Please fill in your Student Number and Name.

Student Number : _____

Name:

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Student Number:

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University of Cape Town ~ Department of Computer Science

Computer Science 1015F ~ 2008

June Exam

Question	Max	Internal	External	Question	Max	Internal	External
1	9			7	3		
2	8			8	8		
3	8			9	9		
4	15			10	8		
5	10			11	8		
6	14						
				TOTAL	**100**		

Marks : 100

Time : 180 minutes

Instructions:

a) Answer all questions.

b) Write your answers in the space provided.

c) Show all calculations where applicable.

Question 1 [9]

a) State Moore's Law. [1]

Number of transistors on a chip will double every 2 years

b) Does Moore's Law still hold? Explain your answer. [1]

No: single cores have reached a limit [1] Yes, if we count muliple cores [1]

c) What is the purpose of a central processing unit? [1]

Perform core computation, execute instructions, ...

d) What is computer hardware? [1]

the physical components of the computer

e) What is a computer program? [1]

a set of instructions given to a computer to perform a task

f) What is the difference between a high-level and low-level programming language? [2]

high level is human-centric while low-level is machine-centric

g) Briefly describe 2 disadvantages of using Java bytecode, as opposed to machine code. [2]

slower[1] more work [1]

Question 2 [8]

Consider the following program and answer the questions that follow.

```
import java.util.Scanner;

class Test
{
   public static void main ( String [] args )
   {
      Scanner input = new Scanner (System.in);

      int a = input.nextInt();
      int b = input.nextInt();
      int c = input.nextInt();

      int x = Math.min (Math.min (a, b), c);
      int y = Math.max (Math.max (a, b), c);

      System.out.println (a+b+c-x-y);
   }
}
```

a) What does this program do? [2]

calculates the median value of 3 integers

b) What is the output if the input is the numbers 5, 3 and 7? [1]

5

c) List all variables from within the main method. [1]

a,b,c,x,y,input

d) Why must the main method be public? [1]

so it can be invoked from outside the class

e) Rewrite the last statement of the main method so there is a logic error. [1]

anything syntactically correct: e.g., System.out.println (a+b+c+x+y);

f) What are 2 techniques that can be used to find the logic error? [2]

trace statements [1] assertions [1] debugging [1] equivalence class testing [1]

Question 3 [8]

a) Briefly describe an algorithm to put on your shoes. Assume you already have chosen/found the shoes. There should be at most 6 steps. [3]

remove current shoes if necessary, open left shoe if necessary, put in foot, close shoe if necessary, repeat for other foot, put away previous pair

b) Write the Java statement to input the number of pairs of shoes into the variable **N**. You may assume **N** is already declared as an int and there is already a Scanner object named **input**. [2]

```
N = input.nextInt();
```

c) Write the Java statement to calculate the variable **totalWorth** as the price of **N** pairs of shoes at a cost of **pricePerPair** for each pair. You may assume **totalWorth** and **pricePerPair** are already declared as float variables and **N** is declared as an int. [1]

```
totalWorth = N * pricePerPair;
```

d) Write the Java statement to output "Worth of shoes: ", immediately followed by the value of the variable **totalWorth**. [2]

```
System.out.println ("Worth of shoes" + totalWorth);
```

Question 4 [15]

Examine the following code and answer the questions that follow.

```
// print quarter information for specific months
int month = 0;
for (month=0; month<10; month++ )
{
  switch (month) {
     case 1:
     case 2:
     case 3: System.out.println("First quarter: Month " +
month);
     break;
     case 4:
     case 5:
     case 6: System.out.println("Second quarter: Month " +
month);
     break;
     default: System.out.println("No information");
  }
}
```

a) What is the output of this program? [4]

No information

First quarter: Month 1

First quarter: Month 2

First quarter: Month 3

Second quarter: Month 4

Second quarter: Month 5

Second quarter: Month 6

No information

No information

No information

b) Rewrite this program, converting the nested **if-else** statement to a **switch** statement. [2]

```
if (month>=1 && month <=3) {
  System.out.println("First quarter: Month " + month);
} else if (month >=4 && month <=6) {
```

```
    System.out.println("Second quarter: Month " + month);
 } else {
   System.out.println("No information");
 }
```

c) Rewrite the program using a **while** loop instead of a **for** loop. Note: You do not need to write the body of the loop. [2]

```
int month =0 ;
while (month < 10) {
    //body of the previous loop
  month++;
}
```

d) What is the result of each of the following expressions? The result will be either true or false. Assume variable week = 7. [2]

i. `week > 3 && week < 20`

True [1/2]

ii. `week >=0 || week <2`

True [1/2]

iii. `week > 0 && week < 5`

False [1/2]

iv. `week < 7 && week==2`

False [1/2]

e) Write a Java method to print out a blank grid for a working week calendar, such as:

```
+  -  +  -  +  -  +  -  +
|     |     |     |     |
+  -  +  -  +  -  +  -  +
|     |     |     |     |
+  -  +  -  +  -  +  -  +
```

