Instructions:

- **Do not open this exam until told by the proctor.**
  You will have exactly 90 minutes to finish it.

- **Make sure your phone is turned OFF (not to vibrate!) before the exam starts.**

- Food, gum, and drink are strictly forbidden.

- **You may not use your phone or open your bag for any reason,** including to retrieve or put away pens or pencils, until you have left the exam room.

- This exam is **closed-book, closed-notes, and closed-computational devices.**

- If you get stuck on a problem, it may be to your benefit to move on to another question and come back later.

- All code must be written out in proper java format, including all curly braces and semicolons.

- **Do not separate the pages.** You may tear off the one scratch page at the end of the exam. This scratch paper must be turned in or you lose 3 points.

- Turn in all scratch paper to your exam. Do not take any sheets of paper with you.

- If you require extra paper, please use the backs of the exam pages or the extra pages provided at the end of the exam. **Only answers on the FRONT of pages will be grading. The back is for scratch work only.**

- Use a pencil, or blue or black pen to complete the exam.

- If you have any questions, raise your hand and a proctor will come to answer them.

- When you turn in your exam, you may be required to show ID. **If you forgot to bring your ID, talk to an exam proctor immediately.**

- We wish you the best of luck.

Scores: [For instructor use only]

<table>
<thead>
<tr>
<th>Question</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 1</td>
<td>6 pts</td>
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<tr>
<td>Question 2</td>
<td>14 pts</td>
</tr>
<tr>
<td>Question 3a</td>
<td>5 pts</td>
</tr>
<tr>
<td>Question 3b</td>
<td>8 pts</td>
</tr>
<tr>
<td>Question 4</td>
<td>15 pts</td>
</tr>
<tr>
<td>Question 5a</td>
<td>8 pts</td>
</tr>
<tr>
<td>Question 5b</td>
<td>4 pts</td>
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<tr>
<td>Question 6</td>
<td></td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>62 pts</strong></td>
</tr>
</tbody>
</table>
1.) Miscellaneous (6 points)

1.1) (1 point) The Easy One:
- Check that your exam has all 9 pages (excluding the cover sheet, which is no numbered).
- Write your name, recitation number, and PennKey (username) on the front of the exam.
- Sign the certification that you comply with the Penn Academic Integrity Code.

1.2) (2 points) In the space provided, write code to draw the figure pictured in the window to the right (you can assume the square is half as wide as the window it is in. You do not have to draw the window, only the shapes. You do not need to write the class or main declaration.

```java
PennDraw.circle(0.5, 0.75, 0.25);
PennDraw.filledCircle(0.5, 0.25, 0.25);
```

1.3) (1 point) How many times would the following print HelloWorld?

```java
int i = 22;
while (i > 0) {
    i /= 3;
    if (i % 2 == 0) {
        System.out.println("Hello World");
    }
}
```

2 Times

(2 points) Rewrite the above code using a for loop so it prints the same number of times. You are welcome to change the starting value of i, the exit condition, and/or the modification step. The goal is to print Hello World the same number of times.

```java
for (int i = 0; i < 2; i++) {
    System.out.println("Hello World");
}
```
2.) Operators and Expressions (14 points) – 1 point for each blank

For each code fragment, (a) fill in the most appropriate word in the 1st column (if there are multiple blanks, all blanks are the same word) and (b) give the value that `z` contains after the code has been executed in the 2nd column.

If the code would result in an error, write “ERROR” in the 1st column and give the reason for the error in the 2nd column (you do not need to write the exact error message, just a general explanation). The first two problems have been completed for you.

