X206/701

NATIONAL QUALIFICATIONS 2010

THURSDAY, 3 JUNE 9.00 AM – 11.30 AM

COMPUTING ADVANCED HIGHER

Attempt **all** questions in Section I.

Attempt **one** sub-section of Section II.

For the sub-section chosen, attempt **all** questions.

Read all questions carefully.

Do not write on the question paper.

Write as neatly as possible.

Each section should be answered in a separate answer book.

SECTION I

Marks

Software Development & Developing a Software Solution

Answer ALL questions in this section.

1. A large supermarket is undertaking a project to introduce small electronic tags embedded in products. When an electronic reader sends out a wireless signal the tags respond by sending a code to the reader. The supermarket hopes to improve:

- stock control by using the electronic reader to count stock in the warehouse
- checkout by scanning an entire trolley's contents using the electronic reader
- the re-stocking of shelves by scanning for low or missing stock items.

(*a*) The supermarket begins by creating a document which outlines its requirements.

State the name of this document. **1**

(*b*) The supermarket appoints a project leader. The project leader commissions a study to investigate issues such as the transmission range of electronic tags and the costs involved.

(i) Name the study that investigates these issues. **1**

(ii) The study investigates *technical*, *legal*, *cost* and *time* issues. State **two** other outcomes which would be of benefit to the supermarket of such a study. **2**

(iii) The supermarket chooses to continue with the project. State **one** method that the project leader could employ to plan the project effectively and explain why it improves project management. **2**

(*c*) A systems analyst is appointed to write an *operational requirements document* (*ORD*).

(i) The ORD will contain the functional requirements specifying exactly what the proposed system will do as well as budgetary considerations.

State **three** other items specified in the ORD. **3**

(ii) The ORD is a legally binding document.

State **one** other use for the ORD during the development of software. **1**

(*d*) A project team is formed. The project team intends to make use of *Computer-Aided Software Engineering* (*CASE*) *tools*.

State **one** way in which CASE tools used in one stage of the software development process may lead to automation of later stages. **1**

(*e*) On completion of the implementation stage of the project the programmers begin testing. A document specifying a range of test data is created.

(i) During this testing the software stops responding.

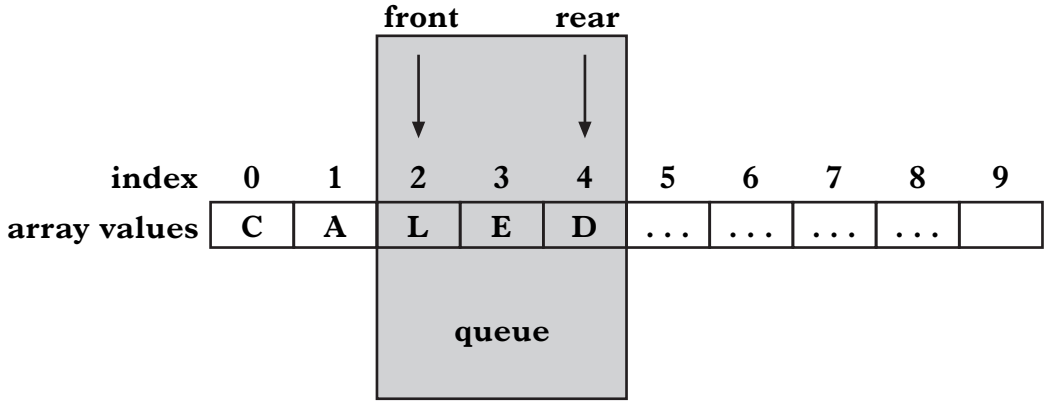
Describe how the software development environment could be used to identify the problem. **2**

(ii) State **two** examples of documentation that would be created during the testing stage. **2**

(iii) Describe how the supermarket could *beta test* the software. **2**

SECTION I (continued)

2. A keyboard buffer stores keystrokes until they are ready to be processed. The keyboard buffer uses the *queue* data structure. The queue is held within in a 1-D array that can hold a maximum of ten characters. The diagram shows the current state of the array containing the queue.



