



22097012



**COMPUTER SCIENCE
HIGHER LEVEL
PAPER 2**

Wednesday 20 May 2009 (morning)

2 hours 15 minutes

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.

Answer *all* the questions.

1. The following class represents a chemical element.

```
public class Element
{
    private String symbol;
    private int atomicNumber;

    public Element(String s, int a)
    {
        symbol = s;
        atomicNumber = a;
    }
    public String getSymbol(){ return symbol; }
    public int getAtomicNumber(){ return atomicNumber; }
}
```

An Element array is created which holds element information in alphabetical order of symbol.

```
Element[] metals = new Element[100];
```

The first three items in the array are shown below.

Array Index	Symbol	Atomic Number
[0]	Al	13
[1]	Be	4
[2]	Cu	29

(a) State the value that would be output by the following statement.

```
output(metals[2].getSymbol())
```

[1 mark]

A second class contains the following two methods which can be used to search the metals array.

Method 1 performs a linear (sequential) search:

```
public int findRecord(int atomicNumber, int size, Element[] metals)
```

Method 2 performs a binary search:

```
public int findRecord(String symbol, int size, Element[] metals)
```

The number of elements in the array is held in the identifier size.

(This question continues on the following page)

(Question 1 continued)

- (b) By considering the two `findRecord()` methods, explain how it is permissible to have two methods with the same name in the same class. *[3 marks]*

Method 1 performs a linear search on the array `metals`, returning the array index if found, and the value `-1` if not found.

- (c) Construct Method 1. *[6 marks]*

Method 2 performs a binary search on the array `metals`, returning the array index if found, and the value `-1` if not found.

The basic steps of the algorithm are as follows:

```
repeat until top < bottom
  middle = (top + bottom) / 2;
  if search value = middle return array index;
  if search value < middle value change value of top;
  if search value > middle value change value of bottom;
return -1;
```

- (d) Construct Method 2. *[10 marks]*

2. (a) Construct a binary search tree using the following list of names:

Stefano, Waters, Peters, Williams, Sánchez, Chin, Smith.

[2 marks]

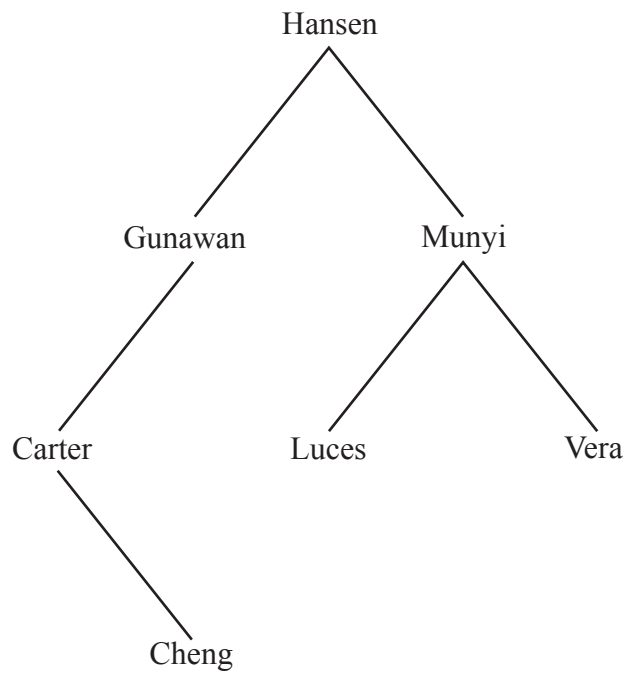
- (b) Identify a sub-tree on your tree structure from part (a).

[1 mark]

Traversal of a binary tree consists of visiting each node in a specific order.

- (c) Traverse the tree shown below in pre-order (root, left, right) and state the name at each node as it is visited.

