X206/701

NATIONAL QUALIFICATIONS 2008

MONDAY, 2 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.

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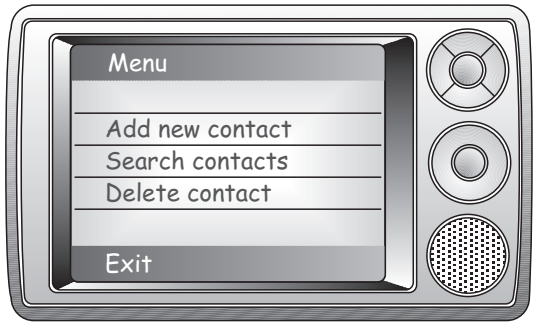
SECTION I

Software Development & Developing a Software Solution

Marks

Answer ALL questions in this section

1. A company that manufactures a wireless palmtop computer has decided to introduce the capability for it to be used for free voice calls over the Internet using a broadband connection.



The company intends to create software for their servers to allow users access to the voice calls.

(*a*) Initially, the company undertook a *feasibility study* by investigating technical feasibility.

(i) When investigating technical feasibility, the system performance of the palmtop was considered. State **two** hardware characteristics that affect system performance. **2**

(ii) State **two** other aspects of feasibility that the company would have considered. **2**

(iii) Describe **two** benefits of a feasibility study for the company. **2**

(*b*) The company begins the analysis stage of the software development process. State **two** elements that would be identified during this stage. **2**

(*c*) The company has decided that the user interface will be *menu-driven* rather than *textual* or *graphical* for this device.

Explain why a menu-driven interface would be best for this device. **2**

(*d*) The company has a *user-defined module library* containing a number of procedures. State **two** items that the documentation would specify about a procedure. **2**

(*e*) The testing stage will involve both *module* and *component* testing.

(i) Explain why both these types of testing are necessary. **2**

(ii) A *summary of results* for testing is documented. Describe **two** uses that the company would make of this summary. **2**

[Turn over

SECTION I (continued)

2. A 1-D array is used to implement a *stack*. The variable **top** is a stack pointer which changes as items are added to or removed from the stack. The numbers 42, 4 and 11 have been placed on the stack. The current value of the variable **top** is 2.

Index	0	1	2	3	4	5	6	7	8	9
	42	4	11							

(*a*) Describe how a stack operates. **2**

(*b*) State the value of **top** when the stack shown above is empty. Explain your answer. **2**

(*c*) There are **two** operations that can cause stack errors to occur. State **both** of these operations. **2**

SECTION I (continued)

3. Over the first term of a course, a student submits six assignments. The percentage scores for each assignment are shown below.

80 89 96 88 79 75

The scores are to be sorted into **descending** order.

(*a*) The *selection sort using two lists* algorithm is to be used.

The initial state of two 1-D arrays is shown below.

Index	0	1	2	3	4	5
Unsorted	80	89	96	88	79	75
Sorted	0	0	0	0	0	0

This algorithm uses a dummy value.

(i) Explain the purpose of the dummy value. **3**

(ii) The dummy value used is –1. State **two** reasons for this choice. **2**

(iii) Copy and complete the following tables to show the state of the lists after **two** values have been moved to their correct position. **2**

Index	0	1	2	3	4	5
Unsorted						
Sorted						

(*b*) An alternative sort algorithm is the *bubble sort*.

(i) Explain how a bubble sort algorithm operates. **3**

(ii) Compare the *bubble sort* to the *selection sort using two lists* in terms of its use of memory and the number of comparisons. **2**

[Turn over

SECTION I (continued)

4. The monthly rainfall figures for Ayr over a five-year period are shown below.

	Year 1	Year 2	Year 3	Year 4	Year 5
Jan	116	112	98	123	125
Feb	136	112	100	125	108
March	98	88	92	101	75
April	102	82	98	123	76
May	57	52	40	63	80
June	67	73	61	56	53
July	75	72	56	78	52
Aug	85	81	77	80	62
Sept	99	87	101	87	93
Oct	111	121	123	132	112
Nov	135	142	110	155	125
Dec	125	122	108	132	152

