C206/SQP257

Computing
Advanced Higher

NATIONAL QUALIFICATIONS

Contents *Page*

Course Assessment Specification

Computing Advanced Higher

The purpose of this document is to provide:

- Details of the structure of the Question Paper for this Course
- Details of the structure of the Practical Coursework task that contributes to this Course
- Guidance to centres on how to use information gathered from the Question Paper and the Practical Coursework Task in this Course to estimate candidate performance.

Part 1

This part of the Course Assessment Specification details the structure of the Question Paper for this Course

The Question Paper

- consists of 2 sections
- has a mark allocation of 120 marks
- has a time allocation of 2 hours 30 minutes.

Section I - 60 marks

- consists of questions requiring extended responses demonstrating structuring and reasoning
- questions have varying mark allocation and therefore do not have to be of the same length. Most questions will subdivided into a number of connected parts with the marks for each part clearly indicated.
- questions will involve both knowledge and understanding and problem solving, and will be set in a range of contexts
- approximately 20 marks will be for knowledge and understanding
- approximately 40 marks will be for problem solving
- questions will sample across the content statements associated with the mandatory units (Software Development and Developing a Software Solution)
- some questions, or parts of questions, will require integration of knowledge from the two mandatory units
- candidates will be expected to tackle all questions in the section.

Section II - 60 marks

- this section has three sub-sections, one for each of the optional units (Artificial Intelligence, Computer Networking and Computer Architecture)
- candidates will be expected to tackle all the questions within **one** sub-section
- each sub-section consists of questions requiring extended responses demonstrating structuring and reasoning

- questions have varying mark allocation and therefore do not have to be of the same length. Most questions will subdivided into a number of connected parts with the marks for each part clearly indicated.
- questions will involve both knowledge and understanding and problem solving, and will be set in a range of contexts
- approximately 20 marks will be for knowledge and understanding
- approximately 40 of the marks will be for problem solving
- questions in each sub-section will sample across the content statements associated with the appropriate optional unit
- some questions, or parts of questions, will require integration of knowledge from the mandatory units.

Part 2

This part of the Course Assessment Specification details the structure of the Practical Coursework Task in this Course.

- The Practical Coursework Task has a mark allocation of 80 marks
- There is no set time allocation, but an appropriate project should be achievable by a typical candidate during the 40 hours of the Developing a Software Solution unit, with approximately 10 additional hours to produce the documentation and report

- The task provides the candidate with the opportunity to demonstrate and integrate practical skills and knowledge they have developed within the mandatory units (Software Development and Developing a Software Solution) in a more complex and less familiar context than is possible within the units

- A practical project will be chosen by the candidate in discussion with the teacher/ lecturer
- The project should be at an appropriate level for the course (see guidance in the support notes for the unit Developing a Software Solution)

- The task may be undertaken in "open book" conditions, but under supervision of the teacher/lecturer, to ensure that the work presented is the candidate's own work
- Where a number of candidates undertake a collaborative project, the teacher/ lecturer must ensure that each candidate's individual contribution can be clearly identified and assessed
- The task will be marked by the teacher/lecturer, using a marking scheme provided by SQA, but be subject to moderation
- The candidate is required to submit
  - the problem specification
  - evidence of project planning
  - evidence of a completed solution (preferably files on a CD plus hard copy of coding/data files, screen shots)
  - user documentation and technical documentation
  - an evaluation report
- The marking scheme will provide a mark out of 80, which will be submitted directly to SQA without scaling
- The teacher or lecturer may give the candidate guidance and/or help if requested. Any significant help should be reflected in the marks awarded
- Once the task has been completed and marked, it should **not** be returned to the candidate for further work.

Part 3

This part of the Course Assessment Specification provides guidance on how to use assessment information gathered from the Question Paper and the Practical Coursework task to estimate candidate performance

Component	Mark Range
Question Paper	0-120
Practical Coursework	0-80
Total Marks	0-200

The mark range for each component takes account of the weighting of each component.

In National Qualifications cut-off scores should be set at approximately 70% for grade A and 50% for grade C with grade B falling midway.

For a total mark range of 0-200, the following gives an indication of the cut-off scores based on the candidate's **total** score.

Grade	Band	Mark Range
A	1	170-200
A	2	140-169
B	3	130-139
B	4	120-129
C	5	110-119
C	6	100-109
D	7	90-99
NA	8	80-89
NA	9	0-79

These cut-off scores may be lowered if question paper component turns out to be more demanding or raised if less demanding.

Worked example

- In a centre's own prelim, a candidate scores 88/120, and the candidate scores 37/80 in the practical coursework
- The two marks are added together, giving a total of 125/200
- The centre's view is that their own prelim is slightly less demanding than SQA examination.
- Using the mark range, a realistic estimate may be **band 5** rather than band 4.

C206/SQP257

Advanced Higher Computing

Time: 2 hours 30 minutes

NATIONAL QUALIFICATIONS

Specimen Question Paper
for use in and after 2006

Answer questions from **both** sections: Section I and Section II.

Section I: attempt all questions in this section.

Section II has three parts: answer questions from any **one** of the parts A, B, or C.

Read the instructions at the beginning of each section.

SCOTTISH QUALIFICATIONS AUTHORITY

SECTION I — Software Development & Developing a Software Solution

Answer ALL questions in this part

Marks

1. The Principal of Clydeside College would like to introduce a computerised system to replace the current manual system that is used to process student enrolments at the start of each new academic session.

The Principal has discussed the possible benefits of a computerised system with the College Administration Department and with each Head of Faculty. Together, they have produced a project proposal which outlines their plans for the new computerised system.

(*a*) The Principal decides to employ a team of systems analysts to study the project proposal and develop a computerised enrolment system that meets the College requirements.

The team of systems analysts will be involved in a number of activities including:

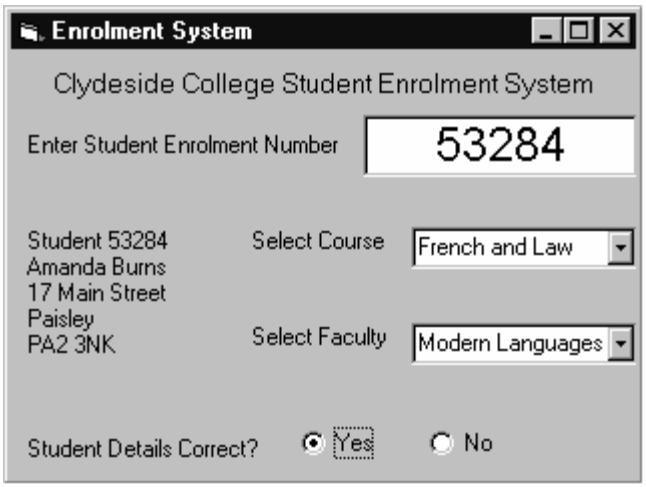
- carrying out a *feasibility study*
- producing an *operational requirements document*.

For each of the activities listed above, describe in detail what is meant by the term shown in italics and what would be involved at this stage of the analysis in relation to the college enrolment system. **6**

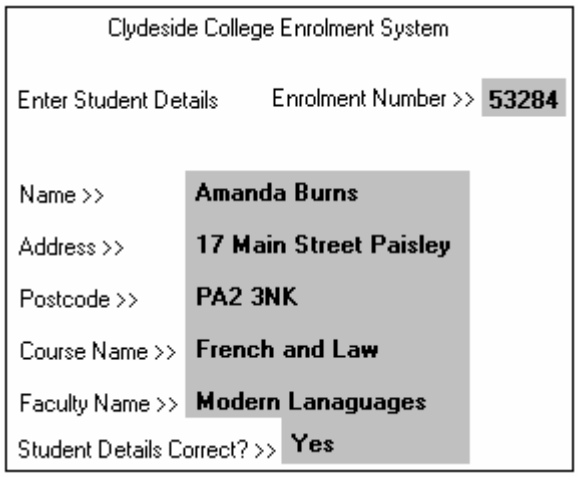
(*b*) The result of the analysis stage of the software development process will be an operational requirements document. State **one** difference between an operational requirements document and a system specification. **2**

(*c*) Once the system specification has been produced, the design team begin to work on the design of the new computerised system. An important part of the designers' work is to consider a suitable interface for the new enrolment system. Look carefully at the interfaces shown below.

Interface A



Interface B



Comment on each of these interfaces in terms of:

(i) ease of use; **2**

(ii) scope for error. **2**

Marks

(*d*) An important part of the design process is planning the detailed logic for the solution.

