

**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 ~ 2009**

**June Exam**

Question	Max	Internal	External	Question	Max	Internal	External
1	10			7	8		
2	10			8	7		
3	10			9	15		
4	10			10	20		
5	5						
6	5						
<b>TOTAL</b>					<b>100</b>		

**Marks : 100**

**Time : 180 minutes**

**Instructions:**

- a) Answer all questions.
- b) Write your answers in pen in the spaces provided.
- c) Show all calculations where applicable.

**Question 1 [10]**

a) What is an algorithm? [1]

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*Set of instructions to accomplish a task*

b) Are all algorithms also computer programs? Explain your answer. [1]

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*No. Instructions to take the bus are not a program.*

c) What is the purpose of a compiler? [1]

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*Translate program from high level to low level language*

d) What is the purpose of a debugger? [1]

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*Help to find errors in program*

e) Briefly describe 1 advantage and 1 disadvantage of using Java bytecode as opposed to machine code. [2]

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*ad: worm, easier to optimise; disad: more work, slower, less optimal*

f) What is the difference between computer hardware and computer software? [2]

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*hardware is physical parts; software is instructions*

g) What is the purpose of the following hardware components: (i) memory (ii) hard drive? [2]

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*(i) store data while computer is on (ii) store data permanently*

## Question 2 [10]

Consider the following program and answer the questions that follow.

```
public boolean action ( int number )
{
    for ( int i=2; i<number; i++ )
        if ( number % i == 0 )
            return false;
    return true;
}
```

- a) What does this method do? [2]

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*checks if a number is prime*

- b) What is the formal parameter in this method? [1]

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*number*

- c) Is the dangling else a problem in this program? Explain why or why not. [2]

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*No. There are no nested if statements.*

- d) What simple change can be made to the loop so it performs fewer iterations without changing the meaning of the method? [2]

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*only check up to Math.sqrt (number)*

- e) Assume you want to use equivalence classes to test the method. Describe the equivalence classes and provide a test value corresponding to each. [3]

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*one prime, one not prime, 7/10*

### Question 3 [10]

Consider the following method and answer the questions that follow.

```
public void drawShape ( int n )
{
    for ( int i=1; i<=n; i++ )
    {
        for ( int j=0; j<i; j++ )
            System.out.print ( '*' );
        System.out.println ( );
    }
}
```

- a) What is the output if n = 2? Write one character in each block and assume the top-left corner is where the output starts. [2]


```
*
* *
```

- b) What is the output if n = 4? Write one character in each block and assume the top-left corner is where the output starts. [2]


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```
*  
**  
***  
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```

c) Rewrite the following 2 lines of the program in the form of a **while** loop. [2]

```
for ( int j=0; j<i; j++ )  
    System.out.print ( '*' );
```

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```
int j=0; [1/2]  
while (j<i) [1/2]  
{  
    System.out.print ('*'); [1/2]  
    j++; [1/2]  
}
```

f) Write a method to draw the following square of single digit integers, for any given height from 1-9. In the example below, the height is 5. [4]

```
11111  
22222  
33333  
44444  
55555
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```
public void drawShape ( int n )  
{  
    for ( int i=1; i<=n; i++ )  
    {  
        for ( int j=1; j<=n; j++ )  
            System.out.print (i);  
        System.out.println ();  
    }  
}
```



### Question 4 [10]

Examine the following incomplete class definition and answer the questions that follow.

```
public class Person
{
    private String name;
    private int age;

    public Person ( String aName, int anAge )
    {
        name = aName;
        age = anAge;
    }
    ...
}
```

a) Write accessors for the 2 instance variables.

[2]

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```
public String getName () { return name; }
public int getAge () { return age; }
```

b) Write mutators for the 2 instance variables.

