X206/13/01

NATIONAL QUALIFICATIONS 2013

TUESDAY, 28 MAY
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.

LI X206/13/01 6/1910

SECTION I

Marks

Software Development & Developing a Software Solution

Answer ALL questions in this section.

1. The Scottish Government is considering the introduction of a new electronic voting system for elections. The government appoints a small team to undertake a *feasibility study*. Some of the concerns include:

- voters' accessibility to a suitable computer system
- the possibility of electoral fraud
- the cost of such a system.

(*a*) The government creates a document specifying the features of the new system. State the name of this document. **1**

(*b*) (i) People will not be charged to vote. Explain why aspects of *economic feasibility* would still need to be considered. **1**

(ii) Name **one** other type of feasibility and explain why it would be considered for the voting system. **2**

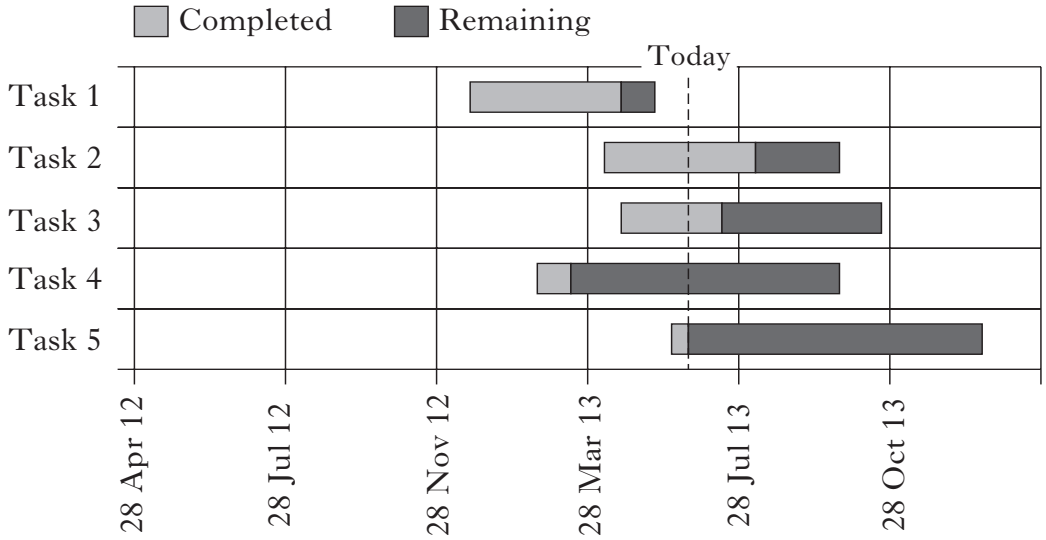
(*c*) The government decides to proceed and a full system investigation results in an Operational Requirements Document (ORD).

(i) The ORD contains details of the *scope and boundaries* of the voting system. Explain what is meant by scope and boundaries. **2**

(ii) State **one** other item specified in the ORD. **1**

(*d*) During the design stage, the development team decide to create their design using a standardised design notation. State **two** advantages of having a completed design written in a standard design notation. **2**

(*e*) The team use a number of *project management techniques*. An example is shown below.



The chart shows how much of a task has been completed. State **two** other project management techniques that are incorporated in this diagram. **2**

2. A computerised version of a card game based on various animals native to Scotland is being developed for a website.

There are forty cards in the game.

(*a*) (i) Define a suitable *record structure* to store the four items of data below the image. **3**

(ii) Declare a suitable variable that can store the data for forty cards. **2**

(*b*) During game play, players can take a card from or place a card on a pile of cards. A *stack data structure* will represent this pile of cards.

(i) Explain what is meant by a stack data structure. **1**

(ii) The stack is held in a 1-D array and the last item placed in the stack was the Golden Eagle. The 1-D array in which the stack is held is shown below.