(i) It may be necessary to delete a student's details from the college enrolment system. Describe, using an appropriate design methodology, how student details could be removed from the enrolment file so that the file contains no blank spaces. **3**

(ii) Explain how a *dry run* could be used to validate the design produced in part (i) above. **2**

(*e*) During the implementation stage of development, the programming team produce code that matches the detailed design produced by the designers. The solution could be coded using an *object-oriented programming language*.

What features of an object-oriented programming language

(i) assist the programmer in developing the solution and **2**

(ii) aid the maintainability of the solution? **2**

(*f*) Once the system has been implemented, testing is carried out.

(i) Explain the need for both *component* and *module testing*. **2**

(ii) Explain how *trace tables* and *breakpoints* are used in the testing process. **2**

(*g*) On completion of the project, the solution is evaluated. In the evaluation, there are comments about the use made by the development team of *user-defined modules* and *CASE tools*.

(i) Explain why the use of user-defined module libraries can lead to a reduction in development time. **2**

(ii) Identify **two** benefits to the development team of using CASE tools. **2**

Marks

2. Compilers must to be able to deal with arithmetic expressions such as

(9 - 2) * (3 + 4)

One way of dealing with expressions of this type is to:

- transform the expression into a sequence of symbols.
- process the sequence of symbols using a *stack data structure*.

(*a*) Explain what is meant by a stack data structure. **2**

(*b*) The above expression is transformed into the following sequence of symbols:

9 2 - 3 4 + *

This sequence of symbols is then processed using a stack by applying the following algorithm:

```
start loop
  get next symbol
  if symbol is a number then
    add symbol to top of stack
  end if
  if symbol is an operator then
    remove the top two items from the stack and carry out
    the operation on these values
    add the result to the top of the stack
  end if
end loop
```

Using a diagram, show the state of the stack after the "3" has been added to it. **2**

(*c*) Give the upper limit of the size of the stack needed in this case. **1**

3. A printer buffer uses a *queue data structure* to hold items of data that are to be printed.

Explain how a queue data structure can be used to hold and process items in the printer buffer queue. Draw a labelled diagram to illustrate your answer. **4**

Marks

4. At a canoe slalom event, twenty competitors are timed on a section of river. At the finishing line, a judge writes down each competitor's name, bib number, time and penalty points. After three competitors have completed the course, the judge's notes look like this:

Name	*Bib number*	*Time (seconds)*	*Penalty points*
J Ashcroft	273	127·4	15
N Khan	185	153·2	10
S Buchanan	99	187·4	45

The judge is to be provided with a laptop computer running a specially designed program. This will allow each competitor's name, bib number, time and penalties to be entered as they finish.

(*a*) Describe how you would store the competitors' details **using** a record data type (you should assume that a record data type exists in the language selected for implementation of the program). You may illustrate your answer in a programming language of your choice. **3**

(*b*) Describe how you would store the competitors' details **without using** a record data type (you should assume that the language selected for implementation of the program **does not** support a record data type). You may illustrate your answer in a programming language of your choice. **4**

Marks

5. A list of names has been stored in an array as part of a personal organiser program which is being developed by a team of programmers.

The programmers want to add a search feature to the program so that a person's name can be found quickly. It has been decided that a *binary search* will be used.

(*a*) What would need to be done to the list of names before a *binary search* can be used? **1**

(*b*) State **three** data items, other than the list of names and the name being searched for, that would be required to implement the *binary search algorithm* and explain how these data items are used in the algorithm. **4**

(*c*) Using the list of names below

Ann, David, Hardeep, Mhairi, Sean

show that the *binary search algorithm* uses fewer comparisons than the *linear search algorithm* to find the name Mhairi. **3**

(*d*) In what circumstances would the *linear search algorithm* use fewer comparisons than the *binary search algorithm*? Explain your answer. **2**

(*e*) The programmers would like to add a sort feature to the program so that when a new name is added, the list of names is automatically sorted into alphabetical order. The possible algorithms are *selection sort*, *simple sort* and *bubble sort*.

(i) Describe how a simple sort works. **2**

(ii) Most sort algorithms work in place, ie by rearranging the given array without using additional temporary memory. Which algorithm **does** need additional temporary memory? Explain your answer. **2**

(iii) Explain why the bubble sort algorithm is best when the list is already partially sorted. **1**

(60)

[*END OF SECTION I*]

SECTION II

Part A — Artificial Intelligence
Part B — Computer Networking
Part C — Computer Architecture

Choose **one** of the parts A, B or C.
Answer **all** questions from that part.

Marks

SECTION II — Part A — Artificial Intelligence
Answer ALL questions in this part.

6. Following a consultation with a user, an expert system is normally expected to offer some advice. Many expert systems offer the advice accompanied by a *certainty factor*.

(*a*) Describe **two** benefits that can be claimed for the provision of certainty factors. **4**

(*b*) Why might some expert systems not provide certainty factors? **2**

(*c*) The following rules are created to give a certainty factor (CF) between 0 and 1 to the chances of someone being able to play basketball:

IF is-tall(X)
AND has-good-coordination (X)
THEN could-play-basketball(X) CF 0·5

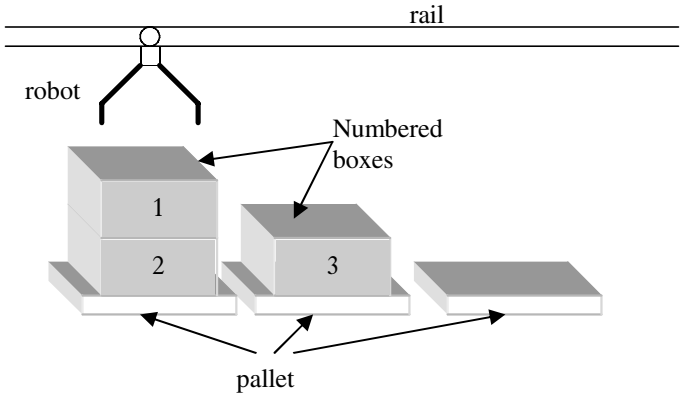
If the expert system has already concluded that is-tall(fred) with CF 0·3 and has-good-coordination(fred) with CF 0·8 then what would be the certainty factor of could-play-basketball(fred)? **3**

7. An early AI program uses *forward chaining* and works by matching its rules against the user's last sentence. The selection of a rule to fire is based on fixed strategies, known as *conflict resolution* strategies. Describe **two** strategies that can be used to decide which rule to fire. **4**

8. An automated warehouse contains numbered boxes which are to be stacked on three pallets. The boxes are manipulated by a robot that travels on an overhead rail. The robot is fitted with an extendable gripper and can perform two types of operation as follows:

- If the robot's location is above a non-empty pallet, it may transfer the top box from this pallet onto another pallet. Thus, the robot can transform the scene shown in scene S1 into the one shown in scene S2.

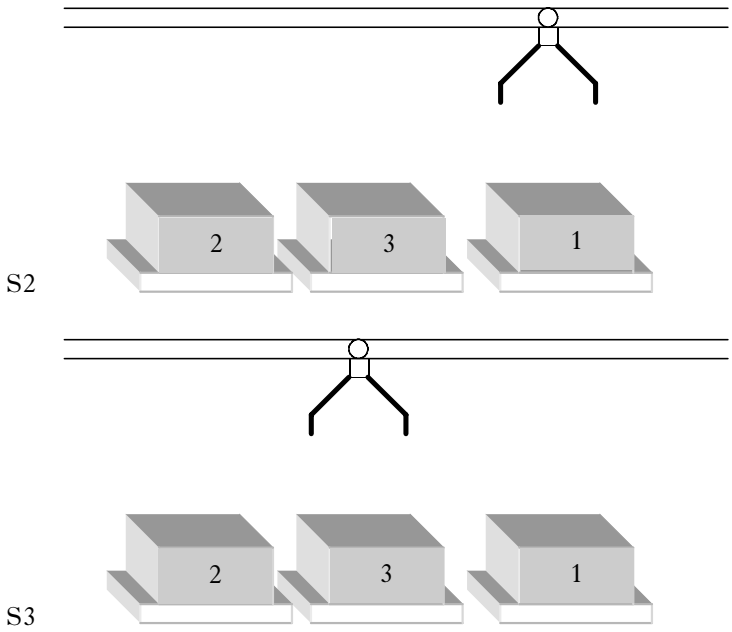
- The robot can move from one location to another directly above a pallet without transferring any box. Thus, scene S2 can be transformed into scene S3 by this operation.