(*a*) Declare a 2-D array to store the **rainfall** figures shown in the table. **3**

(*b*) Write an algorithm that will count the number of months for which the rainfall was over 60. **6**

SECTION I (continued)

5. The following list of numbers is to be held in a 1-D array as shown below.

Index	0	1	2	3	4	5	6
List	12	14	19	25	32	42	55

A binary search for the number 42 will be performed using the following algorithm.

```
set lower to lowest index
set upper to highest index
        loop
              set middle to (lower+upper) div 2
              if search_item> list[middle] then
                    lower=middle+1
              else
                    upper=middle–1
              end if
        until list[middle] =search_item or lower>upper
if search_item=list[middle] then
        write 'Search item was found at', middle
else
        write 'Search item is not in list'
```

(*a*) Use the values of lower, middle and upper to explain how the algorithm would perform when searching for the value 42. **6**

(*b*) This algorithm will not function correctly if the list is in **descending** order. This can be corrected by changing **one** line of the algorithm. Identify the line to be changed and state the change required. **2**

[Turn over

SECTION I (continued)

6. Meetysoft is developing a new game. Level One of the game involves the player fighting a number of identical enemies. In Level Two, there are new enemies which have additional characteristics and features as well as those of the Level One enemies.

(*a*) Meetysoft considers using a *low level language, procedural language* or *object-oriented language*.

(i) Describe **two** similarities between procedural and object-oriented languages. **2**

(ii) Describe **two** advantages of an object-oriented language when compared to a low level language. **2**

(iii) Describe **one** advantage of a low level language when compared to an object-oriented language. **1**

(*b*) Meetysoft decides to use an object-oriented language to implement the game.

(i) Describe how an object-oriented language could be used to implement a Level One enemy. **2**

(ii) Describe how an object-oriented language would be used to implement a Level Two enemy efficiently. **2**

(60)

[*END OF SECTION I*]

SECTION II

Attempt ONE sub-section of Section II

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

[Turn over

Marks

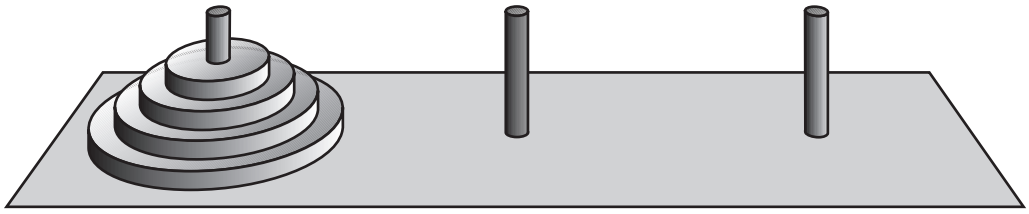
SECTION II

Part A — Artificial Intelligence

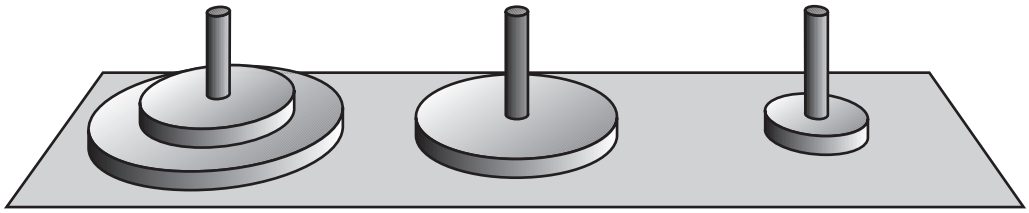
Answer ALL questions in this part.

7. The Tower of Hanoi is a puzzle which can be solved using search techniques. The problem is to move a set of discs from one peg to another. Discs can only be moved one at a time. A larger disc cannot be placed on a smaller disc.