Index	Character
1	Ptarmigan
2	Otter
3	Golden Eagle
4	
5	

An item is added to the stack by "pushing" and removed by "popping". Draw the final state of the stack after the following five operations:

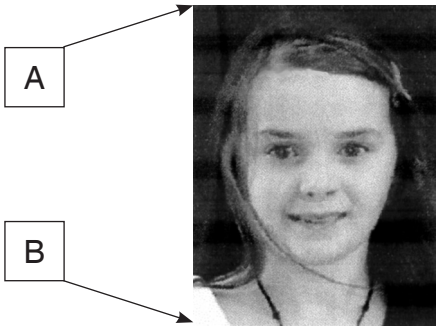
1. Pop
2. Push Loch Ness Monster
3. Pop
4. Pop
5. Push Grouse **2**

(iii) Apart from the 1-D array, describe another item of data required to implement a stack. **2**

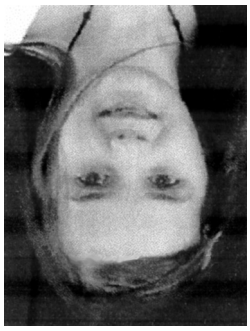
(iv) When a stack is implemented using a 1-D array adding a valid item can cause a runtime error.

Explain why a runtime error can occur in this situation. **2**

3. A program is to be written to edit photographs. The program will make it possible to flip a photograph vertically. This can be achieved by swapping the values of corresponding pixels such as those marked A and B.



Original



After flip vertical

The image is 400 pixels high by 300 pixels wide and is stored in a 2-D array of integers called ***photo***. Each integer will represent the colour of the pixel.

photo(1 to 400, 1 to 300) of integers

(*a*) The pixel at the top left corner of the photo marked A is ***photo(1,1)***. In order to flip it vertically it must swap values with the pixel marked B at the bottom left corner of the photo. State the array element of the pixel at B. **1**

(*b*) The vertical flip will be achieved by swapping the values in the first row of pixels with the bottom row of pixels, the second row with the second last row. State the number of **pairs** of rows to be swapped in order to flip the photograph. **1**

3. (continued)

(*c*) The following table shows some information on the rows and their corresponding swap row.

Row	Swaps with Row
1	400
2	399
3	398
....	....
....	....
100	301
101	300
j	?

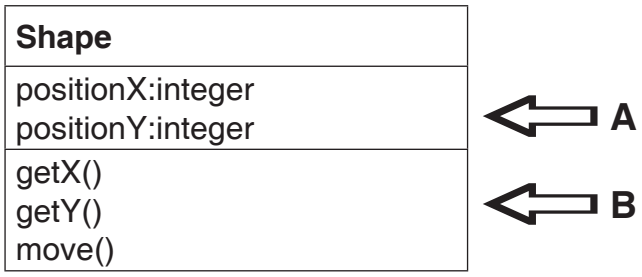
(i) The letter **j** represents any row. State the row with which it swaps. **1**

(ii) The rows must be swapped pixel by pixel. The pixel at the centre of the girl's right eye is photo(180,75). State the array pixel with which it must swap its value. **2**

(*d*) An algorithm is to be written to flip the picture vertically by swapping the values of the corresponding pairs of pixels. Use detailed pseudocode to write this algorithm. **5**

[Turn over

4. An *object-oriented language* is being used to create a vector graphics drawing package. Every vector object will have a position stored by its x and y coordinates. The class definition for a **Shape** is shown below:



The vector graphics package will also include classes for lines, rectangles and other shapes.

(*a*) Class definitions consist of two sections.

(i) Explain the purpose of the section marked **A** in a class definition. **2**

(ii) Explain the purpose of the section marked **B** in a class definition **2**

(*b*) The vector graphics package allows for many different types of shapes to be drawn.

(i) A rectangle is a shape, explain how a class for rectangles would be created. **2**

(ii) Explain the benefit of an object-orientated language when coding additional shapes such as lines and rectangles. **2**

5. A program has been written to calculate a sequence of numbers in which each successive number is the sum of the two preceding numbers.

A programmer has written the following algorithm which contains an error.

```
1.   first   =2
2.   second  =3
3.   print first
4.   print second
5.   for counter  =1 to 5
6.        sum      = first + second
7.        first    = second
8.        second   = sum
9.        print first
10.  end loop
```

(*a*) The programmer decides to create a trace table to locate the error. The trace table shows the value of variable first, second and sum **at the end of each pass** through the loop.

Copy and complete the trace table below.

Counter	sum	first	second
1	5	3	5
2	8	5	
3			

2

(*b*) The expected output is 2, 3, 5, 8, 13, 21, 34. The actual output does not match.

(i) State the actual output of the algorithm **for the first five values**. **1**

(ii) Explain how the algorithm could be corrected. **1**

(*c*) A programmer can use *breakpoints* to pause the execution of a program. Describe how pausing the execution of the code can be used to find errors. **2**

[Turn over

6. A computer game includes a high score table with the names and scores of the top five players stored in two 1-D arrays.

