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Sample Final Exam #1

(Spring 2005; thanks to Stuart Reges)

1. Array Mystery

Consider the following method:

```
public static void arrayMystery(int[] a) {
    for (int i = 1; i < a.length; i++) {
        a[i] = i + a[i - 1] - a[i];
    }
}
```

Indicate in the right-hand column what values would be stored in the array after the method `arrayMystery` executes if the integer array in the left-hand column is passed as a parameter to it.

Original Contents of Array	Final Contents of Array
`int[] a1 = {7};` `arrayMystery(a1);`	_____
`int[] a2 = {4, 3, 6};` `arrayMystery(a2);`	_____
`int[] a3 = {7, 4, 8, 6, 2};` `arrayMystery(a3);`	_____
`int[] a4 = {10, 2, 5, 10};` `arrayMystery(a4);`	_____
`int[] a5 = {2, 4, -1, 6, -2, 8};` `arrayMystery(a5);`	_____

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2. Reference Semantics Mystery

The following program produces 4 lines of output. Write the output below, as it would appear on the console.

```
public class BasicPoint {
    int x;
    int y;

    public BasicPoint() {
        x = 2;
        y = 2;
    }
}

public class ReferenceMystery {
    public static void main(String[] args) {
        int a = 7;
        int b = 9;
        BasicPoint p1 = new BasicPoint();
        BasicPoint p2 = new BasicPoint();

        addToXTwice(a, p1);
        System.out.println(a + " " + b + " " + p1.x + " " + p2.x);

        addToXTwice(b, p2);
        System.out.println(a + " " + b + " " + p1.x + " " + p2.x);
    }

    public static void addToXTwice(int a, BasicPoint p1) {
        a = a + a;
        p1.x = a;
        System.out.println(a + " " + p1.x);
    }
}
```


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3. Inheritance Mystery

Assume that the following classes have been defined:

```
public class A extends B {
    public void method2() {
        System.out.print("a 2  ");
        method1();
    }
}

public class B extends C {
    public String toString() {
        return "b";
    }

    public void method2() {
        System.out.print("b 2  ");
        super.method2();
    }
}
```

```
public class C {
    public String toString() {
        return "c";
    }

    public void method1() {
        System.out.print("c 1  ");
    }

    public void method2() {
        System.out.print("c 2  ");
    }
}

public class D extends B {
    public void method1() {
        System.out.print("d 1  ");
        method2();
    }
}
```

Given the classes above, what output is produced by the following code?

```
C[] elements = {new A(), new B(), new C(), new D()};
for (int i = 0; i < elements.length; i++) {
    System.out.println(elements[i]);
    elements[i].method1();
    System.out.println();
    elements[i].method2();
    System.out.println();
    System.out.println();
}
```


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4. File Processing

Write a static method named `printStrings` that takes as a parameter a `Scanner` holding a sequence of integer/string pairs and that prints to `System.out` one line of output for each pair with the given `String` repeated the given number of times. For example if the `Scanner` contains the following data:

```
6 fun. 3 hello   10    <> 2      25    4  wow!
```

your method should produce the following output:

```
fun.fun.fun.fun.fun.fun.
hellohellohello
<><><><><><><><><><>
2525
wow!wow!wow!wow!
```

Notice that there is one line of output for each integer/string pair. The first line has 6 occurrences of `"fun."`, the second line has 3 occurrences of `"hello"`, the third line has 10 occurrences of `"<>"`, the fourth line has 2 occurrences of `"25"` the fifth line has 4 occurrences of `"wow!"`. Notice that there are no extra spaces included in the output. You are to exactly reproduce the format of this sample output. You may assume that the input values always come in pairs with an integer followed by a `String` (which itself could be numeric, such as `"25"` above). If the `Scanner` is empty (no integer/string pairs), your method should produce no output.

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5. File Processing

Write a static method named `reverseLines` that accepts a `Scanner` containing an input file as a parameter and that echoes the input file to `System.out` with each line of text reversed. For example, given the following input file:

```
If this method works properly,
the lines of text in this file
will be reversed.

Remember that some lines might be blank.
```

Your method should print the following output:

```
,ylreporp skrow dohtem siht fI
elif siht ni txet fo senil eht
.desrever eb lliw

.knalb eb thgim senil emos taht rebmemeR
```

Notice that some of the input lines can be blank lines.

