X206/701

COMPUTING
ADVANCED HIGHER

Attempt **all** questions in Section I.

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

Part A	Artificial Intelligence	Page 10	Questions 6 to 10
Part B	Computer Architecture	Page 15	Questions 11 to 15
Part C	Computer Networking	Page 21	Questions 16 to 19

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.

SQA

Software Development & Developing a Software Solution

Answer ALL questions in this section.

1. A Scottish bank developed software to enable customers to use their mobile phones to check balances, transfer funds, pay bills and pay for goods. The bank employed a software development company at the beginning of the project.

(*a*) The software development company considered whether to deliver the proposed services using the browser software already available on mobile phones or to create an application. The application was to be downloaded from the bank's website onto the mobile phone.

  (i) State **two** types of *feasibility* that would have been considered when making this choice. **2**

  (ii) Explain why each of your answers to (i) is relevant in this situation. **2**

(*b*) After the feasibility study, a *project plan* was created.

State **two** elements of a project plan and explain why each is used. **4**

(*c*) An *operational requirements document* was produced.

  (i) State **one** benefit of this document for the bank. **1**

  (ii) State **one** benefit of this document for the software development company. **1**

  (iii) Describe how the operational requirements document would have been used at the evaluation stage of the software development process. **2**

(*d*) During the testing stage of the software development process a *summary of results* was produced. Describe how the summary of test results would be of benefit during maintenance. **2**

(*e*) The software development company made use of *CASE* tools.

State **one** benefit of using CASE tools. **1**

2. A teacher is writing a program to deliver a computerised version of a multiple choice test. The test has twenty questions and each correct response is awarded one mark. An incorrect response is awarded zero marks.

   The test is in a text file. Each question in the text file has a stem, four possible responses and the correct answer.

   Here is part of the text file showing two of the twenty questions:

Stem	Choice A	Choice B	Choice C	Choice D	Answer
Which of the following is a suitable file format to use for a photograph?	RTF	JPEG	CSV	MP3	JPEG
Which malicious software self-replicates without a host file?	Virus	Trojan	Worm	Spam	Worm

   (*a*) The teacher decides to create a *record* data structure for each question.

      (i) Describe what is meant by a record data structure. **2**

     (ii) Define a suitable record for a question. **3**

    (iii) Declare a variable that can store the twenty questions. **2**

   (*b*) When running the program an error occurs when reading the file.

      (i) State **one** example of a run-time error that could occur when reading the text file. **1**

     (ii) Describe **one** feature of a software development environment used to identify where in the program the run-time error occurred. **2**

   (*c*) When taking the test, a pupil's twenty responses are stored in a 1-D array called **responses**.

responses

JPEG
Worm
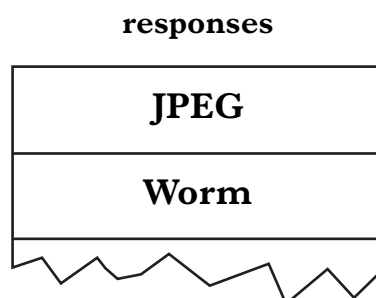
   Write an algorithm, using detailed pseudocode, which will calculate the pupil's total for the test.

   Your answer should refer to the variable defined in (*a*)(iii). **4**

3. A salesperson is given a list of six locations that he must visit. His IT department has given him a program to plan his journeys. He enters the locations into the program and it calculates the distances of each location from his house. The distances are displayed as shown below:

Journey Planner   X

Locations   Distances

Edinburgh   84
Hawick   137
Crieff   40
Dumfries   59
Carluke   42
Prestwick   3

Sort   Reverse

(*a*) The program has an option to sort the distances. The program uses the *simple sort* algorithm.

   (i) Explain how the *simple sort* algorithm sorts a list into ascending order. **3**

   (ii) State **two** swaps that will take place during the first pass through the list. **2**

   (iii) State the number of comparisons that took place on this first pass. **1**

   (iv) Calculate the total number of comparisons that will take place to complete the simple sort for the distances. Show your working. **2**

3. (continued)

(b) The distances after sorting are held in a 1-D array as shown.