(*a*) A bubble sort can be used to sort a 1-D array. Explain how a bubble sort rearranges a list into ascending order. **2**

(*b*) The 1-D array that holds the scores is shown below:

Index	1	2	3	4	5
Scores	23	25	27	50	58

Senga plays the game and scores 48. Her score of 48 replaces the lowest score that was in position 1. The 1-D array for the scores is now:

Index	1	2	3	4	5
Scores	48	25	27	50	58

The bubble sort is used to sort the scores. After the first pass the list will be sorted:

Index	1	2	3	4	5
Scores	25	27	48	50	58

(i) State the **two** exchanges that took place in this pass. **2**

(ii) Explain why the bubble sort will make another pass through the list even though it is sorted. **2**

6. (*b*) (continued)

(iii) The high score table is displayed as shown:

Identify the error in the table and explain one possible cause of this error. **2**

(iv) Morag plays the game and is added to the high score table with a score that results in the bubble sort only making one pass. State **one** possible score that Morag could have achieved and explain why only one pass was necessary. **2**

(*c*) (i) Name another sort that could be used to sort the list. **1**

(ii) Explain how many comparisons the sort algorithm answered in (*c*)(i) would make. **2**

(60)

[*END OF SECTION I*]

[Turn over

SECTION II

Attempt ONE sub-section of Section II

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

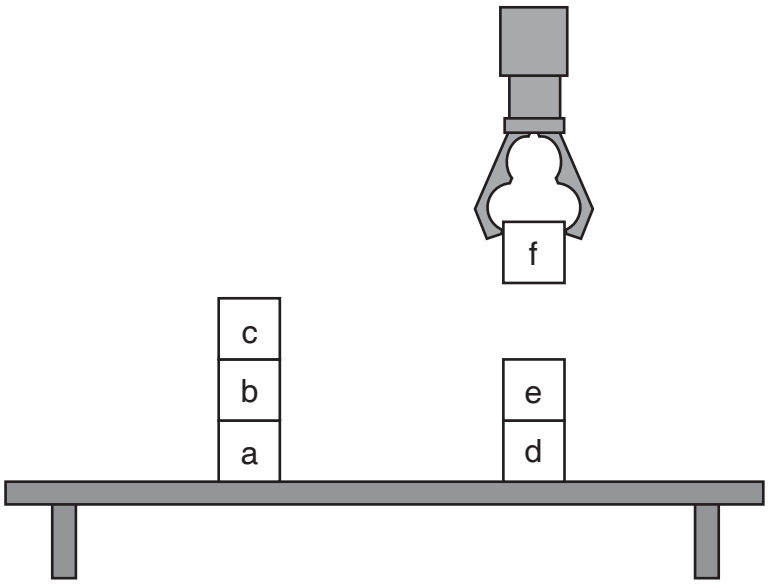
SECTION II

Marks

Part A — Artificial Intelligence

Answer ALL questions in this section.

7. The diagram below shows a typical *blocks world* scenario.



(*a*) Explain each of the following states in a blocks world environment. Use the diagram above to give an example of each of the states.

(i) clear **2**

(ii) holding **2**

(*b*) Stack is an action that can happen in blocks world. It can be defined as

stack(x,y) : place block x on top of block y.

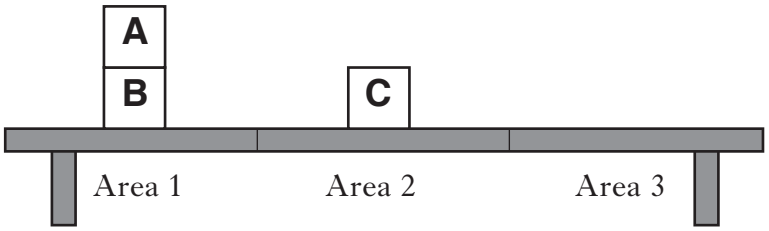
Some pre-conditions must be satisfied to allow actions to take place. To carry out stack(x,y), **two** pre-conditions are needed.