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6. Array Programming

Write a static method `isAllEven` that takes an array of integers as a parameter and that returns a boolean value indicating whether or not all of the values are even numbers (true for yes, false for no). For example, if a variable called `list` stores the following values:

```
int[] list = {18, 0, 4, 204, 8, 4, 2, 18, 206, 1492, 42};
```

Then the call of `isAllEven(list)` should return `true` because each of these integers is an even number. If instead the list had stored these values:

```
int[] list = {2, 4, 6, 8, 10, 208, 16, 7, 92, 14};
```

Then the call should return `false` because, although most of these values are even, the value 7 is an odd number.

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7. Array Programming

Write a static method named `isUnique` that takes an array of integers as a parameter and that returns a boolean value indicating whether or not the values in the array are unique (`true` for yes, `false` for no). The values in the list are considered unique if there is no pair of values that are equal. For example, if a variable called `list` stores the following values:

```
int[] list = {3, 8, 12, 2, 9, 17, 43, -8, 46, 203, 14, 97, 10, 4};
```

Then the call of `isUnique(list)` should return `true` because there are no duplicated values in this list. If instead the list stored these values:

```
int[] list = {4, 7, 2, 3, 9, 12, -47, -19, 308, 3, 74};
```

Then the call should return `false` because the value 3 appears twice in this list. Notice that given this definition, a list of 0 or 1 elements would be considered unique.

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8. Critters

Write a class `Ostrich` that extends the `Critter` class from the Critters assignment, including its `getMove` and `getColor` methods. An `Ostrich` object first stays in the same place for 10 moves, then moves 10 steps to either the WEST or the EAST, then repeats. In other words, after sitting still for 10 moves, the ostrich randomly picks to go west or east, then walks 10 steps in that same direction. Then it stops and sits still for 10 moves and repeats. Whenever an `Ostrich` is moving (that is, whenever its last call to `getMove` returned a direction other than `Direction.CENTER`), its color should be white (`Color.WHITE`). As soon as it stops moving, and initially when it first appears in the critter world, its color should be cyan (`Color.CYAN`). When randomly choosing west vs. east, the two directions should be equally likely.

You may add anything needed (fields, other methods) to implement the above behavior appropriately. All other critter behavior not discussed here uses the default values.

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9. Classes and Objects

Suppose that you are provided with a pre-written class `Date` as described at right. (The headings are shown, but not the method bodies, to save space.) Assume that the fields, constructor, and methods shown are already implemented. You may refer to them or use them in solving this problem if necessary.

Write an instance method named **`compareTo`** that will be placed inside the `Date` class to become a part of each `Date` object's behavior. The `compareTo` method accepts another `Date` as a parameter and compares the two dates to see which comes first in chronological order. It returns an integer with one of the following values:

- a negative integer (such as -1) if the date represented by this `Date` comes before that of the parameter
- 0 if the two `Date` objects represent the same month and day
- a positive integer (such as 1) if the date represented by this `Date` comes after that of the parameter

For example, if these `Date` objects are declared in client code:

```
Date sep19 = new Date(9, 19);
Date dec15 = new Date(12, 15);
Date temp = new Date(9, 19);
Date sep11 = new Date(9, 11);
```

The following `boolean` expressions should have `true` results.

```
sep19.compareTo(sep11) > 0
sep11.compareTo(sep19) < 0
temp.compareTo(sep19) == 0
dec15.compareTo(sep11) > 0
```

Your method should not modify the state of either `Date` object (such as by changing their `day` or `month` field values).

```
// Each Date object stores a single
// month/day such as September 19.
// This class ignores leap years.

public class Date {
    private int month;
    private int day;

    // Constructs a date with
    // the given month and day.
    public Date(int m, int d)

    // Returns the date's day.
    public int getDay()

    // Returns the date's month.
    public int getMonth()

    // Returns the number of days
    // in this date's month.
    public int daysInMonth()

    // Modifies this date's state
    // so that it has moved forward
    // in time by 1 day, wrapping
    // around into the next month
    // or year if necessary.
    // example:  9/19 -> 9/20
    // example:  9/30 -> 10/1
    // example: 12/31 -> 1/1
    public void nextDay()


    // your method would go here

}
```


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Sample Final Exam #1 Key

1.

