International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

Computer Science

Higher level and standard level

Specimen papers 1, 2 and 3

For first examinations in 2014

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International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

COMPUTER SCIENCE
HIGHER LEVEL
PAPER 1

SPECIMEN PAPER

2 hours 10 minutes

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer all questions.

SECTION A

*Answer **all** questions.*

1. State **one** example of *application software*.   *[1 mark]*

2. Identify **two** methods that can be used to prevent data loss.   *[2 marks]*

3. Identify **two** methods of providing *user documentation*.   *[2 marks]*

4. Outline the need for higher level languages.   *[2 marks]*

5. State **one** function of the *operating system* in managing memory.   *[1 mark]*

6. Construct a *logic diagram* for the Boolean expression

    A AND B OR NOT B.   *[3 marks]*

7. Define the term *recursion*.   *[1 mark]*

8. Consider the following array

NAMES	[0]	[1]	[2]	[3]	[4]
	Robert	Boris	Brad	George	David

    and the following algorithm, which is constructed to reverse the contents of the array NAMES.

    ```
    N = 5  // the number of elements in the array
    K = 0  // this is the first index in the array

    loop while K < N - 1
      TEMP = NAMES[K]
      NAMES [K] = NAMES [N – K – 1]
      NAMES [N – K – 1] = TEMP
      K = K + 1
    end loop
    ```

    (a) Trace the algorithm, showing the contents of the array after each execution of
         the loop.   *[2 marks]*

    (b) Identify the type of error that occurs.   *[1 mark]*

    (c) Outline why the error occurs and how it could be corrected.   *[2 marks]*

9.   (a)   Outline the differences between a LAN and a VLAN.   *[3 marks]*

   (b)   Identify **two** factors that should be considered when selecting transmission media.   *[2 marks]*

10.   Consider the following binary search tree.
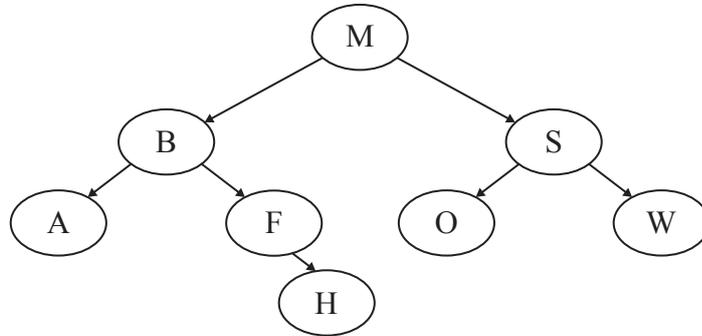
   (a)   State the order in which data will be listed using *preorder* traversal.   *[1 mark]*

   (b)   State the number of leaf nodes in the tree.   *[1 mark]*

   (c)   Construct the tree after adding the node L.   *[1 mark]*

Turn over

SECTION B

*Answer **all** questions.*

11. The temperature (in °C) of a lake was recorded every hour, every day, for one week. As each reading was taken, it was added sequentially to the collection TEMPERATURES, which is stored permanently.

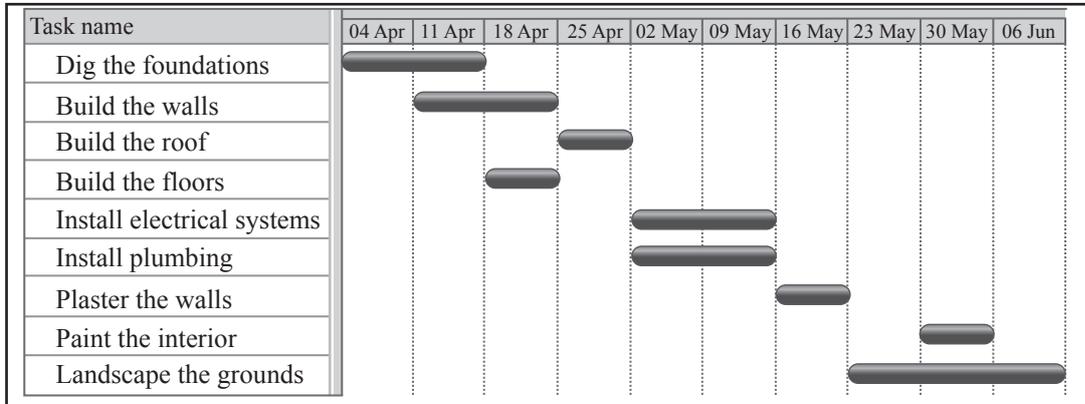At the end of the week this data was read into a two-dimensional array named TEMPWEEK as shown below.

hours	indices	Monday [0]	Tuesday [1]	· · · · · ·	Sunday [6]
00:00	[0]	12.4	12.3		12.6
01:00	[1]	12.3	12.3		12.5
⋮	⋮				
16:00	[16]	12.9	12.9		12.9
17:00	[17]	13.0	13.0		13.0
18:00	[18]	13.1	13.1		13.1
⋮	⋮				
22:00	[22]	12.3	12.3		12.3
23:00	[23]	12.3	12.3		12.3

(a) Construct the algorithm that will read the data from the collection into the array. You can use the collection functions TEMPERATURES.getNext() and TEMPERATURES.isEmpty(). *[5 marks]*

(b) Using the array TEMPWEEK, construct an algorithm to determine and output the minimum temperature for the week. *[4 marks]*

(c) If the temperature is less than 12.0 °C then the day, time and temperature are also placed in a separate data structure.

(i) Describe a **dynamic** data structure that might be used to hold this data. You may use a labelled diagram. *[3 marks]*

(ii) Using this dynamic structure suggest how the number of days when the temperature of the lake was below 12.0 °C can be found. *[3 marks]*

12. A business has decided to replace their current computer system with a new computer system.

    (a)   Identify **three** examples of how employees, as users of the computer system, may participate in the development of the new system.   *[3 marks]*

    (b)   One method of conversion from the old computer system to the new computer system is parallel running.

        (i)   Define the term *parallel running*.   *[1 mark]*

        (ii)   Identify **one** other method of conversion.   *[1 mark]*

        (iii)   Compare parallel running with the method of conversion identified in part (ii).   *[4 marks]*

    (c)   The data from the old computer system needs to be transferred onto the new computer system. Discuss **two** problems that may arise as a result of this data migration.   *[6 marks]*

13. Señor Rodriguez is having a new house built and will require local tradesmen to complete a number of tasks.

The Gantt chart below shows the tasks involved in the building of the house.

Task name	04 Apr	11 Apr	18 Apr	25 Apr	02 May	09 May	16 May	23 May	30 May	06 Jun
Dig the foundations	███									
Build the walls		███								
Build the roof				██						
Build the floors			██							
Install electrical systems					███					
Install plumbing					███					
Plaster the walls							██			
Paint the interior									██	
Landscape the grounds								████		

(a) Define the term *concurrent processing*. [1 mark]

(b) Identify **two** tasks that are carried out concurrently. [1 mark]

(c) Identify **two** tasks that are carried out sequentially. [1 mark]

(d) Describe how the idea of abstraction applies to one of the tasks. [2 marks]

(e) Explain **one** advantage and **one** disadvantage of carrying out a number of tasks concurrently. [4 marks]

Amalia Rodriguez, his daughter, is a student and is completing her homework. This requires her to view web pages, edit a document, and print out draft copies.

However, she is also surfing the web, keeping up to date on her social networking site as well as downloading apps and music from a P2P site.

(f) For one of the application programs which she uses to perform these activities, outline **one** task that is carried out by the application program itself. [2 marks]

Within the application the graphical user interface (GUI) elements are reliant on the operating system.

(g) Identify **two** GUI components that are common to all of the above and are carried out by the operating system. [2 marks]

(h) Outline how the use of abstract GUI components simplifies application programming. [2 marks]

14. The operating system in the latest mobile phones allows the user to open more than one application at the same time.

(a)   State **three** possible applications that might be open at the same time.   *[1 mark]*

(b)   Explain the role of the operating system in the management of these applications.   *[4 marks]*

The intended uses of a mobile phone influence its design with regard to system resources.
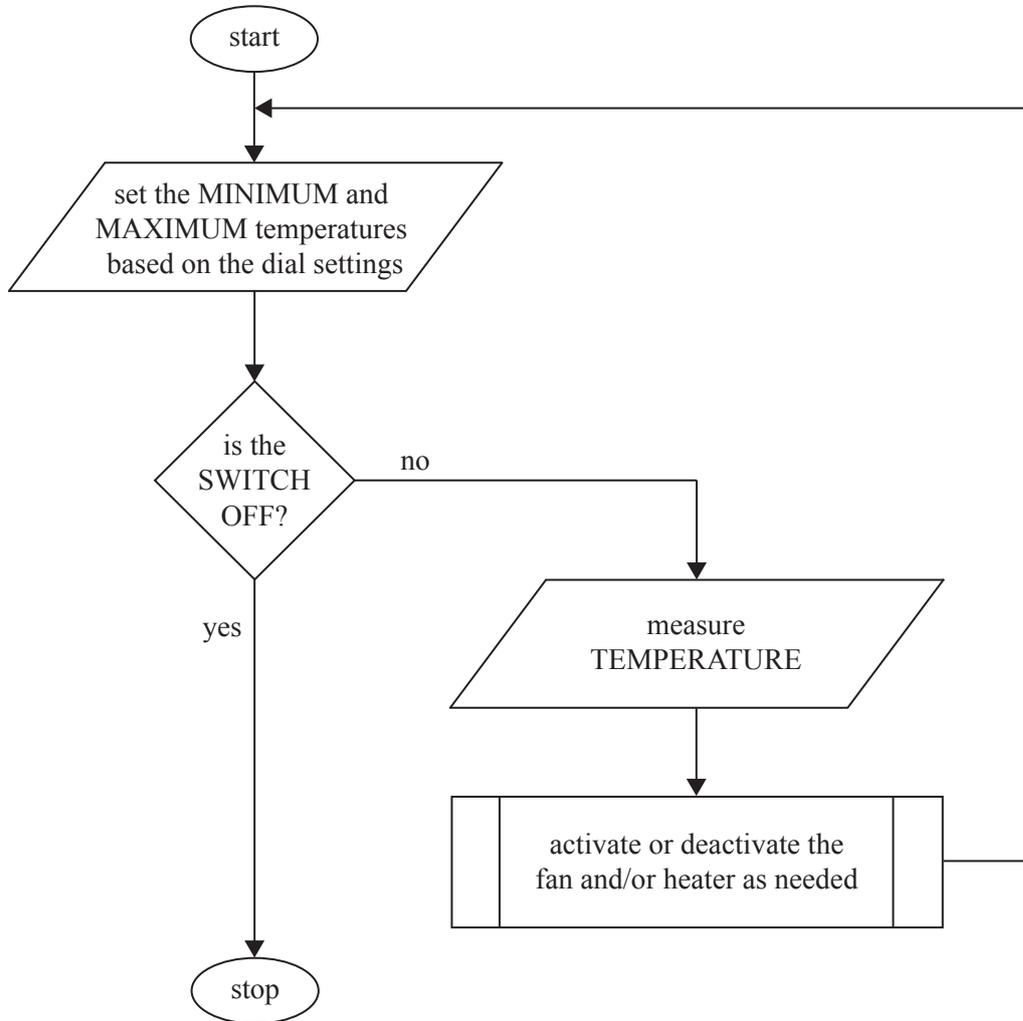
(c)   With reference to **two** specific resources, outline how the design of these resources for a mobile phone would differ from those of a standard PC.   *[4 marks]*

A mobile phone manufacturer is considering adding a graphics card to one of its models.

(d)   Discuss the possible consequences of going ahead with this modification.   *[6 marks]*

15. A company uses computer controlled equipment to monitor and control a heating system. The user controls the system via an on/off switch and two dials that are used to set the maximum and minimum temperatures desired.

The following flowchart represents the algorithm used to control temperature.

```
                    ( start )
                        |
                        v
        /  set the MINIMUM and        /
       /   MAXIMUM temperatures      /
      /    based on the dial settings/
                        |
                        v
                   < is the
                     SWITCH     >-- no --+
                      OFF? >              |
                        |                 v
                       yes       / measure        /
                        |       / TEMPERATURE     /
                        |                 |
                        |                 v
                        |      [ activate or deactivate the
                        |        fan and/or heater as needed ]
                        v
                    ( stop )
```

The temperature is constantly measured and the process of making the decision on which action to take is as follows.

If it is too cold (temperature is less than the minimum) then the heater should be switched on. If it is too hot (temperature is greater than the maximum) then the fan should be switched on. If temperature is within the given range (temperature greater than the minimum and less than the maximum) then both the fan and heater should be switched off.

(This question continues on the following page)

(Question 15 continued)

(a)   Identify **one** situation in which the system should respond to

     (i)   input from a user;   *[1 mark]*

     (ii)   temperature.   *[1 mark]*

(b)   State **three** hardware devices that are needed to capture the input data and
produce the system outputs.   *[3 marks]*

(c)   Construct pseudocode for the algorithm outlined on the previous page.   *[4 marks]*

(d)   The company wants to use its heating system to control the temperature
of ten different places at the same time. All ten places will have the same
maximum and minimum temperatures and each will have its own heater, fan,
and temperature sensor. Evaluate the decision of having all ten temperature
sensors, fans, and heaters connected to a single control computer instead of
having ten separate heating systems.   *[6 marks]*

MARKSCHEME

SPECIMEN

COMPUTER SCIENCE

Higher Level

Paper 1

General Marking Instructions

1.   Once markscheme is received mark in pencil until final markscheme is received.

2.   Follow the markscheme provided, do **not** use decimals or fractions and mark only in **RED**.

3.   Where a mark is awarded, a tick (✓) should be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark.

4.   Sometimes, careful consideration is required to decide whether or not to award a mark. Indeed, another examiner may have arrived at the opposite decision. In these cases write a brief annotation in the **left hand margin** to explain your decision. You are encouraged to write comments where it helps clarity, especially for moderation and re-marking.

5.   Unexplained symbols or personal codes/notations on their own are unacceptable.

6.   Record sub-totals (where applicable) in the right-hand margin against the part of the answer to which they refer. Show a mark for each part question (a), (b), *etc.* Do **not** circle sub-totals. Circle the total mark for the question in the right-hand margin opposite the last line of the answer.

7.   Where an answer to a part question is worth no marks, put a zero in the right-hand margin.

8.   **Section A:** Add together the total for the section and write it in the Examiner Column on the cover sheet.
       Section B: Record the mark awarded for each of the six questions answered in the Examiner Column on the cover sheet.
       Total: Add up the marks awarded and enter this in the box marked TOTAL in the Examiner Column on the cover sheet.

9.   After entering the marks on the cover sheet check your addition of all marks to ensure that you have not made an arithmetical error. Check also that you have transferred the marks correctly to the cover sheet. **We have script checking and a note of all clerical errors may be given in feedback to all examiners.**

10.   Every page and every question must have an indication that you have marked it. Do this by **writing your initials** on each page where you have made no other mark.

11.   A candidate can be penalized if he/she clearly contradicts him/herself within an answer. Once again make a comment to this effect in the left hand margin.

Subject Details: **Computer Science HL Paper 1 Markscheme**

Mark Allocation

Section A: Candidates are required to answer **all** questions. Total 25 marks.
Section B: Candidates are required to answer **all** questions. Total 75 marks.
                Maximum total = 100 marks.

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional.
Do not award more than the maximum marks allowed for that part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the
following points:

- Each statement worth one point has a separate line and the end is signified by means of a
  semi-colon (;).

- An alternative answer or wording is indicated in the markscheme by a "/"; either wording can
  be accepted.

- Words in (…) in the markscheme are not necessary to gain the mark.

- If the candidate's answer has the same meaning or can be clearly interpreted as being the
  same as that in the markscheme then award the mark.

- Mark positively. Give candidates credit for what they have achieved and for what they have got
  correct, rather than penalising them for what they have not achieved or what they have got wrong.

- Remember that many candidates are writing in a second language; be forgiving of minor
  linguistic slips. In this subject effective communication is more important than grammatical
  accuracy.

- Occasionally, a part of a question may require a calculation whose answer is required for
  subsequent parts. If an error is made in the first part then it should be penalized. However, if
  the incorrect answer is used correctly in subsequent parts then **follow through** marks should
  be awarded. Indicate this with "**FT**".

General guidance

Issue	Guidance
Answering more than the quantity of responses prescribed in the questions	- In the case of an "identify" question read all answers and mark positively up to the maximum marks. Disregard incorrect answers. - In the case of a "describe" question, which asks for a certain number of facts *e.g.* "describe two kinds", mark the first two correct answers. This could include two descriptions, one description and one identification, or two identifications. - In the case of an "explain" question, which asks for a specified number of explanations *e.g.* "explain two reasons …", mark the first two correct answers. This could include two full explanations, one explanation, one partial explanation *etc*.

SECTION A   *Total: [25 marks]*

1.   *Award [1 mark] for a valid example.*
     Word processor; spreadsheet; database management system; e-mail; web browser;
     CAD; graphic processing software;   *[1 mark]*

2.   *Award [1 mark] for each method identified up to [2 marks max].*
     Failover systems;
     Redundancy;
     Removable media;
     Offsite / online storage;   *[2 marks]*

3.   *Award [1 mark] for each method identified up to [2 marks max].*
     Help files;
     Online support;
     Printed manuals;   *[2 marks]*

4.   *Award [1 mark] for identifying one need for a higher level language and [1 mark]*
     for further development of that idea or the identification of a second need up to
     [2 marks max].
     In machine language, the basic operations available are too simple;
     The operations used in modern programming are far more abstract than the basic
     operations of the computer;
     It would take too long to complete systems in machine code;   *[2 marks]*

5.   *Award [1 mark] for a function stated.*
     Allocating storage for data and instructions;
     Keeping track of free and occupied parts of memory;   *[1 mark]*

6.   *Award [1 mark] for each correct logic gate up to [3 marks max].*
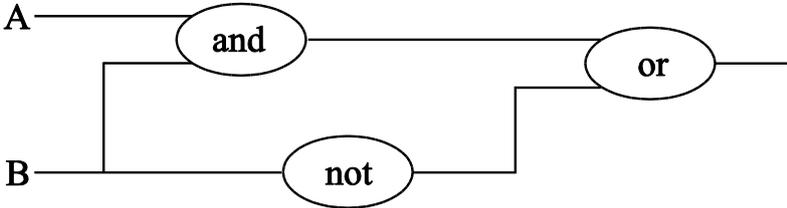
                                                                          [3 marks]

7.   *Award [1 mark] for a definition that covers the basis of the term.*
     Process that calls itself;   *[1 mark]*

8. (a)   1st

[0]	[1]	[2]	[3]	[4]
David	**Boris**	**Brad**	**George**	**Robert**

2nd

[0]	[1]	[2]	[3]	[4]
David	**George**	**Brad**	**Boris**	**Robert**

3rd

[0]	[1]	[2]	[3]	[4]
David	**George**	**Brad**	**Boris**	**Robert**

4th

[0]	[1]	[2]	[3]	[4]
David	**Boris**	**Brad**	**George**	**Robert**

[2 marks]

(b)   Logic error;   *[1 mark]*

(c)   *Award [1 mark] for stating a possible cause of error.*
Loop executes too many times;
Terminating value for controlling variable was not correctly set;

Award [1 mark] for stating a possible solution.
Condition should be changed to k = n div 2;   *[2 marks]*

9. (a)   *Award [1 mark] for identifying one difference between a LAN and a VLAN and [1 mark] for further development of that idea or identifying another difference up to [3 marks max].*
A LAN is a physical, local area network defined by cables, and networking hardware whereas;
A VLAN is a virtual LAN defined by software parameters programmed into the networking hardware;   *[3 marks]*

(b)   *Award [1 mark] for each factor identified up to [2 marks max].*
Cost;
Speed;
Security;
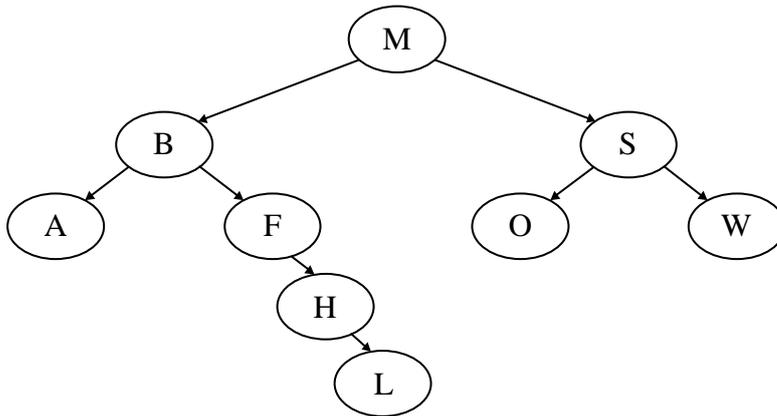Reliability;   *[2 marks]*

10. (a) *Award [1 mark] for correctly stating the solution.*
M B A F H S O W;   *[1 mark]*

(b) *Award [1 mark] for stating the correct number of leaf nodes.*
4;   *[1 mark]*

(c) *Award [1 mark] for correctly adding the node L.*

[1 mark]

SECTION B   *Total: [75 marks]*

11. (a)   *Award marks as follows up to [5 marks max].*
Award [2 marks] for correctly using isEmpty() and getNext() to retrieve all the items from the collection.
Award [1 mark] for looping through the 7 days.
Award [1 mark] for looping through the 24 hours.
Award [1 mark] for correctly filling the TEMPWEEK array.

Example pseudocode:

```
DAYS = 0
HOURS = 0
loop while NOT TEMPERATURES.isEmpty ()
    TEMPWEEK[DAYS,HOURS] = TEMPERATURES.getNext()
    HOURS = HOURS + 1
    if HOURS = 24 then
        HOURS = 0
        DAYS = DAYS + 1
    end if
end loop
```
                                                       [5 marks]

(b)   *Award marks as follows up to [4 marks max].*
Award [1 mark] for looping through 7 days and the 24 hours.
Award [1 mark] for initializing the minimum value to something reasonable (an element of the array or a value less than absolute zero, –273.15 ℃).
Award [1 mark] for correctly finding the minimum value.
Award [1 mark] for outputting the minimum value.