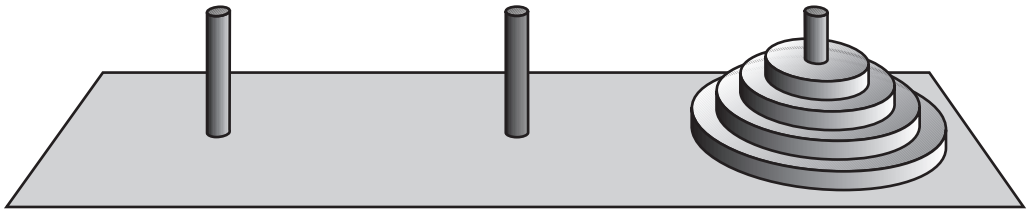
The starting position is:



An intermediate position after several moves might be:



The goal position is:



A possible symbolic representation of the start state is [(4,3,2,1),( ),( )]. Using the same symbolic representation, the intermediate position shown above could be represented as [(4,2),(3),(1)].

(*a*) Using the same symbolic representation, represent:

(i) the **goal** state; **1**

(ii) the **two** states which can be reached in a single move from the start state. **2**

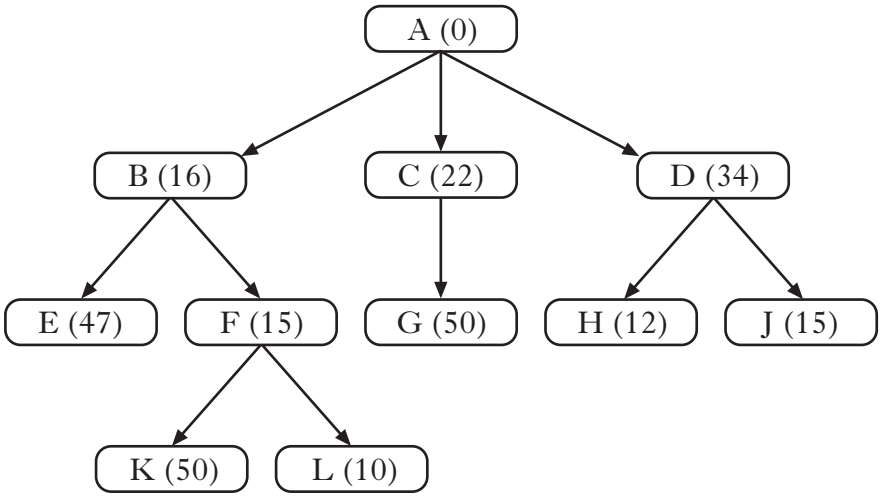
(*b*) (i) Draw a *state space graph* which represents all the positions which can be reached with up to **four** moves. **4**

(ii) Describe **two** features of your graph which would **not** be features of a *search tree*. **2**

SECTION II

Part A — Artificial Intelligence (continued)

8. The following *search tree* represents the *state space* for a problem. An *evaluation function* has been calculated for each *node*, with higher values indicating more promising states. The *start state* has value 0, and any *goal state* has value 50.



(*a*) This tree could be searched using either an *exhaustive* search technique or a *heuristic* search technique.

(i) Describe the main characteristic of a search tree which could **not** be searched using exhaustive search. **1**

(ii) Describe a problem which would suffer from the characteristic identified in (*a*)(i). Your description should explain clearly why your chosen problem could not be solved using exhaustive search. **1**

(*b*) The tree above is to be searched using the *best-first* algorithm. The following is an incomplete description of how the best-first algorithm would find a goal state:

1. Search begins at node A. A is not a goal state, so the successors of A (B, C and D) are added to the current agenda, which becomes the list [B, C, D].
2. D is selected from the agenda, as it has the highest value. D is not a goal state, so it is removed and its successors (H and J) are added to the agenda, which is now [B, C, H, J]
3. . . . . .
4. . . . . .

Complete the description by describing steps 3 and 4. **5**

(*c*) *Hill-climbing* and *best-first* are both heuristic algorithms which could be used to search the tree.

(i) State **one** disadvantage of the hill-climbing algorithm compared to the best-first algorithm. **1**

(ii) Explain how the best-first algorithm overcomes the disadvantage identified in (*c*)(i). **1**

SECTION II

Part A — Artificial Intelligence (continued)

9. A language translation system stores the words of each sentence as a Prolog list, for example: [a, blue, car, won, the, race].

