This is an open notes, open computer, closed conversation exam. You may not speak to anyone but me about this. I reserve the right to ask you to have a conversation with me where I ask you to talk through your answers.

Question:	1	2	3	4	5	6	7	8	Total
Points:	2	12	6	8	2	6	2	6	44

1. (2 points) Consider the beginning of the ArrayBag class that we wrote in class:

```
public class ArrayBag implements Bag
{
   private String[] contents;
   private int count;

   ...
}
```

   In a few sentences, explain why we added the variable count instead of using `contents.length`.

2. (12 points) On the next page, I have provided a framework for a Die class. This ckass stores a history of all rolls made so that it can analyze them. Read over the class framework I have provided, and fill in the details accordingly. If you don't have room to write one or more of the methods, or if you need to start over with more space, that's fine.

   You may assume that the user will never roll the die more than 100 times, and you don't need to do error checking on that.

```
public class Die {

   private int[] history;
   private int numRolls;

   public Die() {









   }

   // Return an integer value between 1 and 6, inclusive, and remember the value
   // in the history.
   public int toss() {









   }

   // Return an array of the values produced by the die so far. The
   // size of the array should be the number of time the die has been tossed.
   // Assume that this will never be called if the die hasn't been rolled yet.
   public int[] getTossHistory() {









   }

   // Return an array of size 6, where location 0 contains the total number of 1s that
   // have been rolled, location 1 contains the total number of 2s that were rolled, and so on.
   public int[] getCounts() {









   }
}
```

3. (6 points) Suppose that I have the following Java code, each in its own file as appropriate:

```
public interface Pet
{
   public void act();
}

public class Dog implements Pet
{
   public void act()
   {
      System.out.println("Woof!");
   }
}

public class Cat
{
   public void act()
   {
      System.out.println("Meow!");
   }
}
```

(a) Suppose that the following code appears in a `main` method somewhere:

```
Pet fuzzy = new Dog();     // line 1
fuzzy.act();               // line 2
```

Which of the following will occur?

A. The program will run without error and print out `Woof!`
B. The program will run without error and print out nothing
C. The program will give an error at line 1, indicating that `Pet` and `Dog` are different types and one can't be assigned to the other
D. The program will give an error at line 2, indicating that `act` has not been implemented in `Pet`

(a) _____

Explain why in a few sentences.

(b) Now suppose that the following code appears in a `main` method somewhere:

```
Pet fluffy = new Cat();     // line 1
fluffy.act();               // line 2
```

Which of the following will occur?

A. The program will run without error and print out `Meow!`
B. The program will run without error and print out nothing
C. The program will give an error at line 1, indicating that `Pet` and `Cat` are different types and one can't be assigned to the other
D. The program will give an error at line 2, indicating that `act` has not been implemented in `Pet`

(b) _____

Explain why in a few sentences.

4. (8 points) Write down the output to the following program in the box provided to the right. For each section, draw a diagram below to indicate what is happening to each variable (i.e. draw boxes and arrows to indicate what the program is doing).

```
public class Variables {

   public static void main(String[] args) {
      int x = 3;
      int y = x;
      x = 5;
      System.out.println(x);
      System.out.println(y);

      System.out.println("---");

      int[] a = {1, 2};
      int[] b = a;
      a[0] = 4;
      System.out.println(a[0]);
      System.out.println(b[0]);
      System.out.println(a[1]);
      System.out.println(b[1]);

      System.out.println("---");

      String s = "hello";
      String t = s;
      s = "goodbye";
      System.out.println(s);
      System.out.println(t);

      System.out.println("---");

      String s1 = new String("hello");
      String s2 = new String("hello");
      System.out.println(s1 == s2);
      System.out.println(s1.equals(s2));
   }
}
```

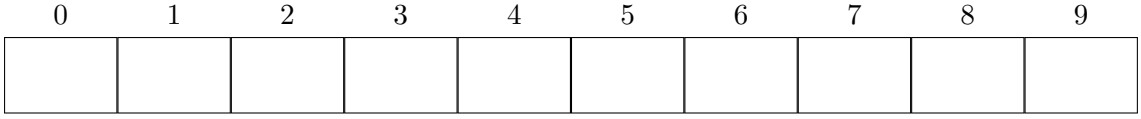
5. (2 points) Suppose that we implemented an `ArrayBag` where we expand the array as necessary, as we eventually did in class. Suppose that the initial capacity for the array is 20, and that it starts off empty. What is the length of the array after adding 145 entries to an `ArrayBag` object?

5. _____

6. (a) (6 points) Suppose that we implement an `ArrayQueue` using a circular array as we have in class, and we run the following code:

```
ArrayQueue<Integer> q = new ArrayQueue<Integer>();
for (int i=10; i < 15; i++)
{
   q.enqueue(i);
}
```

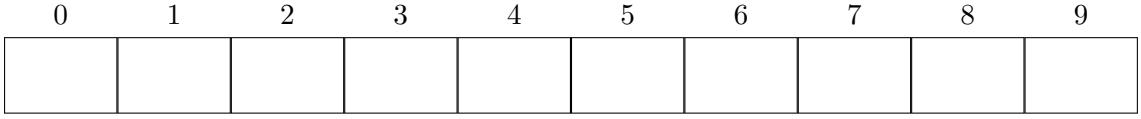
Fill in the boxes below to show what the internal array to the `ArrayQueue` looks like. (I've assumed an initial capacity of 10.)



(b) Now suppose that I run the additional lines of code, after the above:

```
q.dequeue();
q.dequeue();
q.dequeue();
```

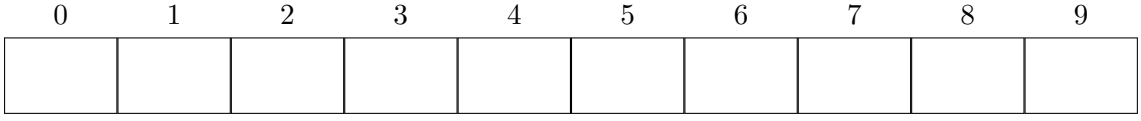
Now fill in the boxes below to show what the internal array looks like.



(c) Now suppose that I run the additional lines of code, after the above:

```
for (int i=15; i < 21; i++)
{
   q.enqueue(i);
}
```

Now fill in the boxes below to show what the internal array looks like.



7. (2 points) When we were building a queue using an array in class, we ran into a problem when our array became full. In a few sentences explain the problem and potential solutions.

8. Suppose I have an Stack that uses array resizing, and that initally it is size 2.

   (a) (2 points) After I insert 4 elements into the stack, how many total array assignments will I have done (keeping in mind resizing)?

   (b) (2 points) After I insert 16 elements into the stack, how many total array assignments will I have done (keeping in mind resizing)?

   (c) (2 points) After I insert N elements into the stack, how many total array assignments will I have done (keeping in mind resizing)?

Here is some more scrap paper if you need it.

Name: _____