Index	0	1	2	3	4	5
Distance	3	40	42	59	84	137

The button marked **Reverse** becomes active once the list has been sorted. It is intended to reverse the order of the list from highest to lowest or vice versa but this feature does not work. He asks the IT department to correct it. The incorrect algorithm used is shown below:

```
1    set lower to lowest index
2    set upper to highest index
3    for counter=lower to upper
4          temp=distance[counter]
5          distance[counter]=distance[upper−counter]
6          distance[upper−counter]=temp
7    end for
```

(i) The distances in the 1-D array have been used with the section of code shown above to partially complete a trace table. State the missing values at positions A, B, C, D and E for the first pass through the loop. **5**

Line No	lower	upper	counter	temp	upper−counter	distance[counter]	distance[upper−counter]
1	0						
2		5					
3			A				
4				B			
5					C	D	
6							E

(ii) The last pass through the loop has the effect of undoing the first pass. Explain how the algorithm can be corrected. **2**

(iii) The order of the list could have been reversed using the simple sort algorithm. Explain why the corrected algorithm is more efficient. **2**

[Turn over

4. Senga is a computer science student investigating the efficiency of the following binary search algorithm:

```
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
```

She decides to examine its performance on a list of seven characters held in a 1-D array. The array is shown below:

Index	0	1	2	3	4	5	6
Char	C	D	E	I	L	M	T

The character **I** is found on the first pass through the loop. On the second pass the character **D** is one of two characters that could be found. Senga decides to represent the performance of the algorithm using a binary decision tree.
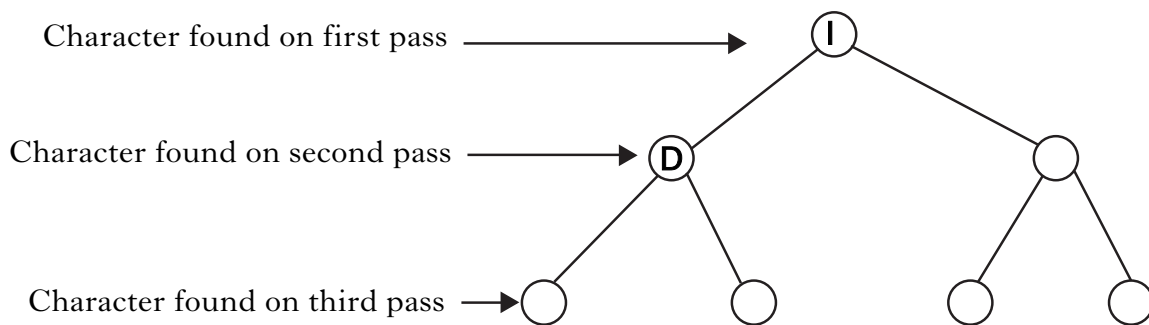
Copy and complete the diagram for all of the characters. **3**

5. (*a*) When programming using a *procedural language*, the programmer defines how the data is to be stored using variables and then creates the procedures to operate on these variables. Describe how classes are used in an *object-oriented language*. **3**

(*b*) A programmer is developing software that requires the use of several stacks.

The programmer creates a class called **stack**.