(*a*) List membership is defined using **two** clauses. The first clause is the fact member(X, [X|Tail]). The second clause is a rule.

(i) Write the **second** clause required to define list membership. **2**

(ii) The following query could be used by the system to check whether the word "blue" is present in a sentence: ?member(blue, [a, blue, car, won, the, race]).

Describe how Prolog would evaluate this query. **3**

(*b*) The system uses a combination of *syntactic, semantic* and *pragmatic* analysis during the translation process.

(i) Explain what is meant by the term **syntactic** analysis. **1**

(ii) Describe, using an example, an ambiguity that could arise during syntactic analysis. **2**

(iii) *Parsing* is used during the process of syntactic analysis. Implement a parse tree for the sentence "a blue car won the race". **3**

SECTION II

Part A — Artificial Intelligence (continued)

10. The following frames represent some information about astronomical objects. The information will be used to develop software useful to astronomy students.

astronomical object	
*is_at_distance:	millions of miles

planet	
*sub_class:	astronomical object
*made_of:	gas

jupiter	
instance:	planet

earth	
instance:	planet
made_of:	rock

star	
sub_class:	astronomical object
*made_of:	plasma
*temperature:	very hot

the sun	
instance:	star

alpha centauri	
instance:	star

betelgeuse	
instance:	star

(*a*) Represent this information as a *semantic net*. **4**

(*b*) (i) Explain why the sun is an *instance* of star, but a star is a *sub-class* of astronomical object. **2**

(ii) The symbol * indicates a *default value*. Explain the meaning of this term. **2**

(*c*) The information could also be represented as a Prolog knowledge base.

(i) Represent this information as Prolog facts, of the form relation(argument, argument). Do not include any facts which can only be deduced by inheritence. **3**

(ii) Explain why the solution to the query ?made_of(the_sun, X) will be false. **1**

(iii) Write **two** rules that will ensure that the sun will inherit the properties of all stars. **2**

(*d*) The development of the software requires the *scope and boundaries* of the problem to be identified.

(i) During which stage of the development process are the scope and boundaries identified? **1**

(ii) Describe an example of scope or boundaries relevant to this example of software development. **1**

SECTION II

Part A — Artificial Intelligence (continued)

11. The following information is to be included in a rule-based diagnosis system.

"A combination of loss of appetite and dull feathers in household pet birds indicates one of two possible diagnoses. In approximately 90% of cases, the correct diagnosis is infection by the CSP-3 virus. The other possibility is a shortage of vitamin B25 in the diet."

(*a*) (i) Write **two** IF . . THEN rules, including *certainty factors*, to represent the information above. **3**

(ii) Rewrite **one** of your rules in a different form, and use your example to explain the meaning of the terms *syntax* and *semantics*. **3**

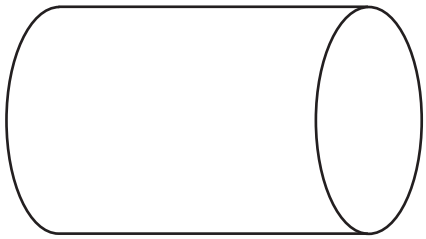
(*b*) At the implementation stage of the development of the system, a choice must be made between *backward chaining* and *forward chaining* inferencing.

Describe clearly these **two** inferencing methods. **4**

SECTION II

Part A — Artificial Intelligence (continued)

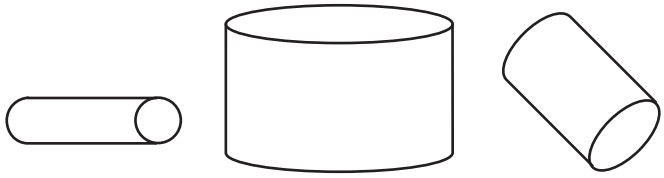
12. A vision system attempts to analyse the following 2-dimensional representation of a 3-dimensional object.