Call	Final Contents of Array
`int[] a1 = {7};` `arrayMystery(a1);`	`{7}`
`int[] a2 = {4, 3, 6};` `arrayMystery(a2);`	`{4, 2, -2}`
`int[] a3 = {7, 4, 8, 6, 2};` `arrayMystery(a3);`	`{7, 4, -2, -5, -3}`
`int[] a4 = {10, 2, 5, 10};` `arrayMystery(a4);`	`{10, 9, 6, -1}`
`int[] a5 = {2, 4, -1, 6, -2, 8};` `arrayMystery(a5);`	`{2, -1, 2, -1, 5, 2}`

2.

```
14 14
7 9 14 2
18 18
7 9 14 18
```

3.

```
b
c 1
a 2  c 1

b
c 1
b 2  c 2

c
c 1
c 2

b
d 1  b 2  c 2
b 2  c 2
```

4.

```
public static void printStrings(Scanner input) {
    while (input.hasNextInt()) {
        int times = input.nextInt();
        String word = input.next();
        for (int i = 0; i < times; i++) {
            System.out.print(word);
        }
        System.out.println();
    }
}
```


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5.

```
public static void reverseLines(Scanner input) {
    while (input.hasNextLine()) {
        String text = input.nextLine();
        for (int i = text.length() - 1; i >= 0; i--) {
            System.out.print(text.charAt(i));
        }
        System.out.println();
    }
}
```

6.

```
public static boolean isAllEven(int[] list) {
    for (int i = 0; i < list.length; i++) {
        if (list[i] % 2 != 0) {
            return false;
        }
    }
    return true;
}
```

7.

```
public static boolean isUnique(int[] list) {
    for (int i = 0; i < list.length; i++) {
        for (int j = i + 1; j < list.length; j++) {
            if (list[i] == list[j]) {
                return false;
            }
        }
    }
    return true;
}
```


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8.

```
import java.awt.*;    // for Color
import java.util.*;   // for Random

public class Ostrich extends Critter {
    private Random rand;
    private int steps;
    private boolean west;     // true if going west; false if east
    private boolean hiding;

    public Ostrich() {
        rand = new Random();
        hiding = true;
        steps = 0;
        west = rand.nextBoolean();   // or call nextInt(2) and map 0=false, 1=true
    }

    public Color getColor() {
        if (hiding) {
            return Color.CYAN;
        } else {
            return Color.WHITE;
        }
    }

    public Direction getMove() {
        if (steps == 10) {
            steps = 0;   // Pick a new direction and re-set the steps counter
            hiding = !hiding;
            west = rand.nextBoolean();
        }

        steps++;
        if (hiding) {
            return Direction.CENTER;
        } else if (west) {
            return Direction.WEST;
        } else {
            return Direction.EAST;
        }
    }
}
```

9. Two solutions are shown.

```
public int compareTo(Date other) {
    if (month < other.month || (month == other.month && day < other.day)) {
        return -1;
    } else if (month == other.month && day == other.day) {
        return 0;
    } else {
        return 1;
    }
}
```

```
public int compareTo(Date other) {
    if (month == other.month) {
        return day - other.day;
    } else {
        return month - other.month;
    }
}
```


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Sample Midterm Exam #1

1. Expressions

For each expression in the left-hand column, indicate its value in the right-hand column. Be sure to list a constant of appropriate type (e.g., `7.0` rather than `7` for a `double`, `String`s in quotes, `true`/`false` for a `boolean`).

Expression	Value
`3 * 4 + 5 * 6 + 7 * -2`	_____
`1.5 * 2.0 + (5.5 / 2) + 5 / 4`	_____
`23 % 5 + 31 / 4 % 3 - 17 % (16 % 10)`	_____
`"1" + 2 + 3 + "4" + 5 * 6 + "7" + (8 + 9)`	_____
`345 / 10 / 3 * 55 / 5 / 6 + 10 / (5 / 2.0)`	_____
`1 / 2 > 0 || 4 == 9 % 5 || 1 + 1 < 1 - 1`	_____

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2. Parameter Mystery

At the bottom of the page, write the output produced by the following program.

```
public class ParameterMystery {
    public static void main(String[] args) {
        String x = "java";
        String y = "tyler";
        String z = "tv";
        String rugby = "hamburger";
        String java = "donnie";

        hamburger(x, y, z);
        hamburger(z, x, y);
        hamburger("rugby", z, java);
        hamburger(y, rugby, "x");
        hamburger(y, y, "java");
    }

    public static void hamburger(String y, String z, String x) {
        System.out.println(z + " and " + x + " like " + y);
    }
}
```


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3. If/Else Simulation

For each call of the method below, write the value that is returned:

```
public static int mystery(int a, int b) {
    int c;
    if (a > b) {
        c = a;
    } else if (b % a == 0) {
        c = b;
    } else {
        c = b + (a - (b % a));
    }
    return c;
}
```

Method Call	Value Returned
mystery(4, 2)	_____
mystery(5, 4)	_____
mystery(5, 13)	_____
mystery(5, 17)	_____
mystery(4, 8)	_____