Your method should have the header:

```
void printGrid ( int numberOfWeeks, int numberOfWorkingDays )
```

The above pattern is produced when invoking **`printGrid(2,4)`**. [5]

```
public void printGrid ( int numberOfWeeks, int numberOfWorkingDays) {
  String out = "+";
  for (int j=0; j<numberOfWorkingDays; j++) {
     out += "-+";
  }
  String out_mid = "|";
  for (int j=0; j<numberOfWorkingDays; j++) {
     out_mid += " |";
  }
  for (int i=0; i<numberOfWeeks; i++) {
     System.out.println(out);
     System.out.println(out_mid);
  }
  System.out.println(out);
}
```

Question 5 [10]

Study the following code and answer the questions that follow.

```
public class ClassA
{
   method()
   {
      /*
         Variable declarations and other code is here
      */
      if (problem) // no point in continuing so we
                   //terminate the method
         return; //terminate the method
      /*
         More code in here
      */
      return usefulDataValue;  // return some data value of
                               //a particular data type
    } //end of method
} //end of class declaration
```

a) Identify the program errors in the code fragment. All of the variables needed have been declared and initialized. (Choose two). [2]

i. The return data type for the method is not specified.

ii. The formal parameter list is not specified (should be declared as void).

iii. An access modifier is not specified.

iv. The method is attempting to return both a data type and a void type concurrently.

v. There should never be more than one return statement in any method

i. The return data type for the method is not specified [1]

iv. The method is attempting to return both a data type and a void type concurrently. [1]

If total < 2 marks then iii. An access modifier is not specified. [1/2]

b) Write the syntax of a method that returns a value. [2]

public Type_Returned Method_Name (Parameter_List) { ….

return <expression that evaluates to Type_Returned>;}

c) Write the syntax of a **void** method. [1]

```
public void  Method_Name (Parameter_List) { ….
return; //This is optional}
```

d) What are Java classes? [2]

Classes are templates or blueprints to create objects. Classes define the data/attributes and associated operations (behaviour/methods) for objects of a particular type.

e) Write minimal Java code to create a class and an object of the class. [3]

```
// Source Filename: Kiddies.java
import java.util.Scanner;
public class Kiddies {
  public  String author = "Hanh Le";
  /**
  * @param args the command line arguments
  */
  public static void main(String[] args) {
     Kiddies kid = new Kiddies();
  }
}
```

Question 6 [14]

a) Consider the Student class below, and add constructors, accessor and mutator methods as described by the comments.

```
public class Student
{
    private String name;
    private String id;
    private double average_grade;
```

// i) Constructor with three arguments that is used to initialize the instance variables [2]

```
public Student(String n, String i, double g)
{
 name = n;
 id = i;
 average_grade = g;
}
```

// ii) Accessor methods for all the instance variables [3]

```
public String getName()
{
 return name;
}
public String getID()
{
 return id;
}
public double getGrade()
{
 return average_grade;
}
```

// iii) Two mutator methods with one argument each to set the *name* and *id* instance variables[2]

```
public void setName(String n)
```

```
{
 name = n;
}
public void setID(String i)
{
 id = i;
}
```

// iv) One mutator method, with an array argument, that is used to calculate the
// *average_grade* instance variable, returning no value [3]

```
public void calculateAverageGrade(double [] g)
{
 double sum = 0.0;
 int i;

 for (i=0; i < g.length; g++)
   sum = sum + g[i];
 average_grade = sum / g.length;
}
```

```
}
```

b) Consider the driver class below, and add statements to create an object called *aStudent* of type **Student** for "Peter" with id no "id1" and an average grade of 0.0, using your constructor above. Use your mutator method above to calculate the average grade of the student after writing four tests for which his grades were 59.12%, 88.55%, 66.21% and 75.20%. Display the name, id and average grade for the student using your accessor methods above. [4]

```
public class ConstructorsDemo
{
   public static void main (String args[])
   {
Student firstStudent = new Student("Peter","id1",0.0);
double [] grades={59.12, 88.55, 66.21, 75.20};
aStudent.calculateAverageGrade(grades);
System.out.println ("Name = " + astudent.getName() + id + aStudent.getId() + "Average
Grade = " + aStudent.getGrade();
```

```
    }
}
```

Question 7 [3]

When used with objects, what is the equality (==) operator really comparing? [3]

The == operator does not check that the objects have the same values for instance variables. It checks for equality of memory address, so two objects in two different locations in memory would test as being "not equal" when compared using ==, even if their instance variables contain equivalent data.