Use the states in part (*a*) to write down what these two pre-conditions are. **2**

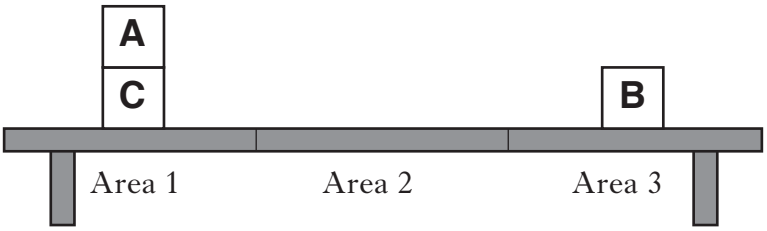
[Turn over

7. (continued)

(*c*) In another scenario, the blocks are placed as follows.



The blocks need to be moved to the following positions:



Using the states "on", "ontable" and "clear", describe the goal state of this blocks problem. "On" and "ontable" are defined as follows:

on(x,y)	block x is on top of block y
ontable(x,m)	block x is on the table at Area m

3

SECTION II

Marks

Part A — Artificial Intelligence (continued)

8. A healthy diet will include food from the following five groups:

Fruit and vegetables
Starchy foods
Meat, fish, eggs and beans
Milk and dairy foods
Foods containing fat and sugar

Pork and beef are well known meats, and dairy foods include yoghurt and cheese. Cheese is classed as a dairy food, that has an average fat content of about 65%. "Crowdie" is a Highland cheese with only 5% fat and "Caboc" is also a well known Scottish cheese but with close to the average fat content of cheese.

(*a*) Use the above knowledge to distinguish between *classes* and *instances* in knowledge representation. **2**

(*b*) Frames may be used to represent this knowledge during the design stage of the software development process.

Name **one** other method of representing this knowledge. **1**

(*c*) Use frame notation to represent **all** the knowledge about the food group "Milk and dairy foods" contained above. Use the two frames below to start your representation.

food groups	
diet	healthy
quantity	in moderation

cheese	
sub-class	milk and dairy foods
average fat content	65%

4

(*d*) State the purpose of *slots* in a frame. **1**

(*e*) A Prolog list structure could be used to represent the sources of milk and dairy foods. For example:

[milk, yoghurt, crowdie, caboc]

Explain how this list would be searched to find out if Crowdie is a member of the list. **3**

(*f*) Fibre found in fruit and vegetables helps the body to digest food.

(i) Represent this information as **two** Prolog facts. **2**

(ii) Write out **one** rule to ensure that all fruits and vegetables will be known to contain fibre. **2**

SECTION II

Marks

Part A — Artificial Intelligence (continued)

9. Some modern computer games make use of machine learning.

(*a*) Explain how a computer could *learn by experience*. **2**

(*b*) Name **one** other type of machine learning and describe how it could be applied to computer games. **2**

(*c*) A computer game can be configured to have an authorised player list. When a player logs into the game, a binary search routine is used to determine whether that player is on the authorised list.

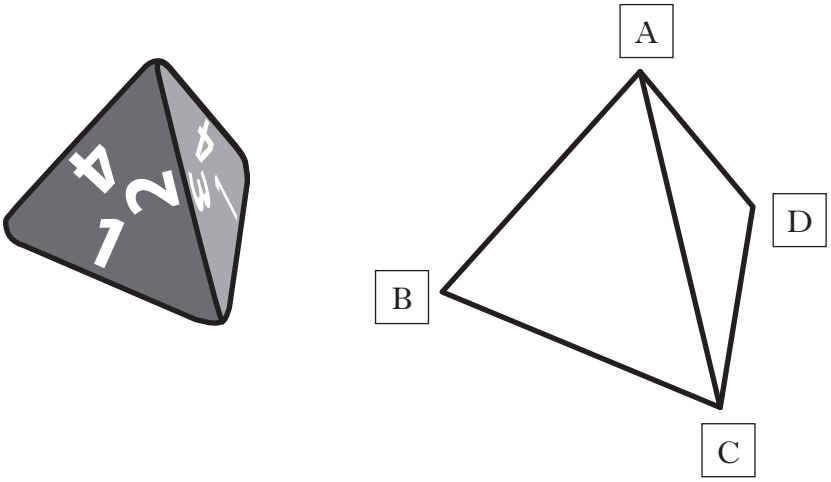
(i) Explain why a binary search is typically faster than a linear search. **1**

(ii) State **one** disadvantage of using a binary search rather than a linear search. **1**

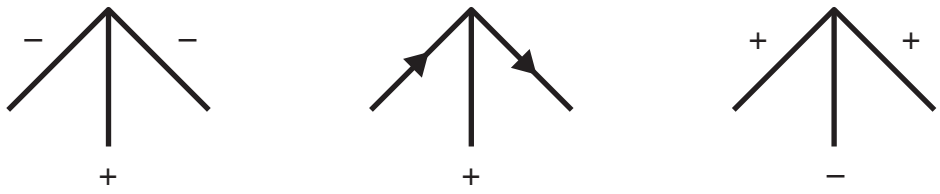
10. The Waltz algorithm is applied to a trihedral figure to produce valid labelling of all edges of the figure.

