TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Student ID: .....

EXAMINATIONS — 2012

MID-YEAR

COMP 102
INTRODUCTION TO COMPUTER PROGRAM DESIGN

Time Allowed: 3 Hours ******** WITH SOLUTIONS **********

Instructions: Attempt ALL Questions.

Answer in the appropriate boxes if possible — if you write your answer elsewhere, make it clear where your answer can be found.

The exam will be marked out of 180 marks.

Only silent non-programmable calculators or silent programmable calculators with their memories cleared are permitted.

Non-electronic foreign language dictionaries are permitted.

Java Documentation will be provided with the exam script

There are spare pages for your working and your answers in this exam, but you may ask for additional paper if you need it.

Questions

	Marks
1. Understanding Java	[57]
2. Files	[27]
3. Arrays of Objects	[26]
4. Interface classes	[12]
5. Event driven input	[15]
6. 2D Arrays	[23]
7. Debugging loops	[20]

SPARE PAGE FOR EXTRA ANSWERS

Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.

Question 1. Understanding Java [57 marks]

(a) [4 marks] What will the following fragment of Java print out?

```
double x =1;
double y = x;
while (y < 16){
    y = y * 2;
    UI. println (x +"  :  " + y);
    x = x + 1;
}
UI. println ("done");
```

x: [ ] y: [ ]

```
1.0  :  2.0
2.0  :  4.0
3.0  :  8.0
4.0  :  16.0
done
```

(b) [5 marks] Almost every line of the following bad method has a syntax error that the compiler would complain about. Circle, and briefly explain each error

```
public String bad(int x; int y){                    // need , not ;
                        ^^^
    while (x =! y){                                 // should be !=
              ^^^
        size = size + y;                            //  size is not declared
        ^^^^
        x = x + 1;

    }

    else {                                          // no if to go with this else
    ^^^^^
        int y = 16;                                 // y is already declared
          ^^^^^
        return (x + y);                             // must return a string , not an int
               ^^^^^^^^^^
    }

}
```

(Question 1 continued on next page)

(Question 1 continued)

(c) [6 marks] The conditionalTest method below has one parameter and prints out a message about the parameter.

```
public void conditionalTest( int datum){
    String ans = "";
    if ( datum > 3 && datum < 10) {
        ans = "first";
    }
    else if ( datum < 5 || datum > 100) {
        ans = "last";
    }
    else {
        ans = "all";
    }

    ans = ans + "  " + datum;

    if (datum % 2 == 0) {
        UI.println (ans + "  done");
    }
    else {
        UI.println (ans + "  quit");
    }
}
```

What would the following calls to conditionalTest print out?
Hint: Note that `%` is the remainder operator.

conditionalTest(4); $\Longrightarrow$ first 4 done

conditionalTest(12); $\Longrightarrow$ all 12 done

conditionalTest(1); $\Longrightarrow$ last 1 quit

(Question 1 continued on next page)

(Question 1 continued)

(d) [5 marks] Complete the following triangleArea method so that it computes and returns the area of a triangle. It should have two parameters (doubles) which are the width and the height of a triangle.
Note: the area of a triangle is half the product of the width and the height.

```
public double triangleArea (double width, double height){

    return (width * height / 2);


}
```

(e) [5 marks] Consider the following reduce method.

```
public void reduce (int first , int last){
    UI. println ("reduce(" + first + "," + last + ")");
    while (last > 0){
        if ( first <= last){
            last = last - first ;
        }
        else {
            int temp = last;
            last = first - last;
            first = temp;
        }
        UI. println ( first + " : " + last);
    }
}
```

first: last: temp:

What will be printed in the text pane if reduce is called with the arguments 6 and 16? (The first line is done for you.)

```
reduce(6,16)
6 : 10
6 : 4
4 : 2
2 : 2
2 : 0
```

(Question 1 continued on next page)

(Question 1 continued)