**DO NOT WRITE WHAT PRINTS. ONLY THE TYPE IN THE BLANK AND THE VALUE OF Z**

<table>
<thead>
<tr>
<th>Code Fragment</th>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>z = 1;</code></td>
<td>int</td>
<td>3</td>
</tr>
<tr>
<td><code>z = z + 2;</code></td>
<td>int</td>
<td>3</td>
</tr>
<tr>
<td><code>int x = &quot;Hello World&quot;;</code></td>
<td>ERROR</td>
<td>Cannot set an int variable to a String</td>
</tr>
<tr>
<td><code>____????  z = x.charAt(0);</code></td>
<td>ERROR</td>
<td>Strings have to use .length()</td>
</tr>
<tr>
<td><code>String str = &quot;hello world&quot;;</code></td>
<td>ERROR</td>
<td>Strings have to use .length()</td>
</tr>
<tr>
<td><code>____????  z = s.length + &quot;14&quot;;</code></td>
<td>String</td>
<td>&quot;514&quot;</td>
</tr>
<tr>
<td><code>int[] x = {1, 2, 3, 4, 5};</code></td>
<td>int</td>
<td>5</td>
</tr>
<tr>
<td><code>____????  z = x.length + &quot;14&quot;;</code></td>
<td>String</td>
<td>54.0</td>
</tr>
<tr>
<td><code>int[] x = {1, 2, 3, 4, 5};</code> String s = &quot;taco salad&quot;;`</td>
<td>int</td>
<td>3</td>
</tr>
<tr>
<td><code>____????  z = x[2] + s.charAt(2) - s.charAt(6);</code></td>
<td>int</td>
<td>5</td>
</tr>
<tr>
<td><code>//line 4 is a continuation of line 3</code></td>
<td>int</td>
<td>3</td>
</tr>
<tr>
<td><code>int y = 5;</code></td>
<td>String</td>
<td>54.0</td>
</tr>
<tr>
<td><code>____????  z = y + &quot;&quot; + 4.0;</code></td>
<td>String</td>
<td>54.0</td>
</tr>
<tr>
<td><code>int[] x = {2, 9, 1, 4, 6};</code></td>
<td>int</td>
<td>3</td>
</tr>
<tr>
<td><code>int[] snd = fst;</code></td>
<td>int</td>
<td>3</td>
</tr>
<tr>
<td><code>____????  z = snd[1] % fst[4];</code></td>
<td>int</td>
<td>3</td>
</tr>
<tr>
<td><code>____????  x = &quot;CIS110&quot;.charAt(0) == 'C';</code></td>
<td>boolean</td>
<td>true</td>
</tr>
<tr>
<td><code>____????  y = 3 != 5;</code></td>
<td>boolean</td>
<td>true</td>
</tr>
<tr>
<td>`____????  z = (!x</td>
<td></td>
<td>y) &amp;&amp; (y</td>
</tr>
<tr>
<td><code>____????  z = 3 * (3 / 2) + 1.5;</code></td>
<td>double</td>
<td>4.5</td>
</tr>
</tbody>
</table>
3a) Conditionals Fill-In (5 points total)

Fill in the blanks for the following method. This method takes in 3 numbers and returns true if they are all different. If any two match, or all 3 match, then it returns false.

```java
public static boolean allDiff(double a, double b, double c) {
    if (a != b) { // 2 points
        if (b != c) { // 2 points
            return a != c;
        }
    }
    return false; // 1 point
}
```

3b) (8 points) Loops Fill-In

Fill in the blanks for the following method. This function counts the number of odd numbers in an array.

```java
public static int oddsInArray(int[] arr) {
    int count = 0; // 2 points

    for (int j = 0; j < arr.length; j++) { // 3 points
        if (arr[j] % 2 == 1) { // 2 points
            count++;
        }
    }
    return count; // 1 point
}
```
4) Tracing (15 points –0.5 points for each blank)
In the following code, print the value of x and y at each checkpoint. It is highly recommended you tear off and use the scratch page at the end of the exam.

```
int[] x = {1, 5, 2, 11, 3};
int[] y = {2, 3, 3, 9, 4};

for (int i = 1; i < 5; i += i) {
    int k = 4 - i;
    while (x[i] > y[k]) {
        x[i] -= y[k];
    }
}
//Checkpoint A

for (int i = 0; i < 5; i++) {
    int j = x[i]*2;
    int k = j % 5;
    if (y[k] > x[i]) {
        y[k] += x[i];
        x[i] = y[k];
    }
}
//Checkpoint B

for (int i = 0; i < 5; i+=2) {
    if (x[i] >= y[i]) {
        y[i] = y[i] - x[i];
        x[i] = y[i] - x[i];
    } else {
        i--;
    }
}
//checkpoint C
```

<table>
<thead>
<tr>
<th>Checkpoint</th>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>[1, 5, 2, 11, 1]</td>
<td>[2, 3, 3, 9, 4]</td>
</tr>
<tr>
<td>B</td>
<td>[4, 5, 6, 11, 5]</td>
<td>[2, 3, 5, 9, 6]</td>
</tr>
<tr>
<td>C</td>
<td>[-6, 5, -7, 11, 5]</td>
<td>[-2, 3, -1, 9, 6]</td>
</tr>
</tbody>
</table>
5a) Method Mixup (8 points)