(*a*) Explain the term "trihedral figure". **1**

Consider the primal sketch of a four sided die.



(*b*) Junction A has to be one of the following:



(i) The symbols below are used by the Waltz Algorithm.

Explain what each of these symbols denotes. **3**

(ii) Identify the junction at Vertex A. Justify your choice. **2**

[Turn over

11. Mycin is an expert system. A rule in Mycin is as follows:

```
IF the identity of the germ is not known with certainty
   AND the germ is gram-positive
   AND the morphology of the organism is "rod"
   AND the germ is aerobic
THEN the germ is of type enterobacteriacae CF 80.
```

(*a*) (i) Describe how *forward chaining* attempts to find a solution during a consultation with an expert system. **2**

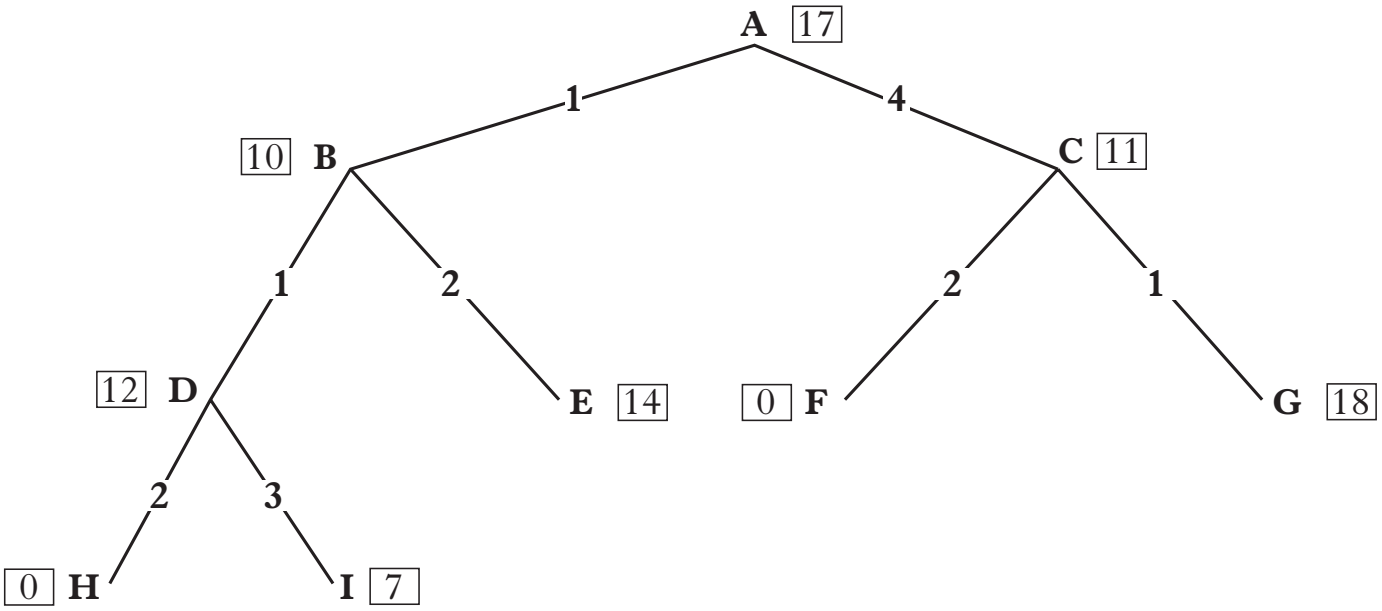
(ii) Describe how *backward chaining* attempts to find a solution during a consultation with an expert system. **2**

(*b*) (i) State what "CF" stands for in "CF 80" as used in the last line of the rule. **1**

(ii) Explain why CFs are needed in an expert system. **1**

(*c*) Explain why conflict resolution strategies may be required during the consultation process. **2**

12. A search tree for a problem is shown below. The nodes have been labelled A to I.



An evaluation function has been used to calculate a value for each node; this is shown as, for example, 17 .