[4]

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```
public void setName ( String aName ) { name = aName; }  
public void setAge ( int anAge ) { age = anAge; }
```

c) What is the purpose of the constructor? [1]

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*initialise the object*

d) Write the code to create an object with the initial values ["Kathy", 60] and assign this object to the variable theDean. [1]

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*theDean = new Person ("Kathy", 60);*

e) If we wish to create another constructor in the same class, what condition must hold for this new constructor? [1]

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*different parameter set*

f) What is information hiding? [1]

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*preventing access to members to avoid errors*

### Question 5 [5]

Consider the code below which shows part of the Course class:

```
public class Course          // line 1
{ String name;              // line 2
  Student classrep;         // line 3
  Course corequisite;       // line 4
  Course prerequisite;      // line 5
  ...                        // other variables and methods...
  public Student someMethod( Course crs )
                                  // line 6
  {
    System.out.println( corequisite.getName( ) ); // line 7
    System.out.println( Course.total );          // line 8
    corequisite = new Course ( );                // line 9
    prerequisite = crs;                          // line 10
    ...
    return new Student( classrep );              // line 11
  }
}
```

- a) In which line above is a static variable being used? (just give the line number) [1]

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- b) In which line above is a copy constructor being called? (just give the line number) [1]

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- c) In which line above is there a privacy leak? (just give the line number) [1]

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- d) Why is it a good idea to use a copy constructor rather than object assignment i.e. what is the reason for having a copy constructor? [1]

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*to prevent privacy leaks/sharing*

- e) When would you use a static variable rather than an ordinary instance variable i.e. what is the advantage of having a static variable in a class? [1]

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*when you want to keep one value for the class as whole not separate values per object*

### Question 6 [5]

Write Java code to do each of the following tasks:

- a) Define a 1-dimensional array that holds the following integer values: [1]

1 3 -2 2 -7 -2 -10 -1

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```
int [] x = {1, 3, -2, 2, -7, -2, -10, -1 }
```

- b) Add 1 to the 1st element, 2 to the second element and so on. [2]

1 3 -2 2 -7 -2 -10 -1

would become

2 5 1 6 -2 4 -3 7

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```
for (int i = 0; i < x.length; i++) x[i] = x[i] + i + 1;
```

- c) Add the 2 adjacent elements of the array together and set the 1st of these elements to the sum. The last element of the array remains the same. [2]

2 5 1 6 -2 4 -3 7

would become

7 6 7 4 2 1 4 7

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```
for (int i = 0; i < x.length-1; i++) x[i] = x[i] + x[i+1];
```

**Question 7 [8]**

- a) Write Java code to set the elements of a 2-dimensional array to the values indicated below. Two loops must be used and no value may be read in. Define all variables used. The code should work for any square array. [6]

-10	10	10	10	10
1	-10	20	20	20
1	2	-10	30	30
1	2	3	-10	40
1	2	3	4	-10

```
public static void main ( String [ ] args )
{
    int max = 5;
```

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```
int [ ] [ ] x = new int [max] [max]; [1]
for (int row = 0; row < max; row++) [1]
for ( int col = 0; col<max; col++) [1]
    if (row == col) x[row] [col] = 10 [1]
    else if (col>row) x[row] [col] = 10*(row + 1) [1]
    else x[row] [col] = col + 1 [1]
```



}

b) If the 2 for loops in your program were swopped around would this change the result of the program? [1]

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*no*

c) Explain why. [1]

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*The loops just ensure that every element of the array is accessed. The order is not relevant.*

**Question 8 [7]**

You are given the class `equilateral` below where each side of the triangle is the same length.

```
public class equilateral
{
    protected int side1;

    public equilateral ( int s )
    { side1 = s; }

    public int perimeter ( )
    { return 3*side1; }

    public String toString ( )
    { return "Side 1 =" + side 1; }
}
```

Write a derived class called `triangle`. `triangle` is similar to `equilateral`, except that each side has a different length. Use the principles of inheritance in your solution and rewrite each of the methods. [7]

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```
public class triangle extends equilateral [1]
{ protected int side2, side3; [1]
public triangle(int s1, int s2, int s3 ) [1]
{ super(s1); [1]
side2 = s2; side3 = s3; } [1]
public int perimeter ( )
{ return side1 + side2 + side3;} [1]
public String toString()
{return super.toString() [1]
+ "Side 2 =" + side 2 + "Side 3 =" + side3;}
}
```