In the array the characters C and A have been processed. The queue currently contains the letters L, E and D. The variable storing the index of the next item to be processed is called **front** and therefore has the value 2. The variable **rear** stores the value 4.

(*a*) Explain why the characters L, E and D have not been moved to the locations identified by indices 0, 1 and 2 after characters C and A have been processed. **1**

(*b*) State the values stored in the variables **front** and **rear** after the characters O and N have been added and a further three characters removed from the queue. **2**

(*c*) Characters will continue to be added and removed from the queue held in the 1-D array.

(i) State the problem encountered as characters continue to be added and removed. **1**

(ii) Describe how to solve the problem encountered in (i). **1**

(*d*) Another data structure used in programming is a *stack*.

(i) Explain how the operation of a stack data structure differs from a queue. **2**

(ii) Explain why a keyboard buffer does not use a stack data structure. **2**

[Turn over

SECTION I (continued)

3. A student is comparing the efficiency of the *linear* and *binary* search algorithms. She begins by investigating the performance of the binary search algorithm on the list shown below.

Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Array values	8	12	26	42	48	49	60	62	65	71	88	89	90	92	99

```
1.    set lower to lowest index
2.    set upper to highest index
3.        loop
4.                set middle to (lower+upper) div 2
5.                if search_value> list[middle] then
6.                        lower=middle+1
7.                else
8.                        upper=middle−1
9.                end if
10.       until list[middle] =search_value or lower>upper
11.   if search_value= list[middle] then
12.       write 'Search item was found at', middle
13.   else
14.       write 'Search item is not in list'
15.   end if
```

(*a*) State the essential requirement of the list for a binary search to function correctly. **1**

(*b*) On the first pass through the algorithm the variable **lower** will store the value 0 and the variable **upper** will store the value 14. This means that **middle** is 7 and the array item 62 would be checked to see if it is the search item.

Which number would be found on the second pass if the search value was less than 62? Explain your answer. **3**

(*c*) The linear search algorithm would require one pass to find the number 8 stored at index 0 but the binary search would require four passes. Explain which algorithm would be more efficient at finding the number 26 stored at index 2. **3**

[Turn over for Section I Questions 4 and 5 on *Pages six* and *seven*

SECTION I (continued)

4. *Object-oriented languages* are a development of high level languages that evolved from procedural languages. Procedural languages use procedures, functions and parameter passing to aid modularity and maintainability. Object-oriented languages use classes and sub-classes.

(*a*) Describe how object-oriented languages use classes to implement modularity. **2**

(*b*) Describe **two** ways in which using classes aids maintainability. **4**

5. A television channel has an annual ice dancing competition with eight celebrities paired with eight professional ice dancers. When each couple completes their dance they are awarded points out of fifty. The scoreboard is updated, ranking them in descending order of points.

Here is an example of the scoreboard when all eight couples have danced.

Position	Name	Points
1	Martina & Lees	48
2	Singh & Graham	45
3	Cechinni & Hamill	42
4	Newton & Roskopf	34
5	Clarke & Picken	33
6	Grant & Wallace	29
7	Johnston & Hill	22
8	McDonald & Morrison	9

The television channel uses software created for the competition.

(*a*) The programmer considered storing the positions, names and points for the eight couples in a 2-D array.

(i) Declare a 2-D array that could be used to store this information for the eight couples. **3**

(ii) The programmer decided to use 1-D arrays instead of a single 2-D array.

State **two** advantages of using the 1-D arrays instead of a 2-D array. **2**

SECTION I (continued)

5. (continued)

(*b*) During this year's competition, the fifth couple scores 45 points and the points array is updated as shown.

Index	Array Values
1	48
2	42
3	27
4	18

Points after four couples sorted

Index	Array Values
1	48
2	42
3	27
4	18
5	45

Points after five couples unsorted

The program arranges the points into descending order using the *bubble sort*.

On the first pass the bubble sort rearranges the points as:

Index	Array Values
1	48
2	42
3	27
4	45
5	18

(i) Write down the state of the list for the remaining passes using the bubble sort. **3**

(ii) Another sort that the programmer could have used is the *simple sort*.