The cost associated with each arc is shown on the arc.

The goal state has an evaluation function value of 0.

(*a*) (i) Explain the term *heuristic*. **1**

(ii) State **one** disadvantage of using a heuristic. **1**

(*b*) Explain how the following search techniques will be applied to this problem. For each search strategy, clearly identify the order of nodes visited.

(i) hill-climbing **2**

(ii) best first **3**

(iii) A* **3**

[Turn over

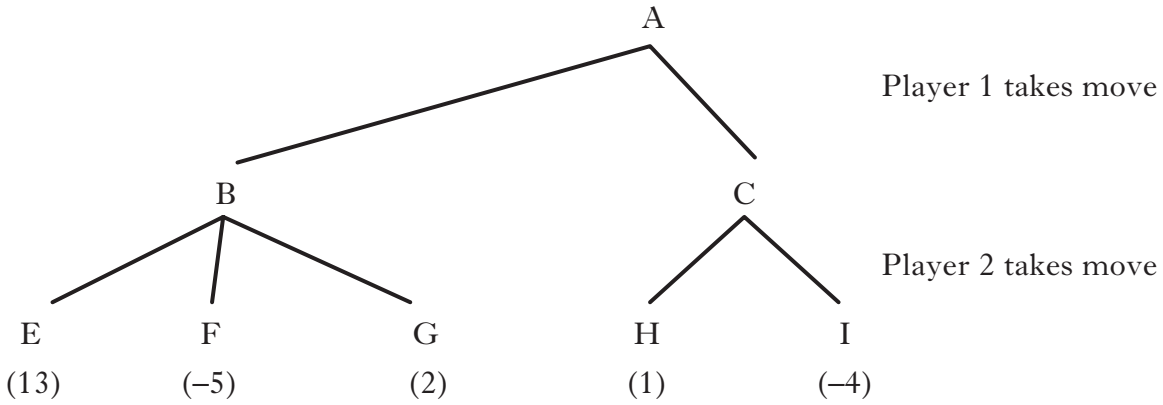
SECTION II

Marks

Part A — Artificial Intelligence (continued)

13. The minimax procedure features in almost all computer board games programs, for example draughts and chess.

(*a*) The minimax game tree below identifies the current state of a game at the top of the tree and shows a two move look ahead with player 1 about to take his turn. A positive evaluation function for a move outcome means a gain for player 1 whereas a negative evaluation function for a move outcome means a loss for player 1.



(i) The best result for player 1 would be node E with a pay-off of 13. Explain why player 1 will not take the move to position B with a view to this payoff. **2**

(ii) Explain how the minimax search procedure would decide which move player 1 should take. **2**

(*b*) State **two** reasons why minimax is unsuitable for many card games. **2**

(60)

[*END OF SECTION II—PART A*]

[Turn over for Section II Part B

SECTION II

Marks

Part B — Computer Architecture

Answer ALL questions in this section.

14. (*a*) A processor contains *registers* which are essential to its ability to process instructions. Some examples of these are the *MAR*, *MDR* and *general purpose registers* such as the accumulator.

(i) Name **two** other registers found in a processor. **2**

(ii) Describe the purpose of each of your chosen registers. **2**

(*b*) An assembly language instruction will usually comprise an *op-code* and an *operand*.

(i) Using an assembly language with which you are familiar, state an example of a ***data transfer instruction*** which has both an op-code and an operand. **1**

(ii) **By reference to this example**, explain what is meant by the terms op-code and operand. **2**

(*c*) One of the general purpose registers in a particular processor is called the accumulator.

"ASL" is an op-code in the assembly language for this processor which causes the contents of the accumulator to be shifted left by one bit. There is no operand with this op-code.

A program segment contains two ASL op-codes to be executed in succession; ie

```
ASL
ASL
```

Immediately before this program segment is executed, the value stored in the accumulator is 2.

(i) State what the value stored in the accumulator would be after these instructions have been executed. **1**

(ii) Justify your answer to (i). **1**

Part B — Computer Architecture (continued)

15. The design of a processor may be classed as *RISC* or *CISC*.

(*a*) One of the features of a RISC type processor is that the instruction set uses a small number of *addressing modes*.

(i) Explain what is meant by an addressing mode. **1**

(ii) Name and describe **two** addressing modes for a processor. **4**

(*b*) State **two** other typical features of RISC processors. **2**

(*c*) Providing a *cache* is a way of improving the performance of a computer system.