(f) [7 marks] Consider the following mixNames method which modifies an array of Strings.

```
public void mixNames(String [ ] data){
    int index=0;
    for( int i=0; i<data.length; i++){
        if (data[i ]. startsWith("J")){
            data[index] = data[i ];
            data[i ] = null;
            index++;
        }
    }
}
```

index: [ ] i: [ ]

Suppose that the variable names is defined as follows:

```
String [ ] names = new String[ ]{"Peter","James","Ann","Jill","Paul","Neil","John"};
```

names:	Peter	James	Ann	Jill	Paul	Neil	John
	0	1	2	3	4	5	6

Show the contents of names after the method call

mixNames(names);

Hint: show your working.

names:	James	Jill	John	null	Paul	Neil	null
	0	1	2	3	4	5	6

(Question 1 continued on next page)

(Question 1 continued)

(g) [7 marks] Suppose the file `games.txt` contains the text:

```
Blues Yellows 15 4
Greens Blacks 8 9
Purples Reds 7 3
```

What will the following printGames method print out?

```
public void printGames(){
    try{
        Scanner scan = new Scanner (new File("games.txt"));
        int teams = 0;
        scan.next();
        while ( scan.hasNext() ){
            teams++;
            if (scan.hasNextInt()){
                int score = scan.nextInt()−scan.nextInt();
                UI. println (" by " + score);
            }
            else {
                UI. println ("Team: " + scan.next());
            }
        }
        scan.close();
        UI. println ("Teams: " + teams);
    }
    catch(IOException e){UI.println("File reading failed");}
}
```

teams:

```
Team:  Yellows by 11
Team:  Greens Team:  Blacks by -1
Team:  Purples Team:  Reds by 4
Teams:  8
```

(Question 1 continued on next page)

(Question 1 continued)

(h) [8 marks] The AssemblyJob class below defines AssemblyJob objects, which have three fields to store an item category, a worker's name, and the time spent on the job. The class defines a constructor and three methods.

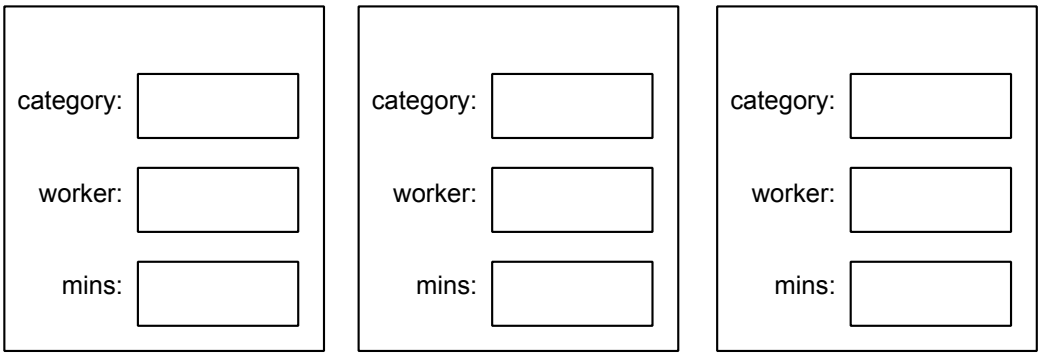
```
public class AssemblyJob{
    private String category;
    private String worker;
    private int mins;

    public AssemblyJob(String what, String who){
        this.category = what;
        this.worker = who;
    }

    public void print(){
        UI.printf("%s on %s for %d mins\n",
                this.worker, this.category, this.mins);
    }

    public void workOn (int m){
        this.mins = this.mins + m;
    }

    public void takeOver(AssemblyJob component){
        this.mins = this.mins + component.mins;
        component.mins = 0;
        if ( ! this.worker.equals(component.worker) ) {
            component.worker = this.worker;
        }
    }
}
```



(Question 1 continued on next page)

(Question 1 continued)