Describe how the simple sort operates. **2**

(iii) Explain why the bubble sort is more efficient in this situation. **2**

(iv) Part of the bubble sort algorithm is shown below:

```
1.  If value(counter)<value(counter+1) then
2.          Swap the values
3.  End if
```

Step 2 requires further refinement resulting in three lines of code.

State these three lines. **3**

(*c*) The couples that score more than 40 points qualify for an international competition.

Write an algorithm in pseudocode that writes these competitors' names and points to a file. **4**

(*d*) A celebrity may be disqualified and would be deleted from the file.

Describe how a celebrity's details could be deleted from the file. **2**

`(60)

[*END OF SECTION I*]

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SECTION II

Attempt ONE sub-section of Section II

For the sub-section chosen, attempt *all* questions.

[Turn over

SECTION II

Part A — Artificial Intelligence

Marks

Answer ALL questions in this part.

6. A programmer is investigating the possibility of developing a software simulation of the "sliding squares" puzzle.

The puzzle consists of a frame holding eight numbered tiles. A tile can slide into a neighbouring vacant space. The aim is to slide the tiles until they are in the correct order. Only one tile may be moved at a time.

For example, the *initial state* of the puzzle might be:

1		5
3	6	8
7	4	2

From this position, there are three possible next moves. Two of these are shown below:

- move A: slide tile 1 to the right, resulting in:

	1	5
3	6	8
7	4	2

- move B: slide tile 6 up, resulting in:

1	6	5
3		8
7	4	2

(*a*) (i) State the third possible move from the initial position, and sketch the resultant state of the puzzle. **2**

(ii) The initial state of the puzzle could be represented as [1,0,5,3,6,8,7,4,2]. Using the same representation, represent the state of the puzzle after move B. **1**

(iii) The programmer plans to use a *procedural high level language*. Explain why a *2-D array* would be more appropriate than a *1-D array* for storing the state of the puzzle. **1**

(*b*) The programmer draws a search tree to represent the problem, and finds that the tree expands slowly with only three nodes at level 1, then five nodes at level 2, ten nodes at level 4 and only fourteen nodes at level 5. He is considering whether to use an exhaustive search technique or a *heuristic search* technique.

(i) Name **one** heuristic search technique and describe how it operates. **4**

(ii) State **one** reason why a heuristic search technique would be required for solving problems in a game like chess, but would **not** be required for the sliding squares puzzle. **2**

(iii) Explain why the *minimax procedure* is **not** relevant to solving the sliding squares puzzle. **1**

SECTION II

Part A — Artificial Intelligence (continued)

6. (continued)

(*c*) The programmer decides to investigate a simpler version of the puzzle, which has only three tiles in a 2 × 2 grid.

The *start state* of this puzzle is:

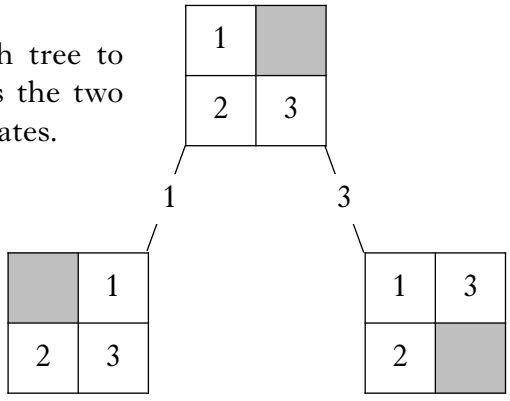
1	
2	3

and the *goal state* is:

1	2
3	

The programmer starts to draw a search tree to explore possible moves. This tree shows the two possible first moves, and their resulting states.

The number on each link shows which of the tiles has been moved.



(i) There are four possible next moves (two from each of the two states).