(i) Explain why the performance of a system is increased by the provision of a cache when a loop in a program is being executed. **2**

(ii) Describe **two disadvantages** of providing a large cache. **2**

16. A computer system is available in two versions.

(*a*) The more expensive system implements the technique of *memory interleaving*.

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

(ii) Explain why memory interleaving is particularly suitable for writing to memory rather than reading from memory. **2**

(*b*) The cheaper system has a main memory which does **not** implement the technique of memory interleaving.

Explain why processing time is wasted when non-interleaved memory is being used. **2**

[Turn over

17. A computer system can be purchased with either a *PCI bus* or a *PCI-X bus*. The two bus options have a common purpose in the system but with different performance levels.

(*a*) State the purpose of a PCI bus. **1**

(*b*) The PCI-X bus has a data throughput rate of 1 GB/s compared with only 132 MB/s for the PCI bus. State **two** reasons why the throughput rates for the two buses are different. **2**

(*c*) These buses are designed with *multipoint topology* functionality. Describe what is meant by multipoint topology. **1**

(*d*) Apart from the greater data throughput rate, state **one** other advantage of the PCI-X bus. **1**

(*e*) Explain the effect of plugging a PCI device into the PCI-X bus. **2**

18. (*a*) The Intel 80386 was the first processor in the x86 series to include a *pipeline*. This was a six stage pipeline so it could theoretically give a six-fold improvement in processing speed compared with not having a pipeline.

(i) State **two** reasons why it was not possible to achieve this improvement in practice. **2**

(ii) The Intel Pentium processor further developed the use of pipelines by including two independent integer pipelines and one floating point pipeline in its design.

Explain why this development improved processor performance. **1**

(*b*) The technique of *branch prediction* can improve the performance of a processor containing a pipeline.

(i) Describe this technique. **2**

(ii) Explain why the performance of the processor would be improved by branch prediction when it is executing a sort procedure. **2**

(*c*) Another technique that can improve performance is *predication*.

Explain why predication should provide better performance than branch prediction. **3**

19. Multitasking computers require an operating system that has a *scheduling system*.

(*a*) An operating system uses a *pre-emptive* scheduling system.

State what is meant by a pre-emptive scheduling system. **1**

(*b*) Pre-emptive scheduling can be implemented by a *multi-level feedback queue*.

(i) Describe how a multi-level feedback queue works. **3**

(ii) Describe **one** reason a multi-level feedback queue may be more efficient than *round-robin scheduling*. **1**

[Turn over

20. (*a*) Explain why the file management system of an operating system has to map the logical view of files to their physical location. **1**

(*b*) The operating system saves files on the hard drive using a non-contiguous method of file allocation.

(i) Describe **one** method of storing files non-contiguously on a hard drive. **2**

(ii) Explain **one advantage** that non-contiguous file allocation has compared with contiguous file allocation. **2**

(iii) Explain **one disadvantage** that non-contiguous file allocation has compared with contiguous file allocation. **2**

(*c*) An operating system provides a number of *services*, one of which is to provide a *standard look and feel* for applications.

(i) State how an operating system may provide this service to applications. **1**

(ii) Explain why this provides a standard look and feel for applications. **1**

(*d*) Another service provided by an operating system *allows communication between programs and the passing of data*.

(i) Describe an example of a situation where this service would be required **1**

(ii) Describe how this service may be implemented by the operating system. **1**

(*e*) The operating system provides a printer spooler service to manage printing. This service uses a queue structure to store the list of jobs waiting to be printed.

Explain why a queue is used for this purpose. **1**

(60)

[*END OF SECTION II—PART B*]

[Turn over for Section II Part C

SECTION II

Marks

Part C — Computer Networking

Answer ALL questions in this part.

21. Rebecca is creating a website which she plans to use to sell makeup products.

(*a*) Rebecca begins by writing the following HTML code.

```
<html>
        <head>
A               <title><b>Rebecca's Makeup</b></title>
        </head>
        <body>
B               Products
        </body>
</html>
```

(i) The HTML code at **line A** above adds a title to the page, but it contains an error. Explain what this error is. **1**

(ii) Write the HTML code that could be added to **line B** above to ensure the text "Products" appears as a section heading, centre aligned, and coloured blue. **3**

(*b*) Rebecca wants to include an animation on her web page. She will need to install a *plug-in*.

