SCOTTISH QUALIFICATIONS AUTHORITY

2005 Computing

Advanced Higher

Finalised Marking Instructions

These Marking Instructions have been prepared by Examination Teams for use by SQA Appointed Markers when marking External Course Assessments.

GENERAL NOTE

The marking instructions provide a guide to markers as to the points which should be made by candidates in their answers in the context of the question scenario. This application of knowledge to the problem is a vital component of Advanced Higher Computing. Markers are reminded that these instructions do not constitute sample answers.

SECTION I – Software Development and Computing Project

1. **(a)**
- Analysis of technical, economic and legal feasibility.
- A range of approaches.
- A recommended choice.
- Preliminary costings and timings.

Marks: 3 x 1 mark for each full description. Full description of technical, economic and legal feasibility can be awarded 2 marks.

(b)
- Staff are reluctant to cooperate with systems analyst and are concerned about job losses.
- Terminology used by staff and documentation may be unfamiliar and difficult.
- Documentation might not reflect current practice.
- Ambiguity in staff descriptions of the current system.
- Conflicting views about what the system should achieve, exacerbated by lack of consultation.
- Implications of external influences such as the Data Protection Act.

Marks: 5 x 1 mark for each description. Maximum 3 marks if no reference to nursery.

(c) **(i)** Description of the contents of this document could include:
- functional specification stating what the system will do
- physical specification of the hardware
- data requirements of the system
- details of scheduling
- user documentation required
- training needed.

Marks: 5 x 1 mark for each description or 2 marks for full description of functional or data requirements, 1 mark for others.

(ii) **Three** ways that this document will be used later in the software development process are:
- used to validate the system specification
- used contractually if any dispute about the resulting software arises
- evaluation of software, acceptance testing
- used as reference/road map of whole process
- used to validate that the design will fulfil the demands of the ORD
- checking budget/timelines.

Marks: 3 x 1 mark for each use.

(d) Pseudocode (1) – represents a solution using English statements (1), with indentation to identify control structures (1), and numbering to indicate dependencies of modules (1).
Jackson structured design (1) – data components identified and then relationships defined (1), structures program logic based on data structures (1), defines the tasks to be performed and assigns these operations to suitable components of the program structure (1).
Other methods might be Data flow design, Structured charts, UML, Yourdon and DeMarco.

Marks: 1 mark for named method and 3 marks awarded for description.

(e) **(i)**
- Current documentation and forms so that on screen forms match the clients experience.
- Take cognizance of the current invoicing software.
- Information on the level of expertise of the staff.
- Type of hardware and OS the system will run on.
- Accessibility.

Marks: 3 x 1 marks for each.

(ii)
- Prototyping.
- Programming team check proposed designs with the end users before delivery and consider staff feedback.
- Acceptance testing before final delivery where the clients are observed by the programmers.
- Any other acceptable answer.

Marks: 1 mark for dialogue between programmers and staff even if via project leader, 2 x 1 mark for description.

(f) Structured listing or design – for dry run to identify logic errors.
Testing – to identify test data already specified and to allow identification of additional test cases.
System specification – to identify hardware and software of current environment and to evaluate need for adaptive maintenance.
Any other acceptable answer.

Marks: 1 mark document, 1 mark for relevant description.

(g) Existing programmers spend their time informing new programmers instead of producing code.
Problem might not be suitable for dividing among more programmers.
Over budget.

Marks: 2 x 1 mark for any valid answer.

2. **(a)** Minimalist answer (similar to NAB)

```
set valid to false
while not valid do
        ask user for customer code
        set size to length of customer code
        if size <> 10 then
                output error message
        else if characters not in A..Z, 1..9 then
                output error message "upper case and digits only"
        else
                set valid to true
        end if
end while
```

Marks: 1 mark for correct use of Boolean variable valid
1 mark for determining length of customer code
1 mark for correctly terminating loop
1 mark for IF invalid characters, 1 mark for invalid length of string
1 mark for setting valid to true

The following answer is too detailed but is here in case candidates interpret question in this way. Marks should still be awarded as above.

```
set valid to false
while not valid code
        ask user for code
        set size to length of code
        set goodchar to true
        set counter to 0
        loop
                increment counter
                set character to string of length 1 at position counter
                case character of
                        "A" to "Z" :set goodchar to true
                        "1" to "9" :set goodchar to true
                otherwise
                        set goodchar to false
                end case
                until goodchar is false or counter is 10
                if size is not 10 or goodchar is false then
                        prompt user "Customer code not valid"
                else
                        set valid to true
                end if
end while
```

(b) Structured walkthrough – run test data through the design (pseudocode) to check logic. Comparison with requirements specification to check it meets the customer requirements.