Explain why only **two** of these moves need to be added to the search tree. **2**

(ii) Extend both branches of the search tree for a further 5 moves. **2**

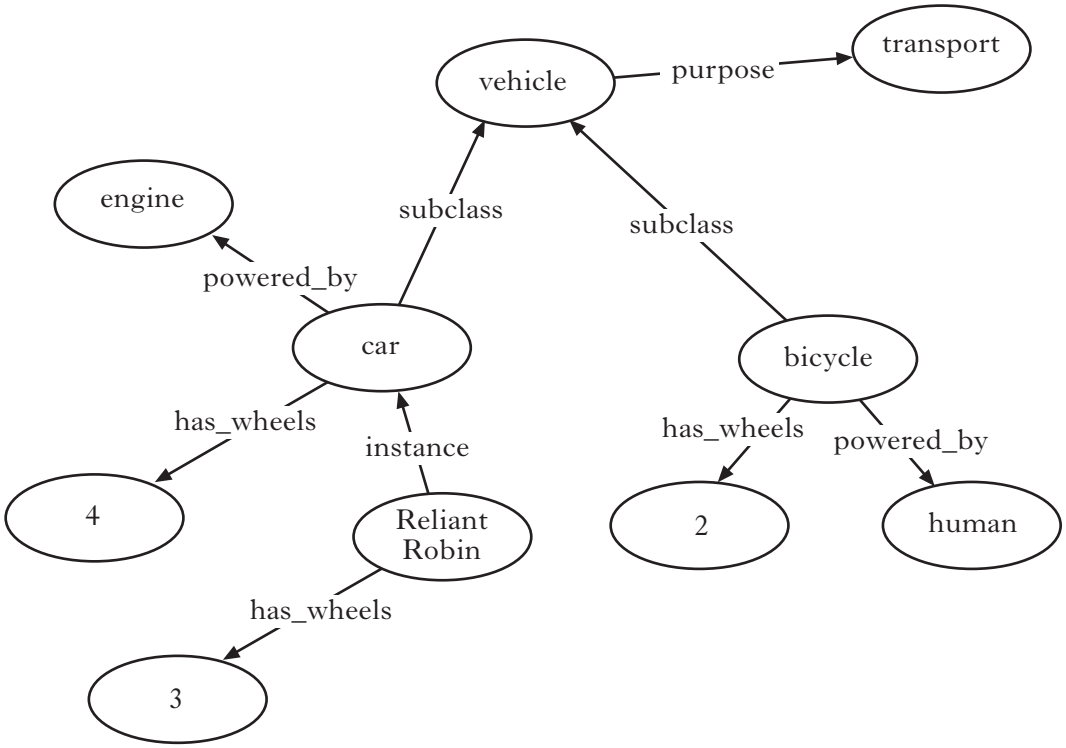
(iii) By referring to the extended search tree, show that this puzzle does not have a solution. **2**

[Turn over

SECTION II

Part A — Artificial Intelligence (continued)

7. This *semantic net* represents some information about vehicles.



(*a*) (i) Represent this information using *frames*. **4**

(ii) Using this example, explain the meaning of the term *default value*. **2**

(*b*) The same information could be represented in Prolog by these facts:

```
purpose(vehicle, transport).
subclass(car, vehicle).
subclass(bicycle, vehicle).
powered_by(car, engine).
powered_by(bicycle, human).
has_wheels(car, 4).
has_wheels(bicycle, 2).
has_wheels(reliant_robin, 3).
instance(reliant_robin, car).
```

(i) The following rule is added to the knowledge base:

```
powered_by(X, engine) :- instance(X, car)
```

Explain how this rule will allow the knowledge base to be extended **efficiently** to include other cars. **2**

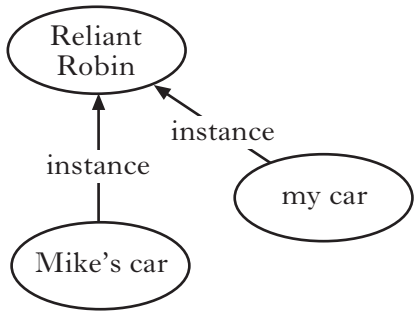
(ii) Write a rule which will ensure that **any** *instance* of **any** *subclass* of vehicle will *inherit* the property that its purpose is transport. **2**

SECTION II

Part A — Artificial Intelligence (continued)

7. (*b*) (continued)

(iii) The semantic net could be extended to include specific examples of cars, like this:



Write a *recursive* rule that will ensure that the rule written for (*b*) (ii) on *Page twelve* will apply to every specific car, such as "my car" or "Mike's car", which may be added to the knowledge base. **2**

[Turn over

SECTION II

Part A — Artificial Intelligence (continued)

8. The results of a school sports 100 m final race were stored in a Prolog *list*:

sprint100m([steele, mcbain, fleming, khan, matheson, thom]).