S1

Question 8 is continued on the next page

Marks



The scene S1 can be represented by

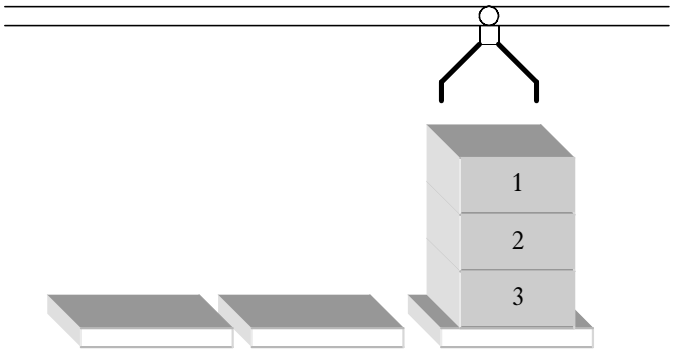
<L, [1,2],[3],[ ]>

(*a*) Using the same symbolic notation, write down the representations of:

(i) the **three** other transformations which could be applied to the boxes in scene S1; **3**

(ii) the **three** other transformations which could be applied to the boxes in scene S2. **3**

(*b*) In a typical problem, the robot's task is to transform scene Sl into the scene shown below by a suitable sequence of operations.



(i) Write down the symbolic representation of this problem's goal state. **1**

(ii) Draw part of a search tree for the problem, labeling each node with the appropriate symbolic state representation. Your tree should show all states reachable from scene Sl within **two** operations. One branch, which you should identify clearly, should be extended further to reveal a solution to the problem. **6**

(iii) Ideally, the robot's control software should find very quickly a solution which requires the fewest operations. Explain why *depth-first* and *breadth-first* search methods may not give rise to ideal performance. **4**

Marks

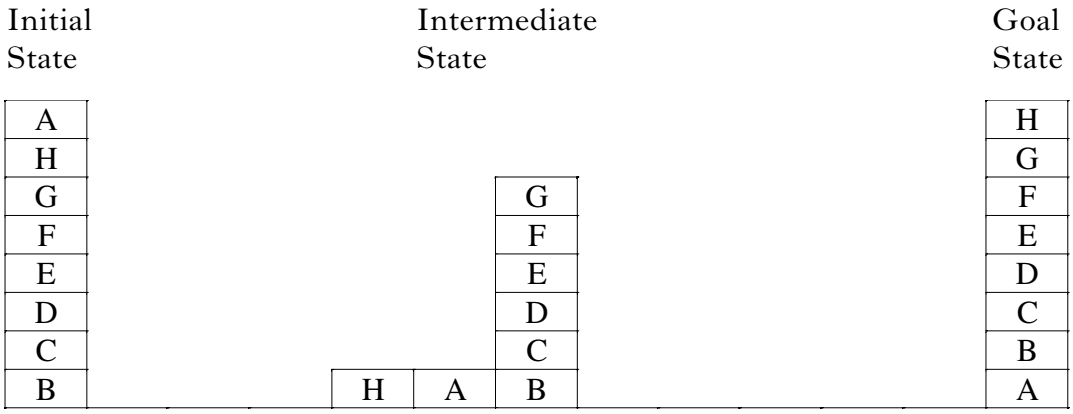
9. Describe the *minimax procedure* and give an example of when it may be used. **3**

10. Represent the following knowledge using an AND/OR graph.

> *Jane decides she wants a different outfit to wear to a school dance. She can either borrow a friend's dress and shoes or she can earn enough money, to buy a new dress and shoes. To earn the money Jane could get a job at the local supermarket or do some gardening and window washing. Once she has enough money, Jane has to decide whether to buy everything from a catalogue or go to a shoe shop and a dress shop.*

6

11. Consider the *blocks world* problem below:



Two operators can be used namely:

- *Pick up one block and put it on another and*
- *Pick up one block and put it on the table*

Assume that the following state evaluation function is used:

Add one point for every block that is resting on the block that it is supposed to be resting on or is in the correct position resting on the table. Subtract one point for every block that is NOT resting on the block that it is supposed to be resting on.

(*a*) Using this function what is the score of the goal state? **1**

(*b*) Using this function what is the score of the initial state? **1**

(*c*) Describe the only possible first move and evaluate the resulting state. **2**

(*d*) There are then three possible second moves. Write down these **three** moves using block notation and evaluate each of the states. **3**

(*e*) Explain what would happen next if the *hill-climbing heuristic* is used. **1**

Marks

12. Apply the *Waltz algorithm* to label the lines of the cuboid.

4

13. Parse the following sentence:

The young cat sat on the red mat. **3**

14. An example of a member rule in Prolog is as follows:

member(X,[X|_]).

(*a*) Use this rule to explain list processing. **3**

(*b*) What would be the answer to the following Prolog query?

?-member(david,[john,mary,david,tom,ann])

Explain your answer. **3**

(60)

[*END OF SECTION II — Part A*]

Marks

SECTION II —Part B — Computer Architecture
Answer ALL questions in this part.

15. (*a*) Name and describe the purpose of **two** processor registers. **4**

(*b*) Explain what is meant by the term *instruction set* for a processor. **2**

16. RISC and CISC are two different processor architectures.

Explain how RISC processors aim to achieve performance gains over CISC processors. **4**

17. A processor has a 32 bit data bus and a 32 bit address bus. The operation code of a machine instruction occupies 1 byte. Two machine instructions available to the processor are described below.

Load the accumulator - direct addressing mode, eg LODA 1EF0
Load the accumulator - immediate addressing mode, eg LODA #0F

(*a*) (i) What is meant by addressing mode with respect to a machine instruction? **1**

(ii) How much memory, in gigabytes, can be addressed by this processor? **2**

(*b*) The processor must undergo various tests. One section of a test program has an instruction LODA #N, which must be fetched and executed.

If the program counter is currently set at location 1000_{hex}, what will it be set at after the instruction LODA #N has been fetched from memory and executed? Explain how you obtained your answer. **2**

(*c*) The fetch part of the instruction requires reading the contents of the appropriate memory location.

Describe in detail the operating steps, with reference to the buses and registers involved, that take place to enable the instruction to be read from memory. **4**

18. (*a*) Explain the advantages of using Direct Memory Access (DMA) over other techniques, for example software-serviced interrupts, when transferring data from a disk to main memory. **3**

(*b*) Explain, with the aid of a diagram, one method of implementing DMA. Your diagram should indicate how DMA techniques make use of the address and data buses. **3**

(*c*) A certain processor takes 30 nanoseconds to complete one clock cycle. The speed of memory to carry out a read or write request is 70 nanoseconds.

Name and describe one memory technique which can be used to enable multiple accesses simultaneously in this situation. **5**

Marks

19. Consider the following storage media:

hard disk
magnetic tape;
CD-RW;
rewriteable DVD.

Evaluate the suitability of each of the above storage media for the backup of one gigabyte of data. **4**

20. Describe the benefits and limitations of parallel processing. **4**

21. Operating systems must provide functions such as scheduling programs, managing data transfers and managing files. Recent operating system designs also aim to adhere to the "convenience of the user" principle. This allows the user to place more demands on system resources.

(*a*) Recent trends have led to operating systems including services and providing capabilities that were formerly within applications.

(i) Give details of the operating system's services in terms of:

- providing a standard look and feel for applications
- improving the capability of programs to communicate and pass data. **4**

(ii) Explain why the trend to expand the role of the operating system to include these services has taken place. **2**

Marks

(*b*) In a disk filing system which uses contiguous allocation of files, two popular algorithms for allocating files to unused disk space are *first fit* and *best fit*.

Below is a list of files to be stored on disk and a list of unused disk blocks and their sizes. The list of unused disk blocks is sorted by address.

Files to be Written to disk	**Unused disk blocks and sizes**
File 1: 45 Kb	Block A: 75 Kb
File 2: 74 Kb	Block B: 40 Kb
File 3: 35 Kb	Block C: 50 Kb
File 4: 38 Kb	Block D: 35 Kb

Describe what happens when an attempt is made to write the above files using:

(i) first fit; **2**

(ii) best fit. **2**

(*c*) Operating systems need to schedule programs in a multitasking system. Two types of pre-emptive scheduling are *round robin scheduling* and *multi-level feedback queue*.