Example pseudocode:

```
MINIMUM = TEMPWEEK[0, 0]
loop DAYS from 0 to 6
  loop HOURS from 0 to 23
    if TEMPWEEK[DAYS, HOURS] < MINIMUM then
      MINIMUM = TEMPWEEK[DAYS, HOURS]
    end if
  end loop
end loop

output MINIMUM
```
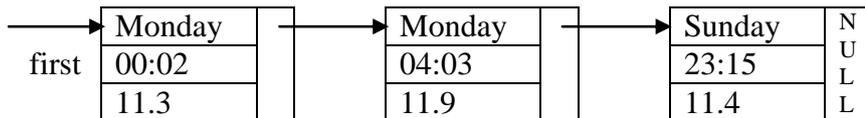   *[4 marks]*

Question 11 continued

(c) (i) *However the answer is presented, descriptive text or graphically, award marks as follows up to [3 marks max].*
Award [1 mark] for indicating that each node contains a pointer to the next node.
Award [1 mark] for indicating that each node contains day, time, and temperature.
Award [1 mark] for stating/showing that the pointer in the last node is null.

Linked list;
In which each node contains link/reference to the next node;
And data field that contains three data items;
Data items are day, time and temperature;
External pointer points to the first node in the list;
And the pointer field of the last node is null;

OR

[3 marks]

(ii) *Award [1 mark] for each step identified up to [3 marks max].*
Set counter to zero (0);
Start from the beginning of the list;
While the end of list is not reached;
Increase counter by 1;
Follow the pointers/links;   *[3 marks]*

Total: [15 marks]

12. (a) *Award **[1 mark]** for each example up to **[3 marks max]**.*
They may explain how the current system works;
They may explain how it could be improved;
They may provide requirements/objectives;
They may be involved in approving the proposed solution;
They may evaluate one or more prototypes;
They may test the system to ensure that it works as expected;
They will be attending the training lessons to learn how to use the new system;
They will be using the system;   *[3 marks]*

(b) (i) *Award **[1 mark]** for a correct definition.*
The old system continues alongside the new system for a certain period
of time;   *[1 mark]*

(ii) *Award **[1 mark]** for one method of conversion (other than parallel running) identified.*
Direct changeover;
Phased conversion;
Pilot conversion;   *[1 mark]*

(iii) *Award marks as follows up to **[4 marks max]**.*
*Award **[1 mark]** for identifying the similarities between parallel running and direct changeover.*
*Award **[1 mark]** for identifying the differences between parallel running and direct changeover.*
*Award **[1 mark]** for an explicit and direct comparison of parallel running and direct changeover.*
*Award **[1 mark]** for the correct use of appropriate terminology.*
Answers to include:

Parallel running	Direct changeover
Output results can be compared with known results; In the case of any difficulties system operation continues under the old system; Slow; Inefficient; Duplication of work; More personnel needed as long as two systems work at the same time;	System operation will be disrupted if the new system does not work properly; Fast; Efficient, minimum duplication of work involved;

[4 marks]

Question 12 continued

(c)   *Award marks as follows up to **[6 marks max]**.*
        *Award **[1 mark]** for each distinct problem identified, up to **[2 marks max]**.*
        *Award **[1 mark]** for a description of each identified problem, up to **[2 marks max]**.*
        *Award **[1 mark]** for an elaboration of the identified problems.*
        *Award **[1 mark]** for correct terminology used throughout.*
        Answers may include:

Incompatible formats of data: The new system may store data in a format different from that used in the old system. This might be a simple matter of translation, such as converting integers to decimals. It could also be very difficult if the new system stores more detailed data than the old system, such as the date and time of each transaction while the old system stored only the date.

Data lost in migration: Data might be lost due to errors in the translation process or because perfect translations simply aren't possible, *e.g.* if the old system stored ratings on a scale of 1–5 while the new system stored only 1–3.

The systems may be unavailable during the migration process; one way to avoid having two systems with incompatible data is to shutdown the business, perform the migration, and then restart with the new system. If the migration takes a long time however, shutting down the business for that time may be undesirable.

New data may continue coming in during the migration process; if the business is not shutdown during the migration process, transactions will either have to be performed on the new system without the old data being available or they will have to be performed on the old system which will add to the data needing to be migrated.   *[6 marks]*

Total: [15 marks]

13. (a) *Award [1 mark] for a definition that covers the basis of the term.*
Concurrent processing means to do more than one activity at the same time; *[1 mark]*

(b) *Award [1 mark] for a pair of tasks correctly identified.*
Install plumbing and install electrical systems; *[1 mark]*

(c) *Award [1 mark] for a pair of tasks correctly identified.*
Any two tasks in which one cannot begin before the other is completed:
Digging the foundation and building the floors;
Building the walls and building the roof;
Building the roof and plastering the walls; *[1 mark]*

(d) *Award [1 mark] for identifying a task as composed of subtasks.*
Award [1 mark] for describing some reasonable set of subtasks.
Describe one of the tasks as being composed of subtasks:
Build the floors: Install the beams, install the joists, install the subfloor, install the finish floor.
Paint the walls: Mask off things not to paint, cover floors, select paint colours, paint trim, paint walls, paint ceilings.
Landscaping: Plan the plantings, get the plants, dig holes, plant things, seed the lawn, install lighting. *[2 marks]*

(e) *Award [1 mark] each for the identification of an advantage and a disadvantage.*
Award up to [2 marks] for explaining the advantage and disadvantage.

Advantages:
Building could be finished faster; By doing some tasks concurrently, the overall time needed to complete the building will be reduced. Since construction workers are paid by the hour, getting the building done sooner will reduce the cost of the building.

Disadvantages:
Workers on concurrent tasks may get in each other's way; If the plumbers and the electricians are both working at the same time and both need to get at the same place at the same time, one will have to wait. Thus, it may take longer to do the electrical work while the plumbing is being done than it would take to do it alone.

Harder to supervise; The supervisor needs to look at the work being done and make sure that its being done correctly and explain what needs to be done, *etc.* If there are two (or more) sets of workers the supervisor will have to work harder to watch both of them at the same time. *[4 marks]*

(f) *Award [1 mark] for identifying an application.*
Award an additional [1 mark] for outlining a task carried out by the application.
The word processor: counting the number of words in the document.
The browser: Interpreting the HTML to figure out what to display.
The downloading program: Calculating the amount of time remaining to complete the download. *[2 marks]*

Question 13 continued

(g)   *Award **[1 mark]** for each GUI component identified up to **[2 marks max]**.*
      Toolbars;
      Menus;
      Dialogue boxes;
      Buttons;
      Check boxes;
      Text-entry fields;   *[2 marks]*

(h)   *Award **[1 mark]** for identifying one way in which the use of abstract GUI components simplifies application programming.*
      *Award an additional **[1 mark]** for a description of the idea identified above or the identification of a second idea up to **[2 marks max]**.*
      Application developers do not have to implement basic GUI components.
      All applications use the same basic GUI elements resulting in a better user experience.
      The operating system coordinates GUI elements for all applications reducing the need for developers to do so.
      Application code is much smaller since all the GUI-related code is in a standard library.   *[2 marks]*

                                                                                 Total: [15 marks]

14. (a)   *Award [1 mark] for three or more acceptable possible applications stated.*
Internet browser
Phone application (making a call)
Camera application (taking a picture)
MP3 player
E-mail reader   *[1 mark]*

(b)   *Award marks as follows up to [4 marks max].*
Award [2 marks] for a basic description of the operating system in the management of applications.
Award [1 mark] for elaborating on the description.
Award [1 mark] for an explanation that is clear, detailed and balanced.
Answers may include:

Memory management: The OS allocates a certain portion of the memory for each application. The amount of memory needed by each application may change so the OS will need to be able to allocate more memory to an application as needed and to recover memory when the application no longer needs it.

Allocation of processing time for each application: This could involve time-slicing in which each application is given a certain amount of processor time before control is switched to the next application. Alternatively, the OS could use an event-driven model in which control of the processor is passed to the appropriate application as events such as an incoming call, a button press, or an interrupt occur.

Coordination of interfaces: The OS determines which application should be notified if a button is pressed and updates the display based on requests received from each of the applications.   *[4 marks]*

Question 14 continued

(c) *Award **[1 mark each]** for identifying each valid system resource up to a maximum of **[2 marks]**.*
*Award an additional **[1 mark each]** for describing how the design of each of the identified resources differ between the mobile phone and PC platforms up to a maximum of **[2 marks]**.*
Answers may include:

Memory: The small size of the mobile phone restricts the amount of memory that can be included to less than what can be included in a PC. More importantly, the mobile must use much less power than a PC and this further restricts the amount of memory that can be included and also makes some designers choose slower memory that consumes less power.

Display Screen: The small size of the mobile restricts the size of the screen to something much less than a PC. To compensate, the screen may need to have a much higher resolution. Also, the mobile screen must be readable in direct sunlight, which most PC displays are not.

Input devices: The PC usually uses a full-size keyboard. The mobile must generally use a much smaller keyboard which results either in a greatly reduced number of keys or in very tiny keys such as on a Blackberry. The PC also usually has a pointing device like a mouse which itself is already larger than many mobile phones. Instead, mobile phones may use a touch sensitive screen. *[4 marks]*

(d) *Award marks as follows up to **[6 marks max]**.*
*Award **[1 mark]** for each consequence identified, up to **[2 marks max]**.*
*Award **[2 marks]** for a deeper description of the consequences, demonstrating some knowledge and understanding.*
*Award **[2 marks]** for a clear discussion of the consequences in terms of size, weight, power, usability, and user appeal, showing detailed knowledge and understanding.*
Answers may include:

Will speed the display of complex graphics, will make animations and movies look great.
Video card uses a lot of power, will reduce battery life and increase heat.
Video card occupies space, will make phone larger and heavier. *[6 marks]*

Total: [15 marks]

15. (a) (i) *Award [1 mark] for identifying a user input.*
Min and max temperature;
System on or off;   *[1 mark]*

(ii) *Award [1 mark] for identifying one of the situations.*
When the temperature is above the max;
When the temperature is below the min;
When the temperature is between the max and the min;   *[1 mark]*

(b) *Award [1 mark] for each hardware device identified up to [3 marks max].*
Sensors;
Transducers;
AD converters;
Actuators;
Heater;
Fan;   *[3 marks]*

(c) *Award [1 mark] for reading setting and temperature in a loop*
Award [1 mark] each for correctly controlling the fan and heater in each of the
three temperature conditions.

Example pseudocode:

```
loop while SWITCH is ON
  MAX = current setting on dial for maximum temperature
  MIN = current setting on dial for minimum temperature
  TEMPERATURE = current reading from temp sensor

  if TEMPERATURE > MAX then
    turn on fan
    turn off heater
  else if TEMPERATURE < MIN then
    turn off fan
    turn on heater
  else
    turn off fan
    turn off heater
  end if
end loop
```
                                                                     [4 marks]

Question 15 continued

(d) *Award marks as follows up to **[6 marks max]**.*
*Award **[1 mark]** for each advantage identified, up to **[2 marks max]**.*
*Award **[1 mark]** for each disadvantage identified, up to **[2 marks max]**.*
*Award **[1 mark]** for a contrast of the identified advantages and disadvantages.*
*Award **[1 mark]** if the contrast is clear, and explains the relevance of the advantages and disadvantages.*

Possible advantages include:
Only need a single set of max/min dials and only one on/off switch.
There is no way for the locations to accidently have different settings.
All ten locations can be controlled from a single place so you don't have to run around to each one.
All the temperature data is available in one place, which may make recording and analyzing it easier.

Possible disadvantages include:
May need a lot of wires to connect all the locations to the control computer.
If the control computer breaks, all the locations suffer.
The software will have to be changed. *[6 marks]*

Total: [15 marks]

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COMPUTER SCIENCE
HIGHER LEVEL
PAPER 2

SPECIMEN PAPER

1 hour 20 minutes
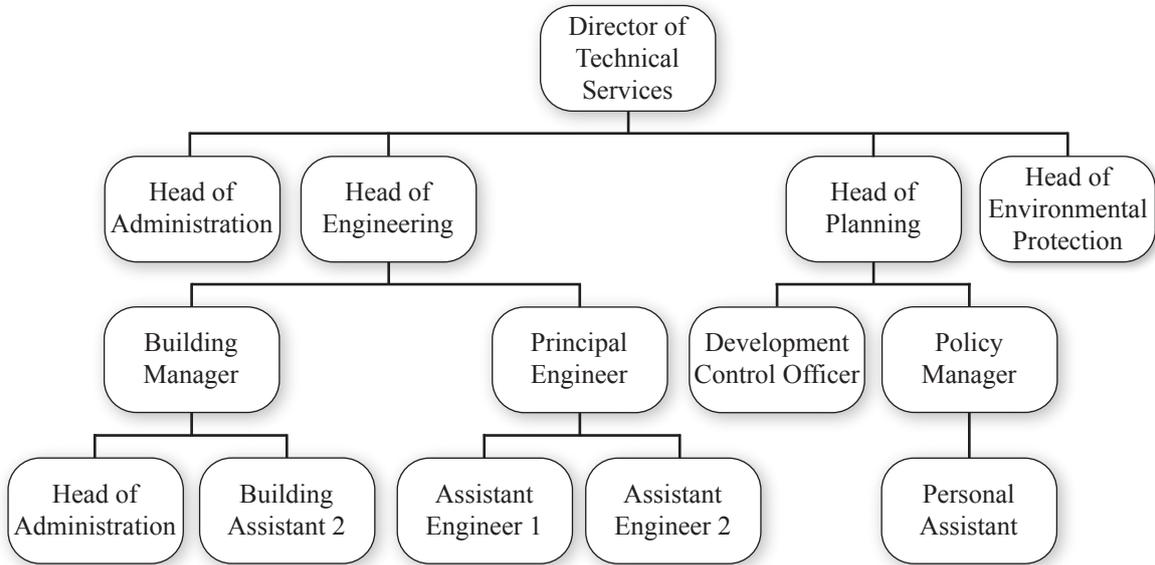
INSTRUCTIONS TO CANDIDATES

• Do not open this examination paper until instructed to do so.
• Answer all of the questions from one of the Options.

Option A — Databases

A1. A company has a division called Technical Services. This division is organized into departments. The following chart shows how the various staff are organized.

The Human Resources Department maintains a flat file database to store information about all the staff members for salary, holiday and promotion purposes. A sample of the stored information is shown below.

Staff Number	Surname	Forename	Job Title	Line Manager	Salary
948	Kent	McKenzie	Head of Planning	Adrienne Mathis	90875
156	Barker	Rae	Head of Administration	Adrienne Mathis	30465
815	Riddle	Kevyn	Development Control Officer	Kent McKenzie	34768
580	Figueroa	Rina	Policy Manager	Kent McKenzie	45078
871	Mathis	Adrienne	Director of Technical Services	Russell Z. Harrell	45800
457	Neal	Paul	Head of Environmental Protection	Adrienne Mathis	80670
297	Oliver	Ralph	Principal Engineer	Daria Gilmore	50796
51	Gilmore	Daria	Head of Engineering	Adrienne Mathis	90655

(This question continues on the following page)

(Question A1 continued)

The Human Resources Department is experiencing many errors when compiling reports of personnel and has been advised that it should change to a relational database.

(a)   (i)   Define the term *database*.   *[1]*

    (ii)   Describe the difference between a *flat file database* and a *relational database*.   *[2]*

(b)   (i)   Identify **two** problems caused by data redundancy.   *[2]*

    (ii)   Outline using examples how data redundancy in this database could lead to errors.   *[2]*

(c)   The departments usually have many ongoing projects that occupy their team members. The Human Resources Department needs to produce lists showing who is involved in current projects.

The following information has been provided:

Project: Project_Ref, Project_Name, Budget
Department: Dept_Ref, Dept_Name
Staff: Staff_Number, Forename, Surname, Job_Title, Salary
The projects are owned by a department.
Each member of staff is a member of a department.

    (i)   Construct an Entity Relationship Diagram to show how a relational database could be designed to make this possible with the least chance of producing errors caused by data redundancy.   *[4]*

    (ii)   Identify the steps to create a query that could be constructed to produce a list of staff members whose salary is greater than $50 000 who are involved in a project called "Relocation_2012".   *[4]*

A2. A bank wants to transfer money from one account to another. Both accounts are held in the bank's database management system (DBMS). The account DBMS carries out a series of separate operations in order to achieve this transaction. These include removing of money from one account and adding it to the other. An error may occur if this process is interrupted, for example due to a power failure. This could compromise the integrity of the account database.

    (a)   (i)   Identify **two** characteristics of a *transaction* in terms of a database. *[2]*

          (ii)   Distinguish between a database *schema* and a database *state*. *[2]*

          (iii)   Explain why the interruption described above could compromise the integrity of the account database. *[2]*

    (b)   Identify the steps that should be taken by the software in order to maintain the integrity of the account database. *[4]*

    (c)   The bank account data is shared between various applications, such as the bank's internal accounting systems and the online transaction system. Explain how problems of concurrency can arise and how they can be avoided. *[6]*

A3.   (a)   (i)   Identify **two** functions of a *database management system* (DBMS). *[2]*

          (ii)   List **two** tools usually provided with a DBMS. *[2]*

    (b)   Database management systems allow data sharing and multiple views. Explain why these features are important to an organization that uses databases. *[4]*

    (c)   Explain why it is important for data to be independent of the application software that manipulates it. *[6]*

A4. Meubles de France is a large company that manufactures and sells furniture. It maintains a large factory and offices in Provence and over a hundred retail outlets. It employs hundreds of workers. It holds huge amounts of data on separate computer systems to handle:

- customer orders
- employees
- sales data
- production data
- finance
- budgeting.

All these systems have been acquired from different software suppliers. The management of Meubles de France has been advised that a data warehouse would be of great benefit to the business.

(a) (i) Identify **two** characteristics of a data warehouse.   *[2]*

(ii) Identify **four** features of Meubles de France's business that indicate the need for a data warehouse.   *[4]*

(iii) Identify **four** transformations that may be necessary in order to produce usable data in a data warehouse.   *[4]*

Meubles de France uses data mining to uncover patterns of consumer spending so they can optimise their marketing for future products and services.

(b) Contrast the use of association and cluster analysis for this purpose.   *[4]*

Many organizations such as Meubles de France use data mining to build a complex profile of its customers.

(c) Explain why civil liberty groups may be concerned about Meubles de France having such detailed information.   *[6]*

Option B — Modelling and Simulation

B1. Mathematical models are used to provide information to building designers.

(a) Identify **two** characteristics of a mathematical model. *[2]*

Any new building must be constructed to resist the force of a possible earthquake. The force (V) that the building must resist in order to prevent collapse varies according to the following variables:

Variable	
Z	The Earthquake zone (1–3) in which the building is constructed
I	Importance of the building according to its intended use (*e.g.* school, hospital, *etc.*)
C	Structure index based on the dimensions, the weight and the shape of the building
R	Flexibility of the building

A simplified version of V can be calculated by the formula:

$$V = (Z * I * C) / R,$$

where Z and I are given and the values of C and R are obtained from published tables.

A building designer needs to be able to calculate the value of V for any one of a large number of buildings that is being designed. Z is fixed for all buildings; I, C and R can vary from building to building.

(b) Outline why the use of a spreadsheet is appropriate for this modelling task. *[2]*

(c) Construct a diagram to show the way in which data and calculations would be implemented in a spreadsheet. *[4]*

(d) Outline how data from the look up tables could be input into the spreadsheet. *[4]*

Within a city in an earthquake zone there are many different designs of buildings. It is decided to test all buildings for their resistance to a possible earthquake in that zone.

(e) Describe the data collection and data input needed to use the spreadsheet to test all buildings. *[6]*
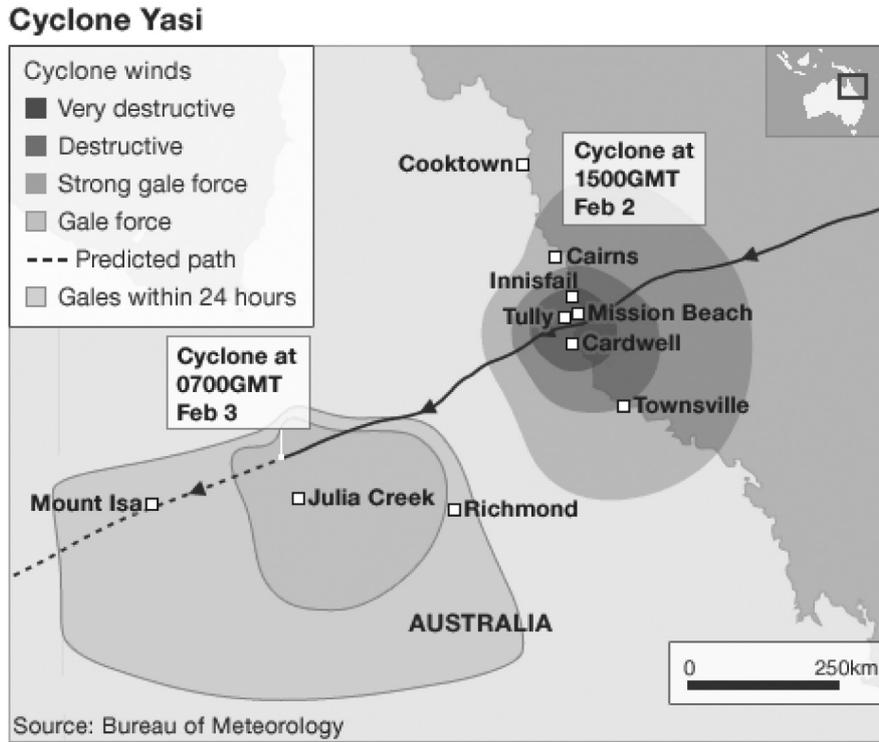
B2. Despite many attempts, the simulation of an earthquake by computer has proved inaccurate and planned buildings are tested by making a physical model and applying the relevant forces to see if it can withstand an earthquake in the given zone.

(a) Explain the relationship between a *simulation* and *mathematical modelling*.   *[2]*

(b) With reference to a simulation with which you are familiar, explain the importance of accurate rules and data in a simulation.   *[4]*

Simulation has proved successful in predicting weather patterns.

(c) Describe **one** advantage and **one** social consequence of using simulations for weather forecasting.   *[4]*

B3. Cyclone Yasi hit Northern Australia in February 2011. There were many after effects such as flooding and landslides.

Cyclone Yasi

[Source: Australian Government Bureau of Meteorology (accessed 07 February 2011)]

To ensure that the emergency services could be located where they will be most needed a 2D visual model of likely danger areas, shown above, was created and distributed to surrounding areas in real time.

(a) Outline the ways in which visualization can be used to display the possible effects of the cyclone in real time. *[4]*

(b) Explain the technical difficulties that could arise in data collection and processing when attempting to predict in real time. *[4]*

(c) Explain the advantages of using visualization in this case. *[6]*

(d) Compare the use of 2D visualization with 3D visualization in this situation. *[3]*

B4. "Rescue robots capable of understanding the changing and unpredictable environment of disaster scenarios may one day be deployed to search for survivors in the aftermath of earthquakes.