[3 marks]



(This question continues on the following page)

(Question 2 continued)

The class `BinaryTreeNode` allows, through its constructor, the creation of tree nodes. This class is shown below.

```
public class BinaryTreeNode
{
    public String name;
    public BinaryTreeNode left;
    public BinaryTreeNode right;

    public BinaryTreeNode(String name) // class constructor
    {
        this.name = name;
        left = null;
        right = null;
    }
}
```

The class `BinaryTree`, allows the construction of a binary tree. There are various methods associated with this class, some of which are shown below.

```
public class BinaryTree
{
    private BinaryTreeNode root;
    public BinaryTree() // class constructor
    {
        root = null;
    }
    public void addNode(String newName) // inserts a new node
    { // into the tree
        // code missing
    }
    public int size(BinaryTreeNode root) // returns the number of
    // nodes in a tree
    {
        // code missing
    }
}
```

The recursive method `size()` returns the number of nodes in the tree, which can be found by traversing the tree in any order.

(d) Construct the method `size()`, which has been started above. [6 marks]

The method `addNode()` inserts a new name into the correct place in the tree.

(e) Construct the method `addNode()`, which has been started above. You can assume that the new name does not already exist in the tree. [8 marks]

3. A large unsorted file is stored on disk. When the file requires processing, the key field for each record is read into a hash table in the memory. The key field is an integer.
- (a) Define the term *key field*. [2 marks]
 - (b) Outline the data structure that will hold the hash table in the memory. [2 marks]
 - (c) Describe how the hash table is created as each key field is read from disk. [2 marks]
 - (d) Given that the hash algorithm is $\text{index} = \text{key_field} \bmod 1000$,
 - (i) identify the index, if the ID equals **13001**. [1 mark]
 - (ii) explain what would happen if the ID **26001** was read in later. [3 marks]

Once the hash table has been formed, a record ID number can be used to directly access the record on disk. The position of the record is determined by applying the same algorithm used in part (d).

- (e) (i) Outline the steps that would display the record with an ID of **13001**. [4 marks]
 - (ii) Outline the extra steps that must be taken to display the record with the ID number **26001**. [2 marks]
- (f) Describe an alternative method by which an individual record could be directly accessed. [4 marks]

4. *This question requires the use of the case study.*

Compared to a desktop, a laptop typically uses a lower-power processor, a smaller keyboard and a smaller screen. It also has a touchpad instead of a mouse and a battery with a relatively short life. Disabled persons use these for word processing.

- (a) Outline a problem that **one** of these features can cause for
 - (i) sight-impaired users. *[2 marks]*
 - (ii) users with limited dexterity. *[2 marks]*
- (b) Outline a way in which laptops can benefit
 - (i) hearing-impaired users. *[2 marks]*
 - (ii) users with limited dexterity. *[2 marks]*
- (c) Outline **three** ways in which specialist keyboards can assist disabled people. *[6 marks]*
- (d) For the following two features of an operating system, discuss a problem that a disabled person might have in using them, and suggest a possible improvement that will help that person.
 - (i) menus and icons *[4 marks]*
 - (ii) sounds *[4 marks]*
- (e) For the following two hardware devices, identify a problem that a disabled person might have in using them, and suggest a possible modification that will help that person.
 - (i) screen *[3 marks]*
 - (ii) scanner *[3 marks]*
- (f) Explain the role of analogue to digital conversion in the operation of a voice-activated wheelchair. *[4 marks]*

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(Question 4 continued)

- (g) The case study states, “connection to the network is critically important to one’s social and economic advancement”.
- (i) Explain **one** example of **social** advancement which would illustrate the problems of people on the wrong side of the “digital divide”. *[3 marks]*
- (ii) Explain **one** example of **economic** advancement which would illustrate the problems of people on the wrong side of the “digital divide”. *[3 marks]*

Voice recognition allows easy entry of text for people with dexterity problems.

- (h) Outline **one** feature of a word processor, apart from voice recognition, that could reduce the amount of typing required when producing letters. *[2 marks]*
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