Will is notoriously disorganized. It's gotten so bad he's actually gotten all of this lines of code out of order. The lines of code below belong to a method that search through an array create a new array with ONLY the even numbers. However, the lines are out of order. In the space at the bottom, put the lines of code below in the correct order. You may not write your own code. You must use the code as written.

```java
int count = 0;
for (int i = 0; i < arr.length; i++) {
    if (arr[i] % 2 == 0) {
        count++;
    }
}
int insertAt = 0;
int[] out = new int[count];
for (int i = 0; i < arr.length; i++) {
    if (arr[i] % 2 == 0) {
        out[insertAt] = arr[i];
        insertAt++;
    }
}
return out;

public class Exam {
    public static int[] getEvenArray(int[] arr) {
        int count = 0;
        for (int i = 0; i < arr.length; i++) {
            if (arr[i] % 2 == 0) {
                count++;
            }
        }
        int insertAt = 0;
        int[] out = new int[count];
        for (int i = 0; i < arr.length; i++) {
            if (arr[i] % 2 == 0) {
                out[insertAt] = arr[i];
                insertAt++;
            }
        }
        return out;
    }
    }
```
5b) Method Mix-up Testing (4 points)
The method on the previous page takes in an array and returns an array that contains only the even numbers in the same order. Given this description, complete the Junit test below. You can assume that the method `getEvenArray` is in a file called `Exam.java` in the same folder as this program. (Hint: The method `assertArrayEquals(int[] a, int[] b)` returns true if the contents of the arrays `a` and `b` are equal. `assertEquals()` without the word Array does NOT work on arrays.) Write the test as we have shown in class. A test input has been generated for you.

```java
import static org.junit.Assert.*;
import org.junit.*;

public class ExamTest {
    @Test
    public void getEvenArrayTest() {
        int[] inputArray = {5, 6, 2, 1, 4, 3};
        int[] expectedOutput = {6, 2, 4};
        int[] actualOutput = Exam.getEvenArray(inputArray);
        assertArrayEquals(expectedOutput, actualOutput);
    }
}
```
MC BananaPeelZ, a soundcloud star, has recently been contacted by DMX to produce a cool hip and trendy rap song. While MC BananaPeelZ was very excited to work with a legend, he discovered something tragic: DMX does not write his own ad-libs. In fact, MC Banana Peelz found out that the positioning of the various “Come on!”s, “Yeah”’s and “Uh”’s throughout DMX songs are actually computer generated!

MC BananaPeelZ discovered that the algorithm works as follows

- 1 YEAH on every beat that is a power of 2 (the beat = 2^n for some n >= 0).
- 1 uh-huh per every 2 beats
- Finally, the song ends with a “Grrr… WOOF WOOF.”

Here’s an example of a series of adlibs created by DMX’s adlib method, for a song with only 9 beats. We have annotated the beats with comments. The comments are NOT part of the program output. The method does not return anything, but simply prints.

```
uh-huh  //beat 0
YEAH!  //beat 1
YEAH!  //beat 2
uh-huh //beat 2
YEAH!  //beat 4
uh-huh //beat 4
uh-huh //beat 6
YEAH! //beat 8
uh-huh //beat 8
Grrr... WOOF WOOF //end of the song
```

Wanting to expose DMX as a computer generated hack, MC BananaPeelZ has tasked you with writing the code that performs this behavior on the next page. Write a function that produces DMX's "ad-libbing" on the next page.
public static void dmxAdLibPrinter(int totalBeats) {
    int nextPowerOfTwo = 1; // 2 ^ 0

    for (int beat = 0; beat < totalBeats; beat++) {
        // if beat is a power of two, print yeah
        if (beat == nextPowerOfTwo) {
            nextPowerOfTwo *= 2;
            System.out.println("YEAH!");
        }
        // if even print uh-huh
        if (beat % 2 == 0) {
            System.out.println("uh-huh");
        }
    }

    // end the song
    System.out.println("Grrr... WOOF WOOF");
}
Extra Space for Answers

DO NOT RIP THIS PAGE OFF. ANY WRITING ON THIS PAGE CAN BE GRADED
Scratch Paper

YOU MAY USE THIS PAGE FOR SCRATCH WORK, BUT NOTHING ON IT WILL BE GRADED