(i) Why does the operating system need to schedule programs in a multitasking system? **2**

(ii) Compare round robin scheduling and multi level feedback queue. Your explanation should include the effect each type has on system performance. **4**

(*d*) Name **two** operating systems and compare how the following tasks could be accomplished:

(i) organising and viewing directories; **2**

(ii) installing and uninstalling programs; **2**

(iii) resource sharing. **2**

(60)

[*END OF SECTION II — Part B*]

Marks

SECTION II —Part C — Computer Networking

Answer ALL questions in this part.

22. (*a*) Explain the need for organisations that define standards such as the *ISO* and *IEEE*. **2**

(*b*) (i) A school network system uses *TCP/IP*. Describe how this protocol can be mapped onto the *OSI* model layers. **1**

(ii) Explain why the school would benefit from using *TCP/IP* for its internal network. **2**

23. A school network system has a *fibre* connection to the local authority intranet. The local authority acts as an Internet Service Provider (ISP) for the school. For example, all requests for pages on the World Wide Web from the school go first to the local authority system and the results of these requests are passed back through the fibre link to the school.

Internally, the school network uses *unshielded twisted pair* (UTP) cabling. The school network consists of approximately 200 personal computers as well as a smaller number of networked resources such as printers.

(*a*) Compare the bandwidth of these two transmission media:

- fibre;
- UTP. **2**

(*b*) Explain why fibre is appropriate for the local authority whilst UTP is more appropriate for the school. **2**

(*c*) A new science block is built for the school on the other side of a road from the existing school building.

Explain the advantages and disadvantages to the school of using a wireless communication method to network the computers in the new science block.

Your answer should refer to

- modern data standards (eg 802.11g)
- security
- performance issues. **6**

24. A network uses a *Classless Inter-Domain Routing* (CIDR) IP addressing scheme. A CIDR address is written as:

206.13.01.48/16

(*a*) Describe CIDR. You may find it helpful to refer to the above example. **5**

(*b*) Show how the CIDR address 206.13.01.48/16 can be considered equivalent to one Class B IP address. **2**

Marks

25. A school allows all pupils, staff and parents to vote in an election to choose the school captain and vice-captain. Votes will be cast on-line either in the school on its intranet or from home through the Internet.

(*a*) One proposal is to simply allow voters to send their vote by e-mail. Describe how the following protocols are involved in the sending and receiving votes by e-mail:

(i) SMTP **3**

(ii) POP. **3**

(*b*) The voting e-mail could be a simple text message such as:

```
Vote Captain          Jan Grey
Vote Vice-Captain     Olivia Munroe
```

Explain why the MIME protocol would **not** be required to send votes in this format. **2**

(*c*) One problem with using e-mail to send votes would be ensuring that each person was only allowed one vote. Part of the solution to this problem could be to use *public-key encryption* and *digital signatures*.

(i) Give a detailed description of *public-key encryption* and *digital signatures*. **4**

(ii) Explain how these network security methods could be used to help ensure each person could cast only one vote. **4**

(*d*) An alternative voting method is also being considered which will allow parent voters to connect to a secure server in the school from their home computers using a *virtual private network*.

Explain why a virtual private network protocol (for example PPTP or L2TP) would make the casting of parents' votes more secure. **2**

Marks

26. A computer on a school network system cannot create an *end-to-end TCP* connection when transferring data using HTTP from a remote server. Instead, the computer has to use an intermediate system as a relay.

(*a*) Describe how the process of requesting a Web page is handled using each of these intermediate connections:

- proxy
- gateway
- tunnel. **6**

(*b*) A pupil in the school wishes to access a simulation of a science experiment on a Web page but discovers that the simulation cannot be used with the basic installation of the browser software on the school computer.

(i) Describe how the browser functionality can be enhanced using plug-ins and Java applets. **4**

(ii) How might these be used in the science experiment simulation? **2**

(*c*) The provider of the on-line web-based science experiment simulation offers a video telephone helpline.

Describe the technical implications of accessing this helpline.

Your answer should refer to:

- hardware;
- software;
- data transmission;
- data compression. **8**

(60)

[*END OF SECTION II — PART C*]

[*END OF SPECIMEN QUESTION PAPER*]

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C206/SQP257

Advanced Higher Computing

Time: 2 hours 30 minutes

NATIONAL QUALIFICATIONS

Specimen Marking Instructions
for use in and after 2006

SCOTTISH QUALIFICATIONS AUTHORITY

SECTION I — Software Development & Developing a Software Solution

1 . (*a*)

Stage	*Meaning*	*What is Involved*
Feasibility Study	An investigation of the problem to see whether the problem is worth solving.	Assessing the technical, economic, legal and time feasibility to see if a solution is worth doing. Consider alternative approaches to proceeding with the task.
Operational requirements document	This describes the proposed system clearly in a form that will be understood by designers and client.	The ORD will form a legally binding contract. It will be the basis of what goes next so must be stated clearly.

Award 1 mark for correct meaning of each stage; award 2 marks for a full description of what is involved at each stage. Maximum of 6 marks.

(*b*) A system specification is a document that states the way that the problem must be solved whereas a requirements specification states what is required by the solution.

Award 1 mark for clear description of purpose of each. Maximum of 2 marks.

(*c*) (i) Interface A makes use of drop down lists and radio buttons which means it is user-friendly and users are more inclined to explore the facilities of the software. Interface B is a text interface and therefore may be more threatening to less experienced users.

Award 1 mark for each relevant comment up to a maximum of 2 marks.

(ii) Since Interface A demands less keyboard input than Interface B, there is less scope for keyboarding errors. It isn't possible for an invalid course or faculty to be entered in Interface A whereas it is possible with Interface B.

Award 1 mark for each relevant comment up to a maximum of 2 marks.

(*d*) (i)
1. if item is at start or middle of file then
2. move successive items up one position in file
3. end if
4. reduce file length by 1

Award 3 marks for correct algorithm. Deduct 1 mark for each omission.

(ii) Dry run involves walking-through each step of the algorithm using test data and updating the value of any variables manually as the processor would. This will highlight any errors in the logic of the design work.

Award 2 marks for clear description of use made of dry run. Reduce marks for lack of clarity or detail.

(*e*) *Development time*

Inheritance, defining subclasses of data objects that share some or all of the main class characteristics, forces a more thorough data analysis, reduces development time, and ensures more accurate coding.

OOPL produces software modules that can be plugged into one another, which aids creation of new programs.

Maintainability

Using OOPL, programmers can create modules that do not need to be changed when a new type of object is added. A programmer can simply create a new object that inherits many of its features from existing objects. This makes object-oriented programs easier to modify.

An object-oriented system programmed with an OOPL results in less complexity in the system design and implementation, which can lead to an increase in maintainability.

Award 2 marks for each correct comparison. Deduct marks for lack of clarity or detail. Maximum 4 marks.

(*f*) (i) Module testing involves integrating groups of procedures which co-operate with each other to make sure that there is effective data flow between the procedures.

Component testing involves testing individual procedures or functions to make sure that they work on their own.

Award 1 mark for correct description of purpose of each. Maximum of 2 marks.

(ii) Trace tables allow the programmer to inspect the value of all variables and follow the logical execution of the program.

A breakpoint is a flag set in source code that is used in debugging. When code that is executing reaches a breakpoint, execution is suspended. Breakpoints allow you to inspect the values of selected variables and trace the code statements that have already executed.

Award 1 mark for correct description of purpose of each. Maximum of 2 marks.

(*g*) (i) User-defined modules can be re-used. This reduces development time since they have already been designed, coded and tested and there is therefore no need to carry out any further component testing.

Award 2 marks for correct explanation.

(ii) For example:

Specs are kept up-to-date since all members of the development team access them through the CASE tools.

Encourages and facilitates communication between development team since most CASE tools have an e-mail facility.

Less effort spent on document administration, such as redrafting diagrams

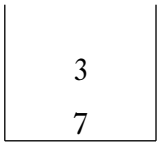
automated generation of system documentation reducing development time.

Award 1 mark each for any 2 correct benefits. Maximum 2 marks.

2. (*a*) A stack is a Last In First Out (LIFO) list structure. Items are removed from the top of the stack and new items are added to the top of the stack.

Award 2 marks for clear description. Reduce marks if description lacks clarity or detail.

(*b*)

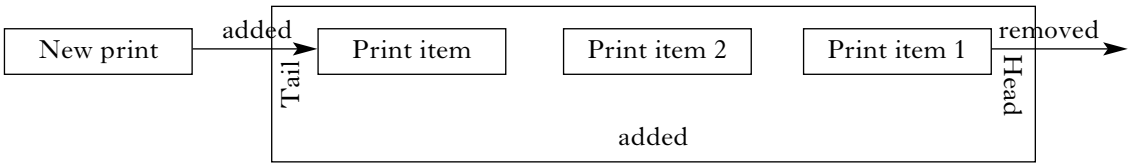


Award 1 mark for correct values in stack; award 1 mark for correct order of values in stack. Maximum of 2 marks.