(i) State the purpose of **two** variables required for the implementation of the **stack** class. **2**

(ii) Describe **two** operations that the **stack** class would contain. **2**

(*c*) Describe **two** advantages of programming in an object-oriented language when using several stacks compared to a procedural language. **4**

(60)

[*END OF SECTION I*]

[Turn over

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SECTION II

Attempt ONE sub-section of Section II

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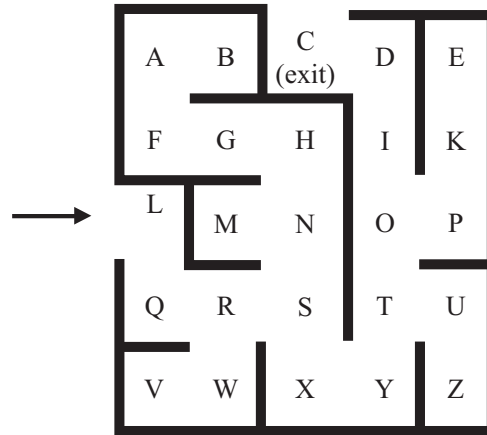
**[Turn over**

Part A — Artificial Intelligence

Marks

Answer ALL questions in this part.

6. AI techniques of problem representation and search can be used effectively in route-finding problems like this maze.

(*a*) (i) Complete the search tree to represent all the possible routes in and through this maze, from the entrance at L to the exit at C. You need only show nodes such as R, where a decision must be made, or nodes such as V, which are dead ends.
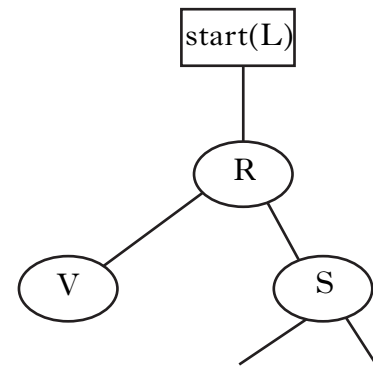
3

(ii) A *heuristic* search of this tree would require an *evaluation function* for each node. A suitable evaluation function is the sum of the horizontal distance and vertical distance from the exit, C. For example, the value for node Z would be 6, as it is 4 rows below C, plus 2 columns to the right.

Label each node on the tree you have drawn with the value of its evaluation function.

3

(iii) List the order of nodes which would be considered if the tree was searched using the *hill-climbing* algorithm. Assume that a lower value of the evaluation function is considered more favourable.

2

(iv) Name **another** heuristic search technique that would be more successful than hill-climbing in this situation. Explai your answer.

2

(*b*) (i) The maze described above could easily be searched using an exhaustive search technique, such as breadth-first search. Explain why an application to find the best way to travel between any two towns in the UK would require an heuristic rather than an exhaustive search.

2

(ii) Describe a *planning* technique that could be used to increase the efficiency of route finding through a maze.

1

Part A — Artificial Intelligence (continued)

7. The following frames represent some information about living creatures, gathered during the analysis stage of developing an expert system.

mammal	
sub_class	living creature
*habitat	land
*reproduces_by	live young

dog	
sub_class	mammal

whale	
sub_class	mammal
habitat	water

reptile	
sub_class	living creature
reproduces_by	eggs

crocodile	
sub_class	reptile

fish	
sub_class	living creature
habitat	water

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

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

(c) The expert system is to be developed using *Prolog*.

   (i) Represent all the information in the frames above as Prolog facts, of the form relation(argument, argument). Do **not** include any facts which can only be deduced by inheritance or recursion. **3**

   (ii) A dog is a mammal, and therefore reproduces by live young. Explain why the solution to the query ?reproduces_by(dog, live_young) will be false. **1**

   (iii) Explain what is meant by *inheritance*. **1**

   (iv) Write a Prolog rule to ensure that any subclass will inherit its appropriate "reproduces_by" property. **2**

(d) The expert system is to be installed on public access computers in a Natural History Museum. Describe how *beta testing* may be carried out on the software. **2**

[Turn over

Part A — Artificial Intelligence (continued)

8. A *natural language* system stores vocabulary as Prolog *lists* of related words. For example: [red, green, blue, brown, purple, yellow], [north, south, east, west] and [a, an, the].

When analysing a sentence, the system must check if a word is a member of one of these lists.

(*a*) List membership can be defined using two clauses. The first of these is member_of(X,[X|Tail]).

