There are in total ten questions in this paper. 
Answer all ten questions. 
Each question carries 10 marks in total. 
Calculators and other electronic devices are not permitted.
The examination is closed book. 
No supplementary material is provided. 
This paper is not prior disclosed. 
The quote marks for strings are in the following style: "string".
1. Consider the following Java program.

```java
public class HelloPrinter {
    public static void main(String[] args) {
        System.out.println("Hello World");
    }
}
```

a) The above program is compiled and run in the BlueJ Java Development Environment. Describe what is observed when the program is run. (2 marks)

b) Why is it necessary for a Java program to include a method called `main`? (2 marks)

c) List four of the reserved words used in the above program. (4 marks)

d) State the name of the class in the program. (2 marks)

2. a) Find the values of the following arithmetical expressions when they are evaluated in a correct Java program.

   i) \(3.5/2\)  
   ii) \(35/2\)  
   iii) \(9+(7*4)\)  
   iv) \(19 - (19\%3)\)  

   (4 marks)

b) A variable of type `int` can take integer values in the range \(-2^{31}\) to \(2^{31} - 1\). Explain what is meant by the statement that a variable of type `int` has overflowed. (2 marks)

c) Consider the following Java instructions.

   ```java
   int total = 0;
   int a = total+1;
   int b = a+1;
   int c = 2*total;
   total += 4;
   ```

   What is the value of `total` and what are the values of `a`, `b` and `c` when the above instructions are executed in a correct Java program? (4 marks)
3. a) Find the values of the following expressions when they are evaluated in a correct Java program. In all four cases state the type of the result.
   i) “Harry”.charAt(0)
   ii) “AA”+1
   iii) “AA”+“1"
   iv) “John Smith”.substring(0, 4)

   (4 marks)

b) Find the values of the following expressions when they are evaluated in a correct Java program. The variable x is of type int and has the value 5.
   i) 5 < 0
   ii) x > 0
   iii) x > 6 && x < 10
   iv) 0 < 10 || 10 < 20

   (4 marks)

c) The following instructions are executed in a correct Java program. What are the values of b1 and b2?

   String str = ”test”;
   boolean b1 = str.equals(”test”);
   boolean b2 = str.equals(str);

   (2 marks)
4. a) State what is meant by a compile time error and what is meant by a run time error. (4 marks)

b) Identify four compile time errors in the following Java program.

```java
import java.util.Scanner;
public class HasErrors
{
    public static vacant main(String[] args)
    {
        System.out.println("Please type in a number: ");
        Scanner in = new Scanner(System.in);
        int x = in.nextInt();
        System.out.println(Please type in another number: ");
        int x = in.nextInt();
        System.out.println("sum: "+x+y);
    }
}
```

(4 marks)

c) A Java program to sort an array of numbers in increasing order has been written. The program compiles without any errors. Suggest one way of testing the program for run time errors. (2 marks)

5. a) Consider the following format specifier for floating point numbers: "%10.2f". Explain the role of the symbol % and the number 10 in the format specifier. (4 marks)

b) It is required to print the numbers 0.361, 1.25, 31.75, 4.9752 on separate lines, placed such that the decimal points are aligned. For each number, the three digits to the right of the decimal point are printed. State with reasons a single appropriate format specifier. Add the notation for a new line to the format specifier. (4 marks)

c) Find the error in the format specifier "%5.2d". (2 marks)
6. a) Show clearly which of the following can be chosen as names of variables in a correct Java program and show clearly which cannot be chosen as names of variables.
   i) v
   ii) double
   iii) 6double
   iv) const8tent

   (4 marks)

b) The following instruction is a correct declaration and initialization of a variable in a Java program.

   int double_ = -4;

   Explain why the above instruction is an example of poor programming style. (2 marks)

c) The following Java instructions contain a compile time error. Describe the error.

   int bottles;
bottles = bottles+4;

   (2 marks)

d) The following Java instructions contain a run time error. Describe the error.

   int x = 4, y = 2;
   System.out.println("The sum of x and y is"+(x*y));

   (2 marks)
7. Consider the following Java method.

```java
public static double pm(double[] a)
{
    double m = 0;
    for(int i = 0; i < a.length; i++)
    {
        m = m+a[i];
    }
    m = m/a.length;
    return m;
}
```

a) Suppose that the method `pm` is called with the argument `a = {1.0, 4, 7}`. How many times is the for loop traversed? what value is returned by `pm`? (2 marks)

b) Modify the method `pm` to produce a new method `pm1` which does not return a value but instead uses the instruction `System.out.println()` to output the string "The average value is: ", followed by the value of `m`. Note that it is necessary to supply `System.out.println()` with an appropriate argument. Write out the entire method `pm1`. (4 marks)

c) Modify the method `pm` to produce a new method `pm2` that returns the same value as `pm`, but which calculates this value using a while loop in place of the for loop. Write out the entire method `pm2`. (4 marks)
8.  
   a) What is the value of \( x \) when the following instructions are executed in a correct Java program.