This is the vision of inventors Erwin Prassler and Ivan Bratko, who have developed a software algorithm that takes data from a robot's sensors as it moves through an area to create models and predict how objects in the vicinity will change their position relative to its movements.

Using the same algorithm, Bratko said that the robot can learn physical concepts such as whether an object is moveable and where it can be moved to. He added that it also gives the robot the ability to learn 'abstract concepts' such as the structural stability of an object."

[Source: http://www.theengineer.co.uk, 1 September 2010]

In this question you can assume that the robot is equipped with distance and angle sensors.

Robots involved in rescue are placed in an unknown environment and have to model the environment. Part of this process involves genetic algorithms.

(a) Outline, using examples, the difference between *supervised learning* and *unsupervised learning*. *[4]*

(b) Explain the way in which *genetic algorithms* help in the learning process. *[6]*

(c) Describe the way in which the robot could model the situation in which it finds itself. *[4]*

Once the robot has found a victim, it needs to communicate this information back to emergency services.

(d) Suggest ways in which the robot and human rescue workers could communicate to make a successful rescue of a person. *[6]*
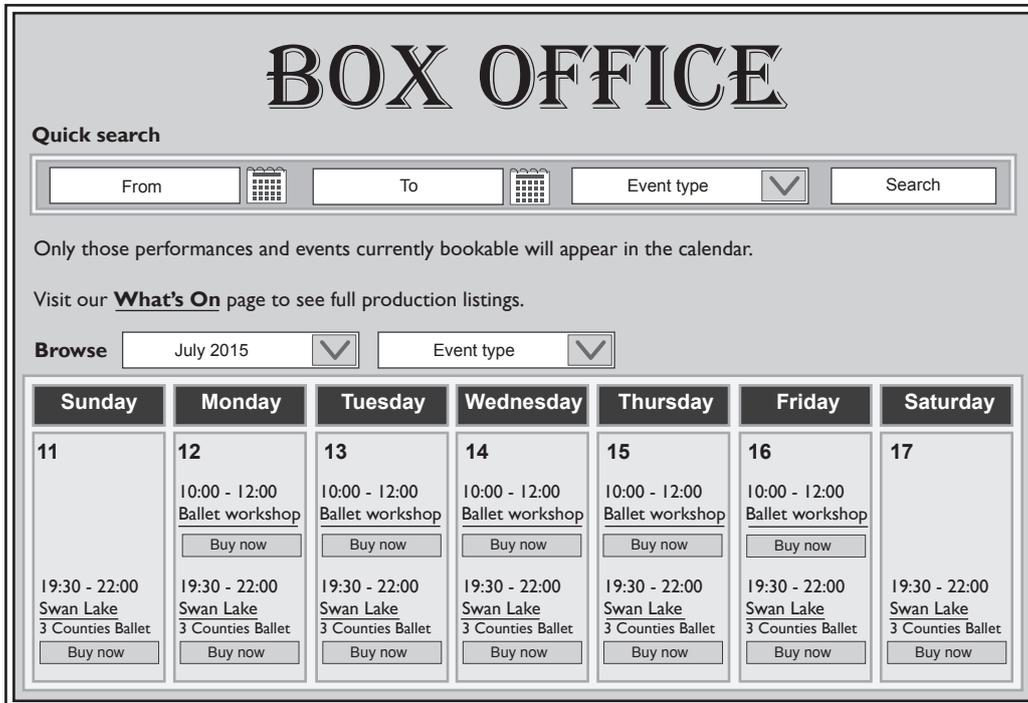
Turn over

Option C — Web Science

C1. A publishing company, ABC Publications, based in London has a large IT department. This department is responsible for:

- providing IT services to the company
- maintaining the company's web site
- creating and maintaining web based learning resources that are sold to schools and colleges.

The company is finding it difficult to recruit and retain sufficient high quality IT staff to keep these functions operating at an optimal level. It is investigating transferring at least part of its IT operations to a cloud computing solution. At the moment it has not been decided how much of this should be implemented by a private cloud and how much by a public cloud.

(a)   Define the term *private cloud*.   *[1]*

(b)   Distinguish between a cloud computing model and a conventional client server model in providing computing services.   *[4]*

(c)   Explain why ABC Publications might benefit from changing part of its IT provision to a cloud based model.   *[4]*

(d)   Comment on the privacy **and** security issues relating to ABC's use of cloud computing.   *[4]*

C2. A theatre box office maintains a web site that can display what productions are coming up and which seats are available for a particular production. It can then take orders online. The interface consists of dynamic web pages such as the one below, in which the underlying HTML interacts with client-side and server-side scripts.

Part of the source code for this page is:

```
<script type="text/javascript" src="http://assets.ophse.org/_inc/popdt/init_live.js"></script>
<script type="text/javascript" src="http://assets.ophse.org/_inc/popdt/src/flash.js"></script>
```

(a)   Identify **one** characteristic of Hypertext Markup Language (HTML).   *[1]*

(b)   Identify the steps that the server would carry out so that the information in the events' calendar can be displayed on the client's computer.   *[4]*

(c)   (i)   Identify **two** ways that a client-side script may be made available to a web browser.   *[2]*

      (ii)   Describe **one** reason why a client-side script may be used in preference to a server-side script.   *[2]*

(This question continues on the following page)

Turn over

(Question C2 continued)

    (d)   The organizers of the theatre want to ensure their web pages appear higher up the ranking of search engines.

           Suggest whether the use of meta-tags can help achieve this aim.   *[4]*

    (e)   It is common for dynamic web pages to make use of a mixture of client-side and server-side scripting. Explain how the interaction of HTML, client-side and server-side scripting have allowed the production of a web page such as the one shown here.   *[6]*

C3. As the web has developed, data formats, communication protocols and standards such as XML or SQL have proven crucial to progress. Two fundamental concerns that have been central to this development are the issues of interoperability and that of open standards.

    (a)   (i)   Identify **one** characteristic of XML.   *[1]*

           (ii)   Define the term *protocol*.   *[1]*

    (b)   Describe, with the use of examples, how the use of open standards allows interoperability to occur.   *[3]*

Music is distributed across the web in a variety of different ways such as peer-2-peer (P2P) networks.

    (c)   Discuss **two** factors that would affect the decision to use either lossless or lossy compression when transferring files across the Internet.   *[6]*

    (d)   Explain **one** advantage of the use of a peer-2-peer (P2P) network for obtaining and downloading music and movie files.   *[2]*

C4. The World Wide Web (web) can be regarded as a directed graph. This allows search engines to make use of algorithms based on graph theory.

(a)   Identify how the web may be represented as a directed graph.   *[1]*

The web can be represented as having a bowtie structure as indicated in the diagram below.
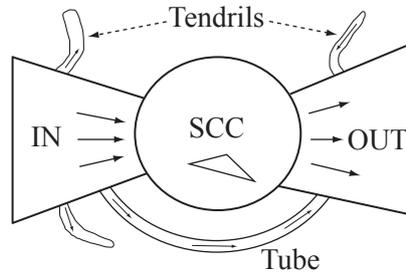
[Source: http://nlp.stanford.edu/IR-book/html/htmledition/the-web-graph-1.html (accessed 13 April 2011)]

(b)   (i)   Define the term *Strongly Connected Core* (SCC).   *[1]*

      (ii)   Outline the characteristics of web sites that are located in the IN portion of the bowtie.   *[2]*

With the growth of the web, web site developers have realized that there are possible concerns about the ability of being able to link to all web pages as well as ensuring a page is highly ranked by search engines.

(c)   Describe how power laws suggest it will be possible to link from one web page to any other web page despite the fact the web is growing so rapidly.   *[2]*

(d)   Explain how the relative importance of a web page can be determined in search engines.   *[4]*

The development of the web has changed the way that users interact with the web and with each other.

(e)   With reference to specific examples, distinguish between an ontology and a folksonomy.   *[2]*

The growth of the web has enabled the development of new ways to solve problems. Collective intelligence is one such approach.

(f)   Identify **two** characteristics of collective intelligence.   *[2]*

(g)   With the increasing world population and the effects of globalization, the world's population is facing new and complex problems such as the recent banking crisis. To what extent is it likely that collective intelligence could help to address these problems?   *[6]*

Turn over

Option D — Object-oriented programming

A bus company operates in a local city. The bus company operates along fixed routes where there are marked stops and sometimes bus shelters for people to wait in out of the weather. People (passengers) pay the driver a specified fare for travel when they enter a bus.

There are many objects in this company, here are some of them:

Object	Description
Bus	A physical vehicle that carries *passengers* on a specific *route* and has a *driver*.
Passenger	A person that travels on a *bus*.
Route	A series of roads/streets the *bus* travels over from its start to its destination.
Bus Stop	A **named** place on a *route* where people wait for a *bus*. May be a simple marker or may have a shelter and seats.
Driver	A person qualified to drive a *bus* and trained to drive it over a given *route*.

These two objects have already been defined for the bus company:

```
BusRoute
-----------------------
Integer: route
String: start
-----------------------
setRoute(Integer: route)
setStart(String: start)
Integer getRoute()
String getStart()
String toString()
```

```
Bus
-----------------------
Integer: id
String: driver
BusRoute: busRoute
-----------------------
setId(Integer: id)
setDriver(String: driver)
setBusRoute(BusRoute: route)
Integer getId()
String getDriver()
BusRoute getBusRoute()
String toString()
```

The `toString()` method returns a String implementation of an object.

These are implemented in code as follows:

```
public class BusRoute
{
  private int route;
  private String start;
  public BusRoute(int r, String s)
  {
    setRoute(r);
    setStart(s);
  }
  public void setRoute(int r){ route = r; }
  public void setStart(String s){ start = s; }
  public int getRoute(){ return route; }
  public String getStart(){ return start; }
  public String toString()
  {
    return "Route: " + route + " start: " + start;
  }
}


public class Bus
{
  private int id;
  private String driver;
  private BusRoute busRoute;
  public Bus(int i, String d, BusRoute r)
  {
    setId(i);
    setDriver(d);
    setBusRoute(r);
  }
  public void setId(int i){ id = i; }
  public void setDriver(String d){ driver = d; }
  public void setBusRoute(BusRoute r){ busRoute = r; }
  public int getId(){ return id; }
  public String getDriver(){ return driver; }
  public BusRoute getBusRoute(){ return busRoute; }
  public String toString()
  {
    return "Bus id:" + id + " - " + driver + ": " + busRoute.toString();
  }
}
```

Turn over

D1. (a) Explain the term *parameter variable*, using an example from the code. *[2]*

(b) Describe **one** additional field that might have been included in the `BusRoute` object/class. Include data types and sample data. *[2]*

(c) Identify the output produced by the following code fragment.

```
Bus bus = new Bus(1001, "N Prakesh", new BusRoute(431, "Klang"));
System.out.println(bus.toString());
```
[2]

Consider the code fragment below.

```
private static final int MAX_BUSES = 12;
private Bus[] buses = new Bus[MAX_BUSES];
buses[0] = new Bus(1001, "N Prakesh", new BusRoute(431, "Klang"));
buses[1] = new Bus(1010, "J Carey", new BusRoute(342, "Tanglin"));
buses[2] = new Bus(1014, "H Lee", new BusRoute(411, "Queenstown"));
buses[3] = new Bus(1015, "K Peters", new BusRoute(319, "Jamaica Street"));

showBusDrivers(buses, 1010);
```

(d) Construct the method `showBusDrivers(Bus[] b, int n)` which lists the drivers for all buses with a route number less than or equal to the parameter variable (`n`). *[6]*

The company wishes to keep track of its drivers in more detail, including first and last name and employee number – this is a 4-digit whole number.

(e) Construct a suitable diagram for this `Driver` object. *[3]*

D2. In relation to the Bus example:

(a)   Outline how encapsulation is used.   *[2]*

(b)   Outline a disadvantage of using Object Oriented Design.   *[2]*

(c)   Explain how a programming team could benefit from an Object Oriented Design approach.   *[4]*

Recall that a *Bus Stop* is one of many **named** places on a *route* where *buses* stop to pick up or drop off *passengers*. It may or may not have a **shelter** to protect *passengers* from the weather. The **distance** in km from the start point of the *Bus Route* is important information for planning.

(d)   Design the Bus Stop Object using a simple object diagram.   *[3]*

(e)   Suggest how Bus Stop information for a given Bus Route instance could be stored, giving both sample data and sample code fragments to show how it could be implemented.   *[4]*

D3. The company grows, offers more routes of different types and decides to use three different types of bus:

- A bus that operates on busy city routes – the Urban Bus – has only a driver.
- A smaller bus that operates on longer country routes – it carries an additional person to collect the fares.
- A van that can be used for heavy equipment deliveries rather than passengers – the Delivery Van – it carries a co-driver and a helper.

These vehicles will have some things in common, such as a *driver*, and other elements that are different, for example both Urban and Rural buses will operate on a fixed *route* whereas the Delivery Van will take equipment to specified *destinations* (such as factories or other businesses).

(a)   Construct diagrams to show how you would re-design the `Bus` class to implement inheritance.   *[8]*

(b)   Explain the advantage of inheritance for this situation.   *[4]*

A method is required in the subclasses that returns the number of employees per vehicle.

(c)   Outline how polymorphism might apply in this design.   *[3]*

Turn over

D4. The bus company decides to run a simulation over a particular route to see what happens when several buses are started on the route a set time apart. A queue will be used to hold the individual `Bus` instances.

(a) Identify **three** features of a queue that make it suitable for this purpose. *[3]*

(b) Construct a diagram of the queue after the following code has been executed.

```java
public class BusSim
{
  private LinkedList<Bus> busQueue;

  public static void main(String[] args){ new BusSim(); }
  public BusSim()
  {
    // Create new LinkedList for Bus instances
    busQueue = new LinkedList<Bus>();
    BusRoute route = new BusRoute(903, "Nerang Creek Road");
    Bus bus1 = new Bus(2011, "C Humbley", route);
    Bus bus2 = new Bus(3943, "M Hillier", route);
    Bus bus3 = new Bus(4923, "J Inglis", route);
    busQueue.addFirst(bus1);
    busQueue.addFirst(bus2);
    busQueue.addFirst(bus3);
  }
}
```
[3]

Recall that the method of the `LinkedList` class `remove(int index)` removes the element at the specified position in the list while the method `size()` returns the number of elements in the list.

(c) Construct the method `removeBus(int pos)` which attempts to remove a bus from the queue at the specified position, and returns true if successful and false if it fails. *[4]*

A large company might have several hundred buses running. Each one has a unique id stored with the `Bus` instance.

(d) Explain how a binary tree could be used to store these ids such that they can be quickly retrieved (if they exist) by a search. *[3]*

The tree stores the ids 2045, 3474, 5877, 1099, 9644.

(e) Draw a diagram of an ordered binary tree containing these keys assuming they were inserted in the order given. *[5]*

A binary tree node may be inserted iteratively or recursively.

(f) Identify **two** disadvantages of the recursive algorithm. *[2]*

MARKSCHEME

SPECIMEN

COMPUTER SCIENCE

Higher Level

Paper 2

General Marking Instructions

These instructions should be read in conjunction with the examiner instructions on IBIS.

Once approved for marking, you can download up to 20 scripts into your worklist.

1. Follow the markscheme provided, do **not** use decimals or fractions and mark only in **RED**.

2. Where a mark is awarded, a tick (✓) should be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark.

3. For extended responses where markbands are used, it is helpful to write a brief comment indicating why the level was awarded.

4. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases write a brief annotation in the **left-hand margin** to explain your decision. You are encouraged to write comments where it helps clarity.

5. Unexplained symbols or personal codes/notations on their own are unacceptable.

6. Where an answer to a part question is worth no marks, put a zero in the mark entry box.

7. Every page and every question must have an indication that you have marked it. Do this by **writing "seen"** on each page where you have made no other mark.

8. Examiners should be aware that in some cases candidates may take a different approach, which if appropriate should be rewarded. If in doubt check with your Team Leader.

Subject Details: Computer Science HL Paper 2 Markscheme

Mark Allocation

For the option chosen candidates are required to answer **all** questions. Total 65 marks.

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for that part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:
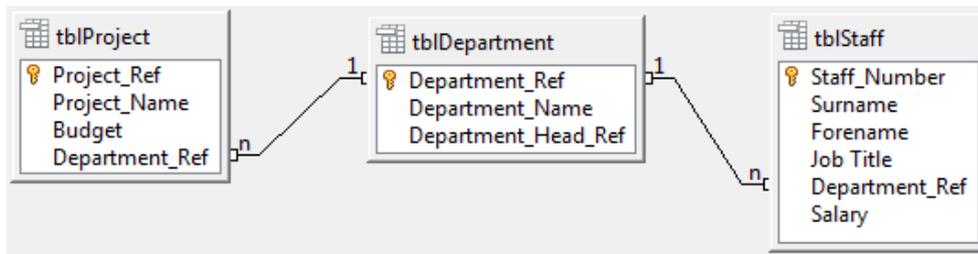
- Each statement worth one point has a separate line and the end is signified by means of a semi-colon (;).

- An alternative answer or wording is indicated in the markscheme by a "/"; either wording can be accepted.

- Words in (…) in the markscheme are not necessary to gain the mark.

- If the candidate's answer has the same meaning or can be clearly interpreted as being the same as that in the markscheme then award the mark.

- Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalizing them for what they have not achieved or what they have got wrong.

- Remember that many candidates are writing in a second language; be forgiving of minor linguistic slips. In this subject effective communication is more important than grammatical accuracy.

- Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded. Indicate this with "**FT**".

General guidance

Issue	Guidance
Answering more than the quantity of responses prescribed in the questions	• In the case of an "identify" question read all answers and mark positively up to the maximum marks. Disregard incorrect answers. • In the case of a "describe" question, which asks for a certain number of facts *e.g.* "describe two kinds", mark the first two correct answers. This could include two descriptions, one description and one identification, or two identifications. • In the case of an "explain" question, which asks for a specified number of explanations *e.g.* "explain two reasons …", mark the first two correct answers. This could include two full explanations, one explanation, one partial explanation *etc*.

Option A — Databases

A1. (a) (i) Organized data store;   *[1 mark]*

(ii) Flat file – all data is stored in one table;
Relational – data is stored in separate related tables;   *[2 marks]*

(b) (i) *Award up to [2 marks max].*
Repetition of data;
May lead to inconsistencies;
May lead to partial updates;
Unnecessary duplication;   *[2 marks]*

(ii) *Award up to [2 marks max].*
Line managers are entered multiple times;
Likelihood of inconsistencies;
May lead to wrong connections between subordinates and managers;   *[2 marks]*

(c) (i) *Award marks as follows up to [4 marks max].*
Award [1 mark] for creating separate tables;
Award [1 mark] for showing three suitable tables;
Award [1 mark] for showing links;
Award [1 mark] for showing the nature of the relationships;
Award [1 mark] for correct ref to primary key;

[4 marks]

Question A1 continued

    (ii) *Award marks as follows up to **[4 marks max]**.*
          *Award **[1 mark]** for all relevant tables selected;*
          *Award **[1 mark]** for all relevant fields selected;*
          *Award **[1 mark]** for correct condition;*
          *Award **[1 mark]** for correct link between tables (WHERE clause);*
          *Award **[1 mark]** for correct use of AND;*

QBE View

Field	Surname	Salary	Project_Name
Alias			
Table	tblStaff	tblStaff	tblProject
Sort			
Visible	✓	✓	✓
Function			
Criterion		>= 50000	

SQL View

SELECT "tblStaff"."Surname", "tblStaff"."Salary",
"tblProject"."Project_Name" FROM "tblProject", "tblDepartment",
"tblStaff" WHERE "tblProject"."Department_Ref" =
"tblDepartment"."Department_Ref" AND "tblStaff"."Department_Ref" =
"tblDepartment"."Department_Ref" AND "tblStaff"."Salary" >= 50000   ***[4 marks]***

A2. (a) (i) *Award up to **[2 marks max]**.*
          A unit of work / logical action;
          Performed on a database;
          Performed by the DBMS;
          Independent of other transactions;   ***[2 marks]***

        (ii) *Award **[1 mark]** for an answer that only identifies either the nature of a database state or a database schema. Award **[2 marks]** for an answer that covers both the ideas in the points below.*
          State is the completed database with data;
          Schema is the plans for the database;   ***[2 marks]***

        (iii) *Award **[1 mark]** that only identifies that conflicting results may occur. Award an additional **[1 mark]** for the development of the initial point up to **[2 marks max]**.*
          Queries may produce conflicting results;
          Because the total amount of money in all the accounts should be the same as before the transaction took place;   ***[2 marks]***

Question A2 continued

    (b)   *Award **[1 mark]** for each step identified in the correct order, up to **[4 marks max]**.*
        Begin the transaction;
        Copy original data to a log;
        Perform the debit operation;
        Perform the credit operation;
        Error checks;
        If no errors occur then commit the transaction and end it;
        If errors occur then roll back the transaction and end it;   ***[4 marks]***

    (c)   *Award marks as follows up to a maximum of **[6 marks max]**.*
        *Award **[2 marks]** for identifying a cause of the conflict;*
        *Award **[2 marks]** for explaining the consequence;*
        *Award **[2 marks]** for the solution;*

        Answers may include:
        Different systems may attempt to access the same data at the same time;
        Both wanting to make updates;

        If one starts and then the second finished before the first is saved;
        This could potentially lead to inconsistent updates;

        Solution is to isolate the transactions;
        When one system is accessing the data, lock the transaction;
        Release it when transaction is committed;   ***[6 marks]***

A3. (a) (i)   *Award up to **[2 marks max]**.*
            Controls the creation of a database;
            Controls the maintenance of a database;
            Controls the use of a database;
            Mediates between the data handling applications and the operating system;   ***[2 marks]***

        (ii)   *Award up to **[2 marks max]**.*
            A means to query the data;
            Forms for displaying the data;
            Reports for producing output;
            Charts for displaying data;
            A DDL or equivalent for constructing/amending the schema;   ***[2 marks]***

Question A3 continued

(b)   *Award marks as follows up to a maximum of [4 marks max].*
       Award [1 mark] for each clear use of data sharing/different views;
       Award [1 mark] for an explanation of why the feature is important;
       Answers may include:

       Data sharing allows use of the data by different users;
       and by different applications;
       Multiple views present different subsets of the data to different users;
       Data can be presented in different ways according to the user's needs;   *[4 marks]*

(c)   *Award marks as follows up to a maximum of [6 marks max].*
       Award [1 mark] for an implication of changes to data structures;
       Award [1 mark] for an implication of changes to data itself;
       Award [1 mark] for relating each of these to applications, up to [2 marks max];
       Award [2 marks] for a clear, detailed and balanced explanation;
       Answers may include:

       The organization uses a variety of applications for manipulating data;
       It may need to amend or add to these;
       Changes to applications may conflict with existing data structures;
       Applications may conflict with each other;
       Applications must therefore act through the DBMS;
       This imposes consistency on the way that the data is manipulated;
       Data integrity is maintained by the DBMS rather than the applications;
       Data structures do not necessarily need to be altered in order to accommodate
       new applications;

                                                                            [6 marks]

A4. (a) (i) *Award up to **[2 marks max]**.*
A repository of stored data;
Related to a specific subject;
Time variant and non-volatile data;
Includes tools to extract, transform and load data into the repository;
Tools to manage and retrieve metadata;   *[2 marks]*

(ii) *Award up to **[4 marks max]**.*
Large volumes of data;
Very different types of data;
Data is probably poorly integrated;
Legacy systems working independently;
Difficulty in answering strategic questions;   *[4 marks]*

(iii) *Award up to **[4 marks max]**.*
Selecting only certain columns to load;
Translating coded values (*e.g.* if the source system stores 1 for male and
2 for female, but the warehouse stores M for male and F for female),
this calls for automated data cleansing;
Encoding free-form values (*e.g.* mapping "Male" to "1" and "Mr" to M);
Deriving a new calculated value (*e.g.* sale_amount = qty * unit_price);
Sorting;
Joining data from multiple sources (*e.g.* lookup, merge);
Aggregation;
Transposing or pivoting;
Splitting a column into multiple columns;
Disaggregation of repeating columns into a separate detail table;
Lookup and validate the relevant data;
Applying any form of simple or complex data validation;   *[4 marks]*

Question A4 continued

(b) *Award marks as follows up to [4 marks max].*
Award [1 mark] for an outline of association;
Award [1 mark] for an outline of cluster analysis;
Award [2 marks] for a contrast between the two;
The contrast should be awarded if the outlines between the two show clear difference. Accept examples for "Meubles de France" to show contrast.
Answers may include:

Association
Looks at how entities/events are connected, and finds where one or more events may lead to another;
May use examples linked to Meubles de France such as purchasing patterns of customers to assist in decision making;

Cluster analysis
Finds patterns in customer behavior by grouping and analyzing variables that connect them. Can find previously unknown links which help in decision making.
May use examples linked to Meubles de France such as age of customers, amount spent on each visit, days of the week of visits, *etc*. to assist in decision making;

The difference is that association looks to see if a set of events leads to another whereas cluster analysis looks for unknown patterns of behavior. *[4 marks]*

(c) *Award marks as follows up to [6 marks max].*
Award [3 marks] for each clear explanation of a consequence of data mining which could lead to an infringement of civil liberties.
Answers may include:

Data mining can reveal connections in personal data;
Which could be misinterpreted/give a misleading data profile (shadow);
Used for reasons that the individual does not know/would not want;

Once the data is available, it may be hard to restrict access to it;
There may be pressure from third parties to share the data for example from insurance companies or government agencies;
Which is unknown/not wanted by the individual;

The data may appear benign, but in the hands of a third party lead to unforeseen issues or when analysed provide information that may not be accessible from a standard query. Not all customers will be able to foresee the extent to which their data may be used;

There may be mission creep and the reasons for the original data collection may be superseded meaning that the security of the data originally collected cannot be guaranteed; *[6 marks]*

Total: [65 marks]

Option B — Modelling and simulation

B1. (a) All the variables acting in a situation/system;
Inputs and outputs;
Reduces the system to a mathematical representation;
Using functions/formulae/equations;
Award [1 mark] for each relevant point up to a maximum of [2 marks].   *[2 marks]*

(b) Equation only has to be entered once;
Values of Z, C, I and R can be changed;
For each of the different buildings entered on the sheet;
Value of V calculated automatically;
Award [1 mark] for each relevant point up to a maximum of [2 marks].   *[2 marks]*

(c) All variables included – descriptions do not need to be given;
Column for V contains formula for at least one building;
Formula is correct;
Copy down indicated for more than one building;   *[4 marks]*

(d) *More than one method may be used:*

Method 1 (not efficient but worth *[3 marks]*)
    Lookup values held within the spreadsheet;
    On separate named sheets;
    User goes to each table as required;

Method 2
    Drop down list for columns holding C and R;
    Linked to the lookup values;
    Held in lists;
    For example when R input different materials presented to choose from;
    Appropriate number inserted in cell;

Other methods may be used. If necessary consult with your Team Leader.
Award [1 mark] for each relevant point up to a maximum of [4 marks].   *[4 marks]*

(e) Z input once as it is constant for all buildings, and known for the city;
I known for each building – (purpose of library, school. *etc*.);
Input manually;
Each building would have to have C and R classified;
Either by experts visiting or records held;
Entered by drop down box for each building;
V calculated;
Those with V below a specified limit identified as in danger;
Award [1 mark] for each relevant point up to a maximum of [6 marks].   *[6 marks]*

B2. (a)   Computer simulation changes the values of variables in the model;
To see the effect that the changes have on the model (or its outcomes);
*Award **[1 mark]** for the initial point and **[1 mark]** for any appropriate subsequent development of it up to a maximum of **[2 marks]**.*   ***[2 marks]***

(b)   *Award marks as follows up to **[4 marks max]**.*
*Award **[1 mark]** for a suitable simulation identified;*
*Award **[1 mark]** for clear rules embedded outlined;*
*Award **[1 mark]** for type of data and rules inaccuracy;*
*Award **[1 mark]** for an effect of inaccuracy;*

For example:
In a traffic flow simulation a town planner may wish to restrict the traffic in a particular zone and sets up a simulation;
Using a map of the town, traffic flows according to the known traffic density and direction;
An out of date road plan is used and traffic flow simulated;
(for example it is ignored that a new road is under construction that goes around the town). The results could cause the planner to set up expensive and unnecessary measures to restrict traffic in the town causing local unrest;
In particular if the position of residents housing in the town was left out of the simulation these residents could find themselves unable to reach their own houses by car;   ***[4 marks]***

(c)   *Award marks as follows up to **[4 marks max]**.*
*Award **[2 marks]** for a relevant advantage discussed;*
*Award **[2 marks]** for a relevant social consequence discussed;*

Answers may include:
Advantages – knowing the weather in advance makes it possible to plan events such as harvesting of crops, deciding to hold the school fête indoors instead of out of doors, *etc.*
Predictions of drought or floods give organizations time to prepare to help with food aid or plan for evacuation.

Social consequences – having life more easily planned for disasters makes for a secure environment.
Lives can be saved if measures to cope with disasters are in place before they occur. Too much dependence could lead to misreading some of the known "weather symptoms". The predictions are not perfect and a false sense of security could result in not being able to adapt to unexpected and unpredicted weather events.   ***[4 marks]***

B3. (a)   Data collected (from satellite or observation) continually;
Recent path stored and updated as data received;
Predicted path calculated;
Using model based on current situation (and behaviour of previous cyclones);
Predicted (and past) path displayed on simple 2D map of area;
Coloured (shaded) to show force of cyclone;
Award [1 mark] for each relevant point up to a maximum of [4 marks].   *[4 marks]*

(b)   *Award marks as follows up to [4 marks max].*
Award [1 mark] for identifying a technical difficulty of data collection;
Award [1 mark] for identifying a technical difficulty of processing;
Award [1 mark] for each technical difficulty that is explained, up to [2 marks max];
*If only difficulties relating either to data collection **or** processing are addressed, award [3 marks max].*

The following points are likely to be included:
Continual data collection from centre of cyclone difficult;
Strength of cyclone needs to be recorded and transmitted which may not show on satellite picture;
Transmission could be broken (unclear/interrupted) by the effect of the cyclone;
Inaccurate data fed into the model would give false results;
Real-time processing needs fast powerful computers;
Which may not be readily available at the start of the cyclone;
Computer resources need to be distributed to avoid losing the information in case of failure;   *[4 marks]*

(c)   *Award marks as follows up to [6 marks max].*
Award [1 mark] for each advantage identified, up to [3 marks max];
Award [1 mark] for each advantage explained, up to [3 marks max];

Visualization gives a quick way of seeing where the dangers are now and where they are likely to be;
No need to interpret figures so time is saved;
Location where rescue/support services are needed now and in near future are shown;
Emergency services hence more effective and dangers to people can be minimized;
Images distributed easily to many places – aid from across the world;   *[6 marks]*

Question B3 continued

(d)   2D visualization is more rapid than 3D as the calculations are less complex and speed is necessary in this situation;

3D also requires more powerful computers which could be difficult to find in a situation that requires a distribution of computers;

Some aspects on the effect of the cyclone such as in a mountainous area would be visualized in 3D but not in 2D visualization;

Potential difficulty in arriving at an area due to damage could be seen in 3D but not 2D;

*Award **[1 mark]** for each relevant point up to a maximum of **[3 marks]**.*   *[3 marks]*

B4. (a)   In supervised learning the goal, or pattern, is known in advance;
For example in optical character recognition where the set of characters is known in advance;
Unsupervised learning involves finding unknown solutions, patterns or conditions;
For example in data mining where unknown patterns can identify trends;
*Award **[2 marks]** for a clear outline of the difference and for each case **[1 mark]** for an identified application.*   *[4 marks]*

(b)   *Award **[1 mark]** for each relevant point, up to **[6 marks max]**.*
Genetic algorithms work successively towards a solution from a starting point;
Which may even be a random set of solutions;
A (*fitness) function* is used to measure the ranking of a solution;
The set of solutions is examined against a fitness function;
The best solutions (generally the 50 % best) are retained and;
The retained solutions are mutated to generate another set of solutions;
This process is repeated until the best possible fit solution is identified;   *[6 marks]*

Question B4 continued

(c)   *Award marks as follows up to [4 marks max].*
      Award [2 marks] for an outline of the use of sensors by the robot;
      Award [2 marks] for the way in which the model can be built from the data collected;

      The following points should be included:
      The robot makes a random set of moves;
      Records distances and direction of objects reached;
      In relation to itself;
      Building up a map of surrounding objects;
      This is repeated until all objects in the space have been placed in distance and direction from a starting point;   *[4 marks]*

(d)   *Award marks as follows up to [6 marks max].*
      Award [1 mark] for a feasible link between the robot and human;
      Award [2 marks] for an outline of method and format of information sent from robot to human;
      Award [2 marks] for a method of human communication/control of robot;
      Award [2 marks] for a description of the way in which the rescue could be carried out;

      Answers may include:
      A suggested link from robot to rescue workers;
      The format of the information sent (visual *etc.*);
      A description of the two-way communication between robot and rescue workers;
      A description of the way the above could be used to make a successful rescue;   *[6 marks]*

Total: [65 marks]

Option C — Web Science

C1. (a)   Cloud computing services are provided for a particular group with a limited
number of users;   *[1 mark]*

(b)   *Award marks as follows up to [4 marks max].*
Award [2 marks] for the features of traditional client-server;
Award [2 marks] for features of cloud computing **which distinguish the two**;

Traditional client-server model:
Servers on the one of the premises of the company;
Connected to a Local Area Network (LAN);
Maintained by IT team of that organization;

Cloud computing:
Servers outsourced to third party;
Maintained by third party technical support team;
Based on Internet connectivity;
Connected to a WAN;

If feature are given, but are not different for each award [2 marks max].
[4 marks]

(c)   *Award marks as follows up to [4 marks max].*
Award [1 mark] for each benefit identified, up to [2 marks max];
Award [1 mark] for a reason for each benefit, up to [2 marks max];

Answers may include:
Reduce costs as fewer technical staff will need to be employed;
Technical staff in third party may have greater expertise as they may be able to
specialize;
May reduce costs as third party may benefit from economies of scale for
purchase of storage, hardware, *etc*;
Expertise may be held by more people, so staff turnover may have less effect;
The effects of unexpected hazards may be reduced as data may be distributed
across a number of locations;   *[4 marks]*

Question C1 continued

(d)   *Award marks as follows up to **[4 marks max]**.*
      *Award **[2 marks]** for a privacy issue identified and elaborated;*
      *Award **[2 marks]** for a security issue identified and elaborated;*

Privacy
Sensitive data is accessible to a third party;
If outsourcing occurs, potential exposure of data is increased;

Security
How secure is the data?;
Can it be guaranteed that this data will not be inadvertently passed to another company?;   ***[4 marks]***

C2. (a)   Can be rendered by all internet browsers;   ***[1 mark]***
               Other answers relating to the language itself (e.g. use of tags to delimit statements) would also be acceptable.

     (b)   Server retrieves event for days to be displayed from a database server;
           Takes results and generates HTML to display them in a table;
           Embeds HTML in page;
           Page sent to browser;
           Use of bullet points and a list is acceptable for this type of question.   ***[4 marks]***

     (c)   (i)   A client-side script may be made available to a browser by the use of script tags that are embedded in the HTML code;
                   By the use of an external file;   ***[2 marks]***

           (ii)   A client-side script will not require access to a remote server so that any processing that is done will be done more quickly and use less bandwidth;
                   This will reduce the load on the server;   ***[2 marks]***

Question C2 continued

(d)	*Award marks as follows up to **[4 marks max]**.*
	*Award **[2 marks]** for outlining the way meta-tags are used;*
	*Award **[2 marks]** for alternative methods;*

	Answers may include:
	Meta tags contain keywords/descriptions related to the web page's content;
	They are embedded in HTML code can be read by search engines;
	This can help their ranking;
	Search engines have become more sophisticated;
	They no longer place a high value on the content of meta tags;
	As they are not always a reliable guide to the web page's content;
	Search engines now use other parameters;
	e.g. Some will place more value on the number of links pointing to a web page;	***[4 marks]***

(e)	*Award marks as follows up to **[6 marks max]**.*
	*Award **[2 marks]** for an explanation of the creation of server side scripts;*
	*Award **[2 marks]** for an explanation of the client-side interaction;*
	*Award **[2 marks]** for relating to the box office website;*

	Answers may include:
	Before the web page is generated scripts will be run on the server-side;
	Examples of these scripts are;
	The handling of inputs;
	The retrieval of information from databases;
	The performing of calculations;
	Scripts will be written in languages such as PHP;
	Server-side scripts are hidden from users and therefore secure;
	The server sends data to the browser (client) in HTML;
	This could also include JavaScript code which will be interpreted by the client's browser;
	Allowing (in this case) booking details to be entered by the user on the client side;
	Server driven information can be delivered on the fly using software such as Ajax;	***[6 marks]***

C3. (a) (i)   It does not contain a fixed set of tags, therefore new ones can be added;   *[1 mark]*

   (ii) A set of rules and procedures that both sender and receiver must adhere
         to in order to allow coherent data transfer;   *[1 mark]*

(b) *Award up to [3 marks max].*
   The use of open standards implies that anyone can use them;
   They are standards that are agreed from the beginning;
   therefore ensuring interoperability;
   For example, the Internet backbone relies on the IP protocol which is an agreed
   standard, allowing the transfer of information to occur;   *[3 marks]*

   http://fsfe.org/projects/os/def.html (accessed 16 Aug 2011)

(c) *Award marks as follows up to [6 marks max].*
   Award [2 marks] for the difference between lossy and lossless compression;
   Award [2 marks] for a relative example for each;
   Award [2 marks] for the reason for using lossy or lossless in the example;

   Answers may include:
   Lossless compression is used when loss of data is unacceptable when
   transferring files such as audio files;
   Lossy compression may not significantly affect the final version of the file
   when it is decompressed;
   Lossy compression will reduce file size;
   Reduced file size may be an important requirement such as in the use of MP3
   music files;
   Lossy compression results in faster file transfer;
   Which is important when Internet connections are slow or files are large;
   If lossy compression is used the original file cannot be reinstated;
   Also characteristics of the data itself (e.g. frequencies too high for human hearing)
   could be introduced.   *[6 marks]*

Question C3 continued

   (d)   *Award up to [2 marks max].*
         Easier to set up;
         Less time will need to be spent in configuring the network;
         Other advantages could deal with the increased range of available files and the
         lower (or even zero) costs involved (depending upon the network).   *[2 marks]*

C4. (a)   The web-pages are seen as vertices and the hyperlinks between them as edges;   *[1 mark]*

   (b)   (i)   *Award up to [1 mark max].*
               Answers may include:
               Lies at the centre of the bowtie structure between the IN and OUT web
               pages;
               Is the part of the web where a web surfer is able to navigate to and from
               any particular web page;   *[1 mark]*

         (ii) *Award up to [2 marks max].*
               Answers may include:
               Have no links coming into them;
               Tend to be newer, not had sufficient time to establish a number of in
               links;
               Have links from them to other websites in the SCC, OUT (via tubes) or
               to other web sites (via tendrils);
               Tend to be resource lists;   *[2 marks]*

   (c)   *Award [1 mark] for a basic statement and an additional [1 mark] for the*
         development of it.
         The network diameter of the web growing no more than logarithmically with
         respect to the network size. Sources suggest there were 26 million pages in
         1998, one billion pages by 2000 and 34 billion by 2011;
         Therefore the diameter is not growing in a linear relationship with the number
         of web pages, so the ability of the web surfer to access all sites remains
         possible;
         10-fold increase of web pages results in only 2 more additional "clicks";   *[2 marks]*

Question C4 continued

(d) *Award up to [4 marks max].*
Accept either an explanation of the HITS or an explanation of Google PageRank.
For example:
Search engines use algorithms such as the Google PageRank or HITS to determine the ranking of any web page;
The Google PageRank calculates the rank as follows:
Rank is determined by number of votes for it. This is based on the number of "in" links and importance of pages voting for it;
Page rank uses a recursive algorithm;
However, some web masters use link farms to "artificially" raise the rank of the web page, some algorithms remove this information before calculating the rank;

HITS (hyperlink-induced topic search) is based on the following principles:
• Websites may be hubs (point to lots of authorities) or authorities (are pointed to by a number of hubs);

The HITS algorithm calculates the rank as follows:
• Determines a base set of web sites (a closed network)
• From this set a number of pages are located by a search engine to form a root
• Add to S all pages pointed to by any page in R
• Add to S all pages that point to any page in R
• Maintain for each page p in S:
   o Authority score: a_p (vector a)
   o Hub score: h_p (vector h)
• Calculate the authority weighting for each web page
• Calculate the hub weighting for each web page
• Normalizes the values;   *[4 marks]*

Question C4 continued

(e) *Award **[1 mark]** for a basic statement and an additional **[1 mark]** for the development of it.*

An ontology is the formal description of the concepts and relationships that exist within a specified domain of discourse.

"A folksonomy is a type of distributed classification system. It is usually created by a group of individuals, typically the resource users. Users add tags to online items, such as images, videos, bookmarks and text. These tags are then shared and sometimes refined."

Folksonomies may be imprecise and informal, developing organically through social networking. *[2 marks]*

(f) *Award up to **[2 marks max]**.*

Is a shared or group intelligence;
It can be measured;
May be based on independent decision making and a lack of conformity;
Based on consensual decision making;
Based on groups of people working openly;
Associated with distributed individual intelligences;
Is enabled by the Internet; *[2 marks]*

Question C4 continued

(g)   *Award marks as follows up to **[6 marks max]**.*
*Award **[2 marks]** for advantages;*
*Award **[2 marks]** for disadvantages;*
*Award **[2 marks]** for a conclusion and/or judgments based on the given advantages and disadvantages (may be incorporated into the body of the answer);*

Advantages of collective intelligence:
Information can be easily shared, may prevent unnecessary duplication of data;
Advancements may be rapid as large number of contributors may be involved, for example sites like Wikipedia may be considered as being developed through collective intelligence;
The total sum may be greater than the sum of the parts;
The project may develop further as many collaborators may freely add information therefore being more cost efficient than traditional methods of resolving problems;

Disadvantages of collective intelligence:
Too much information may be submitted;
The "group" may be informal so relevant information may not be processed as required;
The "group" may become unwieldy through too many contributors or lack motivation as there may be no designated project manager;
Knowledge may be developed without suitable checking mechanisms to ensure it is correct, decisions may be based on a consensus which may not be appropriate;   *[6 marks]*

Total: [65 marks]

Option D — Object-oriented programming

D1. (a) *Award [1 mark] for a definition, such as:*
A variable/value that is passed to a method;
The value passed to a method in brackets/parentheses;

Award [1 mark] for a valid example from the code, such as:
`setRoute(int r)`/`r` is a parameter variable;   *[2 marks]*

(b) *Award [1 mark] for a field and its data type, examples:*
`String destination;`
int/**double**/**long** `length;`

Award [1 mark] for a corresponding data example:
"City centre" or "Bus terminal" *etc.*;
23 (km), 13 460 (m), *etc.*;   *[2 marks]*

(c) *Award [1 mark] for any two correct outputs (including descriptors) and an additional mark for the third correct. Award [1 mark] for only the data items, if all correct.*
Examples:
Award [2 marks] for the following:
`Bus id:1001 - N Prakesh: Route: 431 start: Klang`

Award [1 mark] for the following:
`1001 - N Prakesh 431 Klang`   *[2 marks]*

(d) *Award marks as follows up to [6 marks max].*
Award [1 mark] for any loop;
Award [1 mark] for correct loop end point (allow test for fixed number in array, i.e. > 3 or == 4);
Award [1 mark] for running through all array elements;
Award [1 mark] for any test for bus number;
Award [1 mark] for correct access to the Route number (not the Route object);
Award [1 mark] for correct test;
Award [1 mark] for correct output of drivers;

Example answer:
```
private void showBuses(Bus[] b, int n)
{
  // Show buses with route numbers < n
  for (int x = 0; b[x] != null; x = x + 1)
  {
    if (b[x].getBusRoute().getRoute() <= n)
    {
      System.out.println(b[x].getDriver());
    }
  }
}
```
[6 marks]

Question D1 continued

(e)   *Award marks as follows up to [3 marks max].*
        Award [1 mark] for a diagram with title, variable and method sections;
        Award [1 mark] for a variable section with three suitably defined variables;
        Award [1 mark] for a method section with suitably defined methods,
        corresponding to the defined variables;

```
Driver
String: first
String: last
String/Integer: empNumber
setFirst(String: first)
setLast(String: last)
setEmpNumber(String/Integer n)
String getFirst()
String getLast()
String/Integer getEmpNumber()
String toString() // optional
```
                                                                [3 marks]

D2. (a)   *Award [1 mark] for a suitable definition, for example:*
              Encapsulation means having private variables;
              Variables not accessible from outside the class;
              Methods and variables are all included in the class definition;

              Award [1 mark] for relating to an example from the Bus class, such as:
              Class Bus/BusRoute has private (instance) variables;
              Class Bus/BusRoute has int and start as private variables;
              Class Bus/BusRoute has setter and getter methods to access the variables;
              Class Bus/BusRoute has public methods to access the private variables;   *[2 marks]*