   (i) Explain the meaning of this clause. **2**

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

   (iii) The following query could be used by the system to check whether the word "green" was in the list of colour words:

?member_of(green,[red, green, blue, brown, purple, yellow]).

Describe how Prolog would use *recursion* to evaluate this query. **3**

(*b*) Implement a *parse tree* for the sentence "Prolog is a declarative language". **3**

(*c*) Explain, using examples, why the natural language system might check that a word was in a particular list, during:

   (i) *syntactic analysis*; **2**

   (ii) *semantic analysis*. **2**

Part A — Artificial Intelligence (continued)

**9.**   The following rule is part of a *forward chaining* expert system:

IF(I can walk to work AND it is good weather) OR IF I can get the bus to work OR IF I can drive to work THEN I can travel to work.

(*a*) (i)   Represent this rule in the form of an *AND/OR graph*.   **2**

     (ii)   Use the rule and the AND/OR graph to explain the meaning of the terms *syntax* and *semantics*.   **2**

(*b*) The terms *conflict set* and *conflict resolution* are used to describe how forward chaining systems operate.

     (i)   Describe what is meant by the term "conflict set".   **2**

     (ii)   Describe an example of a conflict resolution strategy.   **1**

(*c*) The user interface of the expert system allows the user to answer questions such as "Is the weather good" on a scale of 0 to 100, where 0 means "definitely not", 100 means "definitely yes" and numbers between these two extremes represent responses such as "quite good".

     (i)   A user selects 40 as the answer to a question. Describe how the system will use this information to come to a conclusion.   **2**

     (ii)   At the design stage, a choice has to be made between two methods of data entry: using a mouse-driven slider on the screen, or by typing a number into a text box.

          State which of these you would recommend, and justify your choice.   **1**

[Turn over

Part A — Artificial Intelligence (continued)

10. (*a*) Robotic vision systems may make use of the *Waltz algorithm*.

(i) Describe briefly how the Waltz algorithm determines whether an edge is convex or concave.   **2**

(ii) Describe the **purpose** of the Waltz algorithm in a vision system.   **2**

(*b*) An intelligent industrial robot operates in a waste disposal plant. It identifies and categorises objects as they appear on a conveyor belt, using its vision system.
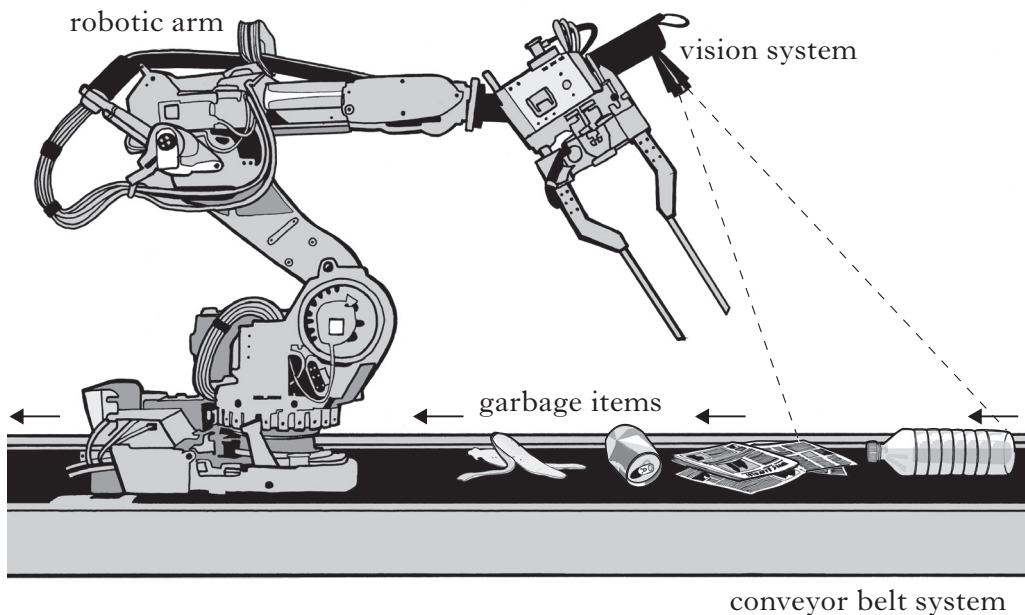
(i) Explain why the Waltz algorithm is unlikely to be very useful to the waste sorting robot.   **1**