What will the following testJobs method print out?

```
public static void testJobs(){

    AssemblyJob jobD = new AssemblyJob("Drawer", "Bill");

    jobD.workOn(20);
    UI.print("1:"); jobD.print();

    AssemblyJob jobC = new AssemblyJob("Cabinet", "James");

    jobC.workOn(30);
    jobD.workOn(10);
    UI.print("2:"); jobC.print();
    UI.print("3:"); jobD.print();

    jobC.takeOver(jobD);
    UI.print("4:"); jobC.print();
    UI.print("5:"); jobD.print();

    AssemblyJob jobM = new AssemblyJob("Mirror", "Bill");

    jobM.workOn(50);
    jobD.workOn(15);
    jobC.workOn(40);
    UI.print("6:"); jobC.print();
    UI.print("7:"); jobD.print();
    UI.print("8:"); jobM.print();
}
```

```
1:  Bill on Drawer for 20 mins
2:  James on Cabinet for 30 mins
3:  Bill on Drawer for 30 mins
4:  James on Cabinet for 60 mins
5:  James on Drawer for 0 mins
6:  James on Cabinet for 100 mins
7:  James on Drawer for 15 mins
8:  Bill on Mirror for 50 mins
```

(Question 1 continued on next page)

(Question 1 continued)

(i) [10 marks] Complete the RentalTool class on the facing page which stores information about tools at a renting agency.

A RentalTool object should contain three fields:

- toolType, which contains the type of tool (*e.g.* "Power Drill")
- purchased, which contains the year that the tool was purchased (*e.g.* 2009)
- rentalDays, which contains the total number of days that the tool has been rented out (initially 0).

RentalTool should have a constructor that takes one String parameter and one integer parameter and stores them in the toolType and purchased fields.

RentalTool should have three methods:

- getDays, which returns the number of days the tool has been rented out.
- rent, which is called when the tool is rented out, and is passed the number of days in the rental period. It should update the rentalDays field.
- toString(), which returns a String containing the name of the tool, the year purchased, and the number of rental days in the format

```
"Power Drill (2009) 391 days"
```

(Question 1 continued on next page)

(Question 1 continued)

```
public class RentalTool{
    // fields
    private String toolType;
    private int purchased;
    private int rentalDays = 0;


    // constructor
    public RentalTool(String tool, int currentYear){
        this.toolType = tool;
        this.purchased = currentYear;
    }


    // methods
    public int getDays(){
        return this.rentalDays;
    }



    public String toString(){
        return ( this.toolType + " (" + this.purchased + ") " + this.rentalDays + " days");
    }



    public void rent(int loanPeriod){
        this.rentalDays = this.rentalDays + loanPeriod;
    }


}
```

Question 2. Files [27 marks]

Suppose the file `biscuits.txt` contains data about packets of biscuits in a store. Each line of the file contains information about one kind of biscuit - the category, the price for the packet, the name of the biscuit, and the packet size (number of biscuits in each packet). For example, the following might be the first nine lines of the file.

```
chocolate  3.40   tim tam              17
plain      1.90   ginger nuts          20
chocolate  2.80   mallowpuffs          10
plain      2.20   macaroons            15
filled     2.45   creme shortbread     23
chocolate  3.80   fudge brownie        12
plain      2.10   oat raisin bar       14
filled     2.80   shrewsbury           18
plain      2.00   anzac biscuits       21
```

The category is always a single word, but the biscuit name may consist of multiple words.

(a) [7 marks] Complete the following listBudget method, whose parameter is a maximum price. listBudget should read the file and print out the name and packet size of each biscuit whose price is not above the specified maximum.

For example, on the data above, listBudget(2.00); should print

```
Biscuits up to $2.00:
     ginger nuts          20
     anzac biscuits       21
```

```
public void listBudget (double maxPrice){
    String filename = "biscuits.txt";
    UI. printf ("Biscuits up to $%4.2f:\n", maxPrice);
    try{
        Scanner sc = new Scanner (new File (filename));
        while (sc.hasNext()){
            String type = sc.next ();
            double price = sc.nextDouble();
            String rest = sc.nextLine ();
            if (price <= maxPrice){
                UI. println (rest );
            }
        }

        sc.close ();
    }catch(IOException e){UI.println("fail");}
}
```

(Question 2 continued)

(b) [10 marks] Complete the following minPrice method which should print out the biscuit (and packet size) that is the cheapest of a given category. You may assume there is at least one biscuit in the category.