        (b)   *Award [1 mark] for each possible disadvantage up to [2 marks max].*
              It is a complex process, unsuited to small scale problems;
              It is not suitable for problems involving direct access to hardware;
              Design principles are very abstract/hard to implement for beginning programmers;
              The world (of buses, for example) does not always divide up neatly into objects
              that can be programmed/encapsulated;   *[2 marks]*

Question D2 continued

(c)   *Award **[1 mark]** for each benefit and **[1 mark]** for a valid example relating to the benefit and a programming team up to **[4 marks max]**.*
Work can be split up among programming teams (so that) programmers can work on classes (independently);
Each team member does not need to know the internal details of a class in order to use/extend it;
Any class already written can be re-used by any other member;
etc.   **[4 marks]**

(d)   *Award marks as follows up to **[3 marks max]**.*
*Award **[1 mark]** for three instance variables of the correct type (String/Logical/Numeric);*
*Award **[1 mark]** for three setter methods with the correct and corresponding parameter types (String/Logical/Numeric);*
*Award **[1 mark]** for three getter methods with the correct and corresponding return types (String/Logical/Numeric);*

Example answer:

```
BusStop
String: name
Boolean: shelter
Integer/Real: distance
setName(String: first)
setShelter(Boolean shelter)
setDistance(Integer/Real distance)
String getName()
Boolean hasShelter()
Integer/Real getDistance()
String toString() // optional
```
                                                                             [3 marks]

(e)   *Award **[2 marks]** for a suitable data structure and a further **[2 marks]** for details, including sample data.*

Example answer:

Array
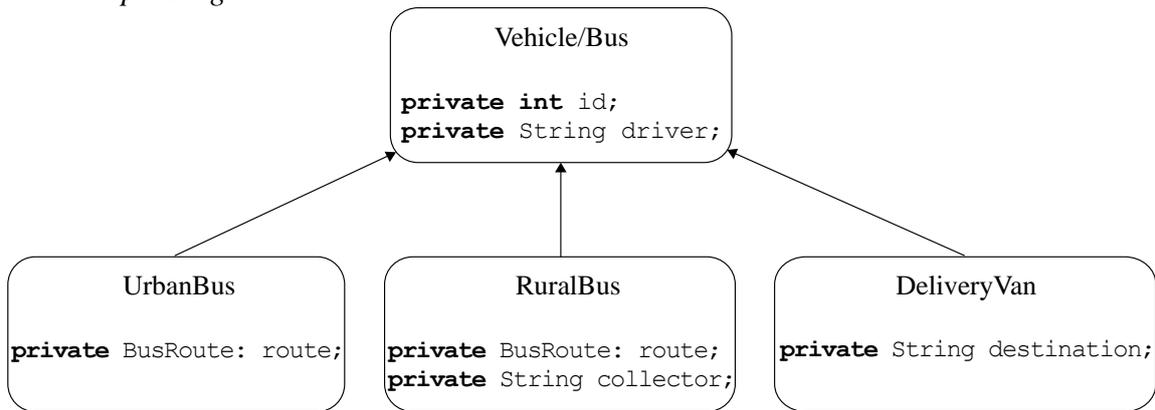The `BusRoute` class could include;
An array of `BusStop` instances;
```
BusStop[] stops = new BusStop[10];
stops[0] = new BusStop("Musgrave Hill", true, 1.5);
```

*For a code fragment such as the above, award **[1 mark]** for using the structure correctly and **[1 mark]** for suitable data samples.*   **[4 marks]**

D3. (a) *Award marks as follows up to **[8 marks max]**.*
*Award **[1 mark]** for a common superclass;*
*Award **[1 mark]** for a common id field;*
*Award **[1 mark]** for a common driver field;*
*Award **[2 marks]** for three sub-classes (arrows not critical, but some form of connection should be shown or labelled, e.g. "extends") if clear, award **[1 mark]** only for a worthy attempt;*
*Award **[2 marks]** for the additional collector field in the RuralBus;*
*Award **[2 marks]** for the different destination field in the DeliverVan;*
*Award **[1 mark]** for BusRoute in the buses but not in the DeliveryVan class;*

Example diagram:

Vehicle/Bus

private int id;
private String driver;

UrbanBus

private BusRoute: route;

RuralBus

private BusRoute: route;
private String collector;

DeliveryVan

private String destination;

[8 marks]

(b) *Award **[1 mark]** for identifying an advantage (may be implied) and **[1 mark]** for explaining what each advantage is. Award a further **[2 marks]** for a discussion of why this advantage is given by inheritance. Accept only the first reason where multiple advantages are presented.*

Enhanced re-use;
Common variables in the superclass;
And therefore common validation methods/coding for these;
No need to maintain code in two or more places;
And therefore less chance of errors in code;

Maintainability;
Since variables and related code are not replicated;
Among different classes;
If a change is required;
Only one class need be re-written/maintained;
And therefore less chance of errors in code;   ***[4 marks]***

(c) *Award up to **[3 marks max]**.*
Each subclass of (vehicle);
Implements this method;
But returns a different value;
(For example) the UrbanBus/RuralBus/DeliveryVan returns 0/1/2;   ***[3 marks]***

D4. (a) *Award up to [3 marks max].*
A queue is a first in first out structure;
Buses/objects should not be inserted in the middle of a queue;
Logically the first bus to leave/enter the queue will be the first to arrive/leave the queue;
Random access will not be required to a particular instance, making a queue more suitable than an array; *[3 marks]*

(b) *Award marks as follows up to [3 marks max].*
Award [1 mark] for three objects clearly representing a bus by some identifier (number or driver);
Award [1 mark] for objects in the correct sequence as represented by arrows or otherwise;
Award [1 mark] for labelled start and end of queue;

Example diagram:
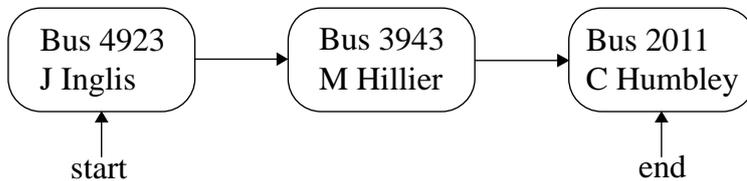
[3 marks]

(c) *Award marks as follows up to [4 marks max].*
Award [1 mark] for correct return type of Boolean;
Award [1 mark] for correct test for pos less than queue size;
Award [1 mark] for correct test for pos > 0;
Award [1 mark] for correct return value;

Example answer:

```
private boolean removeBus(int pos)
{
  if ((pos < busQueue.size()) && (pos >= 0))
  {
    busQueue.remove(pos);
    return true;
  }
  else
  {
    return false;
  }
}
```
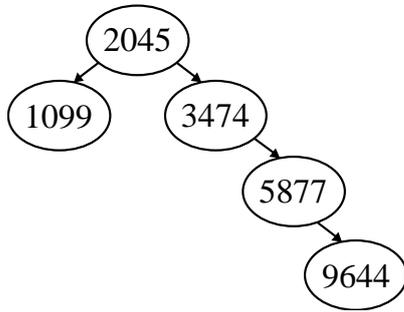
[4 marks]

(d) *Award up to [3 marks max].*
A binary tree has pointers to left and right nodes;
Nodes can be ordered;
Such that smaller values are placed to the left/right of a node;
Which reduces search time;
To $O(\log(n))$; *[3 marks]*

Question D4 continued

(e)   *Award **[1 mark]** for each correctly placed node.*

                                                                          [5 marks]

(f)   A recursive algorithm uses stack space which is finite an overflow error
        may occur;
        Recursive algorithms are often harder to write and understand;   *[2 marks]*

                                                                    Total: [65 marks]

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COMPUTER SCIENCE
HIGHER LEVEL
PAPER 3

SPECIMEN PAPER (1)

1 hour

INSTRUCTIONS TO CANDIDATES

- Do not turn over this examination paper until instructed to do so.
- Answer all questions.

*Answer **all** questions.*

1.	Outline the meaning of the following terms.

	(a)	*cookie*	*[2 marks]*

	(b)	*slack file space*	*[2 marks]*

2.	Companies who recycle their computers by selling them on to someone else will aim to erase all data on their hard drive. However, this may not always be successful.

	(a)	Outline how formatting the disk may not in fact achieve this aim.	*[4 marks]*

	(b)	Outline the possible effects on privacy if all of the data is **not** erased.	*[4 marks]*

3.	In the training exercise, John focused on securing the hard drive of the suspect's computer.

	Explain why other file evidence may have been missed in concentrating solely on the hard drive.	*[6 marks]*

4.	Discuss the methods used by criminals to hide or disguise certain files. For each method, identify the countermeasures that can be taken by a computer forensic scientist.	*[12 marks]*

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COMPUTER SCIENCE
HIGHER LEVEL
PAPER 3

SPECIMEN PAPER (2)

1 hour

INSTRUCTIONS TO CANDIDATES

- Do not turn over this examination paper until instructed to do so.
- Answer all questions.

*Answer **all** questions.*

1.   (a)   Outline the meaning of *MAC times*.   *[2 marks]*

    (b)   Identify **two** characteristics of a *bit-stream image*.   *[2 marks]*

2.   In the training exercise, John's first action was to switch the computer off.

    (a)   Describe the consequences of this action and whether other actions should have
    been taken first.   *[4 marks]*

    (b)   Describe **two** items that should be looked for in a physical search of the
    surrounding area.   *[4 marks]*

3.   Explain how investigation of the File Allocation Table (FAT) and the root directory
can be used to uncover data from previously deleted files.   *[6 marks]*

4.   The investigation has led to legal action being taken against the owner of the computer.
Illegal images were found and the case taken to court. Discuss, with examples,
the importance of following correct procedures during the investigation so that all
the evidence would be accepted by the court.   *[12 marks]*

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MARKSCHEME

SPECIMEN

COMPUTER SCIENCE

Higher Level

Paper 3

General Marking Instructions

1. Once markscheme is received mark in pencil until final markscheme is received.

2. Follow the markscheme provided, do **not** use decimals or fractions and mark only in **RED**.

3. Where a mark is awarded, a tick (✓) should be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark.

4. Sometimes, careful consideration is required to decide whether or not to award a mark. Indeed, another examiner may have arrived at the opposite decision. In these cases write a brief annotation in the **left-hand margin** to explain your decision. You are encouraged to write comments where it helps clarity, especially for moderation and re-marking.

5. Unexplained symbols or personal codes/notations on their own are unacceptable.

6. Record subtotals (where applicable) in the right-hand margin against the part of the answer to which they refer. Show a mark for each part question (a), (b), *etc.* Do **not** circle sub-totals. Circle the total mark for the question in the right-hand margin opposite the last line of the answer.

7. Where an answer to a part question is worth no marks, put a zero in the right-hand margin.

8. **Total:** Add up the marks awarded and enter this in the box marked TOTAL in the Examiner Column on the cover sheet.

9. After entering the marks on the cover sheet check your addition of all marks to ensure that you have not made an arithmetical error. Check also that you have transferred the marks correctly to the cover sheet. **We have script checking and a note of all clerical errors may be given in feedback to all examiners.**

10. Every page and every question must have an indication that you have marked it. Do this by **writing your initials** on each page where you have made no other mark.

11. A candidate can be penalized if he/she clearly contradicts him/herself within an answer. Once again make a comment to this effect in the left-hand margin.

Subject Details: **Computer Science HL Paper 3 Markscheme**

Mark Allocation

Candidates are required to answer **all** questions.
Maximum total = *[30 marks]*.

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for that part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- Each statement worth one point has a separate line and the end is signified by means of a semi-colon (;).

- An alternative answer or wording is indicated in the markscheme by a "/"; either wording can be accepted.

- Words in (…) in the markscheme are not necessary to gain the mark.

- If the candidate's answer has the same meaning or can be clearly interpreted as being the same as that in the markscheme then award the mark.

- Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalizing them for what they have not achieved or what they have got wrong.

- Remember that many candidates are writing in a second language; be forgiving of minor linguistic slips. In this subject effective communication is more important than grammatical accuracy.

- Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded. Indicate this with "**FT**".

1.   (a)   *Award up to [2 marks max].*
          Data/text placed on the computer by a web browser;
          Used for session management/personalization/tracking, *etc*;
          Data that relates a user to a particular site;   *[2 marks]*

      (b)   This is disk space left over;
          Between the end of the data and the end of the last cluster/sector of a file;   *[2 marks]*

2.   (a)   *Award up to [4 marks max].*
          A normal formatting will only modify the FAT/root directory;
          To make available all disk space / to show "no files" are saved;
          The actual data will still be present (in the sectors):
          Which can be retrieved with special software;
          A "forensic wipe" will erase all data;
          By writing (a series of zeros) over every sector;   *[4 marks max]*

      (b)   *Award up to [4 marks max].*
          Use of personal data/passwords to compromise the previous owner financially;
          By means of identity theft / use of bank passwords for fraud;
          Publishing of confidential data to embarrass the owner;
          Such as criminal record/details of affairs, *etc*.
          Use of medical data against owner;
          By insurance company to increase premiums / affect job applications, *etc*.   *[4 marks max]*

3.   *Award marks as follows up to [6 marks max]:*
      Award [1 mark] for a descriptive of each distinctly different type of evidence, and [1 mark] for an explanation of its importance. Only allow [3 marks] for different types of evidence.

      Programs/files running in main memory may not have been saved and will be lost if the computer is switched off. They may contain incriminating data or messages.

      There may be secondary memory away from the computer, *e.g.* flash memory, disks, which contain vital files.

      Passwords may have been written on "sticky notes" or notepads, which would speed up access to computer files.

      Print-outs should be collected as they may contain evidence of files no longer on the hard drive.

      Telephone answering machines should be checked for incriminating messages.

      Photographing the scene may provide clues later on that were initially missed.   *[6 marks max]*

4. *Answers may include:*

<u>Measures:</u>

1. Steganography

   This refers to the hiding of information or files inside other innocent appearing files, *e.g.* text within a graphic file or a picture within a video file. This is better than encrypting files as attention will not be drawn to an ordinary document or file, whereas an encrypted file will certainly be noticed. Image files are particularly good as they are relatively large, and by the alteration of a few specific bytes a message can be included without adversely affecting the actual image.

2. Changing the file extension

   When files are saved, the program being used saves the file with the appropriate file extension *e.g.* a word-processing file might be given the extension .doc, a graphics file the extension .jpg, *etc*. However, these extensions can be manually changed, thus circumventing any search based upon that particular file extension. So, changing all image files to have a .doc extension would suggest at first glance suggest that no images are present. Changing the file extension also causes the operating system to display the appropriate (but incorrect) icon (including a thumbnail).

3. Renaming of files

   File names can be changed to suggest more innocent sounding subjects than their contents might actually merit. Points 2 and 3 together mean that time consuming counter measures must be taken.

<u>Counter measures:</u>

1. Steganographic software has been developed which searches for hidden files (steganalysis). One such technique would be to compare a known good copy of the file with the suspect one.

2/3. Search for images by the contents of the file.

   File signatures can be searched for. Each file type has a specific file signature that is unaltered by any manual changing of the file extension or renaming of the file. This signature will be positioned as the header or footer in the file. The signature is normally 1 byte.

   Hash analysis, which does not include the file's metadata can be used when searching for a specific file. For this type of analysis the hash is created by adding together all of the bytes that code the data in a file. If a specific file is being searched for then its hash value will be known and can be checked against the hashes of the file present. This procedure is also useful for eliminating known files from the search. The fact that the metadata is **not** included in the hash counteracts any changing of the filename or extension.

Markbands

There must be evidence of independent research and investigation for students to reach the top level.

Marks	Level descriptor
No marks	• No knowledge or understanding of the relevant issues and concepts. • No use of appropriate terminology.
Basic 1–3 marks	• Minimal knowledge and understanding of the relevant issues or concepts. • Minimal use of appropriate terminology. • No reference is made to the information in the case study or independent research. • The answer may be little more than a list.
Adequate 4–6 marks	• A descriptive response with limited knowledge and/or understanding of the relevant issues or concepts. • A limited use of appropriate terminology. • There is limited evidence of analysis. • There is evidence that limited research has been undertaken.
Competent 7–9 marks	• A response with knowledge and understanding of the relevant issues and/or concepts. • A response that uses terminology appropriately in places. • There is some evidence of analysis. • There is evidence that research has been undertaken.
Proficient 10–12 marks	• A response with a detailed knowledge and clear understanding of the relevant issues and/or concepts. • A response that uses terminology appropriately throughout. • There is competent and balanced analysis. • There is clear evidence that extensive research has been undertaken. • Conclusions are drawn that are linked to the analysis.

[12 marks]

Total: [30 marks]

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COMPUTER SCIENCE
STANDARD LEVEL
PAPER 1

SPECIMEN PAPER

1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer all questions.

SECTION A

*Answer **all** questions.*

1.   State **one** example of *application software*.   *[1 mark]*

2.   Identify **two** methods that can be used to prevent data loss.   *[2 marks]*

3.   Identify **two** methods of providing *user documentation*.   *[2 marks]*

4.   Outline the need for higher level languages.   *[2 marks]*

5.   The contents of a 12-bit register is represented in *hexadecimal* as A5F.

      (a)   State its binary representation.   *[1 mark]*

      (b)   State how many different integers can be represented in this register.   *[1 mark]*

6.   Construct a *logic diagram* for the Boolean expression

                       A AND B OR NOT B.   *[3 marks]*

7.   When the wages for company employees are calculated, all hours above 38 are paid at
      the overtime rate of 1.5 times the base rate.

      Construct a flowchart that represents this algorithm.   *[3 marks]*

8. Consider the following array

NAMES	[0]	[1]	[2]	[3]	[4]
	Robert	Boris	Brad	George	David

and the following algorithm, which is constructed to reverse the contents of the array NAMES.

```
N = 5  // the number of elements in the array
K = 0  // this is the first index in the array

loop while K < N - 1
  TEMP = NAMES[K]
  NAMES [K] = NAMES [N – K – 1]
  NAMES [N – K – 1] = TEMP
  K = K + 1
end loop
```

(a) Trace the algorithm, showing the contents of the array after each execution of the loop. *[2 marks]*

(b) Identify the type of error that occurs. *[1 mark]*

(c) Outline why the error occurs and how it could be corrected. *[2 marks]*

9. (a) Outline the differences between a LAN and a VLAN. *[3 marks]*

(b) Identify **two** factors that should be considered when selecting transmission media. *[2 marks]*

SECTION B

*Answer **all** questions.*

10. The temperature of a lake for one day is recorded every hour and data is stored in a one-dimensional array named TEMPDAY.
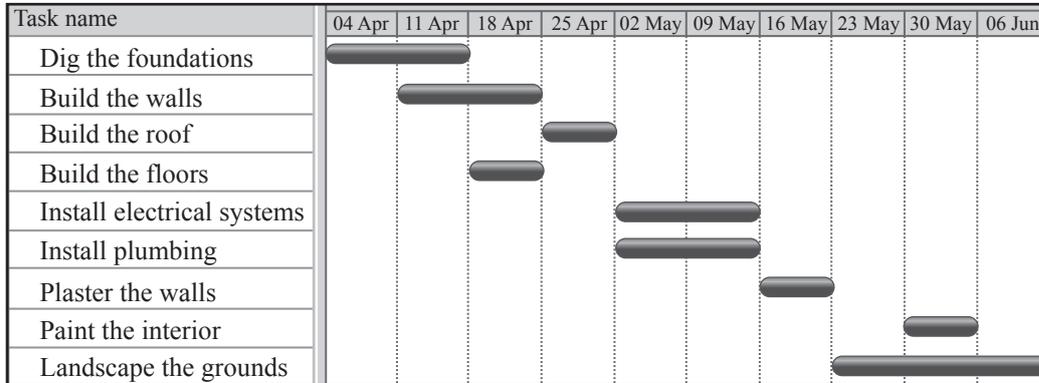
TEMPDAY

[1]	12.4
[2]	12.4
[3]	12.3
.	
.	
.	
[12]	12.9
[13]	13.0
[14]	13.1
.	
.	
.	
[23]	12.3
[24]	12.3

(a)   State the temperature of the lake at noon.   *[1 mark]*

(b)   Construct an algorithm that will calculate and output the average temperature.   *[4 marks]*

(c)   Construct an algorithm to find and output the minimum and maximum temperatures for the day.   *[7 marks]*

(d)   (i)   Describe how a two-dimensional array could be used to hold temperature measured every hour, every day for one week.   *[2 marks]*

       (ii)   Outline how the temperature on Thursday at 5pm can be accessed.   *[1 mark]*

11. A business has decided to replace their current computer system with a new computer system.

(a) Identify **three** examples of how employees, as users of the computer system, may participate in the development of the new system. *[3 marks]*

(b) One method of conversion from the old computer system to the new computer system is parallel running.

    (i) Define the term *parallel running*. *[1 mark]*

    (ii) Identify **one** other method of conversion. *[1 mark]*

    (iii) Compare parallel running with the method of conversion identified in part (ii). *[4 marks]*

(c) The data from the old computer system needs to be transferred onto the new computer system. Discuss **two** problems that may arise as a result of this data migration. *[6 marks]*

12. Señor Rodriguez is having a new house built and will require local tradesmen to complete a number of tasks.

The Gantt chart below shows the tasks involved in the building of the house.

Task name	04 Apr	11 Apr	18 Apr	25 Apr	02 May	09 May	16 May	23 May	30 May	06 Jun
Dig the foundations										
Build the walls										
Build the roof										
Build the floors										
Install electrical systems										
Install plumbing										
Plaster the walls										
Paint the interior										
Landscape the grounds										

(a) Define the term *concurrent processing*. *[1 mark]*

(b) Identify **two** tasks that are carried out concurrently. *[1 mark]*

(c) Identify **two** tasks that are carried out sequentially. *[1 mark]*

(d) Describe how the idea of abstraction applies to one of the tasks. *[2 marks]*

(e) Explain **one** advantage and **one** disadvantage of carrying out a number of tasks concurrently. *[4 marks]*

Amalia Rodriguez, his daughter, is a student and is completing her homework. This requires her to view web pages, edit a document, and print out draft copies.

However, she is also surfing the web, keeping up to date on her social networking site as well as downloading apps and music from a P2P site.

(f) For one of the application programs which she uses to perform these activities, outline **one** task that is carried out by the application program itself. *[2 marks]*

Within the application the graphical user interface (GUI) elements are reliant on the operating system.

(g) Identify **two** GUI components that are common to all of the above and are carried out by the operating system. *[2 marks]*

(h) Outline how the use of abstract GUI components simplifies application programming. *[2 marks]*

MARKSCHEME

SPECIMEN

COMPUTER SCIENCE

Standard Level

Paper 1

General Marking Instructions

1. Once markscheme is received mark in pencil until final markscheme is received.

2. Follow the markscheme provided, do **not** use decimals or fractions and mark only in **RED**.

3. Where a mark is awarded, a tick (✓) should be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark.

4. Sometimes, careful consideration is required to decide whether or not to award a mark. Indeed, another examiner may have arrived at the opposite decision. In these cases write a brief annotation in the **left hand margin** to explain your decision. You are encouraged to write comments where it helps clarity, especially for moderation and re-marking.

