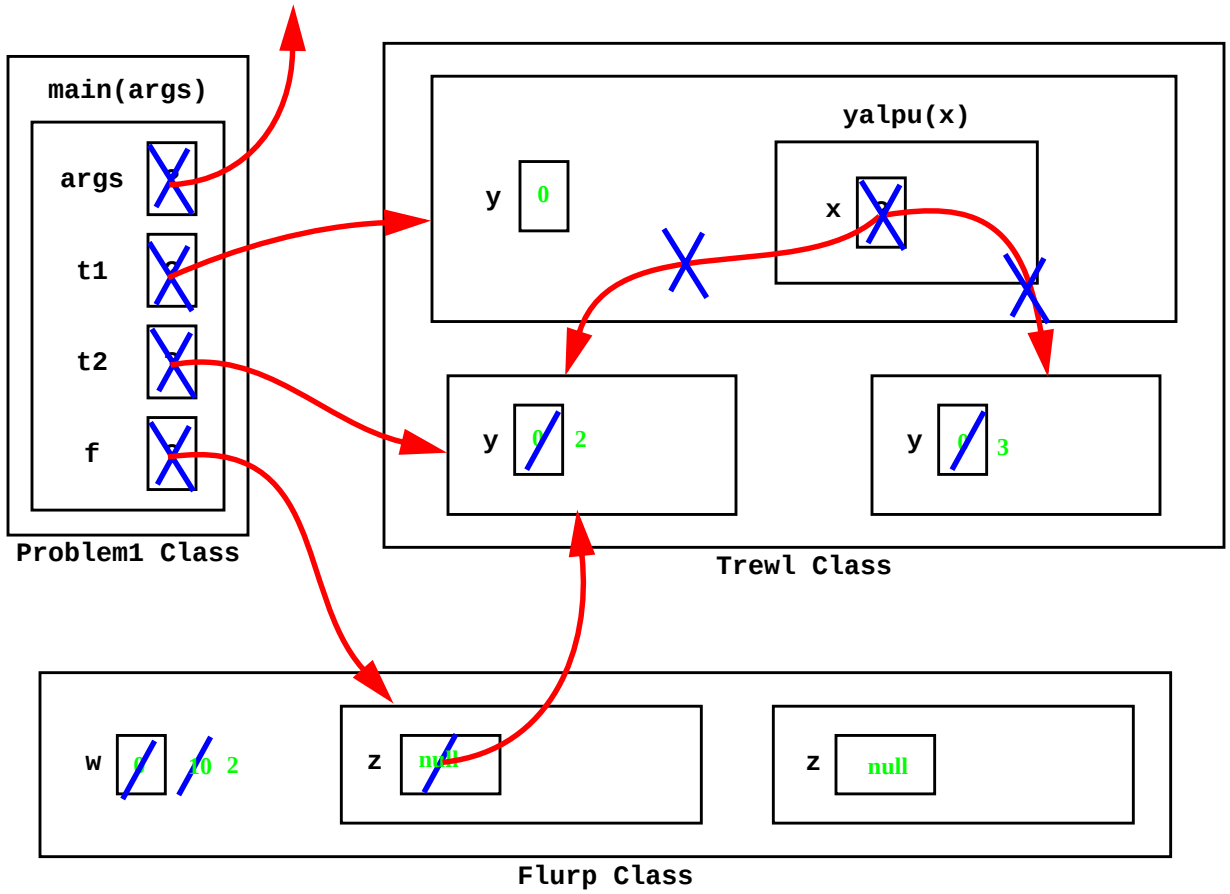
See the next page for spare boxes, in case you need to redraw your solution. **You must indicate which diagram we should grade!** Otherwise, we will choose the first marked diagram for grading.

```
public 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;
}
```



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`.

```
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 {
   private double numlen; // numerical length

   private String units;  // units of length

   // Construct a Length and set values of $numlen$ and $units$:

      public Length(double numlen, String units) {

         this.numlen = numlen;

         this.units = units;

      }

   // Add current Length to another Length $x$. Return the sum as a new Length:

      public Length add( Length x , String choice ) {

         convert( this , choice) ;

         convert( x , choice ) ;

         return new Length(numlen+x.numlen, choice) ;

      }
```

```
   // Convert input Length's $numlen$ to the supplied unit label $choice$ and
   // update instance variables, if necessary:
      private void convert(Length x, String choice) {

         // Do not convert if units are unchanged:

            if (choice.equals(x.units)) return;

         // Otherwise, convert for different units:

            else if (choice.equals("in")) x.numlen /= 2.54;

            else if (choice.equals("cm")) x.numlen *= 2.54;

         // Exit if user supplied unknown units:

            else System.exit(0); // not requested on prelim!

         // Set $units$ to $choice$

            x.units = choice;

      }

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

      public String toString() {

         return numlen+" "+units ;

      }

} // Class Length
```

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 **`Box`**es stored on it.
- instance method **`fillOneCart`** stores **`Box`**es on the current **`Cart`** by instantiating new **`Box`**es 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 **`Box`**es on one **`Cart`**, so far. When no more **`Box`**es can fit on the current **`Cart`**, **`totalBoxes`** increments by **`boxes`** to count the total number of **`Box`**es for all **`Cart`**s, so far.
- class method **`fillAllCarts`** creates **`Cart`**s one at a time. When finished stacking the **`Box`**es on each **`Cart`**, **`fillAllCarts`** reports the total number of **`Box`**es stored on all **`Cart`**s.

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.

```
public 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;                 // number of current Cart
   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) {

         this.cartNumber = cartNumber;     // assign CartNumber
         fillOneCart();                    // fill current Cart with Boxes
         reportOneCart();                  // report number of Boxes in Cart

      }
```

```
      // Put as many Boxes as possible in current Cart:
         private void fillOneCart() {

            // Initialize height:
               double height = new Box().getHeight(); // height so far

            // Use loop to simulate stacking of Boxes:
              /*
               * While the current total height is less than the required height,
               * increment the count of Boxes.
               */

               while (height <= MAXHEIGHT) {       // stop when height exceeds max
                  boxes++;                         // "store" current box
                  height += new Box().getHeight(); // get next box
               }

            // totalBoxes is the number of boxes
               totalBoxes += boxes;
         }

   // 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() {

         // Stack Boxes on each Cart, one Cart at a time:
         // Could also count with $totalCarts$
            for (int count = 1; count <= MAXCARTS; count ++)
               new Cart(count);

         // Report total number of Boxes:
            reportAllCarts();

      }

} // 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

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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?

He often uses JDK, which requires only one public class per file. CodeWarrior lacks that requirement.

[3 Bonus points] Why is Java's method **`main`** modified as **`public static void`**?

`public`: so other code/classes/methods/users can access/start the program

`static`: no object of the class containing **`main`** is instantiated

`void`: no return value