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4. While Loop Simulation

For each call of the method below, write the output that is printed:

```
public static void mystery(int i, int j) {
    while (i != 0 && j != 0) {
        i = i / j;
        j = (j - 1) / 2;
        System.out.print(i + " " + j + " ");
    }
    System.out.println(i);
}
```

Method Call	Output
`mystery(5, 0);`	_____
`mystery(3, 2);`	_____
`mystery(16, 5);`	_____
`mystery(80, 9);`	_____
`mystery(1600, 40);`	_____

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5. Assertions

For the following method, identify each of the three assertions in the table below as being either ALWAYS true, NEVER true or SOMETIMES true / sometimes false at each labeled point in the code. (You may abbreviate these choices as A/N/S respectively.)

```
public static int mystery(int x) {
    int y = 1;
    int z = 0;

    // Point A
    while (y <= x) {
        // Point B
        y = y * 10;
        z++;

        // Point C
    }

    // Point D
    z--;

    // Point E
    return z;
}
```

	y > x	z < 0	z > 0
Point A			
Point B			
Point C			
Point D			
Point E			

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6. Programming

Write a static method named `hasMidpoint` that accepts three integers as parameters and returns `true` if one of the integers is the midpoint between the other two integers; that is, if one integer is exactly halfway between them. Your method should return `false` if no such midpoint relationship exists.

The integers could be passed in any order; the midpoint could be the 1st, 2nd, or 3rd. You must check all cases.

Calls such as the following should return `true` :

```
hasMidpoint(4, 6, 8)
hasMidpoint(2, 10, 6)
hasMidpoint(8, 8, 8)
hasMidpoint(25, 10, -5)
```

Calls such as the following should return `false` :

```
hasMidpoint(3, 1, 3)
hasMidpoint(1, 3, 1)
hasMidpoint(21, 9, 58)
hasMidpoint(2, 8, 16)
```


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7. Programming

Write a static method named `sequenceSum` that prints terms of the following mathematical sequence:

$1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \frac{1}{6} + \ldots$ (also written as $\sum_{i=1}^{\infty} \frac{1}{i}$)

Your method should accept a real number as a parameter representing a limit, and should add and print terms of the sequence until the sum of terms meets or exceeds that limit. For example, if your method is passed 2.0, print terms until the sum of those terms is at ≥ 2.0. You should round your answer to 3 digits past the decimal point.

The following is the output from the call `sequenceSum(2.0);`

```
1 + 1/2 + 1/3 + 1/4 = 2.083
```

(Despite the fact that the terms keep getting smaller, the sequence can actually produce an arbitrarily large sum if enough terms are added.) If your method is passed a value less than 1.0, no output should be produced. You must match the output format shown exactly; note the spaces and pluses separating neighboring terms. Other sample calls:

Calls	`sequenceSum(0.0);`	`sequenceSum(1.0);`	`sequenceSum(1.5);`
Output		`1 = 1.000`	`1 + 1/2 = 1.500`

Call	`sequenceSum(2.7);`
Output	`1 + 1/2 + 1/3 + 1/4 + 1/5 + 1/6 + 1/7 + 1/8 = 2.718`

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8. Programming

Write a static method named `favoriteLetter` that accepts two parameters: a `Scanner` for the console, and a favorite letter represented as a one-letter `String`. The method repeatedly prompts the user until two consecutive words are entered that start with that letter. The method then prints a message showing the last word typed.

You may assume that the user will type a single-word response to each prompt. Your code should be case-sensitive; for example, if the favorite letter is **a**, you should not stop prompting if the user types words that start with an **A**. For example, the following logs represent the output from two calls to your method: (User input is underlined.)

Call	`Scanner console = new Scanner(System.in);` `favoriteLetter(console, "y");`	`Scanner console = new Scanner(System.in);` `favoriteLetter(console, "A");`

Output	`Looking for two "y" words in a row.`
	`Type a word: hi`
	`Type a word: bye`
	`Type a word: yes`
	`Type a word: what?`
	`Type a word: yellow`
	`Type a word: yippee`
	`"y" is for "yippee"`
		`Looking for two "A" words in a row.`
		`Type a word: I`
		`Type a word: love`
		`Type a word: CSE142!`
		`Type a word: AND`
		`Type a word: PROGRAMS`
		`Type a word: are`
		`Type a word: always`
		`Type a word: Absolutely`
		`Type a word: Awesome`
		`"A" is for "Awesome"`

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Sample Midterm Exam #1 Key

Also check out Practice-It to test solving these problems or to type in your own solution to see if it works!