5. Unexplained symbols or personal codes/notations on their own are unacceptable.

6. Record sub-totals (where applicable) in the right-hand margin against the part of the answer to which they refer. Show a mark for each part question (a), (b), *etc.* Do **not** circle sub-totals. Circle the total mark for the question in the right-hand margin opposite the last line of the answer.

7. Where an answer to a part question is worth no marks, put a zero in the right-hand margin.

8. **Section A:** Add together the total for the section and write it in the Examiner Column on the cover sheet.
Section B: Record the mark awarded for each of the six questions answered in the Examiner Column on the cover sheet.
Total: Add up the marks awarded and enter this in the box marked TOTAL in the Examiner Column on the cover sheet.

9. After entering the marks on the cover sheet check your addition of all marks to ensure that you have not made an arithmetical error. Check also that you have transferred the marks correctly to the cover sheet. **We have script checking and a note of all clerical errors may be given in feedback to all examiners.**

10. Every page and every question must have an indication that you have marked it. Do this by **writing your initials** on each page where you have made no other mark.

11. A candidate can be penalized if he/she clearly contradicts him/herself within an answer. Once again make a comment to this effect in the left hand margin.

Subject Details: Computer Science SL Paper 1 Markscheme

Mark Allocation

Section A: Candidates are required to answer **all** questions. Total 25 marks.
Section B: Candidates are required to answer **all** questions. Total 45 marks.
               Maximum total = 70 marks.

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for that part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- Each statement worth one point has a separate line and the end is signified by means of a semi-colon (;).

- An alternative answer or wording is indicated in the markscheme by a "/"; either wording can be accepted.

- Words in (…) in the markscheme are not necessary to gain the mark.

- If the candidate's answer has the same meaning or can be clearly interpreted as being the same as that in the markscheme then award the mark.

- Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalising them for what they have not achieved or what they have got wrong.

- Remember that many candidates are writing in a second language; be forgiving of minor linguistic slips. In this subject effective communication is more important than grammatical accuracy.

- Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded. Indicate this with "**FT**".

General guidance

Issue	Guidance
Answering more than the quantity of responses prescribed in the questions	- In the case of an "identify" question read all answers and mark positively up to the maximum marks. Disregard incorrect answers. - In the case of a "describe" question, which asks for a certain number of facts *e.g.* "describe two kinds", mark the first two correct answers. This could include two descriptions, one description and one identification, or two identifications. - In the case of an "explain" question, which asks for a specified number of explanations *e.g.* "explain two reasons …", mark the first two correct answers. This could include two full explanations, one explanation, one partial explanation *etc*.

**SECTION A**   *Total: [25 marks]*

1.   *Award [1 mark] for a valid example.*
      Word processor; spreadsheet; database management system; e-mail; web browser;
      CAD; graphic processing software;   *[1 mark]*

2.   *Award [1 mark] for each method identified up to [2 marks max].*
      Failover systems;
      Redundancy;
      Removable media;
      Offsite / online storage;   *[2 marks]*

3.   *Award [1 mark] for each method identified up to [2 marks max].*
      Help files;
      Online support;
      Printed manuals;   *[2 marks]*

4.   *Award [1 mark] for identifying one need for a higher level language and [1 mark]
      for further development of that idea or the identification of a second need up to
      [2 marks max].*
      In machine language, the basic operations available are too simple;
      The operations used in modern programming are far more abstract than the basic
      operations of the computer;
      It would take too long to complete systems in machine code;   *[2 marks]*

5.   (a)   *Award [1 mark] for right binary number. Accept any spaces.*
            1010 0101 1111;   *[1 mark]*

      (b)   *Award [1 mark] for either answer.*
            2^{12} or 4096;   *[1 mark]*

6.   *Award [1 mark] for each correct logic gate up to [3 marks max].*
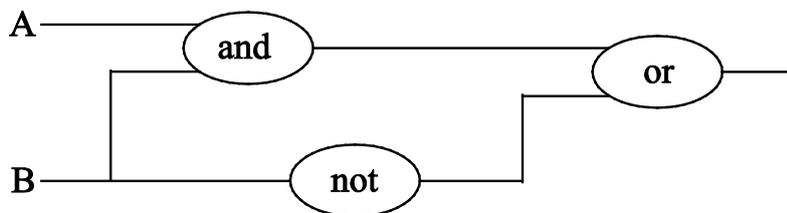
                                                                             [3 marks]

7. *Award marks as follows, up to [3 marks max].*
Award [1 mark] for decision structure.
Award [1 mark] for correct condition.
Award [1 mark] for correct expression for calculation of wage when there are no overtime hours.
Award [1 mark] for correct calculation of wage when there are overtime hours.
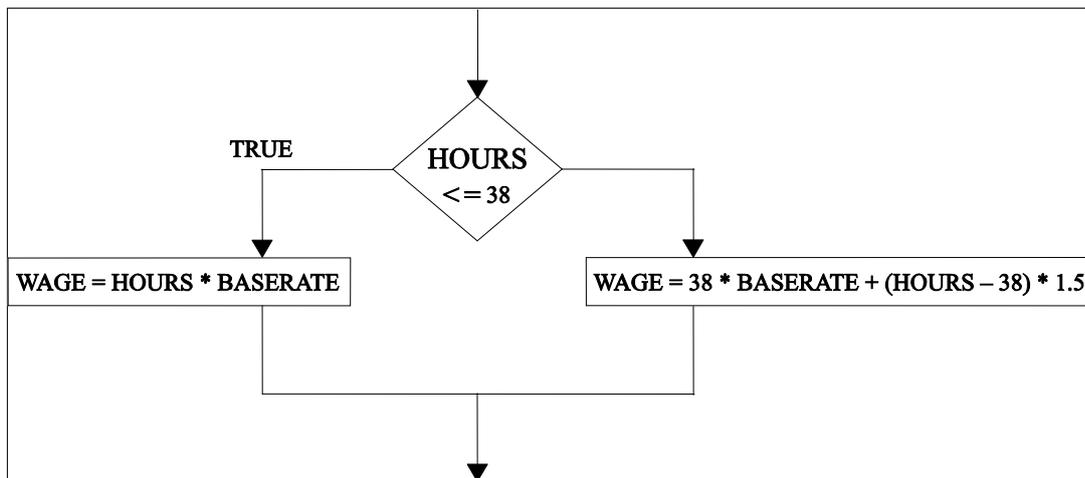
[3 marks]

8. (a) 1st

[0]	[1]	[2]	[3]	[4]
David	**Boris**	**Brad**	**George**	**Robert**

2nd

[0]	[1]	[2]	[3]	[4]
David	**George**	**Brad**	**Boris**	**Robert**

3rd

[0]	[1]	[2]	[3]	[4]
David	**George**	**Brad**	**Boris**	**Robert**

4th

[0]	[1]	[2]	[3]	[4]
David	**Boris**	**Brad**	**George**	**Robert**

[2 marks]

(b) Logic error; *[1 mark]*

(c) *Award [1 mark] for stating a possible cause of error.*
Loop executes too many times;
Terminating value for controlling variable was not correctly set;

Award [1 mark] for stating a possible solution.
Condition should be changed to k = n div 2; *[2 marks]*

9. (a) *Award [1 mark] for identifying one difference between a LAN and a VLAN and [1 mark] for further development of that idea or identifying another difference up to [3 marks max].*
A LAN is a physical, local area network defined by cables, and networking hardware whereas;
A VLAN is a virtual LAN defined by software parameters programmed into the networking hardware; *[3 marks]*

(b) *Award [1 mark] for each factor identified up to [2 marks max].*
Cost;
Speed;
Security;
Reliability; *[2 marks]*

SECTION B   *Total: [45 marks]*

10. (a)   12.9   *[1 mark]*

(b)   *Award marks as follows up to **[4 marks max]**.*
      *Award **[1 mark]** for initializing.*
      *Award **[2 marks]** for correct initial and terminal value of the controlling*
      variable.
      *Award **[1 mark]** for correct assignment statement.*
      *Award **[1 mark]** for dividing sum of all temperatures by 24.*
      *Award **[1 mark]** for output.*

      Possible answer:
```
A = 0.0
loop k from 1 to 24
    A = A + TEMPDAY[k]
end loop
A = A/24
output "the average temperature is" , A
```
                                                                                    [4 marks]

(c)   *Award marks as follows up to **[7 marks max]**.*
      *Award **[1 mark]** for initializing appropriate values to min and max.*
      *Award **[2 marks]** for correct loop, **[1 mark]** for minor mistake.*
      *Award **[1 mark]** for comparing TEMPDAY[k] with minimum.*
      *Award **[1 mark]** for reassigning minimum if needed.*
      *Award **[1 mark]** for comparing TEMPDAY[k] with maximum.*
      *Award **[1 mark]** for reassigning maximum if needed.*
      *Award **[1 mark]** for output.*

```
MIN = TEMPDAY[1]
MAX = TEMPDAY[1]

loop k from 2 to 24
    if  MIN > TEMPDAY[k] then
            MIN = TEMPDAY[k]
    end if
    if  MAX < TEMPDAY[k] then
            MAX = TEMPDAY[k]
    end if
end loop

output "the minimum temperature is" , MIN , "and the maximum
is" , MAX
```
                                                                                    [7 marks]

continued ...

Question 10 continued

(d) (i) *Award [2 marks max].*
Award marks for dimensions 24 x 7 or 7 x 24. Either diagram or description.

Example answer:
Description
Two dimensional array, for example named `TEMPWEEK` could be used
With 24 rows (1 for each hour);
And 7 columns (1 for each day);
OR
Diagram

`TEMPWEEK`

			days		
	Monday	Tuesday			Sunday
hours	1	2			7
1	12.4	12.3			12.6
2	12.3	12.3			12.5
3	12.3	12.3			12.4
4	12.3	12.3			12.3
5	12.1	12.1			12.1
6	12.1	12.1			12.1
7	12.2	12.2			12.2
.					
.					
.					
16	12.9	12.9			12.9
17	13.0	13.0			13.0
18	13.1	13.1			13.1
.					
.					
.					
23	12.3	12.3			12.3
24	12.3	12.3			12.3

[2 marks]

(ii) *Award mark only if answer corresponds to candidate's answer to Part (d)(i).*

Example answer:
`TEMPWEEK [17,2];`   *[1 mark]*

Total: [15 marks]

11. (a) *Award [1 mark] for each example up to [3 marks max].*
They may explain how the current system works;
They may explain how it could be improved;
They may provide requirements/objectives;
They may be involved in approving the proposed solution;
They may evaluate one or more prototypes;
They may test the system to ensure that it works as expected;
They will be attending the training lessons to learn how to use the new system;
They will be using the system;							*[3 marks]*

   (b) (i) *Award [1 mark] for a correct definition.*
The old system continues alongside the new system for a certain period
of time;									*[1 mark]*

      (ii) *Award [1 mark] for one method of conversion (other than parallel running) identified.*
Direct changeover;
Phased conversion;
Pilot conversion;								*[1 mark]*

     (iii) *Award marks as follows up to [4 marks max].*
Award [1 mark] for identifying the similarities between parallel running and direct changeover.
Award [1 mark] for identifying the differences between parallel running and direct changeover.
Award [1 mark] for an explicit and direct comparison of parallel running and direct changeover.
Award [1 mark] for the correct use of appropriate terminology.
Answers to include:

Parallel running	Direct changeover
Output results can be compared with known results; In the case of any difficulties system operation continues under the old system; Slow; Inefficient; Duplication of work; More personnel needed as long as two systems work at the same time;	System operation will be disrupted if the new system does not work properly; Fast; Efficient, minimum duplication of work involved;

[4 marks]

Question 11 continued

(c) *Award marks as follows up to **[6 marks max]**.*
*Award **[1 mark]** for each distinct problem identified, up to **[2 marks max]**.*
*Award **[1 mark]** for a description of each identified problem, up to **[2 marks max]**.*
*Award **[1 mark]** for an elaboration of the identified problems.*
*Award **[1 mark]** for correct terminology used throughout.*
Answers may include:

Incompatible formats of data: The new system may store data in a format different from that used in the old system. This might be a simple matter of translation, such as converting integers to decimals. It could also be very difficult if the new system stores more detailed data than the old system, such as the date and time of each transaction while the old system stored only the date.

Data lost in migration: Data might be lost due to errors in the translation process or because perfect translations simply are not possible, *e.g.* if the old system stored ratings on a scale of 1–5 while the new system stored only 1–3.

The systems may be unavailable during the migration process; one way to avoid having two systems with incompatible data is to shut down the business, perform the migration, and then restart with the new system. If the migration takes a long time however, shutting down the business for that time may be undesirable.

New data may continue coming in during the migration process; if the business is not shut down during the migration process, transactions will either have to be performed on the new system without the old data being available or they will have to be performed on the old system which will add to the data needing to be migrated.   *[6 marks]*

Total: [15 marks]

12. (a) *Award [1 mark] for a definition that covers the basis of the term.*
Concurrent processing means to do more than one activity at the same time;   *[1 mark]*

(b) *Award [1 mark] for a pair of tasks correctly identified.*
Install plumbing and install electrical systems;   *[1 mark]*

(c) *Award [1 mark] for a pair of tasks correctly identified.*
Any two tasks in which one cannot begin before the other is completed:
Digging the foundation and building the floors;
Building the walls and building the roof;
Building the roof and plastering the walls;   *[1 mark]*

(d) *Award [1 mark] for identifying a task as composed of subtasks.*
Award [1 mark] for describing some reasonable set of subtasks.
Describe one of the tasks as being composed of subtasks:
Build the floors: Install the beams, install the joists, install the subfloor, install the finish floor.
Paint the walls: Mask off things not to paint, cover floors, select paint colours, paint trim, paint walls, paint ceilings.
Landscaping: Plan the plantings, get the plants, dig holes, plant things, seed the lawn, install lighting.   *[2 marks]*

(e) *Award [1 mark] each for the identification of an advantage and a disadvantage.*
Award up to [2 marks] for explaining the advantage and disadvantage.

Advantages:
Building could be finished faster; By doing some tasks concurrently, the overall time needed to complete the building will be reduced. Since construction workers are paid by the hour, getting the building done sooner will reduce the cost of the building.

Disadvantages:
Workers on concurrent tasks may get in each other's way; If the plumbers and the electricians are both working at the same time and both need to get at the same place at the same time, one will have to wait. Thus, it may take longer to do the electrical work while the plumbing is being done than it would take to do it alone.

Harder to supervise; The supervisor needs to look at the work being done and make sure that its being done correctly and explain what needs to be done, *etc*. If there are two (or more) sets of workers the supervisor will have to work harder to watch both of them at the same time.   *[4 marks]*

(f) *Award [1 mark] for identifying an application.*
Award an additional [1 mark] for outlining a task carried out by the application.
The word processor: counting the number of words in the document.
The browser: Interpreting the HTML to figure out what to display.
The downloading program: Calculating the amount of time remaining to complete the download.   *[2 marks]*

Question 12 continued

(g)   *Award [1 mark] for each GUI component identified up to [2 marks max].*
       Toolbars;
       Menus;
       Dialogue boxes;
       Buttons;
       Check boxes;
       Text-entry fields;   *[2 marks]*

(h)   *Award [1 mark] for identifying one way in which the use of abstract GUI
       components simplifies application programming.*
       *Award an additional [1 mark] for a description of the idea identified above or
       the identification of a second idea up to [2 marks max].*
       Application developers do not have to implement basic GUI components.
       All applications use the same basic GUI elements resulting in a better user
       experience.
       The operating system coordinates GUI elements for all applications reducing
       the need for developers to do so.
       Application code is much smaller since all the GUI-related code is in a
       standard library.   *[2 marks]*

                                                                        Total: [15 marks]

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COMPUTER SCIENCE
STANDARD LEVEL
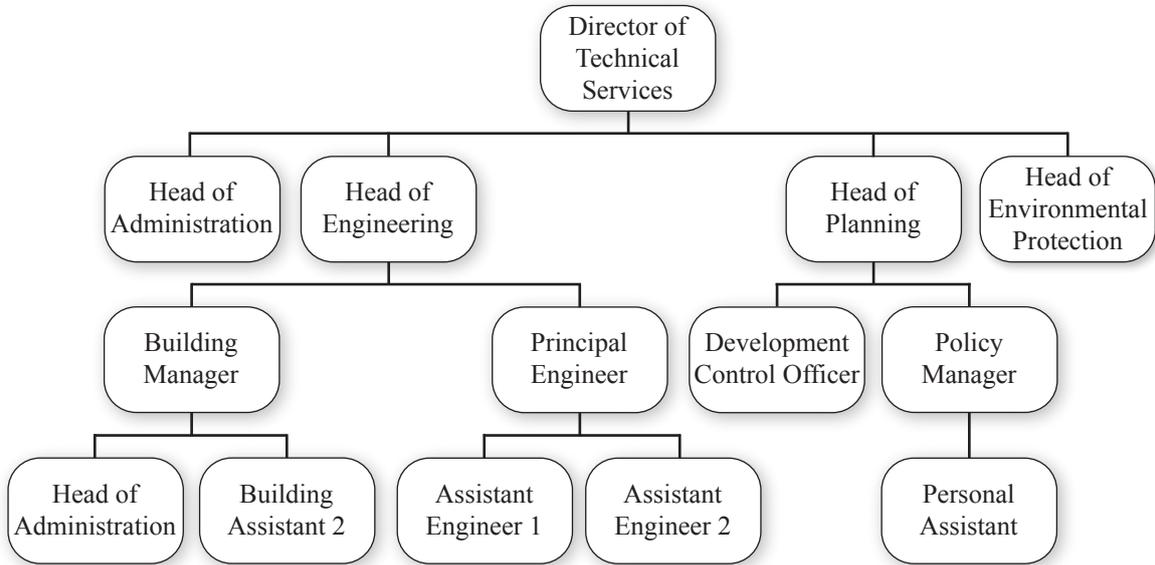**PAPER 2**

SPECIMEN PAPER

1 hour

INSTRUCTIONS TO CANDIDATES

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

Option A — Databases

A1. A company has a division called Technical Services. This division is organized into departments. The following chart shows how the various staff are organized.

The Human Resources Department maintains a flat file database to store information about all the staff members for salary, holiday and promotion purposes. A sample of the stored information is shown below.

Staff Number	Surname	Forename	Job Title	Line Manager	Salary
948	Kent	McKenzie	Head of Planning	Adrienne Mathis	90875
156	Barker	Rae	Head of Administration	Adrienne Mathis	30465
815	Riddle	Kevyn	Development Control Officer	Kent McKenzie	34768
580	Figueroa	Rina	Policy Manager	Kent McKenzie	45078
871	Mathis	Adrienne	Director of Technical Services	Russell Z. Harrell	45800
457	Neal	Paul	Head of Environmental Protection	Adrienne Mathis	80670
297	Oliver	Ralph	Principal Engineer	Daria Gilmore	50796
51	Gilmore	Daria	Head of Engineering	Adrienne Mathis	90655

(Question A1 continued)

The Human Resources Department is experiencing many errors when compiling reports of personnel and has been advised that it should change to a relational database.

(a)　(i)　Define the term *database*. *[1]*

　　(ii)　Describe the difference between a *flat file database* and a *relational database*. *[2]*

(b)　(i)　Identify **two** problems caused by data redundancy. *[2]*

　　(ii)　Outline using examples how data redundancy in this database could lead to errors. *[2]*

(c)　The departments usually have many ongoing projects that occupy their team members. The Human Resources Department needs to produce lists showing who is involved in current projects.

　　The following information has been provided:

　　Project: Project_Ref, Project_Name, Budget
　　Department: Dept_Ref, Dept_Name
　　Staff: Staff_Number, Forename, Surname, Job_Title, Salary
　　The projects are owned by a department.
　　Each member of staff is a member of a department.

　　(i)　Construct an Entity Relationship Diagram to show how a relational database could be designed to make this possible with the least chance of producing errors caused by data redundancy. *[4]*

　　(ii)　Identify the steps to create a query that could be constructed to produce a list of staff members whose salary is greater than $50 000 who are involved in a project called "Relocation_2012". *[4]*

A2. A bank wants to transfer money from one account to another. Both accounts are held in the bank's database management system (DBMS). The account DBMS carries out a series of separate operations in order to achieve this transaction. These include removing of money from one account and adding it to the other. An error may occur if this process is interrupted, for example due to a power failure. This could compromise the integrity of the account database.

    (a)   (i)   Identify **two** characteristics of a *transaction* in terms of a database. *[2]*

           (ii)   Distinguish between a database *schema* and a database *state*. *[2]*

           (iii)   Explain why the interruption described above could compromise the integrity of the account database. *[2]*

    (b)   Identify the steps that should be taken by the software in order to maintain the integrity of the account database. *[4]*

    (c)   The bank account data is shared between various applications, such as the bank's internal accounting systems and the online transaction system. Explain how problems of concurrency can arise and how they can be avoided. *[6]*

A3.   (a)   (i)   Identify **two** functions of a *database management system* (DBMS). *[2]*

           (ii)   List **two** tools usually provided with a DBMS. *[2]*

    (b)   Database management systems allow data sharing and multiple views. Explain why these features are important to an organization that uses databases. *[4]*

    (c)   Explain why it is important for data to be independent of the application software that manipulates it. *[6]*

Option B — Modelling and Simulation

B1. Mathematical models are used to provide information to building designers.

(a)   Identify **two** characteristics of a mathematical model.   *[2]*

Any new building must be constructed to resist the force of a possible earthquake. The force (V) that the building must resist in order to prevent collapse varies according to the following variables:

Variable	
Z	The Earthquake zone (1–3) in which the building is constructed
I	Importance of the building according to its intended use (*e.g.* school, hospital, *etc.*)
C	Structure index based on the dimensions, the weight and the shape of the building
R	Flexibility of the building

A simplified version of V can be calculated by the formula:

$$V = (Z * I * C) / R,$$

where Z and I are given and the values of C and R are obtained from published tables.

A building designer needs to be able to calculate the value of V for any one of a large number of buildings that is being designed. Z is fixed for all buildings; I, C and R can vary from building to building.

(b)   Outline why the use of a spreadsheet is appropriate for this modelling task.   *[2]*

(c)   Construct a diagram to show the way in which data and calculations would be implemented in a spreadsheet.   *[4]*

(d)   Outline how data from the look up tables could be input into the spreadsheet.   *[4]*

Within a city in an earthquake zone there are many different designs of buildings. It is decided to test all buildings for their resistance to a possible earthquake in that zone.