(*c*) Upper limit is 3

Award 1 mark for correct answer.

3. Print items are added to the tail of the printer queue. When the printer is ready to print, the item at the head of the print queue is removed and sent to the printer.



Award 2 marks for appropriate diagram. Award 2 marks for clear description of how queue would be used in this instance. Deduct marks for lack of clarity or detail. Maximum of 4 marks.

4. (*a*) For example:

[**Record**
name as string
bib_number as integer
time as real
penalty_points as integer]

Award 3 marks for correct use of record structure. Deduct marks for incomplete definition of competitor or for omission of individual data types of each component (max 3 deductions). Maximum of 3 marks.

(*b*) Use of 4 one-dimensional arrays. For example:
name(20) as string
bib_number(20) as integer
time_seconds(20) as time
penalty_points(20) as integer

Award 4 marks for correct use of one-dimensional arrays. Deduct marks for any omission of individual details of competitor or incorrect definitions of components (max 4 deductions). Maximum of 4 marks.

5. (*a*) The list must be sorted

Award 1 mark.

(*b*) Bottom - needed to store position of start of section being searched
top - needed to store position of end of section being searched
middle - needed to store position of middle of section being searched

Award 1 mark for each correct data item together with suitable explanation of its purpose.
Item being searched for is compared with item at middle of list. If search item is greater then bottom is set equal to middle. If item is less then top is set equal to middle.

Award 1 mark for description of how data items are used in the algorithm. Maximum of 4 marks.

(*c*) Binary search would require 2/3 comparisons whereas linear search would require 4 comparisons

Award 3 marks, 2 marks for binary search and 1 for linear.

(*d*) When search item is first item in list – because binary search will start search in the middle of the list and then focus on the middle of either the top half or the bottom half of the list.

Award 1 mark for correct situation; award 1 mark for correct explanation. Maximum of 2 marks.

(*e*) (i) The basic idea in a simple sort is this: The smallest (or largest) element in the list is identified and put it in its proper place (the first element). Next, the smallest (or largest) of the remaining N-1 elements is identified, and it is put in its proper place (the second element). This process is continued until there is only one element remaining, at which point the list is in sorted order.

Award 2 marks for clear description. Deduct marks for lack of clarity or detail.

(ii) Selection sort algorithm
This is because this algorithm must store the original unsorted list as well as the sorted list.

Award 1 mark for correct algorithm; award 1 mark for reason. Maximum of 2 marks.

(iii) Bubble sort algorithm
This is because this algorithm takes account of a partially sorted list and terminates as soon as it realises that no swaps have taken place.

Award 1 mark for explanation.

Section II—Part A—Artificial Intelligence

6. (*a*) Two of the following benefits:
- uncertainty is often present in the domain expertise, and the provision of certainty factors enables this to be directly represented
- uncertainty is often present in data that is supplied at run time, and the provision of certainty factors enables this to be directly represented
- the provision of certainty factors enables users to be given an indication of how strongly supported is the conclusion that is reached by the expert system, which should increase their confidence in the system's validity.

2 marks for each benefit up to a maximum of 4 marks.

(*b*) Some expert systems do not provide certainty factors because:
- the domain and runtime information may be completely known
- certainty factors may be considered to be unhelpful to users
- not all KBS development environments support certainty factors
- some developers believe that certainty factor methods are wrong
- certainty factor values may be difficult to obtain.

1 mark for each reason up to a maximum of 2 marks.

(*c*) The certainty attached to the joined premise of is-tall(fred) AND has-good-coordination(fred) is the minimum of the certainties attached to each, ie min(0·3,0·8) which is 0·3 (1 mark). The certainty of the conclusions is the total certainty of the premises multiplied by the certainty factor of the rule (1 mark) ie 0·3*0·5 = 0·15 (1 mark)

Maximum of 3 marks.

7. A number of conflict resolution strategies are typically used to decide which rule to fire. These include:
- Don't fire a rule twice on the same data.
- Fire rules on more recent working memory elements before older ones. This allows the system to follow through a single chain of reasoning, rather than keeping on drawing new conclusions from old data.
- Fire rules with more specific preconditions before ones with more general preconditions. This allows us to deal with non-standard cases. If, for example, we have a rule "IF (bird X) THEN ADD (flies X)'' and another rule "IF (bird X) AND (penguin X) THEN ADD (swims X)'' and a penguin called Tweety, then we would fire the second rule first and start to draw conclusions from the fact that Tweety swims.

2 marks for each max 4 marks.

8. (*a*) Three other transformations from scene S 1:

<L, [1,2], [3], [ ]> → <M, [2], [1,3], [ ]>
<L, [1,2], [3], [ ]> → <M, [1,2], [3], [ ]>
<L, [1,2], [3], [ ]> → <R, [1,2], [3], []>

1 mark for each transformation, up to 3 marks.

Three other transformations from S2:

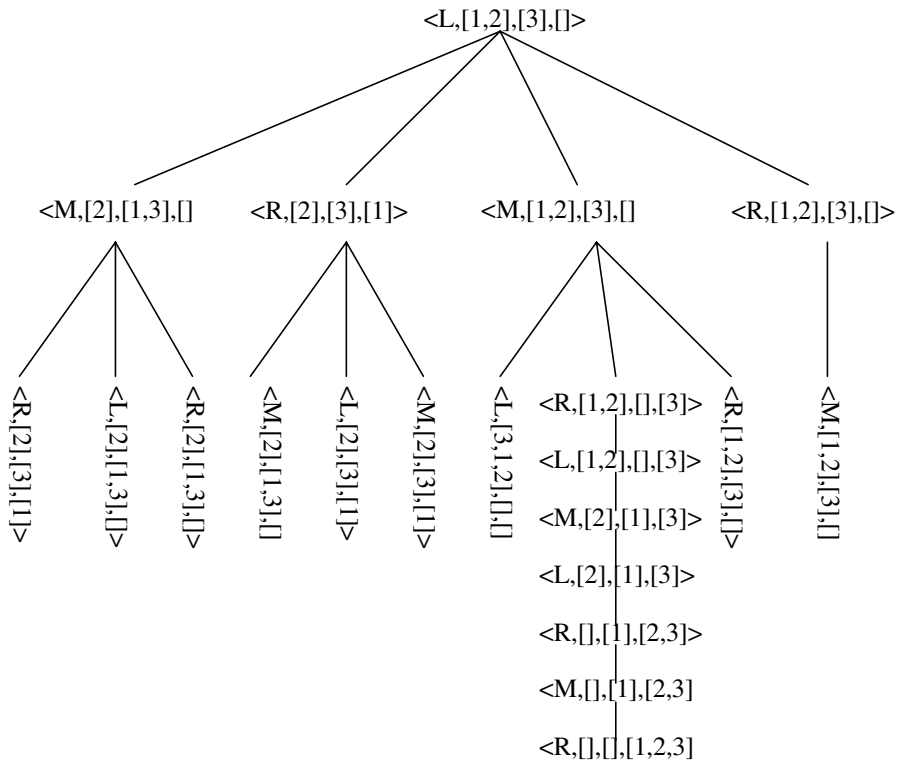
<R, [2], [3], [1]> → <M, [2], [1,3], [ ]>
<:R, [2], [3], [1]> → <L, [1,2], [3], [ ]>
<:R, [2], [3], [1]> → <L, [2], [3], [1]>

1 mark for each transformation, up to 3 marks

(*b*) (i) <R, [], [], [1,2,3]>

1 mark.

(ii)



4 marks for the tree annotated correctly to level 2. All branches should be present but any left-right sequence is acceptable. 2 marks for the extended (solution) branch.

(iii) • Depth-first and breadth-first methods are generally impractical with large trees.

1 mark.