(i) Once the plug-in has been installed, describe the process a web browser would follow in order to use the plug-in to view the animation. **2**

(ii) Name a plug-in that Rebecca could use to display her animation. **1**

(*c*) As an alternative to using a plug-in Rebecca could redesign her animation as a *Java applet* or an *Active X* component. She decides to use a Java applet.

(i) One advantage of Java applets is that they operate in a *sandbox*.

Describe a sandbox, and explain how this would be an advantage to visitors to Rebecca's website. **2**

(ii) State another advantage of Java applets over Active X components, and explain how this would be a benefit to Rebecca. **2**

(*d*) Once Rebecca has completed her website it is made available on a web server.

(i) Describe the stages of an HTTP communication when a client requests a web page from a web server. **4**

(ii) When a web browser requests a web page from a web server a response code is returned. State **two** of these response codes and give their meaning. **2**

Part C — Computer Networking (continued)

22. Fraser is a travelling salesman. He uses his laptop each evening to connect from his hotel room to his office, to send a list of all the orders he has made that day.

(*a*) Fraser previously made use of a dial-up modem to communicate with his office. The modem makes use of the *SLIP* protocol to make the connection.

(i) Name an alternative protocol to SLIP. **1**

(ii) State **two** advantages of this alternative protocol over SLIP. **2**

(iii) State the layer of the OSI Model at which SLIP operates. **1**

(iv) State the layer of the TCP Model at which SLIP operates. **1**

(*b*) While travelling, Fraser makes use of a *tunnelling* protocol to connect to his office.

State **two** characteristics of a tunnelling protocol. **2**

(*c*) Fraser uses *conventional encryption* to send his daily list of orders to his office.

(i) State a precondition of using conventional encryption. **1**

(ii) Explain why both a public and private key are required in order to make use of *public key encryption*. **2**

(*d*) Fraser decides to send an e-mail to the clients he plans to visit the next day.

(i) State the technique that can be used to allow Fraser's clients to know that the e-mails originated from him and have not been spoofed or altered. **1**

(ii) Describe fully how this technique operates. **4**

23. Aufaewee Town Council maintains a website to keep local residents up to date with Council business.

(*a*) The website becomes victim to a denial of service attack, which results in all traffic intended for the website being directed to a fake server.

(i) Explain how the traffic could be directed to a fake server. **1**

(ii) State a precaution that could be taken to ensure this type of attack is not successful. **1**

(*b*) The Council web server is located on the Council's network, which is connected to the Internet.

(i) Describe **one** feature of a *gateway*. **1**

(ii) Explain how this feature could be used to protect the Council network. **1**

(iii) State **two** firewall rules that could be used to allow local residents access to the website while protecting other Council computers**.** **2**

Part C — Computer Networking (continued)

24. A group of friends decide to meet up in order to play some networked games. They bring their computers to a single house to connect them together.

(*a*) The friends debate whether they should use a wired or wireless network to connect their computers.

(i) Name a suitable wired network standard that could be used to create the network. **1**

(ii) Name a suitable wireless network standard that could be used to create the network. **1**

(iii) Compare these two network technologies in terms of range and bandwidth. **4**

(*b*) The friends decide to network their computers wirelessly, and configure a secured wireless access point for the computers to connect to.

(i) Name the **two** pieces of information that they need in order to connect their computer to the wireless access point. **2**

(ii) State **three** security precautions that the friends could take to ensure that their wireless network remains private and secure. **3**

Part C — Computer Networking (continued)

25. LAN Drovers Ltd are networking specialists that build and configure networks for their clients. They have been asked to build a network for a client who plans to purchase a Class B range of IP addresses.

The client's intended Class B network address in dotted decimal notation is 129.44.27.0.

(*a*) Calculate the number of hosts that can exist on the client's proposed network. **2**

(*b*) The client only needs to network 1000 hosts.

(i) Explain why using CIDR is a more efficient method for distributing IP addresses in this example. **2**

(ii) Calculate the CIDR address which would be suitable for the client, rather than using the Class B address 129.44.27.0. You should include your working. **2**

(*c*) The client has four buildings each of which will contain 250 hosts. The network specialists decide that the most efficient way to implement the network would be to set up a *subnet* in each building.

(i) Describe an advantage to the client of setting up a subnet in each building. **2**

(ii) Calculate the value of the subnet mask that would be used to allocate a subnet for each building. State your answer in dotted decimal notation. **3**

(60)

[*END OF SECTION II—PART C*]

[*END OF QUESTION PAPER*]

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