   ```java
   int x;
   boolean flag = false;
   if(flag)
   {
      x = 4;
   }
   else
   { 
      x = 5;
   }
   ```

   (2 marks)

   b) Consider the following instructions.

   ```java
   int x = 0, y = 0;
   if(x == 0)
   {
      if(y == 0)
      {
         y = 1;
      }
      else
      { 
         x = 4;
      }
   }
   ```

   The above instructions are compiled without error, however, the indentations are not appropriate for a human reader of the instructions. Explain why the indentations are not appropriate.

   (2 marks)

   Question 8 continued on next page
c) Radiation dosage is measured in millisieverts. The upper limits on radiation dosage in one year are as follows.

Employees aged 18 years or over: 20 millisieverts.
Trainees: 6 millisieverts.
All others: 1 millisievert.

The category of a person is specified by a variable $c$ of type int. For employees aged 18 years or over, $c$ has the value 1, for trainees, $c$ has the value 2, for all others, $c$ has the value 3. The radiation dose in millisieverts is given as the value of a variable $d$ of type int. Write a public static method with the name `doseExceeded` that takes $c$, $d$ as parameters and that returns a boolean value true if the upper limit on radiation dosage is strictly exceeded and returns a boolean value false otherwise. (6 marks)

9. a) The numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and the letters are ordered in Java in the following way. The numbers are ordered by magnitude. Lower case letters are ordered alphabetically. Upper case letters are ordered alphabetically. Numbers precede all letters and upper case letters precede lower case letters. Explain how this ordering of letters and numbers is extended to give a lexicographic ordering of strings. (4 marks)

b) Place the following four strings in lexicographic order.

i) "1079"
ii) "10794"
iii) "Zebra"
iv) "Zeb2ra"

(2 marks)

c) Write a method $f$ that takes a string as an argument and returns true if every character in the string strictly precedes the character ‘a’ in the ordering of the characters. Otherwise $f$ returns false. The header for the method is

```java
public static boolean f(String str)
```

The method `string1.compareTo(string2)` is noted, but the use of this method is not obligatory. (4 marks)
10. a) Define the terms *index* and *element* as they apply to one dimensional arrays. Let \( \text{ar} \) be the array \{1, 2, 3\}. What is the value of the largest correct index for \( \text{ar} \)? What is the length of \( \text{ar} \)? (2 marks)

b) A partially filled array is by definition an array accompanied by a companion variable that records the number of array elements that are being used, i.e. that have meaningful values. Let \( \text{a} \) be an array and let \( \text{currentSize} \) be a companion variable for \( \text{a} \). The array \( \text{a} \) and the companion variable \( \text{currentSize} \) are defined by

\[
\text{double[]} \ \text{a} = \text{new double}[10]; \\
\text{int currentSize} = 0;
\]

Consider the following method with the name \( \text{update} \).

\[
\text{public static int update(double[]} \ \text{b}, \ \text{int c}, \ \text{double r}) \\
\{ \\
\ \ \ \text{b}[\text{c}] = \text{r}; \\
\ \ \ \text{c} = \text{c}+1; \\
\ \ \ \text{return c;}
\}
\]

State with reasons the value of \( \text{currentSize} \) and the values of the relevant elements of \( \text{a} \) after the following two instructions have been executed in a correct Java program.

\[
\text{currentSize} = \text{update}(\text{a}, \text{currentSize}, 2); \\
\text{currentSize} = \text{update}(\text{a}, \text{currentSize}, 3);
\]

(4 marks)

c) The method \( \text{update} \) in part (b) of this question returns an integer of type \text{int}. Explain why it is not necessary for \( \text{update} \) to return any further information about the array specified by the parameter \( \text{b} \). (4 marks)