(ii) Name and describe one form of *machine learning* which could be used to improve the performance of this robot's ability to categorise objects.   **3**

(60)

[END OF SECTION II—PART A]

Part B — Computer Architecture

Answer ALL questions in this section.

11. Eric enters the following assembly language instructions as part of his programming project.

CLC	clear the carry flag
ADC 2009	add the number from location 2009 to the current value in the accumulator
DEX	reduce the value in the X register by 1
BNE −8	if X is not zero, branch back 8 locations
STA 2006	store the result in location 2006

(*a*) (i) State **one** logical instruction from the set above. **1**

(ii) State **one** data transfer instruction from the set above. **1**

(*b*) (i) State the addressing mode being used by the instruction: DEX. **1**

(ii) State the addressing mode being used by the instruction: STA 2006. **1**

[Turn over

Part B — Computer Architecture (continued)

12. Vid-U-Learn produces video clips using a high performance computer system with large storage capacity. The company considers purchasing the following two computer systems.

Omitron	
Processor clock speed	3·2 GHz
Data bus width	128 bits
Registers	256 general purpose registers, 32 of which are for use with *SIMD* instructions. All registers are 128 bits.
Cache	512 Kilobytes of *level 1 cache*, 2 Megabytes of *level 2 cache* located on the processor.
Internal hard drive capacity	1 Terabyte
External hard drive	2 Terabyte MintorM1 external hard drive connected through a *PCI* bus.

Alphatron	
Processor clock speed	3·2 GHz
Data bus width	128 bits
Registers	16 general purpose registers. All registers are 128 bits.
Cache	512 Kilobytes of *level 1 cache*, 2 Megabytes of *level 2 cache* located on the motherboard.
Internal hard drive capacity	1 Terabyte
External hard drive	2 Terabyte MintorM1 external hard drive connected through a *PCI-X* bus.

(*a*) Identify **two** reasons why the Omitron is likely to perform better than the Alphatron when processing most tasks. Explain your answer.   **2**

(*b*) Explain why the Omitron is more suited to *RISC* processing than the Alphatron.   **2**

(*c*) (i) Explain why the Alphatron will be able to transfer data from the external hard drive 8 times faster than the Omitron.   **3**

   (ii) Describe **one** technique that could improve the speed of data transfer from the hard drive on both the Alphatron and the Omitron.   **3**

Part B — Computer Architecture (continued)

12. **(continued)**

(*d*) The instruction set used by the processor in the Omitron contains SIMD instructions.

    (i) Describe how SIMD instructions operate with reference to the specifications of the Omitron.   **2**

    (ii) Calculate the maximum amount of data that the Omitron can process in one operation using a SIMD instruction.   **2**

   (iii) Describe how the use of SIMD instructions improves the performance of the Omitron when changing the background colour on a video clip.   **2**

[Turn over

Part B — Computer Architecture (continued)

13. The *IA-64* is a *superscalar* processor which uses *data flow analysis*.

(*a*) (i) Describe how the IA-64 superscalar processor can execute instructions in parallel. **2**

(ii) Explain why the processor uses the technique known as data flow analysis. **2**

(iii) Describe data flow analysis. **2**

(*b*) When running a certain program, the processor examines the entire list of instructions and as a result selects and executes the following instructions in advance:

LDY 2004   load the Y register with data held in location 2004
LDX 2005   load the X register with data held in location 2005

(i) Explain why loading instructions in this way will lead to improved processor performance. **3**

(ii) Name the technique being used by the processor. **1**

(*c*) (i) Explain why the following instructions can cause problems for some superscalar processors:

BNE   branch if zero flag is clear
BMI   branch if negative flag is set **2**

(ii) Each time the IA-64 executes the instruction BMI, there is no delay in processing, even when the negative flag is set. Explain why. **3**

(*d*) In a single fetch from memory the IA-64 fetches three instructions and one 5-bit pointer from memory in **one** operation. Each instruction is 41 bits in length.