1. Expressions

Expression	Value
`3 * 4 + 5 * 6 + 7 * -2`	`28`
`1.5 * 2.0 + (5.5 / 2) + 5 / 4`	`6.75`
`23 % 5 + 31 / 4 % 3 - 17 % (16 % 10)`	`-1`
`"1" + 2 + 3 + "4" + 5 * 6 + "7" + (8 + 9)`	`"123430717"`
`345 / 10 / 3 * 55 / 5 / 6 + 10 / (5 / 2.0)`	`24.0`
`1 / 2 > 0 || 4 == 9 % 5 || 1 + 1 < 1 - 1`	`true`

2. Parameter Mystery

```
tyler and tv like java
java and tyler like tv
tv and donnie like rugby
hamburger and x like tyler
tyler and java like tyler
```

3. If/Else Simulation

Method Call	Value Returned
`mystery(4, 2)`	`4`
`mystery(5, 4)`	`5`
`mystery(5, 13)`	`15`
`mystery(5, 17)`	`20`
`mystery(4, 8)`	`8`

4. While Loop Simulation

Method Call	Output
`mystery(5, 0);`	`5`
`mystery(3, 2);`	`1 0 1`
`mystery(16, 5);`	`3 2 1 0 1`
`mystery(80, 9);`	`8 4 2 1 2 0 2`
`mystery(1600, 40);`	`40 19 2 9 0 4 0`

5. Assertions

	`y > x`	`z < 0`	`z > 0`
Point A	SOMETIMES	NEVER	NEVER
Point B	NEVER	NEVER	SOMETIMES
Point C	SOMETIMES	NEVER	ALWAYS
Point D	ALWAYS	NEVER	SOMETIMES
Point E	ALWAYS	SOMETIMES	SOMETIMES

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6. Programming (five solutions shown)

```
public static boolean hasMidpoint(int a, int b, int c) {
    double mid = (a + b + c) / 3.0;
    if (a == mid || b == mid || c == mid) {
        return true;
    } else {
        return false;
    }
}

public static boolean hasMidpoint(int a, int b, int c) {
    double mid = (a + b + c) / 3.0;
    return (a == mid || b == mid || c == mid);
}

public static boolean hasMidpoint(int a, int b, int c) {
    return (a == (b + c) / 2.0 || b == (a + c) / 2.0 || c == (a + b) / 2.0);
}

public static boolean hasMidpoint(int a, int b, int c) {
    int max = Math.max(a, Math.max(b, c));
    int min = Math.min(a, Math.min(b, c));
    double mid = (max + min) / 2.0;

    return (a == mid || b == mid || c == mid);
}

public static boolean hasMidpoint(int a, int b, int c) {
    return (a - b == b - c || b - a == a - c || a - c == c - b);
}
```

7. Programming (one solution shown)

```
public static void sequenceSum(double limit) {
    if (limit >= 1) {
        System.out.print("1");
        int denomenator = 1;
        double sum = 1.0;
        while (sum < limit) {
            denomenator++;
            sum += 1.0 / denomenator;
            System.out.print(" + 1/" + denomenator);
        }
        System.out.printf(" = %.3f\n", sum);
    }
}
```


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8. Programming (three solutions shown)

```
public static void favoriteLetter(Scanner console, String letter) {
    System.out.println("Looking for two \"" + letter + "\" words in a row.");
    int count = 0;
    String word = "";
    while (count < 2) {
        System.out.print("Type a word: ");
        word = console.next();
        if (word.startsWith(letter)) {
            count++;
        } else {
            count = 0;
        }
    }
    System.out.println("\"" + letter + "\" is for \"" + word + "\"");
}

// uses two Strings instead of count, and uses forever/break loop
public static void favoriteLetter(Scanner console, String letter) {
    System.out.println("Looking for two \"" + letter + "\" words in a row.");
    System.out.print("Type a word: ");
    String word1 = console.next();
    System.out.print("Type a word: ");
    String word2 = console.next();
    while (!(word1.startsWith(letter) && word2.startsWith(letter))) {
        word1 = word2;
        System.out.print("Type a word: ");
        word2 = console.next();
    }
    System.out.println("\"" + letter + "\" is for \"" + word2 + "\"");
}

// uses do/while loop
public static void favoriteLetter(Scanner console, String letter) {
    System.out.println("Looking for two \"" + letter + "\" words in a row.");
    int count = 0;
    String word;
    do {
        System.out.print("Type a word: ");
        word = console.next();
        if (word.startsWith(letter)) {
            count++;
        } else {
            count = 0;
        }
    } while (count < 2);
    System.out.println("\"" + letter + "\" is for \"" + word + "\"");
}
```


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