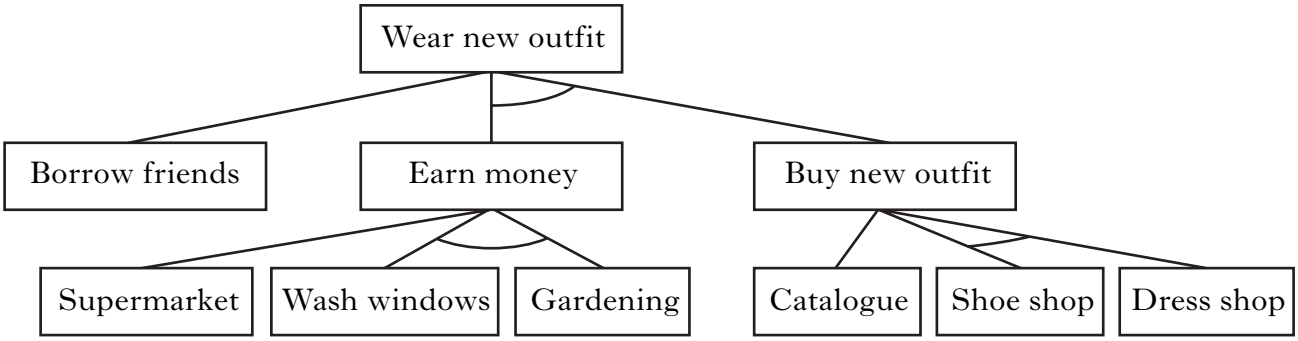
3 marks for clear reasoning as follows:

- If breadth-first search does find a solution then it will be an optimal (fewest operations) solution BUT reaching it is likely to take unreasonable time and memory since every node to the goal node's level must be generated and judged
- Depth-first search may find a solution in reasonable time and memory but this will be the nearest solution to the left hand side of the tree and it could be a highly non-optimal solution that requires the robot to perform an unnecessarily large number of operations.

9. This is a depth first, depth limited search procedure. It is used mainly in game playing when you are trying to maximise the value of the state evaluation function and the opponent's goal is to minimise the value of the evaluation function.

1 mark for description and 2 marks for example.

10.



3 marks for ANDs, 3 marks for ORs.

11. (*a*) Score of 8 - each block is resting on right one

no explanation needed 1 mark for correct value.

(*b*) Score of 4 - 6 points for C,D,E,F,G,H and -2 for A and B

no explanation needed 1 mark for correct value.

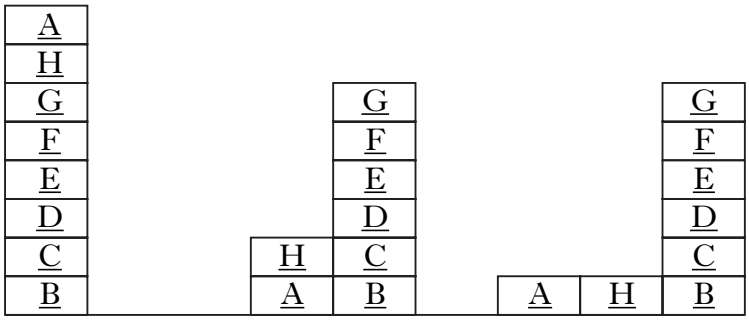
(*c*) The only first move is to move block A on the table.

1 mark.

Score of 6 - 7 points for A,C,D,E,F,G,H and -1 for B

no explanation needed 1 mark for correct value.

(*d*) The three states are:



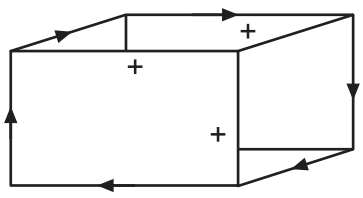
Each of these states will evaluate to 4

1 mark for each state and value, maximum of 3 marks.

(*e*) Hill climbing would cause the process to stop because all of these states have a lower score than the current state.

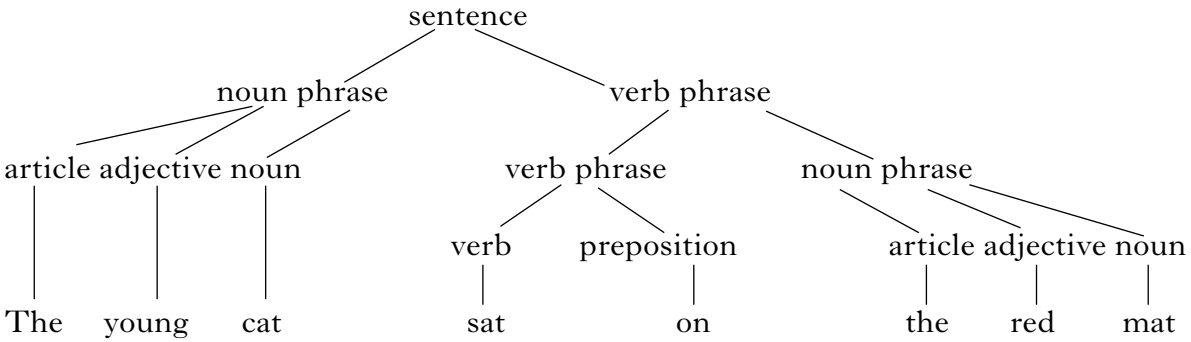
1 mark.

12.



2 marks for 6 arrows.
2 marks for indicating pluses to represent convex.

13.



1 mark for each of the three sections max 3 marks.

14. (*a*) The anonymous variable _ is used to represent the tail. If the person is the same as the head of the list then succeed. (**1 mark**) If not check to see if the person is in the tail of the list. (**1 mark**) To do this check the head of the tail and repeat again and again until we come to the end of the list or succeed (**1 mark**)

3 marks allocated as indicated.

(*b*) Yes.

john becomes head of list and david is checked against john - fail
mary becomes head of list and david is checked against mary - fail
david becomes head of list and david is checked against david - succeeds

1 mark for each line of explanation max 3 marks.

Section II — Part B — Computer Architecture

15. (*a*) Any processor could be specified.
For example the Intel Itanium (IA-64).

128 65 bit general registers — extra bit holds deferred exception token "NaT".
128 floating point registers. Each register is 82 bits and used for floating point calculations.
Application registers for register stack and SW pipelining.
8 branch registers to specify branch target addresses.
64 x 1 bit predicate registers.

2 x 2 marks for description of register and purpose.

(*b*) The instruction set is the set of legitimate instructions for a particular microprocessor. Each instruction usually consists of an op-code and an operand. Different modes of addressing are usually available.

2 marks for full description.

16. CISC uses complex instruction sets and addressing modes. RISC processors uses a minimal instruction set, emphasising the instructions used most often and optimising them for the fastest possible execution. In RISC, most instructions execute in a single clock cycle. Software for RISC processors must handle more operations than traditional CISC processors, but RISC processors have advantages in applications that benefit from faster instruction execution, such as engineering and graphics workstations and parallel-processing systems. They are also less costly to design, test, and manufacture. In the mid-1990s RISC processors began to be used in personal computers instead of the CISC processors that had been used since the introduction of the microprocessor.

Summary of features:

CISC - complex design, expensive to produce.	*RISC - simple design, cheap to produce;*
micro programmed,	hardwired; few instructions,
some instructions need many cycles,	instructions execute in a single cycle,
instructions vary in size & format.	instructions- same size & fixed format.

2 marks for design differences, 2 marks for performance gains.

17. (*a*) (i) Addressing mode - enables the operand to be specified in different ways.
1 mark for correct description.

(ii) 2^{32} bytes = 4 Gigabytes (2^{30} = 1 Gbyte, 2^{31} = 2 Gbytes, 2^{32} = 4 Gbytes)
2 marks for correct answer, 1 mark if arithmetic incorrect.

(*b*) Start address = 1000_{hex}, instruction = 2 bytes (1 for opcode, 1 for operand) so next located instruction = 1002_{hex}

1 mark for correct answer, 1 mark for explanation

(*c*) Fetch from memory —
Step 1 PC (IR) contents transferred to MAR (set up address bus) **1 mark**
Step 2 activate a READ operation on control line
OR address decoder accesses the store location addressed **1 mark**
Step 3 data transferred to Instruction Register (via MDR) **1 mark**
Step 4 PC incremented (and the instruction decoded (and executed)) **1 mark**

4 marks as indicated.

18. (*a*) DMA hardware controlled by DMAC chip, no need to involve CPU or registers. Running program not noticeably affected by transfers. Transfer of data faster than using peripheral interrupts.

1 mark for dedicated hardware, 1 mark for block transfer / CPU bypassed, 1 mark for explanation of improved performance.

(*b*) Diagram showing :– DMAC; re-routing of buses; interrupt request from Peripheral to DMAC & hold request from DMAC to CPU.