For example, if the file had only the nine lines in the example above, minPrice("chocolate") should print out

```
Lowest price chocolate biscuit is
   mallowpuffs        10
```

```
public void minPrice(String biscuitType){
    String filename = "biscuits.txt";
    UI.println("Lowest price "+ biscuitType + " biscuit is");
    try{
        Scanner sc = new Scanner(new File(filename));
        double minPrice = Double.MAX_VALUE;
        String minBiscuit = "";
        while (sc.hasNext()){
            String type = sc.next();
            double price = sc.nextDouble();
            String rest = sc.nextLine();
            if (type.equals(biscuitType) && price < minPrice){
                minPrice = price;
                minBiscuit = rest;
            }
        }
        UI.println(minBiscuit);









        sc.close();
    }
    catch(IOException e){UI.println("Fail: " + e);}
}
```

(Question 2 continued on next page)

SPARE PAGE FOR EXTRA ANSWERS

Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.

(Question 2 continued)

(c) [10 marks] Complete the following pricePerBiscuit method which prints out the biscuit name and price for an individual biscuit for each line in the file. (Note that it must use the number of biscuits in the packet to compute this.)

For example, the output for the first four lines of the `biscuits.txt` file above should be:

```
Prices per individual biscuit:
$0.20 each for tim tam
$0.10 each for ginger nuts
$0.28 each for mallowpuffs
$0.15 each for macaroons
```

```
public void pricePerBiscuit(){
    String filename = "biscuits.txt";
    UI.println("Prices per individual biscuit:");
    try{
        Scanner sc = new Scanner(new File(filename));
        while (sc.hasNext()){
            String type = sc.next();
            double price = sc.nextDouble();
            String biscuit = sc.next();
            while (!sc.hasNextInt()){
                biscuit = biscuit +" " + sc.next();
            }
            int count = sc.nextInt();
            UI.printf("$%4.2f each for %s \n", (price/count), biscuit);
        }
        sc.close();
    }
    catch(IOException e){UI.println("Fail: " + e);}
}
```

Question 3. Arrays of Objects [26 marks]

This question concerns a FlatFinder program to let users examine a list of available flats. The FlatFinder class (first ten lines shown on the facing page) stores the information about the flats in a field containing an array of Flat objects. It also has a count field that contains the number of Flat objects, and the Flat objects are stored in cells 0 through count-1 of the array.

The Flat class, for representing information about individual flats, is shown below. You should use the appropriate Flat methods in your answers.

```
public class Flat{
    // fields
    private String address;
    private String landlord;
    private int bedrooms;  // number of bedrooms
    private double rent;      // weekly rent
    // constructor
    public Flat(String addr, String landl, int beds, double rnt){
        this.address = addr;
        this.landlord = landl;
        this.bedrooms = beds;
        this.rent = rnt;
    }
    //methods
    public void printDetails (){
        UI.printf ("%d beds, $%.0f /week, %s (%s)\n",
                this.bedrooms, this.rent, this.address, this.landlord );
    }
    public String getAddress() {
        return this.address;
    }
    public boolean hasLandlord(String name){
        return (this.landlord.equals(name));
    }
    public int getBeds() {
        return this.bedrooms;
    }
    public double getRent() {
        return this.rent;
    }
}
```

(Question 3 continued)

The following are some of the fields and one of the methods of the FlatFinder class:

```
public class FlatFinder{

    private Flat [ ] flats = new Flat[1000];
    private int count = 0;

    public void listFlats (){
        for (int i=0; i<this.count; i++){
            UI.print(i+": ");
            this.flats[i].printDetails();
        }
    }
```

