1. What output is produced when the following Java program fragment is executed? You should show your working.

```java
int v = 1;
int i = 1;
while (i <= 7) {
    i += 2;
    v += i;
}
System.out.println(v);
```

Answer: 25

Working:

<table>
<thead>
<tr>
<th>v</th>
<th>i</th>
<th>condition</th>
<th>i</th>
<th>v</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1 &lt;= 7 is true</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>3 &lt;= 7 is true</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>5 &lt;= 7 is true</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td>16</td>
<td>7</td>
<td>7 &lt;= 7 is true</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>25</td>
<td>9</td>
<td>9 &lt;= 9 is false</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2. Let country and state be variables of type String. Write an expression (of type boolean) that checks whether country is "USA" but state is neither "HI" nor "AK". (5 marks)

**Answer:** country.equals("USA") && !(state.equals("HI") || state.equals("AK"))

or country.equals("USA") && !state.equals("HI") && !state.equals("AK")

3. What output is produced when the following Java program fragment is executed in each case?

(a) aNumber is 1.
(b) aNumber is 0.
(c) aNumber is -1.

You should show your working.

```java
if (aNumber >= 0)
    if (aNumber == 0)
        System.out.print("A");
    else
        System.out.print("B");
else
    System.out.print("C");
```

(5 marks)

**Answer:**
(a) BC  (b) AC  (c) C

the else belongs to the second if (in spite of what the formatting may suggest)
4. Implement a method
   
   \[
   \text{public static double midrange(double[]} a) \]

   that takes an array \( a \) and returns the midrange of \( a \), that is

   \[
   \frac{\min a + \max a}{2},
   \]

   where \( \max a \) is the largest and \( \min a \) is the smallest element in the array. For instance, if the input array is \( \{ 0, 1, -2, 4 \} \) then the output is 1 because the largest element is 4 and the smallest element is \(-2\): \( (4 + (-2))/2 = 1 \). 

   \( \text{(15 marks)} \)

   \textbf{Answer:}

   \[
   \text{public static double midrange(double[]} a) \}
   \]

   \[
   \quad \text{double min = a[0];}
   \]

   \[
   \quad \text{double max = a[0];}
   \]

   \[
   \quad \text{for (double e : a) \{}
   \]

   \[
   \quad \quad \text{if (e > max)}
   \]

   \[
   \quad \quad \quad \text{max = e;}
   \]

   \[
   \quad \quad \text{if (e < min)}
   \]

   \[
   \quad \quad \quad \text{min = e;}
   \]

   \[
   \}
   \]

   \[
   \quad \text{return (max + min)/2;}
   \]

   \}

   \text{alternatively:}

   \[
   \text{public static double midrange(double[]} a) \}
   \]

   \[
   \quad \text{double min = a[0]; // these should be double}
   \]

   \[
   \quad \text{double max = a[0];}
   \]

   \[
   \quad \text{for (int i = 1; i < a.length; i++) \{ // or from 0}
   \]

   \[
   \quad \quad \text{if (a[i] > max)}
   \]

   \[
   \quad \quad \quad \text{max = a[i];}
   \]

   \[
   \quad \quad \text{if (a[i] < min)}
   \]

   \[
   \quad \quad \quad \text{min = a[i];}
   \]

   \[
   \}
   \]

   \[
   \quad \text{return (max + min)/2;}
   \]

   \}

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5. Implement a method
   
   ```
   public static double[] multiply(double[] v, double c)
   that returns a new array containing the elements of v multiplied by c: for example, if the parameter array is \{0, 1, 2, 3\} and c is 2 then the output is \{0, 2, 4, 6\}.
   (12 marks)
   ```

   Answer:
   ```
   public static double[] multiply(double[] v, double c) {
     int[] s = new double[v.length];
     for (int i = 0; i < v.length; i++)
       s[i] = v[i] * c;
     return s;
   }
   ```

6. What output is produced when the following Java program is executed?
   ```
   public class E15 {
     public static void main(String args[]) {
       int[] a = {0, 1, 2, 1};
       int[] b = {0, 0, 0, 6, -2};
       if (c(a,1) == c(b,2))
         System.out.println("yes");
       else
         System.out.println("no");
     }
     public static int c(int a[], int i) {
       return a[i] + a[i + 1] + a[i + 2];
     }
   }
   ```
   You should show your working. (7 marks)