(*a*) Describe **one** ambiguity which may result when the system tries to identify this object. **1**

(*b*) Explain why the *Waltz algorithm* cannot be applied to this object. **1**

(*c*) The system is being developed to recognise any type or size of cylinder, including the following:



Explain whether *rote learning* or *learning by example* would be a more appropriate method of *machine learning* for this application. Justify your answer. **3**

(60)

[*END OF SECTION II—PART A*]

Marks

SECTION II

Part B — Computer Architecture

Answer ALL questions in this part.

13. Describe **three** key features of parallel architectures which are commonly found in supercomputers. **3**

14. As part of her college course Lesley has to write an assembly language program. Part of her program is shown below.

Instruction	**Meaning**
LDA(10)	Load the value at location 10 into register A
ADD(12)	Add the contents of location 12 to register A
ASL	Shift left register A
STO(9)	Store the contents of register A in location (9)
CMP(15)	Compare the contents of register A to the contents of location 15
JGT(37)	If the flag is set jump to location 37

(*a*) After the instruction ADD(12) is executed the contents of register A are 00010010.

(i) State the contents of register A after instruction ASL is executed. **1**

(ii) Describe the effect the execution of the ASL instruction had on the **value** of the contents of register A. **1**

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

(i) *logic instruction*

(ii) *branch instruction*. **2**

(*c*) Describe the problem that instruction JGT(37) could cause for a processor using a *pipeline*. **2**

SECTION II

Part B — Computer Architecture (continued)

15. The Pentium III processor has eight registers which can be operated on by *SIMD* instructions.

(*a*) Describe what is meant by a SIMD instruction. **1**

(*b*) Describe how the Pentium III could use SIMD instructions and registers when adjusting the brightness of a graphic. **3**

16. A computer manufacturing company is designing a games console. Two key parts of the design process are the design of the operating system which will control the console and the design of the processor which will power it.

Before going on sale the console has to undergo *beta testing*.

(*a*) Describe how beta testing of the console would be carried out. **4**

(*b*) The processor designer has to decide whether to base her design on *CISC* or *RISC* architecture.

Describe **three** key features of CISC processor architecture. **3**

(*c*) RISC processors implement mainly register oriented instructions.

Describe how this feature improves the performance of RISC processors compared to CISC processors. **2**

(*d*) Describe **two** implications of the use of mainly register oriented instructions for the design of a RISC processor. **2**

(*e*) The designer decides to include the use of *pipelines* in her design.

(i) Explain why the structure of CISC instructions prevents the smooth operation of pipeline processing. **2**

(ii) Explain how the *Power PC* processor design avoids the problem identified in (*e*)(i). **2**

17. A *superscalar* processor has to execute the following instructions.

1. Add contents of memory location 100 to the contents of memory location 101
2. Store the result in memory location 102
3. Add the contents of memory location 102 to the contents of memory location 103
4. Store the result in memory location 104

(*a*) Explain why the superscalar processor cannot execute these instructions in parallel. **2**

(*b*) Name and describe a design technique that could help overcome the type of problem identified in (*a*). **4**

SECTION II

Part B — Computer Architecture (continued)

18. David and Andrew are brothers and each has his own computer.

(*a*) David's computer has the following types of memory: *cache, registers, CD-RW, hard disk, main memory.*

Arrange these types of memory in ascending order, according to access time. **1**

(*b*) When David runs a graphics application on his computer there are pauses in the processing and there is constant activity on the hard disk.

What problem does the constant activity on the hard drive point to? **2**

(*c*) David now compares his computer with his brother's computer. Both computers have the same amount of level 1 cache, the same amount of main memory, the same hard drive and CD-RW drive yet Andrew's computer performs better. State an aspect of the **memory** design that could explain this. **1**

(*d*) David discovers that Andrew's computer has a *PCI-X bus* and his own computer has a *PCI bus*.

(i) State the function of a PCI bus. **1**

(ii) State **two** differences between a PCI and a PCI-X bus. **2**

(iii) Explain why the PCI-X bus will increase the performance of Andrew's computer. **2**

SECTION II

Part B — Computer Architecture (continued)

19. Mitsuko stores a large number of files on the hard disk of her computer. These include digital photographs of her holidays as well as text files and spreadsheet files.