(a) [6 marks] Complete the following addFlat method of the FlatFinder class. Its parameter is a Flat and it should add the given Flat to the flats array. If the array is full, the method should print out a message. (You do not need to check for duplicates.)

```
    public void addFlat (Flat flat ){
        if (this.count < this.flats.length) {
            this.flats[this.count++] = flat ;
        }
        else {
            UI.println("No room to add");
        }

    }
```

(Question 3 continued on next page)

(b) [6 marks] Complete the following findMostExpensive method. It should return the address of the most expensive flat. If there is a tie for most expensive, it should return the earliest in the list.

```
public String findMostExpensive(){
    int expensive = -1;
    double maxCost = 0;
    for (int i=0; i<this.count; i++){
        if (this.flats[i].getRent() > maxCost){
            expensive = i;
            maxCost = this.flats[i].getRent();
        }
    }
    return this.flats[expensive].getAddress();









}
```

(c) [6 marks] Complete the following landlordStats method which has one parameter — the name of a landlord — and should print both the number of flats of the given landlord, and their average rent. If the landlord has no flats, print "`No Flats`".

```
public void landlordStats(String name){
    double sum = 0;
    int flatCount = 0;
    for (int i=0; i<this.count; i++){
        if (this.flats[i].hasLandlord(name)){
            sum = sum +this.flats[i].getRent();
            flatCount++;
        }
    }
    if (flatCount > 0){
        UI.printf("%d flats, average rent $%4.2f\n",
                  flatCount, sum/flatCount);
    }
    else {
        UI.println("No flats");
    }
}
```

(Question 3 continued on next page)

(Question 3 continued)

(d) [8 marks] Complete the following removeListing method in the FlatFinder class. Its parameter is *String* specifying an address, and it should remove the flat at that address from the list of flats and return true. If there is no flat with that address, it should return false. When removing the flat, it should not change the order of the other flats in the array. It should not introduce any nulls in positions 0 to count−1.

```
public boolean removeListing(String addr){
    for (int i=0; i<this.count; i++){
        if (addr.equals(this.flats[i].getAddress())) {
            this.count--;
            for (int j=i; j<this.count; j++){
                UI.printf("moving %d %s down over %s\n",
                          j+1, this.flats[j+1].getAddress(),
                          this.flats[j].getAddress());
                this.flats[j] = this.flats[j+1];
            }
            return true;
        }
    }
    return false;
}









}
```

Question 4. Interface classes [12 marks]

This question addresses the design of a computer adventure game in which the player has to collect items to solve a puzzle. Part of the program must store the items that the player has found so far. There are quite a number of different kinds of items: tools, maps, potions, food, jewels, etc. The different kinds of items behave differently, so there is a separate class for each kind of item. However, every item will have the following things in common:

- fields to store values such as the name of the item, the trade-in value of the item, and the weight of the item.
- an infoString method that returns a short String containing a description of the item.
- getValue and getWeight methods that return the trade-in value and the weight of the item.
- an isWorking method that returns a boolean value representing whether the item is working or broken.
- an applySpell method with one parameter (a Spell object) that applies the spell to the item (which may modify the item in some way).

The program must have a single array containing all the items that the player has currently collected. To do this, we need an interface class called GameItem that specifies a type that includes all the different kinds of items.

(a) [6 marks] Complete the following definition of the GameItem interface class.

```
public interface GameItem {
    public String  infoString ();

    public double getValue();

    public double getWeight();

    public boolean isWorking();

    public void applySpell(Spell  spell );




}
```

(Question 4 continued on next page)

(Question 4 continued)

(b) [6 marks] The following Map class describes map items, and provides several methods for maps. In the game, maps are very simple items that can be displayed to the user, and nothing else. They always work, and no spells affect them. Their description consists just of the mapName.