(e)   Describe the data collection and data input needed to use the spreadsheet to test all buildings.   *[6]*
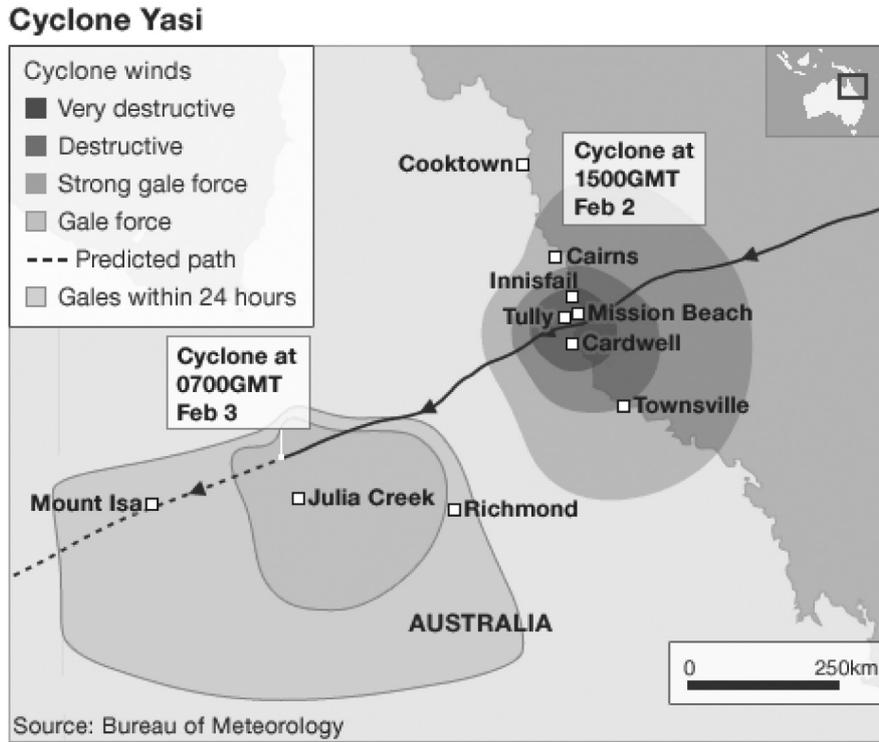
Turn over

B2. Despite many attempts, the simulation of an earthquake by computer has proved inaccurate and planned buildings are tested by making a physical model and applying the relevant forces to see if it can withstand an earthquake in the given zone.

(a)   Explain the relationship between a *simulation* and *mathematical modelling*.   *[2]*

(b)   With reference to a simulation with which you are familiar, explain the importance of accurate rules and data in a simulation.   *[4]*

Simulation has proved successful in predicting weather patterns.

(c)   Describe **one** advantage and **one** social consequence of using simulations for weather forecasting.   *[4]*

B3. Cyclone Yasi hit Northern Australia in February 2011. There were many after effects such as flooding and landslides.

[Source: Australian Government Bureau of Meteorology (accessed 07 February 2011)]

To ensure that the emergency services could be located where they will be most needed a 2D visual model of likely danger areas, shown above, was created and distributed to surrounding areas in real time.

(a)   Outline the ways in which visualization can be used to display the possible effects of the cyclone in real time.   *[4]*

(b)   Explain the technical difficulties that could arise in data collection and processing when attempting to predict in real time.   *[4]*

(c)   Explain the advantages of using visualization in this case.   *[6]*

(d)   Compare the use of 2D visualization with 3D visualization in this situation.   *[3]*

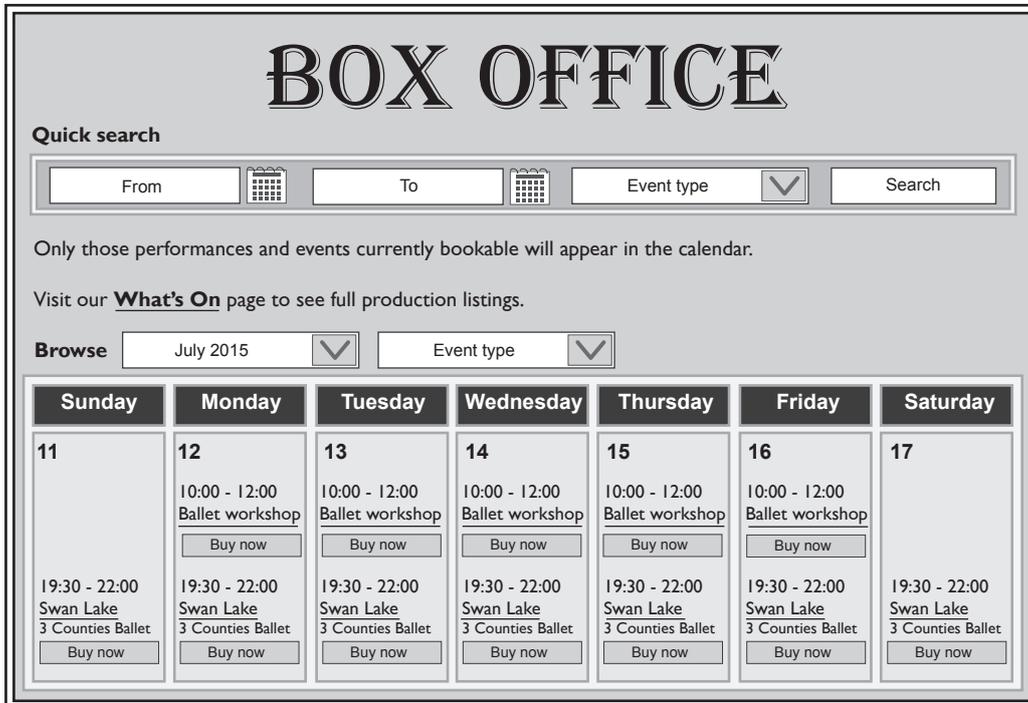**Turn over**

Option C — Web Science

C1. A publishing company, ABC Publications, based in London has a large IT department. This department is responsible for:

- providing IT services to the company
- maintaining the company's web site
- creating and maintaining web based learning resources that are sold to schools and colleges.

The company is finding it difficult to recruit and retain sufficient high quality IT staff to keep these functions operating at an optimal level. It is investigating transferring at least part of its IT operations to a cloud computing solution. At the moment it has not been decided how much of this should be implemented by a private cloud and how much by a public cloud.

(a) Define the term *private cloud*.   *[1]*

(b) Distinguish between a cloud computing model and a conventional client server model in providing computing services.   *[4]*

(c) Explain why ABC Publications might benefit from changing part of its IT provision to a cloud based model.   *[4]*

(d) Comment on the privacy **and** security issues relating to ABC's use of cloud computing.   *[4]*

C2. A theatre box office maintains a web site that can display what productions are coming up and which seats are available for a particular production. It can then take orders online. The interface consists of dynamic web pages such as the one below, in which the underlying HTML interacts with client-side and server-side scripts.

Part of the source code for this page is:

```
<script type="text/javascript" src="http://assets.ophse.org/_inc/popdt/init_live.js"></script>
<script type="text/javascript" src="http://assets.ophse.org/_inc/popdt/src/flash.js"></script>
```

(a) Identify **one** characteristic of Hypertext Markup Language (HTML). *[1]*

(b) Identify the steps that the server would carry out so that the information in the events' calendar can be displayed on the client's computer. *[4]*

(c) (i) Identify **two** ways that a client-side script may be made available to a web browser. *[2]*

(ii) Describe **one** reason why a client-side script may be used in preference to a server-side script. *[2]*

(This question continues on the following page)

Turn over

(Question C2 continued)

(d)   The organizers of the theatre want to ensure their web pages appear higher up the ranking of search engines.

Suggest whether the use of meta-tags can help achieve this aim.   *[4]*

(e)   It is common for dynamic web pages to make use of a mixture of client-side and server-side scripting.   Explain how the interaction of HTML, client-side and server-side scripting have allowed the production of a web page such as the one shown here.   *[6]*

C3.   As the web has developed, data formats, communication protocols and standards such as XML or SQL have proven crucial to progress. Two fundamental concerns that have been central to this development are the issues of interoperability and that of open standards.

(a)   (i)   Identify **one** characteristic of XML.   *[1]*

(ii)   Define the term *protocol*.   *[1]*

(b)   Describe, with the use of examples, how the use of open standards allows interoperability to occur.   *[3]*

Music is distributed across the web in a variety of different ways such as peer-2-peer (P2P) networks.

(c)   Discuss **two** factors that would affect the decision to use either lossless or lossy compression when transferring files across the Internet.   *[6]*

(d)   Explain **one** advantage of the use of a peer-2-peer (P2P) network for obtaining and downloading music and movie files.   *[2]*

Option D — Object-oriented programming

A bus company operates in a local city. The bus company operates along fixed routes where there are marked stops and sometimes bus shelters for people to wait in out of the weather. People (passengers) pay the driver a specified fare for travel when they enter a bus.

There are many objects in this company, here are some of them:

Object	Description
Bus	A physical vehicle that carries *passengers* on a specific *route* and has a *driver*.
Passenger	A person that travels on a *bus*.
Route	A series of roads/streets the *bus* travels over from its start to its destination.
Bus Stop	A **named** place on a *route* where people wait for a *bus*. May be a simple marker or may have a shelter and seats.
Driver	A person qualified to drive a *bus* and trained to drive it over a given *route*.

These two objects have already been defined for the bus company:

```
BusRoute

Integer: route
String: start

setRoute(Integer: route)
setStart(String: start)
Integer getRoute()
String getStart()
String toString()
```

```
Bus

Integer: id
String: driver
BusRoute: busRoute

setId(Integer: id)
setDriver(String: driver)
setBusRoute(BusRoute: route)
Integer getId()
String getDriver()
BusRoute getBusRoute()
String toString()
```

The `toString()` method returns a String implementation of an object.

These are implemented in code as follows:

```java
public class BusRoute
{
  private int route;
  private String start;
  public BusRoute(int r, String s)
  {
    setRoute(r);
    setStart(s);
  }
  public void setRoute(int r){ route = r; }
  public void setStart(String s){ start = s; }
  public int getRoute(){ return route; }
  public String getStart(){ return start; }
  public String toString()
  {
    return "Route: " + route + " start: " + start;
  }
}


public class Bus
{
  private int id;
  private String driver;
  private BusRoute busRoute;
  public Bus(int i, String d, BusRoute r)
  {
    setId(i);
    setDriver(d);
    setBusRoute(r);
  }
  public void setId(int i){ id = i; }
  public void setDriver(String d){ driver = d; }
  public void setBusRoute(BusRoute r){ busRoute = r; }
  public int getId(){ return id; }
  public String getDriver(){ return driver; }
  public BusRoute getBusRoute(){ return busRoute; }
  public String toString()
  {
    return "Bus id:" + id + " - " + driver + ": " + busRoute.toString();
  }
}
```

D1. (a)   Explain the term *parameter variable*, using an example from the code.   *[2]*

(b)   Describe **one** additional field that might have been included in the `BusRoute` object/class. Include data types and sample data.   *[2]*

(c)   Identify the output produced by the following code fragment.

```
Bus bus = new Bus(1001, "N Prakesh", new BusRoute(431, "Klang"));
System.out.println(bus.toString());
```
          [2]

Consider the code fragment below.

```
private static final int MAX_BUSES = 12;
private Bus[] buses = new Bus[MAX_BUSES];
buses[0] = new Bus(1001, "N Prakesh", new BusRoute(431, "Klang"));
buses[1] = new Bus(1010, "J Carey", new BusRoute(342, "Tanglin"));
buses[2] = new Bus(1014, "H Lee", new BusRoute(411, "Queenstown"));
buses[3] = new Bus(1015, "K Peters", new BusRoute(319, "Jamaica Street"));

showBusDrivers(buses, 1010);
```

(d)   Construct the method `showBusDrivers(Bus[] b, int n)` which lists the drivers for all buses with a route number less than or equal to the parameter variable (`n`).   *[6]*

The company wishes to keep track of its drivers in more detail, including first and last name and employee number – this is a 4-digit whole number.

(e)   Construct a suitable diagram for this `Driver` object.   *[3]*

Turn over

D2. In relation to the Bus example:

    (a)   Outline how encapsulation is used.   *[2]*

    (b)   Outline a disadvantage of using Object Oriented Design.   *[2]*

    (c)   Explain how a programming team could benefit from an Object Oriented Design approach.   *[4]*

Recall that a *Bus Stop* is one of many **named** places on a *route* where *buses* stop to pick up or drop off *passengers*. It may or may not have a **shelter** to protect *passengers* from the weather. The **distance** in km from the start point of the *Bus Route* is important information for planning.

    (d)   Design the Bus Stop Object using a simple object diagram.   *[3]*

    (e)   Suggest how Bus Stop information for a given Bus Route instance could be stored, giving both sample data and sample code fragments to show how it could be implemented.   *[4]*

D3. The company grows, offers more routes of different types and decides to use three different types of bus:

- A bus that operates on busy city routes – the Urban Bus – has only a driver.
- A smaller bus that operates on longer country routes – it carries an additional person to collect the fares.
- A van that can be used for heavy equipment deliveries rather than passengers – the Delivery Van – it carries a co-driver and a helper.

These vehicles will have some things in common, such as a *driver*, and other elements that are different, for example both Urban and Rural buses will operate on a fixed *route* whereas the Delivery Van will take equipment to specified *destinations* (such as factories or other businesses).

    (a)   Construct diagrams to show how you would re-design the `Bus` class to implement inheritance.   *[8]*

    (b)   Explain the advantage of inheritance for this situation.   *[4]*

A method is required in the subclasses that returns the number of employees per vehicle.

    (c)   Outline how polymorphism might apply in this design.   *[3]*

MARKSCHEME

SPECIMEN

COMPUTER SCIENCE

Standard Level

Paper 2

20 pages

General Marking Instructions

These instructions should be read in conjunction with the examiner instructions on IBIS.

Once approved for marking, you can download up to 20 scripts into your worklist.

1. Follow the markscheme provided, do **not** use decimals or fractions and mark only in **RED**.

2. Where a mark is awarded, a tick (✓) should be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark.

3. For extended responses where markbands are used, it is helpful to write a brief comment indicating why the level was awarded.

4. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases write a brief annotation in the **left-hand margin** to explain your decision. You are encouraged to write comments where it helps clarity.

5. Unexplained symbols or personal codes/notations on their own are unacceptable.

6. Where an answer to a part question is worth no marks, put a zero in the mark entry box.

7. Every page and every question must have an indication that you have marked it. Do this by **writing "seen"** on each page where you have made no other mark.

8. Examiners should be aware that in some cases candidates may take a different approach, which if appropriate should be rewarded. If in doubt check with your Team Leader.

Subject Details: Computer Science SL Paper 2 Markscheme

Mark Allocation

For the option chosen candidates are required to answer **all** questions. Total 45 marks.

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for that part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:
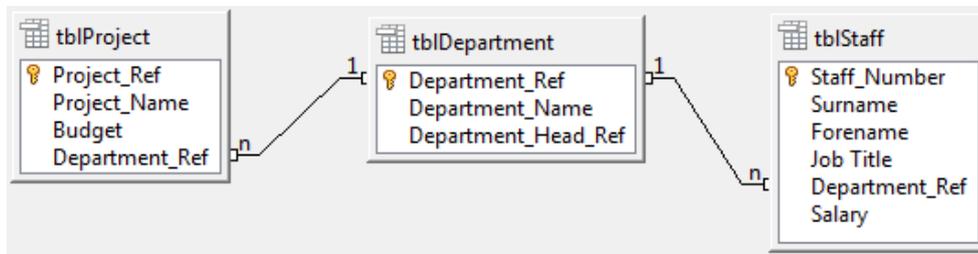
- Each statement worth one point has a separate line and the end is signified by means of a semi-colon (;).

- An alternative answer or wording is indicated in the markscheme by a "/"; either wording can be accepted.

- Words in (…) in the markscheme are not necessary to gain the mark.

- If the candidate's answer has the same meaning or can be clearly interpreted as being the same as that in the markscheme then award the mark.

- Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalizing them for what they have not achieved or what they have got wrong.

- Remember that many candidates are writing in a second language; be forgiving of minor linguistic slips. In this subject effective communication is more important than grammatical accuracy.

- Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded. Indicate this with "**FT**".

General guidance

Issue	Guidance
Answering more than the quantity of responses prescribed in the questions	• In the case of an "identify" question read all answers and mark positively up to the maximum marks. Disregard incorrect answers. • In the case of a "describe" question, which asks for a certain number of facts *e.g.* "describe two kinds", mark the first two correct answers. This could include two descriptions, one description and one identification, or two identifications. • In the case of an "explain" question, which asks for a specified number of explanations *e.g.* "explain two reasons …", mark the first two correct answers. This could include two full explanations, one explanation, one partial explanation *etc.*

Option A — Databases

A1. (a) (i) Organized data store;   *[1 mark]*

       (ii) Flat file – all data is stored in one table;
          Relational – data is stored in separate related tables;   *[2 marks]*

   (b) (i) *Award up to [2 marks max].*
         Repetition of data;
         May lead to inconsistencies;
         May lead to partial updates;
         Unnecessary duplication;   *[2 marks]*

       (ii) *Award up to [2 marks max].*
         Line managers are entered multiple times;
         Likelihood of inconsistencies;
         May lead to wrong connections between subordinates and managers;   *[2 marks]*

   (c) (i) *Award marks as follows up to [4 marks max].*
         Award [1 mark] for creating separate tables;
         Award [1 mark] for showing three suitable tables;
         Award [1 mark] for showing links;
         Award [1 mark] for showing the nature of the relationships;
         Award [1 mark] for correct ref to primary key;

         tblProject: Project_Ref, Project_Name, Budget, Department_Ref
         tblDepartment: Department_Ref, Department_Name, Department_Head_Ref
         tblStaff: Staff_Number, Surname, Forename, Job Title, Department_Ref, Salary
                                                                                        [4 marks]

Question A1 continued

(ii) *Award marks as follows up to **[4 marks max]**.*
*Award **[1 mark]** for all relevant tables selected;*
*Award **[1 mark]** for all relevant fields selected;*
*Award **[1 mark]** for correct condition;*
*Award **[1 mark]** for correct link between tables (WHERE clause);*
*Award **[1 mark]** for correct use of AND;*

QBE View

Field	Surname	Salary	Project_Name
Alias			
Table	tblStaff	tblStaff	tblProject
Sort			
Visible	✔	✔	✔
Function			
Criterion		>= 50000	

SQL View

SELECT "tblStaff"."Surname", "tblStaff"."Salary",
"tblProject"."Project_Name" FROM "tblProject", "tblDepartment",
"tblStaff" WHERE "tblProject"."Department_Ref" =
"tblDepartment"."Department_Ref" AND "tblStaff"."Department_Ref" =
"tblDepartment"."Department_Ref" AND "tblStaff"."Salary" >= 50000   ***[4 marks]***

A2. (a) (i) *Award up to **[2 marks max]**.*
A unit of work / logical action;
Performed on a database;
Performed by the DBMS;
Independent of other transactions;   ***[2 marks]***

(ii) *Award **[1 mark]** for an answer that only identifies either the nature of a database state or a database schema. Award **[2 marks]** for an answer that covers both the ideas in the points below.*
State is the completed database with data;
Schema is the plans for the database;   ***[2 marks]***

(iii) *Award **[1 mark]** that only identifies that conflicting results may occur. Award an additional **[1 mark]** for the development of the initial point up to **[2 marks max]**.*
Queries may produce conflicting results;
Because the total amount of money in all the accounts should be the same as before the transaction took place;   ***[2 marks]***

Question A2 continued

(b)   *Award **[1 mark]** for each step identified in the correct order, up to **[4 marks max]**.*
Begin the transaction;
Copy original data to a log;
Perform the debit operation;
Perform the credit operation;
Error checks;
If no errors occur then commit the transaction and end it;
If errors occur then roll back the transaction and end it;   ***[4 marks]***

(c)   *Award marks as follows up to a maximum of **[6 marks max]**.*
*Award **[2 marks]** for identifying a cause of the conflict;*
*Award **[2 marks]** for explaining the consequence;*
*Award **[2 marks]** for the solution;*

Answers may include:
Different systems may attempt to access the same data at the same time;
Both wanting to make updates;

If one starts and then the second finished before the first is saved;
This could potentially lead to inconsistent updates;

Solution is to isolate the transactions;
When one system is accessing the data, lock the transaction;
Release it when transaction is committed;   ***[6 marks]***

A3.   (a)   (i)   *Award up to **[2 marks max]**.*
Controls the creation of a database;
Controls the maintenance of a database;
Controls the use of a database;
Mediates between the data handling applications and the operating system;   ***[2 marks]***

(ii)   *Award up to **[2 marks max]**.*
A means to query the data;
Forms for displaying the data;
Reports for producing output;
Charts for displaying data;
A DDL or equivalent for constructing/amending the schema;   ***[2 marks]***

Question A3 continued

    (b)   *Award marks as follows up to a maximum of **[4 marks max]**.*
        *Award **[1 mark]** for each clear use of data sharing/different views;*
        *Award **[1 mark]** for an explanation of why the feature is important;*
        Answers may include:

        Data sharing allows use of the data by different users;
        and by different applications;
        Multiple views present different subsets of the data to different users;
        Data can be presented in different ways according to the user's needs;   ***[4 marks]***

    (c)   *Award marks as follows up to a maximum of **[6 marks max]**.*
        *Award **[1 mark]** for an implication of changes to data structures;*
        *Award **[1 mark]** for an implication of changes to data itself;*
        *Award **[1 mark]** for relating each of these to applications, up to **[2 marks max]**;*
        *Award **[2 marks]** for a clear, detailed and balanced explanation;*
        Answers may include:

        The organization uses a variety of applications for manipulating data;
        It may need to amend or add to these;
        Changes to applications may conflict with existing data structures;
        Applications may conflict with each other;
        Applications must therefore act through the DBMS;
        This imposes consistency on the way that the data is manipulated;
        Data integrity is maintained by the DBMS rather than the applications;
        Data structures do not necessarily need to be altered in order to accommodate
        new applications;   ***[6 marks]***

Total: [45 marks]

Option B — Modelling and Simulation

B1. (a) All the variables acting in a situation/system;
Inputs and outputs;
Reduces the system to a mathematical representation;
Using functions/formulae/equations;
Award [1 mark] for each relevant point up to a maximum of [2 marks].   *[2 marks]*

(b) Equation only has to be entered once;
Values of Z, C, I and R can be changed;
For each of the different buildings entered on the sheet;
Value of V calculated automatically;
Award [1 mark] for each relevant point up to a maximum of [2 marks].   *[2 marks]*

(c) All variables included – descriptions do not need to be given;
Column for V contains formula for at least one building;
Formula is correct;
Copy down indicated for more than one building;   *[4 marks]*

(d) *More than one method may be used:*

Method 1 (not efficient but worth *[3 marks]*)
 Lookup values held within the spreadsheet;
 On separate named sheets;
 User goes to each table as required;

Method 2
 Drop down list for columns holding C and R;
 Linked to the lookup values;
 Held in lists;
 For example when R input different materials presented to choose from;
 Appropriate number inserted in cell;

Other methods may be used. If necessary consult with your Team Leader.
Award [1 mark] for each relevant point up to a maximum of [4 marks].   *[4 marks]*

(e) Z input once as it is constant for all buildings, and known for the city;
I known for each building – (purpose of library, school. *etc.*);
Input manually;
Each building would have to have C and R classified;
Either by experts visiting or records held;
Entered by drop down box for each building;
V calculated;
Those with V below a specified limit identified as in danger;
Award [1 mark] for each relevant point up to a maximum of [6 marks].   *[6 marks]*

B2. (a) Computer simulation changes the values of variables in the model;
To see the effect that the changes have on the model (or its outcomes);
*Award **[1 mark]** for the initial point and **[1 mark]** for any appropriate subsequent development of it up to a maximum of **[2 marks]**.*   *[2 marks]*

(b) *Award marks as follows up to **[4 marks max]**.*
*Award **[1 mark]** for a suitable simulation identified;*
*Award **[1 mark]** for clear rules embedded outlined;*
*Award **[1 mark]** for type of data and rules inaccuracy;*
*Award **[1 mark]** for an effect of inaccuracy;*

For example:
In a traffic flow simulation a town planner may wish to restrict the traffic in a particular zone and sets up a simulation;
Using a map of the town, traffic flows according to the known traffic density and direction;
An out of date road plan is used and traffic flow simulated;
(for example it is ignored that a new road is under construction that goes around the town). The results could cause the planner to set up expensive and unnecessary measures to restrict traffic in the town causing local unrest;
In particular if the position of residents housing in the town was left out of the simulation these residents could find themselves unable to reach their own houses by car;   *[4 marks]*

(c) *Award marks as follows up to **[4 marks max]**.*
*Award **[2 marks]** for a relevant advantage discussed;*
*Award **[2 marks]** for a relevant social consequence discussed;*

Answers may include:
Advantages – knowing the weather in advance makes it possible to plan events such as harvesting of crops, deciding to hold the school fête indoors instead of out of doors, *etc.*
Predictions of drought or floods give organizations time to prepare to help with food aid or plan for evacuation.