The six athletes were listed in finishing order. In this example, Jan Steele was the winner, Alison McBain came second and Tina Fleming was third.

(*a*) Identify:

(i) the head of this list; **1**

(ii) the tail of this list. **1**

(*b*) The following rules could be used to define the athletes who should be awarded the gold and silver medals:

```
gold(X) :- sprint100m([X,_,_,_,_,_]).
silver(X) :- sprint100m([_,X,_,_,_,_]).
```

(i) What would be the result of the query

?gold(X) **1**

(ii) The same rules were used the following year, when there were eight runners in the race. Explain why the query ?gold(X) would not work if the list contained eight members. **1**

(*c*) A better form of the gold medal rule would be

gold(X):- sprint100m([X|_]).

(i) Explain why this form of the rule would work for any length of list. **2**

(ii) Write a similar rule, defining the silver medal winner, which will work for any length of list. **2**

SECTION II

Part A — Artificial Intelligence (continued)

9. The National Coin Museum has designed a rule-based expert system to help visitors identify any old coins they have found. A typical rule in the system is of the form:

IF
  shape = 7-sided
  AND design = thistle
  AND colour = silver
THEN
  date = 1652
  origin = Old Caledonian
  value = 4 groats

The system uses *forward chaining* to reach its conclusions.

(*a*) (i) State the meaning of the terms *conflict set* and *conflict resolution* in the context of a forward chaining expert system. **2**

(ii) Describe how a forward chaining system reaches a conclusion. **3**

(*b*) In its present form, the expert system requires a user to key in responses to questions which appear on a screen. The developers are considering improving the system by providing a *menu-based interface*.

Describe **two** benefits of using a menu-based interface for this application. **2**

(*c*) A further development would be to add a *vision* system. This could allow a user to simply place the coin to be identified in front of a digital camera. The vision system would analyse the image. The output of the vision system would be used by the expert system to identify the coin.

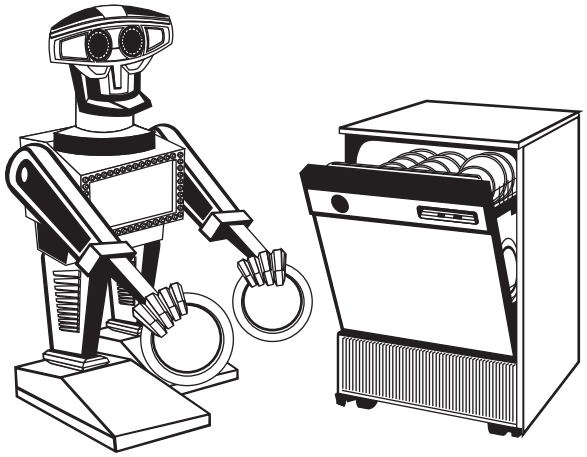
Explain why the processing of the image of a coin is unlikely to make use of the *Waltz algorithm*. **1**

[Turn over

SECTION II

Part A — Artificial Intelligence (continued)

10. Recent developments in *robotics* include experimental domestic robots which are capable of carrying out a wide range of common household tasks, responding to spoken natural language commands and which have the ability to learn.



(*a*) Successful *natural language understanding* involves four main stages:

- *speech recognition*,
- *syntactic analysis,*
- *semantic analysis*, and
- *pragmatic analysis*.

(i) Describe the main purpose of each of these stages. **4**

(ii) State which stage uses *parsing*. **1**

A domestic robot is given the ambiguous command "Clean up the mess".