Question 8 [8]

The following set of methods sorts an array of numbers in descending order. Complete the missing methods as indicated by the comments.

```
/**
Precondition:  The array has values.
Action:Sorts a so that a[0] >= a[1] >= ... >= a[a.length-1]
*/
public void selectionSort ( int[] a )
{
   int indexOfLargest;
   for ( int i=0; i<a.length; ++i )
   {
      indexOfLargest = LargestIndex (i, a);
      swap (i, indexOfLargest, a);
   }
}

/**
Returns the index of the largest value among
a[start], a[start + 1], ... a[a.length-1]                    [5]
*/
private int LargestIndex ( int start, int[] a )
{
int max = a[start];
int indexOfMax = start;
for(int i=start + 1; i < a.length; i++)
{
 if(a[i] > max)
 {
  max = a[i];
  indexOfMax = i;
 }
}
   return indexOfMax;
}

/**
Precondition:  i and j are legal indices for the array a.
```

```
   Postcondition:  Values of a[i] and a[j] have been
   interchanged                                              [3]
   */
   private void swap ( int i, int j, int[] a )
   {
int temp;
temp = a[i];
a[i] = a[j];
a[j] = temp;
   }
```

Question 9 [9]

A 2-dimensional array `table` has been created and filled with values as shown below:

```
int[ ][ ] table = new int[6][4];
table = fillArrayWithValues(6,4);  // puts values in table
```

a) Write Java code to print out the values inside `table`. The values in each row must be on the same line, with each row of values on a new line of output. [5]

```
for (int i = 0; i < table.length; i++)
  {
  for (int k = 0; k < table[i].length; k++)
     System.out.print(table[i][k] + " ");
  System.out.println();
  }
```

b) Now write some Java code to change `table` to be a ragged array that has 55 rows and a triangular shape. Every element should contain the value zero, as shown below: [4]

0				
0	0			
0	0	0		
0	0	0	0	
0	0	0	0	0

– – – etc. – – – for 55 rows altogether.

```
table = new int[55][0];
for (int i = 0; i < 55; i++)
  { table[i] = new int[i];
  for (int k = 0; k < table[i].length; k++)
     table[i][k] = 0;
  }
```

Question 10 [8]

Consider the Java class below:

```
public class Book
{
   private String title;
   private String number;
   public Book( )
   {
      title = "unknown"; number = "?";
   }
   public Book( String bTitle, String num)
   {
      title = bTitle; number = num;
   }
//
// --- other methods not shown here
//
}
```

a) Using the concept of inheritance, create a subclass (derived class) of **Book** called **ChildrensBook** which has 2 extra instance variables *author* and *ageGroup* (both of type String). Include the code for a **ChildrensBook** constructor that takes 2 arguments – the first being the author and the second the age-group for that book. [3]

```
public class ChildrensBook extends Book
{
  String author;  // or private or ....
  String ageGroup; // or private or ....
  public ChildrensBook( String by, String age )
  {
    author = by; ageGroup = age;
  }
}
```

b) Below are 5 Java terms and 3 explanations of Java concepts. Which of the Java terms fits each explanation? The 5 terms (possible answers) are: `getClass`, `instanceof`, `protected`, `super`, `this` [3]

i. Which term is used inside a derived class (subclass) to call the base class (superclass) constructor?

super

ii. Which term can be used instead of public or private to restrict access to subclasses and classes in the same package?

protected

iii. Which is a method that returns a representation of the class of an object?

getClass

c) Given that `ChildrensBook` is a subclass of `Book`, state whether or not there is an error in lines 3 and 4 below. Give a brief reason for each answer to show your understanding of inheritance in Java. [2]

```
Book myBook = new Book( "Exodus", "123.456");
ChildrensBook kidbook = new ChildrensBook("X","?" );
myBook = kidbook;                                    // line 3
kidbook = myBook;                                    // line 4
```

line3 has no error. Any reasonable reason as to why.

line4 is an error. Any reasonable reason as to why.

Question 11 [8]

a) Convert 125.125_{10} to binary (i.e., convert the decimal number 125.125 to base 2). Show your working. [3]

125 / 2 = 62 rem 1

62/2 = 31 rem 0

31/2 = 15 rem 1

15/2 = 7 rem 1

7/2 = 3 rem 1

3/2 = 1 rem 1

1/2 = 0 rem 1

*.125 * 2 = 0.25*

*.25 * 2 = 0.5*

*.5 * 2 = 1.0*

so 01111101.001

b) Convert the binary number `01100101101111` to hexadecimal. [2]

01/1001/0110/1111

so 196F

c) What is the value of the floating point number below? Assume IEEE754 single precision format, i.e., the leftmost bit is the sign bit, the next 8 bits are the biased exponent, and the rightmost 23 bits are the significand. The exponent is biased by 127. Show your working. [3]

1 10000001 10010000000000000000

first 1 => negative

biased exponent = 2 (bias is 127; if say bias is 128 then biased exponent is 1: mark this also)

significand = 1001 so mantissa is 1.1001

hence -1.1001 x 2 ^ 4

(or -11001 = -25)