However, Map is not correctly written to make every Map object also be a GameItem. Modify the definition of Map below so that a Map correctly implements the GameItem interface class.

```
public class MapXX  implements GameItem {
    private String mapName;
    private String pictureFile ;
    private double weight = 0.1;
    private double value;

    public Map(String mapNm, String fileName, double val){
        this.mapName = mapNm;
        this. pictureFile  = fileName;
        this.value = val;
    }
    public double getValue(){return value;}

    public double getWeight(){return weight;}

    public void display(double x, double y){
        UI.drawImage(this.pictureFile, x, y);
    }



    public String infoString (){
        return this.mapName;
    }

    public boolean isWorking(){
        return this.true;
    }

    public void applySpell(Spell spell){
    }



}
```

Question 5. Event Driven Input [15 marks]

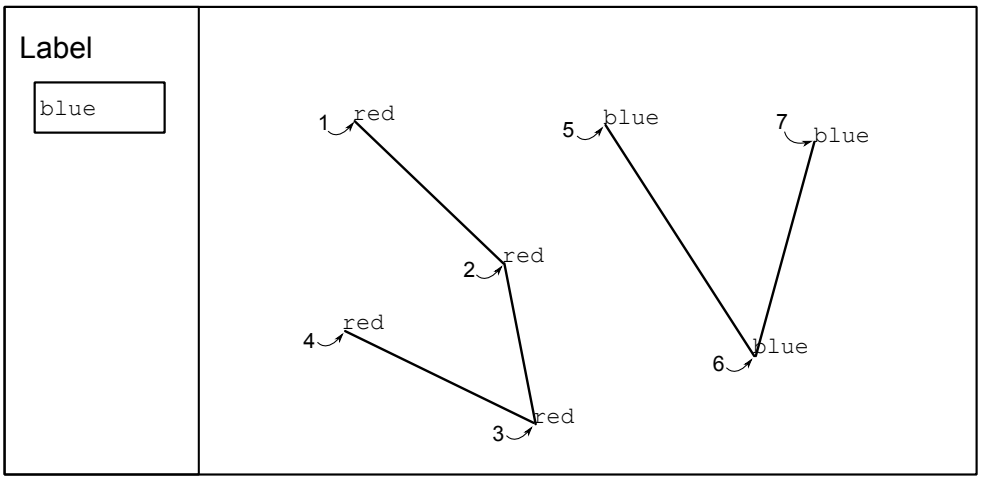
Complete the PolyLine program on the facing page so that it allows the user to draw labeled polylines (connected line segments) on the graphics pane. The program should have one textField called "Label" and should also listen to the mouse.

Every time the user enters a value in the textField, the program should remember the value in the field called lineLabel, and should also reset lastX and lastY to start a new polyline.

When the user clicks the mouse in the graphics pane (ie, the "clicked" action), the program should draw the current value of lineLabel at the point, and should also draw a line connecting the point to the previous point, unless it has just started a new polyline.

The diagram below shows what the program should do if the user

- entered the value "`red`" in the textField,
- clicked the mouse at the positions labeled 1, 2, 3, and then 4
- entered the value "`blue`" in the textField,
- clicked the mouse at the positions labeled 5, 6, 7



(Question 5 continued)

```
public class PolyLine implements UITextFieldListener, UIMouseListener{
    private double lastX = -1;    // -1 indicates it is ready to start a new polyline.
    private double lastY = -1;
    private String lineLabel = "";

    public PolyLine(){
        UI.setMouseListener(this);
        UI.addTextField("Label", this);


    }
    public void textFieldPerformed(String field , String value){
        if (field.equals("Label")){
            this.lineLabel = value;
            this.lastX = -1;
            this.lastY = -1;
        }


    }
    public void mousePerformed(String action, double x, double y) {
        if (action.equals("clicked")){
            UI.drawString(this.lineLabel, x, y);
            if (lastX > -1){
                UI.drawLine(lastX, lastY, x, y);
            }
            lastX = x;
            lastY = y;
        }


    }
}
```