1 mark for re-routing, 1 mark for request protocol, 1 mark for details of transfer. (maximum of 2 marks without a diagram)

(*c*) Memory interleaving uses multiple banks of memory, which results in increased speed as the processor is able to access data much faster than possible with a single bank of memory—

Interleaving means that the processor staggers memory read / writes between two or more banks of RAM, effectively multiplying the bandwidth of memory. If a processor requests a read / write at a given memory location, the amount of time required to complete the operation is limited by the memory's speed, ie 70 ns RAM will complete a read /write request in no less than 70 ns. This means that if the processor can handle data at 30 ns, then it is working at less than half speed for memory transfers.
In the example, the processor takes 30 ns per clock cycle and has to access 70 ns RAM. Each clock cycle takes about 30 ns. If the processor wants to write to a block of RAM, it will have to insert 2 wait states between consecutive writes, meaning that for example it will take 90 ns for each write. However, if each of 2 banks of RAM can be accessed separately, then instead of inserting 2 wait states and leaving the processor idle, it will instead access the second bank of memory during the next clock cycle and insert only one wait state. This has effectively doubled memory throughput.

1 mark for memory interleaving & memory banks, 1 mark for speed incompatibility, 2 marks for explanation of solution, 1 mark for throughput increase. (5 marks)

19. Hard disk – suitable if capacity is greater than 1Gigabyte; possibly not most cost effective solution; removable units required.
Magnetic tape – very suitable; backup and restoration is sequential.
CD-RW – could be used but more than one disk needed. (1 disk = 650 Megabytes).
Rewritable DVD – suitable if only used with this system; rather expensive.

4 x 1 mark for evaluation of each device.

20. Parallel processing means the processing of different instructions of a computer program sharing one or more processors at the same time with the objective of running this program faster. A basic economic principle is the commandment of thrift in the meaning of a rational use of existing resources. Typical resources are computer equipment, time, energy and so on.

However, others argue that the kinds of applications, eg data mining, for which parallel processing is best suited tend to be larger problems in which scaling up the number of processors does indeed bring a corresponding improvement in throughput and performance.

While a system of *n* parallel processors is not more efficient than one processor of n times the speed, the parallel system is often cheaper to build. Therefore, for tasks which require very large amounts of computation and/or have time constraints on completion, parallel computation is an excellent solution. In fact, in recent years, most high performance computing systems, also known as supercomputers, have a parallel architecture.

2 marks for full description of advantages, 2 marks for full description of disadvantages.

21. (*a*) (i) Providing a standard look and feel for applications – can be attributed to the requirement by users to expect (demand) the same ease-of-use features with operating environments. In other words, any new version will provide a familiar environment and increase the ability to secure the system. Adaptive visualization for GUI, data and computational entities is one of the operating system's high level services that enable the users' interface requirements. The idea of **adaptive visualization** is to adapt the level of details in visualization to the level of user knowledge about these constructs (ideas and structures).

Improving the capability of programs to communicate and pass data – eg Windows XP changes these problems by turning your computer into an integrated communications centre. Windows XP includes improved support for real-time voice and video communications, instant messaging, and even on-line assistance. All of these tools are integrated into one place on your computer: Windows Messenger. This tool let's you talk to, work with, and view your friends and family, even when you are far apart.

2 x 2 marks for full description of each service.

(ii) The trend stems from large enterprises relying on middleware (software that "glues together" two existing programs, eg Application and OS) to provide approximated interoperability. This is the ability of two or more systems (parts) to exchange information and use the information that has been exchanged. Development teams often spend too much time coping with middleware complexity and diversity and as a result of this many middleware services will migrate into OS layers.

2 marks for full description of trends.

(*b*) (i) First fit File 1 written to A
File 2 can't be written to B, C or D (no room in any block)
File 3 written to B
File 4 written to C

2 marks for correct list, 1 mark for any 2 or 3 correct statements.

(ii) Best fit File 1 written to C
File 2 written to A
File 3 written to D
File 4 written to B

2 marks for correct list, 1 mark for any 2 or 3 correct statements.

(*c*) (i) The processor can only fetch and execute instructions from one program/process at any one time. The scheduler decides which program/process is allocated the processor

2 marks for explanation.

(ii) **Round robin** – a scheduling algorithm in which processes are activated in a fixed cyclic order. Each process is assigned a processor time-slice. Those which cannot proceed because they are waiting for some event, eg. an I/O operation, simply return control to the scheduler. If the process is still running at the end of the time-slice, it is pre-empted and has to wait its turn again. It is a fair method, suitable to interactive systems. Time-slice about $1/10^{th}$ of a second.

Multi-level feedback queue – in multi-level queue scheduling, a process is assigned to a queue and it remains in that queue until access is allowed to the CPU. However, in multilevel feedback queue scheduling processes are allowed to move between queues. Usually processes that execute in a short period of time, eg less than 8 ms, are in the high priority queue and slower processes are in a lower priority queue.
If a process in a high priority queue does not finish in the allocated time, it is pre-empted and placed at the end of a lower priority queue.
This system favours short jobs and provides a pre-emptive strategy with many ready queues at different priority levels.

2 marks for description of each method, 2 marks for comparison.

(*d*) (i) Organising and viewing directories

Windows – Directories and sub-directories (folders) can be created both outwith and within applications. In the OS you can either click in the active window on 'File", then "New", then "Folder" and enter the name for the folder or right click and click on "New", then "Folder" and enter the name for the folder.

In an application there is usually an icon available in the "Save As" window which will allow you, by clicking on it, to create and name a new folder (in current drive or folder).

The contents of any folder can be viewed by double clicking on the folder icon.

To move a folder - click on folder and drag to new location.

Unix – Files are stored in directories, which are arranged in a tree and the top directory is denoted by "/". To change directory use the command "cd", eg "cd directory".

To create a new directory use the command "mkdir", eg "mkdir wpfiles".

To list files in the current working directory use the command "ls", eg "ls wpfiles"

Mac – The OS takes advantage of the human spatial memory - icons and windows always stay where you left them. The metaphor of the finder desktop is a direct reflection of the filesystem — files on the desktop are actually in a directory called desktop. The Mac OS actually gets you closer to the filesystem (than Windows) so that it doesn't need "wizards" to simplify it for you, because the filestructure is logical and clear down to the system level.

1 mark for each for each operating system. Maximum of 2 marks.

(ii) Installing and uninstalling programs

MSDOS – Boot the system with the install disk in the A: drive and run "Setup". The setup screen will display hardware and software components, DOS type, DOS path, MSDOS shell and Display type - select/change as needed by highlighting and pressing "enter". Setup will then install the OS and when it is complete press "enter" to run MSDOS. You may have to set up "Autoexec" and "Config" files to suit your environment.

Windows – Insert the CD and wait for installation to start automatically (autorun). If not then use the "Control panel" (via "settings" on the "Start menu") and double click the "add/remove programs" icon. This will give you the option to install or uninstall any selected program. Find the program in the listing and click on it. It will install/uninstall all the files associated with that program.

Follow the prompts which in most cases involve clicking the Yes option.

Unix – Most applications for Unix will come with a script that can be used to install the program and related files. The script routine can usually be activated by typing, "/install"

You will have to provide details of the directory where you will place the files and subdirectories. There is usually a similar uninstall command, " /uninstall".

Mac – Double click the "Installer" and choose the drive for installation and click the appropriate options. To uninstall, drag the program to the "trash can". You may have to do the same to extensions and preferences in the "Systems folder".

1 mark for each for each operating system. Maximum of 2 marks.

(iii) Resource sharing

Windows (2000) – Right click on the object that you want to share, eg file, folder, printer, etc. Choose the sharing option and select to share this object. Assuming a network connection or physical link, the object can be used or accessed by logging on to the host computer. One method is to click "Start", click "Run" and type "\\sn987001" – where sn987001 is the identity of the host computer. You will now be able to access the shared items.

Unix – Designed as a multi-user system – built to run networks and allow sharing of resources (plus supervision). Users can be allocated to groups which have access to various resources, eg allow designated files to be shared.

Mac – File sharing has been possible with peer to peer networks on Apple systems since the earliest versions of the operating system. This allows folders to be shared requiring a log in before access to particular resources is possible.

1 mark for each for each operating system. Maximum of 2 marks.

Section II — Part C — Computer Networking

22. (*a*) Without internationally agreed standards, each equipment manufacturer and network provider would have to devise their own standards. This would make it very difficult to share information and resources between different makes of equipment and different organisations. It would also be expensive to set up and maintain network systems built on such non-standard schemes.