(*a*) A major function of the operating system is to map the *logical view* of the files onto the *physical view* of the files.

(i) Describe the difference between the logical and physical view of the files. **2**

(ii) Describe the advantages to Mitsuko of having the operating system display this logical view for her. **2**

(*b*) The operating system displays the logical view using a graphical user interface (GUI). Mitsuko moves a file from one directory to another.

Describe **four** operations carried out by the operating system when the GUI is used for this task, which place demands on the processor. **4**

(*c*) Two methods of allocating disk space are *contiguous allocation* and *non-contiguous allocation*.

The operating system stores the data in Mitsuko's files on a hard disk using contiguous allocation.

(i) Describe how contiguous allocation of disk space operates. **2**

(ii) Describe **one** disadvantage of contiguous allocation of disk space. **1**

(iii) Describe **one** method of non-contiguous allocation. **2**

(iv) Explain how the method of non-contiguous allocation you have described in (*c*)(iii) would overcome a disadvantage associated with contiguous allocation. **2**

(*d*) Mitsuko produces a document which combines her digital photos with data from her text files. She then hopes to send the file by e-mail to a friend.

The operating system can use *embedding* to produce the combined document.

(i) Describe **one** disadvantage of using this method when sending Mitsuko's document by e-mail. **1**

(ii) Suggest **one** method of overcoming the disadvantage identified in (*d*)(i). **1**

(60)

[*END OF SECTION II — PART B*]

Marks

SECTION II

Part C — Computer Networking

Answer ALL questions in this part.

20. A large manufacturing company is planning to centralise several of its divisions in one campus. A site has been selected and draft plans of the area completed.

It is intended to construct five large manufacturing buildings and one management centre on a rectangular block of land which is 2 kilometres long and 1 kilometre wide. The buildings will be linked by a computer network.

Some of the information available on the network will be commercially sensitive.

(*a*) Fibre-optic cable has been chosen as the transmission medium for connecting the five buildings together.

(i) Give **three** reasons why this is the most suitable transmission medium for this purpose. **3**

(ii) Un-shielded twisted pair and Wi-Fi are possible alternatives to fibre-optic. For each one, describe a recent technological advance that would increase the likelihood of it being used for connecting these buildings. **2**

(*b*) The company is considering implementing a new data communication system called Netwile. It is a complete hardware and software solution that uses new data communication protocols developed by the same company that designed Netwile.

Describe **one** advantage and **one** disadvantage of implementing Netwile over an alternative solution that uses internationally recognised standards. **2**

(*c*) When Netwile was being developed it was rigorously tested. One of the testing stages was referred to as *beta testing*. Describe how beta testing would have been carried out in this situation. **2**

21. A reviewer for a PC magazine is testing a wireless router. The router uses the 802.11g standard. One of the tests is timing how long a file takes to transfer between two computers. The computer sending the file has a wired 100 Mbps connection to the router and the laptop receiving the file has an 802.11g wireless card installed. The total number of bytes that has to be transmitted, including all communication overheads, is 162 megabytes.

(*a*) Calculate how long it should take to transfer the file. **3**

(*b*) There is a possibility that some data packets will be dropped during wireless data transmission, thus reducing the transfer rate. Suggest **two** reasons why this 802.11g router might drop packets. **2**

(*c*) A wireless router may require the MAC address of a wireless card that is being used to access it. Explain why the wireless router would need this piece of information. **1**

SECTION II

Part C — Computer Networking (continued)

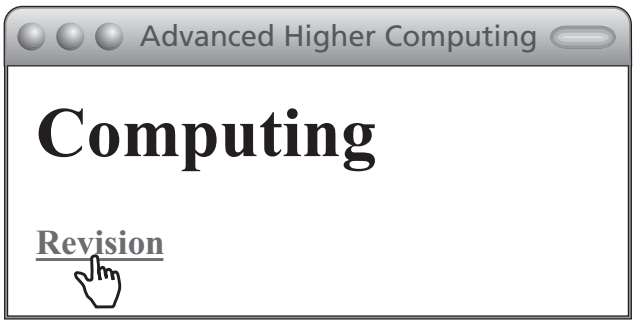
22. One of the most common uses of data communication is to browse the World Wide Web. Web pages are stored on Web servers and transmitted using HTTP.