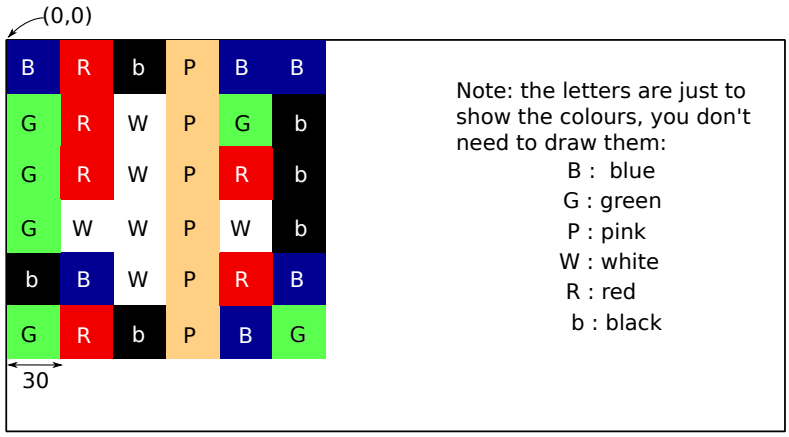
Question 6. 2D Arrays [23 marks]

The Raybits Square is a puzzle consisting of a 6×6 grid of coloured squares. The goal is to rearrange the squares in the grid so that they line up in columns of the same colour. The RayBitsSquare class implements a program that allows users to solve the puzzle. The class stores the current state of the puzzle in a field containing a 2D array of Color values:

```
public class RayBitsSquare{
    private Color [ ][ ] puzzle;
    private double sqSize = 30;
      :
```

You are to write three methods for the RayBitsSquare class.

(a) [6 marks] Complete the following drawPuzzle method which should draw the puzzle in the Graphics pane, as in the following diagram (except it is printed in greys, not colours).



The top left square should be at position (0,0), and the width of the squares should be 30 units. Each square should be a filled rectangle. The colour of each square should be the Color value in the puzzle array.

```
private void drawPuzzle(){
    UI.clearGraphics();
    for (int row=0; row<6; row++){
        for (int col=0; col<6; col++){
            UI.setColor(puzzle[row][col ]);
            UI. fillRect (col*sqSize, row*sqSize, sqSize, sqSize);
        }
    }




}
```

(Question 6 continued on next page)

(Question 6 continued)

(b) [7 marks] Complete the following checkColumn method whose parameter is the index of a column of the puzzle, and should return true if all the cells in the given column of a puzzle are the same color, and false otherwise.

For example, checkColumn(3) on the puzzle shown above should return true.

```
public boolean checkColumn(int col){
    for ( int row=1; row<6; row++){
        if ( !puzzle[row][col ]. equals(puzzle[0][col ]) ){
            return false;
        }
    }
    return true;









}
```

(Question 6 continued on next page)

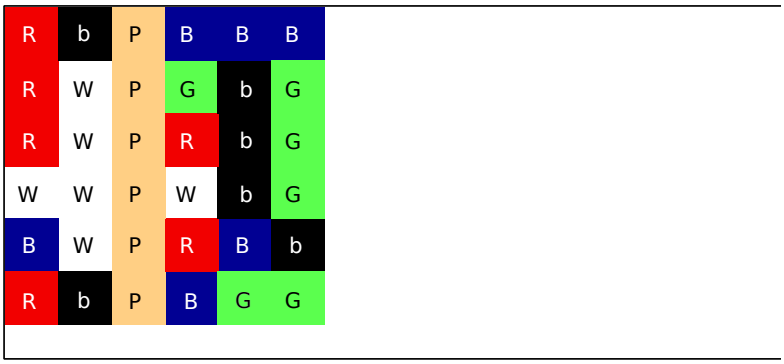
SPARE PAGE FOR EXTRA ANSWERS

Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.

(Question 6 continued)

(c) [10 marks] Complete the following shiftLeft method which should shift all the colors in the puzzle one step to the left, except the colors in the leftmost column which should be moved to the rightmost column.