   Answer:
   yes

   Working: When the method c is called in `c(a,1)`, a refers to the array \{0, 1, 2, 1\} and so, the method returns \(1 + 2 + 1 = 4\). When the method c is called in `y(b,2)`, a refers to the array \{0, 0, 0, 6, -2\} and so, the method returns \(0 + 6 - 2 = 4\). Thus, the method `main` prints "yes".
7. A loyalty card is used by a supermarket to reward regular shopping as follows. A customer has points added to their card every time they shop at one of the supermarket’s stores. The customer may subsequently redeem these points for a cash equivalent.

Write a class LoyaltyCard to simulate a simplified loyalty card.

(a) Each loyalty card stores a card number and a current balance (the number of points). Implement a constructor, which automatically generates the card number. The card number is a String that consists of "LC" followed by a 7-digit number: the numbers start from 0 and incremented each time a new loyalty card is created. (9 marks)

(b) Implement methods getCardNumber() and getPoints(). (3 marks)

(c) Implement a method collect(double amount, int bags) that receives the amount spent (in pounds) and the number of bags re-used and increases the balance by two points for every pound spent and by one point for each bag re-used. (6 marks)

(d) Implement a method redeem(int points) that receives a number of points to be redeemed and returns its cash equivalent (in pounds). If the operation is allowed then the method should reduce the balance by the specified number of points and return £0.01 for every 2 points. The operation is not allowed if less than 500 points is requested to be redeemed or the number of points to be redeemed exceeds the current balance; in these cases the method should return 0 without changing the balance. (7 marks)

Answer:

```java
public class LoyaltyCard {
    private String number;
    private int points;

    private static int lastNumber = 0;

    public LoyaltyCard() {
        number = "LC" + String.format("%07d", lastNumber);
        // + lastNumber will not do the padding (but is ok)
        lastNumber++;
    }

    public String getCardNumber() { return number; }

    public int getPoints() { return points; }
}
```
public void collect(double amount, int bags){
    // rounding first; only then times 2
    balance += 2*(int)amount + bags;
}

public double redeem(int points) {
    if (points < 500 || balance < points)
        return 0;
    balance -= points;
    // integer division first
    return 0.01 * (points / 2);
}

8. Suppose you have declared an interface Shape as follows:

```java
public interface Shape {
    public int getCentreX();
    public int getCentreY();
    public int getArea();
}
```

(these methods return the co-ordinates of the centre and the area of the shape, respectively).

(a) Write a class Rectangle that implements interface Shape (remember to implement all methods of the interface). The constructor of Rectangle should take the co-ordinates of the bottom-left corner and the width and the height of the rectangle.

(10 marks)

(b) Write a method

```java
public static void printAreas(Shape shapes[])
```

that takes an array of shapes, instances of Shape, and prints out the area of each shape on a separate line.

(8 marks)

**Answer:**

(a)

```java
public class Rectangle implements Shape {
    private int x, y, w, h;
    public Rectangle(int x, int y, int w, int h) {
        this.x = x;
        this.y = y;
        this.w = w;
        this.h = h;
    }
    public int getCentreX() { return x + w/2; }
    public int getCentreY() { return y + h/2; }
    public int getArea() { return w * h; }
}
```

(b)

```java
public static void printAreas(Shape shapes[]) {
    for (Shape shape : shapes)
        System.out.println(shape.getArea());
}
```
9. Find five compile-time errors in the following class declaration:

```java
public class Y15 {
    private static int b = 2;
    public static int main(String args)
        int b = 0;
        int[] array = { 2, 3, "4" };
        for (c : array) {
            b += c + c;
        }
        System.out.println(array[array[this.b]]);
    }
}
```

How would you correct the errors you have found? (7 marks)

**Answer:**

```java
public class Y15 {
    private static int b = 2;
    public static void main(String args) {
        int b = 0;
        int[] array = { 2, 3, 4 };
        for (int c : array) {
            b += c + c;
        }
        System.out.println(array[array[Y15.b]]);
    }
}
```

Note that missing [] in the declaration of `main` is not a compile-time error—the Java language does not require `main` (or any other method) to have a specific signature.