Explain why this would not have been possible using an x86 series processor such as the 80386 processor. **2**

Part B — Computer Architecture (continued)

14. A parallel computer has thousands of processors which are connected using a mesh topology.

  (*a*) Describe **two** methods which processors use to communicate with each other in a parallel computer system. **2**

  (*b*) Describe how memory is structured in a *parallel processing* system. **2**

  (*c*) Identify an appropriate application of a parallel computer system and justify your choice. **2**

[Turn over

Part B — Computer Architecture (continued)

15. Jean runs a software development company. She wants to display a hidden file named **accounts** which is stored on the hard drive, labelled C, of her computer system. The operating system, Koala, enables her to change the hidden file *attribute* by using the:

- command **attrib -h C:\accounts.xls**

or

- GUI to perform the same task.

Jean decides to use the GUI to change the file's attribute.

(*a*) (i) Describe **one** demand on memory and **two** demands on processor time made by the operating system in order to change the file's attribute using the GUI. **3**

  (ii) Explain what the advantage would be for Jean in using the command rather than the GUI to reset the file's attribute. **2**

(*b*) Explain the meaning of the terms *syntax* and *semantics* with reference to the **attrib -h C:\accounts.xls** command. **3**

(*c*) The operating system enables applications to perform common tasks such as reading in data entered at the keyboard or displaying output to the screen.

  (i) Describe how the operating system provides this facility. **1**

  (ii) Describe a benefit this facility has for Jean when she is developing software. **2**

  (iii) Describe a benefit this has for the user of the software. **1**

(*d*) All Jean's software contains a module which can identify a user's computer and send this data back to her system over the Internet. This module is activated when a user attempts to copy the software without permission.

Describe **one** legal and **one** ethical implication of her use of this module. **4**

(*e*) Koala uses variable memory partitioning to allocate memory to processes.

Describe variable memory partitioning. **1**

(60)

[END OF SECTION II — PART B]

Part C — Computer Networking

Answer ALL questions in this part.

16. A cable TV company uses a network to deliver video, telephone and data services. A combination of *co-axial* and *fibre* cabling is used to give a cost-effective, yet reasonably high performance, network. Some customers use a *wireless communication method* to share the Internet access available through the cable connection within their households.

   (*a*) Compare the bandwidth of co-axial cable and optical fibre. **2**

   (*b*) Describe how the two different types of cable would be used by the cable company within the network. **2**

   (*c*) State the name and data transfer rate of a wireless communication standard likely to be used by customers to share Internet access within their household. **2**

   (*d*) Wireless networks can use a variety of methods to keep them secure.

      (i) Describe how MAC addresses could be used to help secure a wireless network. **2**

      (ii) Data interception is a security threat that your answer to (*d*)(i) cannot prevent.

         Explain why this vulnerability still exists and describe a method that would help secure the wireless network against this threat. **2**

   (*e*) Many customers use a *firewall* to protect their network from Internet threats.

      (i) Describe **one** possible Internet threat that a firewall could be used to prevent. **1**

      (ii) Describe **one** firewall rule that could be applied to prevent the threat described in (*e*)(i) above. **1**

   (*f*) Some customers use the *PPTP* protocol whilst communicating with remote servers.

      Explain why the PPTP protocol is used. **2**

[Turn over

Part C — Computer Networking (continued)

17. The banking industry is a leading user of computer technologies.

(*a*) Most banks will use hardware and software that employ internationally-recognised standards.