For example, given the puzzle above, shiftLeft should change it to:



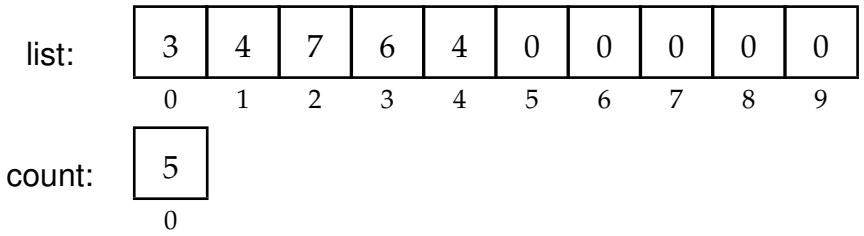

```
public void shiftLeft () {
    for ( int row=0; row<6; row++){
        Color temp = puzzle[row][0];
        for ( int col=1; col<6; col++){
            puzzle[row][col−1] = puzzle[row][col ];
        }
        puzzle[row][5] = temp;
    }

}
```

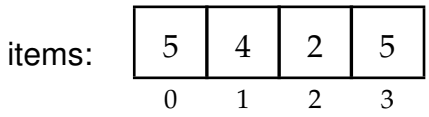
Question 7. Debugging Loops [20 marks]

The following mergeItems method is intended to merge some numbers into a list of numbers, only adding numbers that are not already in this list. The list is represented by an array and a count, and mergeItems may assume that the array has enough extra space for all the new numbers.

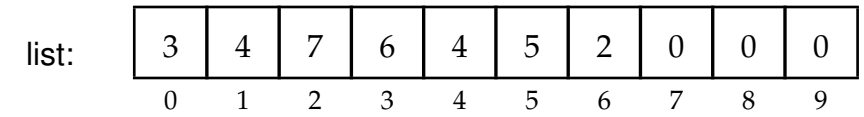
For example, given a list of 5 numbers:



and an array of four new numbers to merge:



mergeItems(list, 5, items) should change the list to be



It should not add 4 since it is already in the list, and 5 is in the list when the second 5 in items is encountered.

This version of mergeItems has multiple errors.

```
1   /* merge items into list. Assumes list is large enough */
2   public void mergeItems (int[] list, int count, int[] items){
3       boolean found = false;                    // wrong place, should be inside first loop
4       for (int i=0; i<items.length; i++){
5           for (int j=0; j<count; j++){
6               found = (items[i] == list[j]);    // needs break or conditional
7           }
8           if (found) {                          // inverted logic
9               count++;                          // incremented before adding
10              list[count] = items[i];
11          }
12      }
13  }
```

(Question 7 continued on next page)

(Question 7 continued)

(a) [6 marks] If this version of mergeItems (with the errors) were called with the arrays above:

mergeItems(list, 5, items);

what would the contents of the list array be when the method was finished?
Hint: show your working.

3	4	7	6	4	0	4	0	0	0
0	1	2	3	4	5	6	7	8	9

(b) [6 marks] Identify and briefly describe three of the errors in the version of mergeItems above. You may answer by annotating the code on the facing page, or list line numbers and describe the errors in the box below.

line 3: found should be initialised inside the first loop - it needs to be reset for each value of items.

line 6: this may reset found to false after it has been set to true. It needs a conditional and only change found when if finds values that are equal (or it could break out of the loop when the values are equal)

line 8: the logic is inverted - should only add if NOT found

line 9: count should not be incremented until after the item is added to list.

(Question 7 continued on next page)

(Question 7 continued)

(c) [8 marks] Write a correct version of mergeItems.

```
/* merge items into list. Assumes list is large enough */
public void mergeGood (int[] list, int count, int [ ] items){
    for (int i=0; i<items.length; i++){
        boolean found = false;
        for (int j=0; j<count; j++){
            if ( items[i]== list [j] ){
                found = true;
            }
        }
        if (!found) {
            list [count] = items[i];
            count++;
        }
    }

}
```

****

Student ID: .....

SPARE PAGE FOR EXTRA ANSWERS

Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.