



22127012



**COMPUTER SCIENCE  
HIGHER LEVEL  
PAPER 2**

Monday 21 May 2012 (morning)

2 hours 15 minutes

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INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- A clean copy of the **Computer Science** case study is required for this paper.
- The maximum mark for this examination paper is [100 marks].

Answer **all** the questions.

- 1. A tourist board has provided an interactive website that describes the 30 most popular towns in the country. The website also allows the user to plan journeys from any of these towns.

To calculate distances between towns, the website uses data that is stored in a two-dimensional integer array called `distances`, which is declared as a global variable. Part of the array is shown below.

```
distances
```

	0	1	2	3	
0	0	18	25	30	
1	18	0	54	32	
2	25	54	0	34	
3	30	32	34	0	

For example: the distance between town 2 and town 3 (`distances[2][3]`) is 34 km.

The website also makes use of the method `getTownName(int j)`, which returns the name of the town with index `j`.

- (a) State the value of `distances[0][2]`. [1 mark]

The website includes a method called `circle()`, which displays the names of all of the towns that are closer than a specified distance from the town where the user is staying.

- (b) Construct the method `circle(int i, int d)`, where `i` is the index of the town where the user is staying and `d` is the distance from the town. [4 marks]

*(This question continues on the following page)*

*(Question 1 continued)*

The website uses a second method called `threeTowns()`, that allows the user to plan a day's journey in which they will visit two other towns before finally returning to the town in which they are staying (the journey can be represented by Town A → Town B → Town C → Town A, where A is the town in which the user is staying).

This method will search the `distances` array to find and display the two towns that will provide the **shortest** total distance.

- (c) (i) Use the array to calculate the total distance for a journey starting at town 2, and then visiting town 0 and town 3, before finally returning to town 2 (Town 2 → Town 0 → Town 3 → Town 2). *[1 mark]*
  
- (ii) Construct the method `threeTowns(int s)`, where `s` is the index of the town in which the user is staying. *[8 marks]*
  
- (d) Suggest how the method `getTownName()` functions. *[2 marks]*
  
- (e) Explain the modifications to `circle()`, that would have to be made if the results had to be returned to the calling method. *[4 marks]*

2. A hash table is used to return the Spanish translation of an English word. The table uses a simple hash function in which the alphabetical position of the first letter of the English word (where a = position 0, b = position 1, *etc.*) becomes the hash value.

For example: the initial letter of the word antelope is “a”, therefore the hash value will be 0.

This value will then point to the object in the hash table that contains the original English word with its Spanish equivalent.

- (a) (i) Using this function, **copy** and complete the following hash table (the first three entries have been completed for you). *[1 mark]*

English Word	Array Index	Hash Table
antelope	0	antelope, antilope
brain	1	brain, cerebro
elephant	4	elephant, elefante
fox		fox, zorro
door		door, puerta

- (ii) Explain why collisions will be inevitable if this hash table is used for a large number of words. *[2 marks]*

To deal with the possibility of collisions, the hash table is changed so that each hash value points to a linked list of objects. As a pair of words (English, Spanish) is added to the table, they are placed at the head of the appropriate list, as shown below.

English Word	Array Index	Hash Table (array of linked lists)
antelope	0	antelope, antilope → null
camel	2	camel, camelo → null
car	2	car, coche → camel, camelo → null
ant	0	ant, hormiga → antelope, antilope → null

- (b) **Copy** the above hash table and complete the two missing entries using the following data (English, Spanish): cat, gato; arm, brazo. *[1 mark]*

*(This question continues on the following page)*

(Question 2 continued)

A program has been written to simulate this hash table using the hash function described at the start of this question. The hash value can be found using the following method call:

```
int hashValue = hash(englishWord);
```

The class that maintains the hash table with its array of linked lists is called `HashTable`. Each object in the linked lists is a member of the `Node` class. Both classes are defined below.

```
public class HashTable
{
    private Node[] listHeads = new Node[26]; // array of head pointers

    private int hash(String englishWord)
    {
        // returns the hash position (array index)
        // for the English word that is input
    }

    class Node // inner class for the hash table objects
    {
        String englishWord;
        String spanishWord;
        Node next;

        public Node(String e, String s) // constructor
        {
            englishWord = e;
            spanishWord = s;
            next = null;
        }
    }

    public void add()
    {
        // lines of code missing
    }

    public void search()
    {
        // lines of code missing
    }
}
```

- (c) Construct the code for the method `add()`, that adds a new English word and its Spanish equivalent to the hash table. [6 marks]
- (d) Construct the method `search()`, that outputs the Spanish equivalent of a given English word. You can assume that the word is in the table. [5 marks]
- (e) (i) Discuss the suitability of using this hash function for this application. [3 marks]
- (ii) Explain **one** improvement that could be made to this hashing process. [2 marks]

3. A large supermarket holds in secondary memory all the records relating to the items it sells. At the beginning of each working day, a small part of each record of this file is read into a dynamic data structure in the primary memory (RAM). This dynamic data structure is accessed by the supermarket checkout terminals whenever a customer purchases goods.
- (a) Suggest **two** reasons why part of this file might be read into a dynamic data structure. *[4 marks]*
  - (b) Explain why a binary tree might be preferred to a linked list as the dynamic data structure to be used. *[2 marks]*
  - (c) The dynamic data structure is used to update stock levels in the main file.
    - (i) Identify **two** fields that would definitely be held in each node in the dynamic data structure. *[2 marks]*
    - (ii) Outline the steps taken to update the stock file after one particular item has been sold at the supermarket checkout. *[6 marks]*
  - (d) Outline **one** way in which stock items can be identified as needing to be reordered. *[3 marks]*
- A separate program prints out a list of all the items on sale in the supermarket in alphabetical order.
- (e) Explain how a dynamic data structure can be used to produce this list even though the items are not stored in alphabetical order in the secondary memory. *[3 marks]*

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

- (a) Suggest **two** principal reasons that have led to the convergence of technologies as shown on page 3 of the case study. [2 marks]
- (b) Explain **two** reasons why flash memory is used extensively by mobile devices. [4 marks]
- (c) Explain why Wi-Fi has been chosen as the communication technology for Internet hotspots as opposed to other technologies. [4 marks]
- (d) Discuss whether the lack of dominance of one operating system for mobile devices might improve the security of data in smartphones in comparison with personal computers. [4 marks]
- (e) Two students are sitting in a café. They both have smartphones which have their Bluetooth facility enabled.
  - (i) Describe the precautions they should take while sending files to each other. [4 marks]
  - (ii) State **two** different examples of a piconet that might be operating within this café. [2 marks]
  - (iii) Outline how *frequency-hopping* prevents the piconets from interfering with each other. [4 marks]
- (f) With reference to **one** specific example, discuss whether the possible disadvantages of the use of smartphones by doctors for their work outweigh the advantages. [6 marks]

Police forces in several countries are being equipped with smartphones.

- (g) (i) Describe **two** ways in which smartphones could aid police who have just stopped a motorist suspected of a crime. [4 marks]
- (ii) Suggest **one** way in which the use of Bluetooth could provide additional assistance. [2 marks]
- (h) With reference to mobile phone networks, explain how two different mobile phones are able to use the same frequency within the same city at the same time. [4 marks]