Having the standard defined by an international body means "…developers can base the development of their products and services on specifications that have wide acceptance in their sectors." An alternative to international standards is to allow proprietary standards to become de-facto standards through market dominance. The disadvantage of this approach is that the developer of the standard may use their dominance unfairly to create a monopoly which keeps costs up and innovation down.

1 mark for each, up to 2 marks.

(*b*) (i) TCP maps onto the *transport* layer of the OSI model and ensures that data is delivered and that packets are delivered in the correct order. IP maps onto the *network* layer and is related to the addressing of packets.

1 mark.

(ii) The benefit would come from the low cost and ease of set up that comes from using a standard protocol. Using TCP/IP also makes it more likely that the range of equipment in use in schools (ages and operating systems) will be able to connect to the network and communicate with other networks through the Internet.

2 marks awarded.

23. (*a*) **Fibre**: Bandwidths start at 100Mbits/s but go up to many Gbits/s

UTP: Bandwidths depend on various categories of cables

1 mark for each, up to 2 marks.

(*b*) The long distances that can be covered by fibre make it appropriate for the connection to the local authority as the authorities schools are likely to be spread over a wide geographical area. The high bandwidth offered is also appropriate given the amount of traffic likely to be generated by a school.

The UTP cabling is more appropriate in school due to the lower cost (relative to fibre) and ease of installation. The smaller area to be covered and the possibility of splitting the school network into smaller units to reduce bandwidth demands within each section also make UTP a good choice.

1 mark for each, up to 2 marks.

(*c*) **Advantages**: No cable! Wireless networking can be effective in closed areas over a range of around 60 metres however could be up to 150 metres though range will drop if you use maximum bandwidth (802.11b max bandwidth 11Mbits/s, 802.11a and 802.11g max bandwidth 54Mbits/s but with reduced range of approximately 20 metres). Signals can (to a certain extent) penetrate walls and floors so a reasonable sized building could be covered a few wireless access points.

Disadvantages: Based on radio waves which can be picked up by any compatible device and therefore poses a major security risk. The obvious solution is to encrypt transmissions using one of the available "standards" (eg WEP, 803.11i and WPA) but using these methods will reduce overall speed. Compatibility problems arise because the standards are still emerging and some manufacturers are producing products that conform to draft specifications of new standards and although all based on the 803.11 standard, they might not be mutually compatible. Congestion problems can arise from overlapping radio networks or other devices that share the same radio frequency.

3 marks for each, up to 6 marks.

24. (*a*) CIDR allows a more efficient allocation of IP addresses than Class A, B and C. The Class system of allocating addresses used a fixed number of bits to identify the network and the host machine which leads to many unused addresses. CIDR uses a variable number of bits to identify the network (the prefix). Currently CIDR uses prefixes of between 13 and 27 bits. **(2 marks)**

CIDR uses a standard 32 bit address but adds further information to specify how many bits are used to identify the network. In the above example the addition of "/16" at the end of the address indicates that 16 bits are used to identify the network – so in this case 206.13 identifies the network and 01.48 the host. **(2 marks)**

CIDR also supports hierarchical routing tables so that the number of routing table entries at each level in the hierarchy can be reduced. **(1 mark)**

Up to 5 marks as above.

(*b*) A Class B address uses the first two bytes to identify the host, ie the first 16 bits, so a CIDR address with a prefix identified as /16 can be considered equivalent to one Class B address.

2 marks awarded.

25. (*a*) (i) **SMTP**: Simple Mail Transfer Protocol is designed to transfer mail between mail servers or from mail client to mail server. When a voter mails their vote, it will be sent to a mail server as follows. First of all a connection is opened and the sender and receiver identify themselves (HELO). Sending then commences with the sender (MAIL) and recipient (RCPT) being identified. The DATA command is used to transfer message and the end is indicated with a single period on a line by itself. Connection is terminated with the QUIT command. **(3 marks)**

(ii) **POP**: Post Office Protocol is used by a mail client to retrieve mail from a POP mail server. The school's e-mail client would use POP to retrieve the votes from the mail server. Whereas SMTP assumes there is a permanent connection to the Internet, POP can be used where there may only be occasional connection (eg if connecting to the network by modem). **(3 marks)**

Note the 6 marks can be distributed between the two descriptions as appropriate, but no more than 4 marks can be given to one of the descriptions.}

(*b*) `Vote Captain Jan Grey`

`Vote Vice-Captain Olivia Munroe`

Explain why the MIME protocol would ***not*** *be required to send votes in this format*.

The MIME protocol is a standard that allows non-ASCII messages (eg messages including sound clips) to be sent by e-mail. The sample messages are clearly just basic text and so there is no need for MIME as the e-mail system will be able to send the message as plain, 7-bit ASCII.

2 marks.

(*c*) (i) A public-key encryption scheme, such as that provided by Pretty Good Privacy (PGP), allows a sender to encrypt a message using a public key published by the recipient of the message. The recipient can then decrypt this message using his or her private key.

2 marks.

A digital signature can be attached to a message and used to uniquely identify the sender (in the same way that a written signature is supposed to authenticate the identity of the person signing the document). The signature has to be encrypted to ensure it cannot be forged.

2 marks.

(ii) The voter uses an algorithm to create a large number called a hash code. This hash code is uniquely tied to the message being sent, if the message changes, the hash code will no longer match the message. The voter then encrypts the hash code (and possibly the message) using their private key. The encrypted hash code is attached to the message and sent to the school. The school then uses the voter's public key to decrypt the hash code. The school then uses the same algorithm to calculate a hash code for the message it received. If the two hash codes match then the school can be confident that the signed message is from the voter and has not been tampered with.

4 marks.

There may be some overlap between pupils' answers to (i) and (ii). The 8 marks can be distributed across both answers as appropriate, however you should ensure you do not give marks twice for the same answer.

(*d*) A virtual private network uses a protocol such as Point to Point Tunnelling Protocol or Layer 2 Tunnelling Protocol to create a secure link to a private network over a public (or otherwise insecure) network connection. So a voter could establish a secure, encrypted, connection with the school intranet by connecting from home over the Internet. The voter would be authenticated by the school intranet so the school could be confident that votes cast were from a legitimate voter and could check that each person only casts one vote.

2 marks for clear explanation.

26. (*a*) **Proxy**: A proxy sits between the web browser and the server from which the browser has requested information. The proxy acts as a trusted source to the client and will often run on a firewall machine hiding the client machine's IP address.

2 marks.

Gateway: A gateway is a server that appears to the client as if it were an origin server. It acts on behalf of other servers that may not be able to communicate directly with a client. There are several scenarios in which servers can be used. As with the proxy, a gateway manages transfers through a firewall.

2 marks.

Tunnel: Tunnelling carries the HTTP messages as if there were a single connection between client and server, but the messages are actually carried over an intermediate system between client and server. The messages are encapsulated within packets carried by the intermediate system. The intermediate system does not need to understand the contents of the packets it is carrying.

2 marks.

(*b*) (i) A plug-in enhances browsers by allowing them to display a greater range of objects. For example, a multimedia plug-in such as QuickTime allows browsers to display time based objects such as movies and sound files. They can also be used to display portable document formats such as Adobe's portable document format files. This allows documents to be displayed on screen as they will be printed, even if the user does not have all the required fonts etc. Java applets extend the browser even further by enabling platform independent programs to run on the client machine. The full power of a high level programming language can therefore be used to provide extremely complex interaction with the user.

4 marks for clear description.

(ii) The simulated experiment could require the learner to interact with the experiment, perhaps changing variables and investigating the results of these changes. The experiment itself could be animated complete with sound to show the results. This type of complex interaction and animated display could be provided either by a Java applet or through a plug-in for a Shockwave/Flash animation

2 marks.

(*c*) Video telephony can use high end, expensive, dedicated equipment and dedicated lines for a high quality connection, but this is more likely in the corporate business world. For the use described it is more likely that the user will require a web cam – a cheap, Charge Coupled Device (CCD) connected to a video capture card on the computer. The video and sound data can be transmitted over the Internet. An example of the software required for this is CUseeMe. Broadband connections allow reasonable quality and a reasonable price. A standard videoconferencing protocol is H.320 which deals with compression as well as transmission issues. Another possibility would be the use of a 3G mobile phone with Multimedia Messaging Services (MMS). Compression screens generally work by only sending information on the sections of the video display that have changed.

Up to 8 marks awarded for appropriate description, up to 2 marks for reference to each.

[*END OF SPECIMEN MARKING INSTRUCTIONS*]