Social consequences – having life more easily planned for disasters makes for a secure environment.
Lives can be saved if measures to cope with disasters are in place before they occur. Too much dependence could lead to misreading some of the known "weather symptoms". The predictions are not perfect and a false sense of security could result in not being able to adapt to unexpected and unpredicted weather events.   *[4 marks]*

B3. (a)   Data collected (from satellite or observation) continually;
Recent path stored and updated as data received;
Predicted path calculated;
Using model based on current situation (and behaviour of previous cyclones);
Predicted (and past) path displayed on simple 2D map of area;
Coloured (shaded) to show force of cyclone;
Award [1 mark] for each relevant point up to a maximum of [4 marks].   *[4 marks]*

(b)   *Award marks as follows up to [4 marks max].*
Award [1 mark] for identifying a technical difficulty of data collection.
Award [1 mark] for identifying a technical difficulty of processing.
Award [1 mark] for each technical difficulty that is explained, up to [2 marks max].
If only difficulties relating either to data collection or processing are addressed, award [3 marks max].

The following points are likely to be included:
Continual data collection from centre of cyclone difficult;
Strength of cyclone needs to be recorded and transmitted which may not show on satellite picture;
Transmission could be broken (unclear/interrupted) by the effect of the cyclone;
Inaccurate data fed into the model would give false results;
Real-time processing needs fast powerful computers;
Which may not be readily available at the start of the cyclone;
Computer resources need to be distributed to avoid losing the information in case of failure;   *[4 marks]*

(c)   *Award marks as follows up to [6 marks max].*
Award [1 mark] for each advantage identified, up to [3 marks max].
Award [1 mark] for each advantage explained, up to [3 marks max].

Visualization gives a quick way of seeing where the dangers are now and where they are likely to be;
No need to interpret figures so time is saved;
Location where rescue/support services are needed now and in near future are shown;
Emergency services hence more effective and dangers to people can be minimized;
Images distributed easily to many places – aid from across the world;   *[6 marks]*

Question B3 continued

(d)	2D visualization is more rapid than 3D as the calculations are less complex and speed is necessary in this situation;

3D also requires more powerful computers which could be difficult to find in a situation that requires a distribution of computers;

Some aspects on the effect of the cyclone such as in a mountainous area would be visualized in 3D but not in 2D visualization;

Potential difficulty in arriving at an area due to damage could be seen in 3D but not 2D;

*Award **[1 mark]** for each relevant point up to a maximum of **[3 marks]**.*		**[3 marks]**

Total: [45 marks]

Option C — Web Science

C1. (a)   Cloud computing services are provided for a particular group with a limited
number of users;   *[1 mark]*

(b)   *Award marks as follows up to [4 marks max].*
Award [2 marks] for the features of traditional client-server;
*Award [2 marks] for features of cloud computing **which distinguish the two**;*

Traditional client-server model:
Servers on the one of the premises of the company;
Connected to a Local Area Network (LAN);
Maintained by IT team of that organization;

Cloud computing:
Servers outsourced to third party;
Maintained by third party technical support team;
Based on Internet connectivity;
Connected to a WAN;

If feature are given, but are not different for each award [2 marks max].
                                                                               [4 marks]

(c)   *Award marks as follows up to [4 marks max].*
Award [1 mark] for each benefit identified, up to [2 marks max];
Award [1 mark] for a reason for each benefit, up to [2 marks max];

Answers may include:
Reduce costs as fewer technical staff will need to be employed;
Technical staff in third party may have greater expertise as they may be able to
specialize;
May reduce costs as third party may benefit from economies of scale for
purchase of storage, hardware, *etc*;
Expertise may be held by more people, so staff turnover may have less effect;
The effects of unexpected hazards may be reduced as data may be distributed
across a number of locations;   *[4 marks]*

Question C1 continued

(d)   *Award marks as follows up to **[4 marks max]**.*
      *Award **[2 marks]** for a privacy issue identified and elaborated;*
      *Award **[2 marks]** for a security issue identified and elaborated;*

Privacy
Sensitive data is accessible to a third party;
If outsourcing occurs, potential exposure of data is increased;

Security
How secure is the data?;
Can it be guaranteed that this data will not be inadvertently passed to another
company?;   *[4 marks]*

C2. (a)   Can be rendered by all internet browsers;   *[1 mark]*
              Other answers relating to the language itself (e.g. use of tags to delimit statements)
              would also be acceptable.

      (b)   Server retrieves event for days to be displayed from a database server;
            Takes results and generates HTML to display them in a table;
            Embeds HTML in page;
            Page sent to browser;
            Use of bullet points and a list is acceptable for this type of question.   *[4 marks]*

      (c)   (i)   A client-side script may be made available to a browser by the use of
                   script tags that are embedded in the HTML code;
                   By the use of an external file;   *[2 marks]*

            (ii)   A client-side script will not require access to a remote server so that any
                   processing that is done will be done more quickly and use less bandwidth;
                   This will reduce the load on the server;   *[2 marks]*

Question C2 continued

(d) *Award marks as follows up to **[4 marks max]**.*
*Award **[2 marks]** for outlining the way meta-tags are used;*
*Award **[2 marks]** for alternative methods;*

Answers may include:
Meta tags contain keywords/descriptions related to the web page's content;
They are embedded in HTML code can be read by search engines;
This can help their ranking;
Search engines have become more sophisticated;
They no longer place a high value on the content of meta tags;
As they are not always a reliable guide to the web page's content;
Search engines now use other parameters;
e.g. Some will place more value on the number of links pointing to a web page;   ***[4 marks]***

(e) *Award marks as follows up to **[6 marks max]**.*
*Award **[2 marks]** for an explanation of the creation of server side scripts;*
*Award **[2 marks]** for an explanation of the client-side interaction;*
*Award **[2 marks]** for relating to the box office website;*

Answers may include:
Before the web page is generated scripts will be run on the server-side;
Examples of these scripts are;
The handling of inputs;
The retrieval of information from databases;
The performing of calculations;
Scripts will be written in languages such as PHP;
Server-side scripts are hidden from users and therefore secure;
The server sends data to the browser (client) in HTML;
This could also include JavaScript code which will be interpreted by the client's browser;
Allowing (in this case) booking details to be entered by the user on the client side;
Server driven information can be delivered on the fly using software such as Ajax;   ***[6 marks]***

C3. (a) (i) It does not contain a fixed set of tags, therefore new ones can be added; *[1 mark]*

(ii) A set of rules and procedures that both sender and receiver must adhere to in order to allow coherent data transfer; *[1 mark]*

(b) *Award up to [3 marks max].*
The use of open standards implies that anyone can use them;
They are standards that are agreed from the beginning;
therefore ensuring interoperability;
For example, the Internet backbone relies on the IP protocol which is an agreed standard, allowing the transfer of information to occur; *[3 marks]*

http://fsfe.org/projects/os/def.html (accessed 16 Aug 2011)

(c) *Award marks as follows up to [6 marks max].*
Award [2 marks] for the difference between lossy and lossless compression;
Award [2 marks] for a relative example for each;
Award [2 marks] for the reason for using lossy or lossless in the example;

Answers may include:
Lossless compression is used when loss of data is unacceptable when transferring files such as audio files;
Lossy compression may not significantly affect the final version of the file when it is decompressed;
Lossy compression will reduce file size;
Reduced file size may be an important requirement such as in the use of MP3 music files;
Lossy compression results in faster file transfer;
Which is important when Internet connections are slow or files are large;
If lossy compression is used the original file cannot be reinstated;
Also characteristics of the data itself (e.g. frequencies too high for human hearing) could be introduced. *[6 marks]*

Question C3 continued

    (d)   *Award up to **[2 marks max]**.*
            Easier to set up;
            Less time will need to be spent in configuring the network;
            Other advantages could deal with the increased range of available files and the
            lower (or even zero) costs involved (depending upon the network).   ***[2 marks]***

Total: [45 marks]

Option D — Object-oriented programming

D1. (a) *Award [1 mark] for a definition, such as:*
A variable/value that is passed to a method;
The value passed to a method in brackets/parentheses;

Award [1 mark] for a valid example from the code, such as:
`setRoute(int r)`/`r` is a parameter variable;   *[2 marks]*

(b) *Award [1 mark] for a field and its data type, examples:*
```
String destination;
int/double/long length;
```

Award [1 mark] for a corresponding data example:
"City centre" or "Bus terminal" *etc*;
23 (km), 13 460 (m), *etc*;   *[2 marks]*

(c) *Award [1 mark] for any two correct outputs (including descriptors) and an additional mark for the third correct. Award [1 mark] for only the data items, if all correct.*
Examples:
Award [2 marks] for the following:
```
Bus id:1001 - N Prakesh: Route: 431 start: Klang
```

Award [1 mark] for the following:
```
1001 - N Prakesh 431 Klang
```
                                                                     [2 marks]

(d) *Award marks as follows up to [6 marks max].*
Award [1 mark] for any loop;
Award [1 mark] for correct loop end point (allow test for fixed number in array, i.e. > 3 or == 4);
Award [1 mark] for running through all array elements;
Award [1 mark] for any test for bus number;
Award [1 mark] for correct access to the Route number (not the Route object);
Award [1 mark] for correct test;
Award [1 mark] for correct output of drivers;

Example answer:

```java
private void showBuses(Bus[] b, int n)
{
  // Show buses with route numbers < n
  for (int x = 0; b[x] != null; x = x + 1)
  {
    if (b[x].getBusRoute().getRoute() <= n)
    {
      System.out.println(b[x].getDriver());
    }
  }
}
```
                                                                     [6 marks]

Question D1 continued

(e)   *Award marks as follows up to **[3 marks max]**.*
       *Award **[1 mark]** for a diagram with title, variable and method sections;*
       *Award **[1 mark]** for a variable section with three suitably defined variables;*
       *Award **[1 mark]** for a method section with suitably defined methods,*
       corresponding to the defined variables;

```
Driver
String: first
String: last
String/Integer: empNumber
setFirst(String: first)
setLast(String: last)
setEmpNumber(String/Integer n)
String getFirst()
String getLast()
String/Integer getEmpNumber()
String toString() // optional
```
                                                                    [3 marks]

D2. (a)   *Award **[1 mark]** for a suitable definition, for example:*
                Encapsulation means having private variables;
                Variables not accessible from outside the class;
                Methods and variables are all included in the class definition;

                *Award **[1 mark]** for relating to an example from the Bus class, such as:*
                Class Bus/BusRoute has private (instance) variables;
                Class Bus/BusRoute has int and start as private variables;
                Class Bus/BusRoute has setter and getter methods to access the variables;
                Class Bus/BusRoute has public methods to access the private variables;   *[2 marks]*

        (b)   *Award **[1 mark]** for each possible disadvantage up to **[2 marks max]**.*
                It is a complex process, unsuited to small scale problems;
                It is not suitable for problems involving direct access to hardware;
                Design principles are very abstract/hard to implement for beginning programmers;
                The world (of buses, for example) does not always divide up neatly into objects
                that can be programmed/encapsulated;   *[2 marks]*

Question D2 continued

(c)   *Award [1 mark] for each benefit and [1 mark] for a valid example relating to the benefit and a programming team up to [4 marks max].*
Work can be split up among programming teams (so that) programmers can work on classes (independently);
Each team member does not need to know the internal details of a class in order to use/extend it;
Any class already written can be re-used by any other member;
etc.   *[4 marks]*

(d)   *Award marks as follows up to [3 marks max].*
Award [1 mark] for three instance variables of the correct type (String/Logical/Numeric);
Award [1 mark] for three setter methods with the correct and corresponding parameter types (String/Logical/Numeric);
Award [1 mark] for three getter methods with the correct and corresponding return types (String/Logical/Numeric);

Example answer:

```
BusStop
String: name
Boolean: shelter
Integer/Real: distance
setName(String: first)
setShelter(Boolean shelter)
setDistance(Integer/Real distance)
String getName()
Boolean hasShelter()
Integer/Real getDistance()
String toString() // optional
```
[3 marks]

(e)   *Award [2 marks] for a suitable data structure and a further [2 marks] for details, including sample data.*

Example answer:
Array
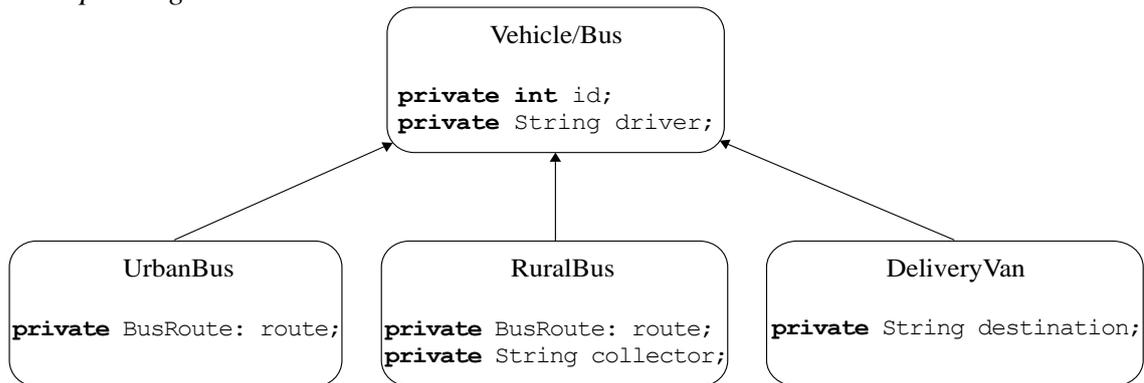The `BusRoute` class could include;
An array of `BusStop` instances;
```
BusStop[] stops = new BusStop[10];
stops[0] = new BusStop("Musgrave Hill", true, 1.5);
```

For a code fragment such as the above, award [1 mark] for using the structure correctly and [1 mark] for suitable data samples.   *[4 marks]*

D3. (a) *Award marks as follows up to **[8 marks max]**.*
*Award **[1 mark]** for a common superclass;*
*Award **[1 mark]** for a common id field;*
*Award **[1 mark]** for a common driver field;*
*Award **[2 marks]** for three sub-classes (arrows not critical, but some form of connection should be shown or labelled, e.g. "extends") if clear, award **[1 mark]** only for a worthy attempt;*
*Award **[2 marks]** for the additional collector field in the RuralBus;*
*Award **[2 marks]** for the different destination field in the DeliverVan;*
*Award **[1 mark]** for BusRoute in the buses but not in the DeliveryVan class;*

Example diagram:

```
                    ┌─────────────────────────┐
                    │       Vehicle/Bus        │
                    │                          │
                    │  private int id;         │
                    │  private String driver;  │
                    └─────────────────────────┘
       ┌──────────────────┐  ↑  ┌──────────────────┐
┌────────────────────────┐ ┌────────────────────────┐ ┌──────────────────────────────┐
│        UrbanBus        │ │        RuralBus        │ │         DeliveryVan          │
│                        │ │                        │ │                              │
│ private BusRoute: route;│ │ private BusRoute: route;│ │ private String destination;  │
│                        │ │ private String collector;│ │                              │
└────────────────────────┘ └────────────────────────┘ └──────────────────────────────┘
```

[8 marks]

(b) *Award **[1 mark]** for identifying an advantage (may be implied) and **[1 mark]** for explaining what each advantage is. Award a further **[2 marks]** for a discussion of why this advantage is given by inheritance. Accept only the first reason where multiple advantages are presented.*

Enhanced re-use;
Common variables in the superclass;
And therefore common validation methods/coding for these;
No need to maintain code in two or more places;
And therefore less chance of errors in code;

Maintainability;
Since variables and related code are not replicated;
Among different classes;
If a change is required;
Only one class need be re-written/maintained;
And therefore less chance of errors in code;   *[4 marks]*

(c) *Award up to **[3 marks max]**.*
Each subclass of (vehicle);
Implements this method;
But returns a different value;
(For example) the UrbanBus/RuralBus/DeliveryVan returns 0/1/2;   *[3 marks]*

Total: [45 marks]

International Baccalaureate®
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COMPUTER SCIENCE
CASE STUDY: HIDDEN FILES – COMPUTER FORENSICS

SPECIMEN PAPER

INSTRUCTIONS TO CANDIDATES

- Case study booklet required for higher level paper 3.

Introduction

Computer forensics is a branch of computer security which specializes in the analysis of computer systems, in order to provide evidence of computer misuse or attacks on computers.

The ordinary desk top computer stores a considerable amount of data that was never consciously put there by its user. This can range from cookies, to print and email logs and browsing history. These will be stored in files (some hidden) which can be reasonably easily accessed. However, it can also preserve data that has supposedly been deleted or even previous versions of files which have subsequently been updated. The fact that data should be so resistant to deletion should concern not only the cyber-criminal but also businesses and individuals who wish to permanently delete data or recycle their computers. Users should be aware that only a "forensic wipe" will effectively erase all data on their hard drives.

The rest of the case study investigates the work of John Martin, a fictitious computer forensic scientist.

Your Secrets Revealed Inc.

John Martin is employed by the computer security company *Your Secrets Revealed Inc*. This company has two divisions: one which acts as security consultants to advise on computer security systems, and one which specializes in computer forensics. John is employed in the forensics division, and although he was already an experienced computer user, he had to undergo extensive training both in the techniques and the software tools used to locate and identify incriminating evidence, and in procedures that had to be rigorously followed in order that evidence might be accepted in court.

One training exercise involved investigating the following scenario:

"The home of a person suspected of organizing the illegal distribution of drugs was raided and the suspect apprehended. The suspect's PC, which was still switched on, was equipped with both an internet connection and a web cam. The information that led to the house being raided had come about from the interception of a telephone call which had made reference to certain names associated with the illegal drug trade."

John's task was to search the computer system and the surrounding area for electronic information that might incriminate the suspect. He was provided with various tools supplied by the company. His tasks included securing and evaluating the scene, conducting preliminary interviews, documenting the incident, collecting the evidence and packaging and transporting the evidence. His first action was to turn all equipment off and then carefully remove the computer's hard drive ready for transport to the company's laboratories.

John has since been involved in various investigations including:

- employee Internet abuse
- criminal fraud
- industrial espionage
- unauthorized disclosure
- child pornography
- identity fraud.

The industrial espionage case was of particular interest as the company was convinced that a rival firm had stolen their ideas, but had no concrete evidence that would show this. The company's main server was subsequently analysed by *Your Secrets Revealed Inc*. who found that "back-door" remote access had been installed. Further to this the forensics team discovered keystroke loggers had been installed which could relay data entered into the system via the Internet to a third party. The third party was identified and found to indeed be one of their rivals who were trying to steal intellectual property from the company.

The company *Your Secrets Revealed Inc*. was then contracted to update their security system, particularly with respect to preventing unauthorized outside access.

John's current investigation involves the search for illegal images on a computer. The suspect's computer was found switched off. Also, no network hardware was found in the house. A typical hard disk can contain thousands of files so after taking an exact copy of the suspect hard disk, John's first task was to filter out all known files (on the copy) using a hash analysis. It is essential not to manipulate the original disk in any way.

Files with the usual image extensions were located using the computer's file manager in the normal way (the operating system was found to be Windows XP), but no incriminating evidence was found.

As the files that he was looking for did not immediately appear, a more complicated analysis would now have to be made which would involve searching for files that had been disguised in some way. Criminals will often attempt to hide files. A further step that might reveal evidence would be to investigate both unallocated space and slack space that is present on the disk.

Challenges Faced

John and his team must focus on the following challenges:

- To ensure that they follow all the correct procedures so that any evidence discovered would be admissible in subsequent legal proceedings.

- To discover all relevant files on a computer system that the user may have attempted to delete.

- To discover all relevant files on a computer system that the user may have attempted to hide or disguise in some way.

Additional Terminology to the Guide

Back-door access
Bit-stream image
Cluster
Cookies
FAT
File signature
Forensic wipe
Hash analysis
Hidden files
Intellectual property
Logical analysis
Keyboard loggers
MAC times
Message digest (Hash)
Metadata
Mirror image
Physical analysis
Root directory
Slack file space
Write blocker

Companies, products, or individuals named in this case study are fictitious and any similarities with actual entities are purely coincidental.