(iii) Explain why the ambiguity in this command would **not** be detected during *syntactic analysis* or during *semantic analysis*. **2**

(iv) Explain why *pragmatic analysis* would be required to resolve the ambiguity in the command. **1**

(*b*) Much research has been carried out into different ways of giving machines, such as robots, the ability to *learn*. *Rote learning* is one strategy that can be used.

(i) Describe what is meant by "rote learning". **1**

(ii) State **one** limitation of rote learning, and explain why rote learning would not be appropriate for most applications of domestic robots. **2**

(iii) Name and describe **another** method of machine learning which overcomes the limitation of rote learning. **2**

(*c*) The introduction of robots into domestic contexts will have many ethical and legal implications.

(i) Describe one **ethical** implication of the use of domestic robots. **1**

(ii) Describe how **one** recent advance in computer hardware has made the development of domestic robots feasible. **1**

(60)

[*END OF SECTION II—PART A*]

[Turn over for Section II Part B on *Page eighteen*

Marks

SECTION II

Part B — Computer Architecture

Answer ALL questions in this section.

11. A fileserver has an *IA-64* processor. In order to increase performance the IA-64 uses 64 registers for *predication* and also uses a technique known as *speculative loading of data*.

(*a*) The fetch-execute cycle is central to the operation of the processor.

The *program counter* and the *memory address register* are used at certain stages of the fetch-execute cycle. Describe the role of these registers in each of these stages. **3**

(*b*) (i) Describe predication. **2**

(ii) Explain why having a large number of registers dedicated to predication improves the performance of the processor. **1**

(*c*) (i) Describe speculative loading of data. **2**

(ii) Explain how speculative loading of data improves system performance. **1**

SECTION II

Part B — Computer Architecture (continued)

12. The Ochre 1.1 laptop has slow memory access times and data transfers to and from peripherals are also slow.

The designer working on the next version of the laptop Ochre 1.2 decides to improve performance by using *memory interleaving* to write to and from memory.

(*a*) (i) Describe how memory interleaving operates. **2**

(ii) Describe a situation in which the improvement in performance gained from using memory interleaving will be greatest. **1**

(iii) Describe a problem which may be encountered when using memory interleaving to access **instructions** from memory. **1**

(*b*) In the Ochre 1.1, the bus connecting the peripherals to the processor has a clock speed of 33·3 MHz, a data transfer rate of 133 Megabytes per second and can connect one peripheral device at a time.

(i) The Ochre 1.2 will use a *PCI-X bus* to connect peripherals to the processor.

If the calculation were **based on clock speed alone**, calculate the improvement in the data transfer rate that could be expected from using a PCI-X bus to connect the peripherals. **1**

(ii) Explain the difference between the 1 Gigabyte per second transfer rate of a PCI-X bus and the result of your calculation in (*b*)(i) above. **1**

(iii) Describe another feature of a PCI-X bus which would be an improvement compared to the original bus. **1**

[Turn over

SECTION II

Part B — Computer Architecture (continued)

13. A processor uses a *pipeline* with the following 6 stages.

1. fetch instruction from memory
2. decode the instruction
3. calculate address of operand
4. fetch operand from memory
5. execute instruction
6. write result into a register

(*a*) Explain how this pipeline should theoretically produce a six-fold increase in processing speed. **2**

(*b*) (i)

MOV AX, 2005	Load the AX register with the contents of location 2005
DEC AX	Decrease the contents of the AX register by 1
JXEZ 6	If the contents of the AX register equals 0 branch forwards 6 locations

Explain why the JXEZ 6 instruction could reduce the efficiency of the pipeline. **2**

(ii) State the value of location 2005 which would lead to the instruction JXEZ 6 being executed. **1**

(iii) Name and describe a solution to the problem caused by the execution of instruction JXEZ 6. **3**

(*c*) Delays in the operation of a pipeline can occur when an instruction depends on the result of another instruction previously loaded in the pipeline.