(*a*) Once a TCP connection has been created between the client and the Web server an HTTP dialogue begins.

(i) What is the normal opening HTTP command from the client? **1**

(ii) The response from the server starts with the HTTP version number and a response code. Give **two** examples of possible response codes and state the meaning of each. **2**

(*b*) Web pages are normally written in HTML. The picture below shows a very basic Web page.



Write the HTML code that would create a hyperlink from the word **revision** to the URL **www.bbc.co.uk/schools/revision.htm**. **3**

(*c*) Requests for Web pages are often routed through an intermediate. These intermediates are typically a *gateway,* a *proxy server* or a *tunnel*.

Describe **two** reasons for using **each** of the following intermediates.

(i) Gateway **2**

(ii) Proxy server **2**

(*d*) Some Web pages contain interactive multimedia games that cannot be created using only HTML code. A standard browser can only interpret HTML code. Describe how the browser could be modified so that a user could play the games. **1**

(*e*) A common use for the Internet is communication between individuals.

(i) Describe the role of the MIME protocol in sending and receiving e-mail attachments. **4**

(ii) Describe the steps the sender of an e-mail should take to ensure that the recipient can be certain it originated from the source given **and** that the contents have not been altered. **4**

SECTION II

Part C — Computer Networking (continued)

23. *Subnetting* and *supernetting* are techniques developed to overcome the limitations of the standard IP addressing scheme.

(*a*) Name **two** characteristics of a network that would indicate the need for subnetting. **2**

(*b*) Supernetting is also known as CIDR. Describe **two** advantages that CIDR has over the standard IP addressing scheme. **4**

(*c*) A host computer has the CIDR address 172.120.54.112/22. What is the maximum possible number of hosts on this network? Justify your answer. **3**

(*d*) IP operates at the **Internet** layer of the TCP/IP model. Name the corresponding layer in the OSI model. **1**

24. A secondary school makes regular backups of the pupil data stored on a fileserver. There is a four week cycle implemented as shown below. All backups start at 10:00 pm on the stated day, eg Monday Week 1 backup begins at 10:00 pm on Monday night.

	Week 1	Week 2	Week 3	Week 4
Monday	Incremental	Incremental	Incremental	Incremental
Tuesday	Incremental	Incremental	Incremental	Incremental
Wednesday	Incremental	Incremental	Incremental	Incremental
Thursday	Incremental	Incremental	Incremental	Incremental
Friday	Full	Differential	Differential	Differential

(*a*) Assuming a complete failure of the school fileserver, which backups would be required to restore as much data as possible if the crash happened on:

(i) Wednesday of week 2 at 11:00 am; **2**

(ii) Tuesday of week 4 at 8:00 pm. **2**

(*b*) Explain why there would be a slight difference in the effectiveness of the data recovery in (*a*)(i) and (*a*)(ii) above. **1**

(*c*) In order to allow such complex configurations for backups, the user interface of the backup software must be good. Describe **two** aspects of a good user interface. **2**

Marks

SECTION II

Part C — Computer Networking (continued)

25. Servers on the Internet can be the target of *denial of service* attacks.

(*a*) An abnormal *ping* command can be used as a tool in a denial of service attack.

(i) Name a denial of service attack that utilises an abnormal ping. **1**

(ii) For the attack named in (*a*)(i) describe how the ping command differs from a normal ping. **2**

(iii) A firewall rule blocking *ICMP* commands may be used to prevent ping based attacks. State **two** reasons for **not** using this solution. **2**

(*b*) A server is operating normally and none of its services are being overrun by demand. However, users may still be suffering from a denial of the services that are normally available from the server. Describe **two** reasons why this might be occurring. **4**

(60)

[*END OF SECTION II — PART C*]

[*END OF QUESTION PAPER*]

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