    (i) Describe **two** advantages of this approach.   **2**

    (ii) Describe **one** disadvantage of this approach.   **1**

(*b*) The banking industry has to consider the legal implications of its use of computer networks. Name a specific law relating to computer use that they will have considered and state how it will have affected their operations.   **2**

(*c*) Banks store their data in centralised data processing centres. Within these centres there is a comprehensive sequence of backups. Explain why the use of incremental backups is particularly relevant in the banking industry.   **3**

(*d*) Banks increasingly use web servers to allow online transactions. Some bank web servers have been the target of *smurf* attacks.

    (i) State **one** step that can be taken to ensure that smurf attacks would not be successful.   **1**

    (ii) Before a bank launches a new online service, the service will have been *beta tested*. Explain what beta testing is.   **2**

    (iii) It is essential that Internet banking services have a good user interface.

    Describe **two** features of a good user interface for an Internet banking service.   **2**

Part C — Computer Networking (continued)

18. The Internet provides access to a range of services including the WWW and e-mail.

(*a*) All e-mail messages have a header and a body. The header part is made up of several items of information, some entered by the user and some created automatically.

State **two** header items that are created automatically. **2**

(*b*) The protocol used in the process of sending an e-mail message is *SMTP*. The sending of a message is broken into three main stages. The first stage is connection setup.

(i) State the purpose of the second and third stages of sending a message. **2**

(ii) The start of the SMTP dialogue between a mail server and a client is shown below.

Sent by	Message
Server	`220 smtp.exampleserver.com`
Client	`HELO relay.example.org`
Server	`250 Hello relay.example.org, I am glad to meet you`

Explain the meaning of the terms *syntax* and *semantics* with reference to the client response:

`HELO relay.example.org` **2**

(*c*) Name and describe a technique that can be used to guarantee that the apparent sender of an e-mail is the actual sender and that the message contents have not been altered. **4**

(*d*) The section of *HTML* code shown below embeds a Flash object within a web page.

```
<object width ="550" height="400">
<param name="movie" value="somefilename.swf">
<embed src="somefilename.swf" width="550" height="400">
</embed>
</object>
```

(i) State why Flash objects are used. **1**

(ii) Describe how a browser handles a Flash object. **2**

(iii) Write HTML code that will display the text "Understanding Flash Objects" as a hyperlink to the URL http://www.webobjects.net/flash/. **3**

(*e*) Requests for web pages are often routed through an *intermediate* such as a *gateway*. Describe **two** reasons for using a gateway as an intermediate. **2**

(*f*) Some web pages have *ActiveX* code embedded within them. State **two** disadvantages of using ActiveX rather than *Java applets*. **2**

[Turn over for Question nineteen on *Page twenty-four*

Part C — Computer Networking (continued)

19. The partially completed diagram below shows how the *TCP/IP* and the *OSI* models relate to each other and gives examples of protocols used at some of the TCP/IP layers.

OSI	TCP/IP	Protocols
Application	Application	POP3, HTML
Presentation		
Session		
Transport	Transport	TCP, UDP
Network		IP
Data Link	Network	
Physical		

(*a*) (i) Name the TCP/IP layer that corresponds to the OSI Network layer. **1**

   (ii) Name a protocol that could be used at the Network level of the TCP/IP model. **1**

(*b*) The IP class system can be amended by using *Subnet masks* or *CIDR*.

   (i) State the core principle of the IP Class system that subnet masks and CIDR alter. **1**

   (ii) Describe the difference in the way that CIDR and subnet masks are used. **3**

   (iii) Calculate the binary and decimal representation of a subnet mask that allows up to 64 nodes on a network. **3**

(*c*) *Trace route* can be a useful troubleshooting tool for networks. Describe how trace route operates. **4**

(60)

[*END OF SECTION II — PART C*]

[*END OF QUESTION PAPER*]