Name and describe a technique that can be used to avoid this problem. **4**

SECTION II

Part B — Computer Architecture (continued)

14. The Mintel PZ100 is a *superscalar* processor which combines features of *RISC* and *CISC* design.

(*a*) State **three** features of CISC design. **3**

(*b*) State **two** features of RISC design which can improve the processor's performance by reducing the need to access main memory. **2**

(*c*) One of the features of *RISC* processor design which the PZ100 incorporates is having all the instructions the same length.

Explain how having all the instructions the same length improves the effectiveness of the PZ100's superscalar design. **2**

(*d*) The PZ100 processor is in the process of speculatively loading data when an interrupt occurs. It uses a *stack* to store the contents of a *general purpose register* and the contents of the program counter.

(i) Explain why the contents of

(A) the program counter;

(B) the general purpose register

need to be stored on the stack. **4**

(ii) Explain why a stack is the most appropriate data structure for this purpose. **2**

[Turn over

SECTION II

Part B — Computer Architecture (continued)

15. Stanislas McKenzie is studying an assembly language program during his university course. Part of it is shown below.

LDX(42)	Load the X register with the contents of location 42
ROR X	Rotate right register X
DEX	Decrement the contents of register X by 1
ROL X	Rotate left register X
BNE 8	If the contents of register X is not 0, go forward 8 locations
STA(58)	Store the result in location 58

(*a*) From the assembly language instructions above identify an example of

(i) an arithmetic instruction; **1**

(ii) a branch instruction; **1**

(iii) a data transfer instruction. **1**

(*b*) Explain the terms *object* and *operation* referring to the op-code and operand in one of the instructions in the assembly code above. **2**

(*c*) After the LDX(42) instruction was executed, register X contains 00010001.

State the contents of register X after the ROR X instruction is executed. **1**

(*d*) Stanislas encodes the contents of a text file by using the ROR instruction to change the ASCII values of the characters.

(i) State which instruction can be used to return the original ASCII values. **1**

(ii) Describe the problem which might occur if *SHIFT* instructions were used to change the ASCII values of the characters and then return them to their original values. **2**

SECTION II

Part B — Computer Architecture (continued)

16. Sabela uses her computer to produce a multimedia catalogue. Her computer has a wide range of peripherals attached to it: a scanner, digital camera, internal and external hard drives and USB flash drives.

The computer has a *multitasking* operating system which uses *pre-emptive scheduling*.

(*a*) Explain why a multitasking operating system needs a *scheduling system*. **2**

(*b*) Describe pre-emptive scheduling. **2**

(*c*) Two pre-emptive scheduling strategies are *round robin* and *multi-level feedback queue*. Compare these strategies in terms of their organisation of job queues and allocation of processor time. **2**

(*d*) The operating system has to deal with a series of input and output demands from the attached peripherals as well as the need to process large high resolution graphic files.

Explain why a pre-emptive scheduling strategy is more efficient in this situation. **4**

(60)

[*END OF SECTION II — PART B*]

Marks

SECTION II

Part C — Computer Networking

Answer ALL questions in this part.

17. A government department holds confidential data on its intranet. It also has an online service that allows confidential data to be submitted securely.

(*a*) Features of *Internet Architecture Security* include the use of digital certificates and encrypted *HTTP* (HTTPS) to transfer data securely. HTTPS requires the server to send a digital certificate to a client.

(i) State **two** reasons for sending a digital certificate. **2**

(ii) The client uses *public-key encryption* to send the server a randomly generated key that is later used in *conventional encryption* of the actual data.

Explain why public key encryption is suitable for this task. **3**

(iii) Describe the impact of secure data transfer on the use of the World Wide Web. **1**

(*b*) The government department has firewalls installed at every external access point to the intranet.

Describe **two** *firewall rules* that may be used to restrict **outside** access to the intranet. **2**

(*c*) The government department servers are the target of regular *denial of service attacks*. One of the more recent attacks was a *SYN Flood* attack.

(i) Describe how a SYN Flood attack operates. **3**

(ii) State **two** server configuration changes that the department could implement in order to ensure that a SYN Flood attack would not be successful. **2**

(iii) State **two** possible reasons why the servers are the targets of these attacks. **2**

SECTION II

Part C — Computer Networking (continued)

18. Sana is an entrepreneurial computing student who is financing her way through university by running an Internet Service Provider (ISP) reseller service with personal web development and web hosting available to customers.