**Question 9 [15]**

- a) Convert the decimal number 123 to binary, showing your working. [2]

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*123/2 = 61 rem 1  
61/2 = 30 rem 1  
30/2 = 15 rem 0  
15/2 = 7 rem 1  
7/2 = 3 rem 1  
3/2 = 1 rem 1  
1/2 = 0 rem 1 hence 1111011*

- b) Convert the octal number 123 to decimal, showing your working. [1]

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*64 + (2\*8) + 3 = 83*

- c) Convert the octal number 321 to hexadecimal, showing your working. [2]

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*011010001 so 0000 1101 0001  
so 0D1*

- d) Convert the decimal fraction 0.3 to binary, showing your working. [3]

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$0.3 * 2 = 0.6$   
 $0.6 * 2 = 1.2$   
 $0.2 * 2 = 0.4$   
 $0.4 * 2 = 0.8$   
 $0.8 * 2 = 1.6$   
so recurring fraction  
hence  $0.0100110011001$  etc or  $0.0(1001)'$

e) Calculate  $3 - 12$  using 8-bit 1's complement binary representation, showing all your working. (i.e. convert the numbers to 8-bit 1's complement before adding) [2]

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0000 0011  
1111 0011  
1111 0110

f) Find the value represented by the floating point number written below using IEEE754 representation (bias of 127 added to the exponent; first bit is the sign bit, next 8 bits are the biased exponent, rightmost 23 bits are the significand). Show all your working. [5]

0 01111111 10000000000000000000000

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*sign implies positive value*

*biased exponent is 127 so actual exponent is  $127 - 127 = 0$*

*mantissa is 1.1 in binary which is 1.5 in decimal*

*so number is  $1.5 * 2^0 = 1.5$*

**Question 10 [20]**

**Bridging the Generation Gap**

Teenagers communicate electronically using a language that adults often do not understand. You have been asked to investigate a solution to translate a list of words in SMS language into regular English. For example, the word “l8r” would be translated into “later”.

You are only required to translate the following 5 words (translations are in brackets) :

u (you), r (are), l8r (later), gr8 (great), c (see)

You need to produce a single string as output, with words separated by spaces. If a word does not appear in the list above, it must remain untranslated.

a) Describe (in English) the algorithm you will use to perform the translation. [4]

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```
create a new empty string  
scan through the words one at a time  
for each word, check through the list of translation candidate matches at that point  
if there is a match, copy the replacement into the new string,  
otherwise copy the old word into the new string
```

b) Describe 2 classes you could use in your solution and what the purpose of each is. [4]

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*driver class, to start program*  
*interface class, to perform input and output*  
*table class, to store translation table and do lookups*  
*translation class, to perform translation*

- c) Write the code for the **translate** method that performs the translation and returns the translated string. Assume the words to be translated are passed as a parameter that is an array of Strings and the return value is a String. A Driver class and code skeleton is provided for you. [10]

```
class TranslationDriver
{
    public static void main ( String [] args )
    {
        String [] words = {"u","r","gr8","dude","c","u","l8r"};
        Translation babel = new Translation ();
        System.out.println (babel.translate (words));
    }
}

class Translation
{
    public String translate ( String [] words )
    {
```

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```
String nStr= "";  
for ( int i=0; i<words.length; i++ )  
{  
    if (words[i].equals ("u"))  
        nStr += "you ";  
    else if (words[i].equals ("r"))  
        nStr += "are ";  
    else if (words[i].equals ("gr8"))  
        nStr += "great ";  
    else if (words[i].equals ("c"))  
        nStr += "see ";  
    else if (words[i].equals ("l8r"))  
        nStr += "later ";  
    else  
        nStr += words[i] + " ";  
}  
return nStr;
```

```
}  
}
```

d) If the input to your method was provided as a single String instead of as separate words, explain how you could convert it into separate words. [2]

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*use StringTokenizer, use a loop to scan for spaces, ...*