(*a*) An example of a class B address is 178.131.20.6. There are 65,536 class B addresses starting with 178.131. Sana has been allocated a block of 1024 IP addresses by her ISP from 178.131.20.0 to 178.131.23.255.

(i) Explain how *CIDR* makes this possible. **2**

(ii) Use this example to explain the two main advantages of using CIDR. **4**

(iii) Sana then splits her block of IP addresses into 8 equally sized networks of 128 addresses.

State the value of the subnet mask required to achieve this. **2**

(*b*) As part of Sana's entrepreneurial activities she has been developing a website.

(i) Some of the pages have MPEG video clips embedded.

Name a browser *plug-in* that will allow embedded MPEG video clips to be viewed. **1**

(ii) The *style* tag is used to control the appearance of web pages.

Name the section of the HTML code in which the **style** tag should be placed. **1**

(iii) Write HTML code using the style tag that could be used to control font and colour attributes used in a web page. **3**

(iv) The HTML code of the website contains the line:

```
<h2><a href="web.html">web hosting</a></h2>
```

Use this example to explain the use of the term "objects and operations". **2**

(*c*) A website being hosted on one of Sana's webservers can be accessed using the hypertext transfer protocol (HTTP).

(i) Name the layer of the *TCP/IP* architecture model at which HTTP operates. **1**

(ii) Name the layers of the *OSI model* at which HTTP operates. **2**

(iii) HTTP commands may pass through an *intermediate*, such as a *tunnel*. This means that the client does not have a direct TCP/IP connection to the server.

Name **one** other intermediate and describe how it operates. **3**

[Turn over

SECTION II

Part C — Computer Networking (continued)

18. (continued)

(*d*) A hard drive in one of Sana's servers experienced a complete and unrecoverable crash. Four backups, A, B, C and D, as listed in the table below, were **all** used to completely recover the lost data.

Backup	**A**	**B**	**C**	**D**
Date backup made	12/05/2010	13/05/2010	14/05/2010	15/05/2010

(i) Which type of backup is A? **1**

(ii) Explain why C must have been an incremental backup. **2**

Marks

SECTION II

Part C — Computer Networking (continued)

19. Four friends, Jim, Alice, Samantha and Khurum, would like to be able to videoconference with each other, play network games, and browse the WWW. However, Alice is the only member of the group who has Internet access at home. Her Internet access is through a wireless router attached to an ADSL modem. All four of the friends stay close together, no-one living more than 100 meters away from any other.

(*a*) Jim suggests that they could share Alice's Internet connection using *bluetooth*.

(i) State **two** reasons why bluetooth may not be suitable. **2**

(ii) Name another wireless communication method that is more likely to allow them to be successful, and state **three** reasons why you believe it to be the best option for the group. **4**

(*b*) The wireless router in Alice's home does not broadcast any identification and uses encryption when transferring data.

(i) State **two** network configuration details that Alice will have to pass onto her friends to allow them to access this network. **2**

(ii) Describe **two** clues that might indicate to Alice that others are using her Internet connection. **2**

(*c*) By sharing Alice's Internet connection all four friends can now use e-mail to transfer files. E-mail systems use SMTP and MIME.

State the function of each of these protocols. **2**

(*d*) The friends use a freeware package called Virtmeet that allows videoconferencing within a local area network.

(i) State **three** advantages of using Virtmeet in this scenario, rather than using Internet videoconferencing. **3**

(ii) Describe **three** processes applied to the video data between being captured by a webcam and being viewed on the recipient's screen. **3**

(*e*) The four friends use a network action game where all four are active at one time. Each competitor's keypresses are stored centrally in an array on one computer. Each keypress is then broadcast to all the competitors' computers for processing.

(i) State whether the data stored in the central array is held as a queue or stack. Justify your answer. **2**

(ii) Explain why most network games transmit only the keypresses across the network. **1**

(60)

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