Marks: 2 x 2 marks for description of method.

(c) **(i)** **Three** techniques to make program code reusable from:

- modularity
- parameter passing
- local/global variables
- readability – internal commentary and documentation of modules
- creation of module library with suitable documentation.

Marks: 3 x 2 marks for description of technique.

(ii)

- Longer development time (1) for this client due to additional coding (1).
- Possible saving on development costs (1) due to shorter process required for future clients (1).

Marks: 2 x 1 mark for a fully described implication.

(d)

- Testing of the components using special routines or stubs (1) to ensure the components work before they are put together (1).
- Integrative testing, white/black box testing.
- Acceptance testing, alpha/beta testing.

Marks: 3 x 2 marks for each description including when the stage takes place.

(e) Iteration means that the team will revisit stages in the SDP and will involve:

Project leader –	Liaise with client to effectively identify/understand the required change. Cost the change. Evaluate time/scheduling implications for change. Communicate changes to analyst/programming team.
Client –	Communicate with project leader to clarify change. Negotiate changes to cost.
Programming team –	Design detailed logic of change. Identify modules where change is required. Code, test and debug new code.

Marks: 3 x 2 marks for detailed responsibilities for each personnel.
Each personnel must be mentioned – but if the responsibilities of one of the personnel is very well detailed 3 marks could be awarded then only 1 mark for one of the others.

SECTION II – Part A – Artificial Intelligence

3. (a) **Two** processes related to problem solving.

- Problem abstraction is identifying any constraints on the solution (1) and defining the starting state and the goal state (1).
- Symbolic representation is representing the starting state, the goal state and valid intermediate states (1) in a clear and unambiguous diagram (1).
- Heuristics uses hints, tricks, rule of thumb or knowledge about the state space (1) to limit the search process and eliminate a lot of wasted searches (1).

Marks: 1 mark for two names and 2 marks for each description.

(b) (i)

- The need to improve communications between humans and computers.
- The need to understand how humans process language.
- Any other appropriate answer.

Marks: 2 x 1 mark for each reason.

(ii)

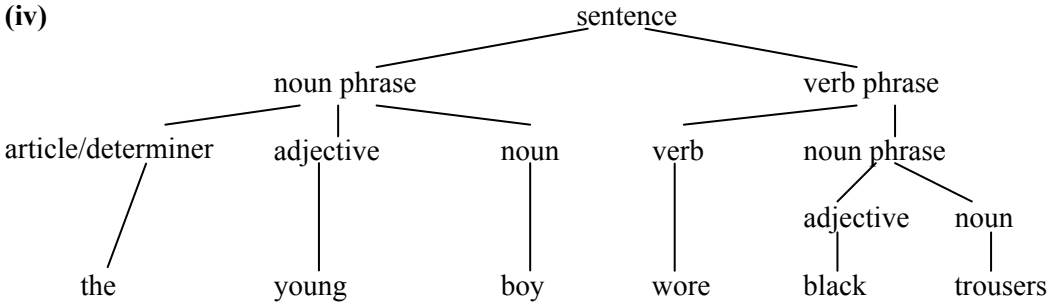
- Ambiguity in the meaning of a word eg old ladies staffroom.
- Imprecision in the use of words eg get lost.
- Assumptions we make when we hear or read words eg orange sweet.
- New words added.

Marks: 3 x 1 mark for each description

(iii) The search technique used is depth-first. If the initial state is the goal-state quit and return success (1). Otherwise select an alternative until the goal is reached (1) or a node is reached where no further downward motion is possible (1), in which case the search is restarted at the nearest ancestor node with unexplored children (1).

Marks: No marks for naming of technique – 4 marks for a full description as indicated.

(iv)



Marks: 2 marks for identification of 3 'phrases', 2 marks correct categorisation of words.

(c) **(i)**

- The domain and runtime information may not be completely known.
- Certainty factors may be considered to be helpful to users.
- Some developers believe that certainty factor methods are a good idea.
- Certainty factor values indicate the reliability of advice.
- Cfs reflect how experts in certain domains eg medicine give advice.
- Any other relevant answer.

Marks: 3 x 1 mark for each reason.

(ii)

- The knowledge engineer – sets up the CF.
- The human expert – puts a value on the rule.
- The inference engine – combines CFs from several rules to produce CF for the conclusion.

Marks: 3 x 1 mark for each role.

(d) The How justification because it's purpose is to explain how the ES arrived at it's conclusion.

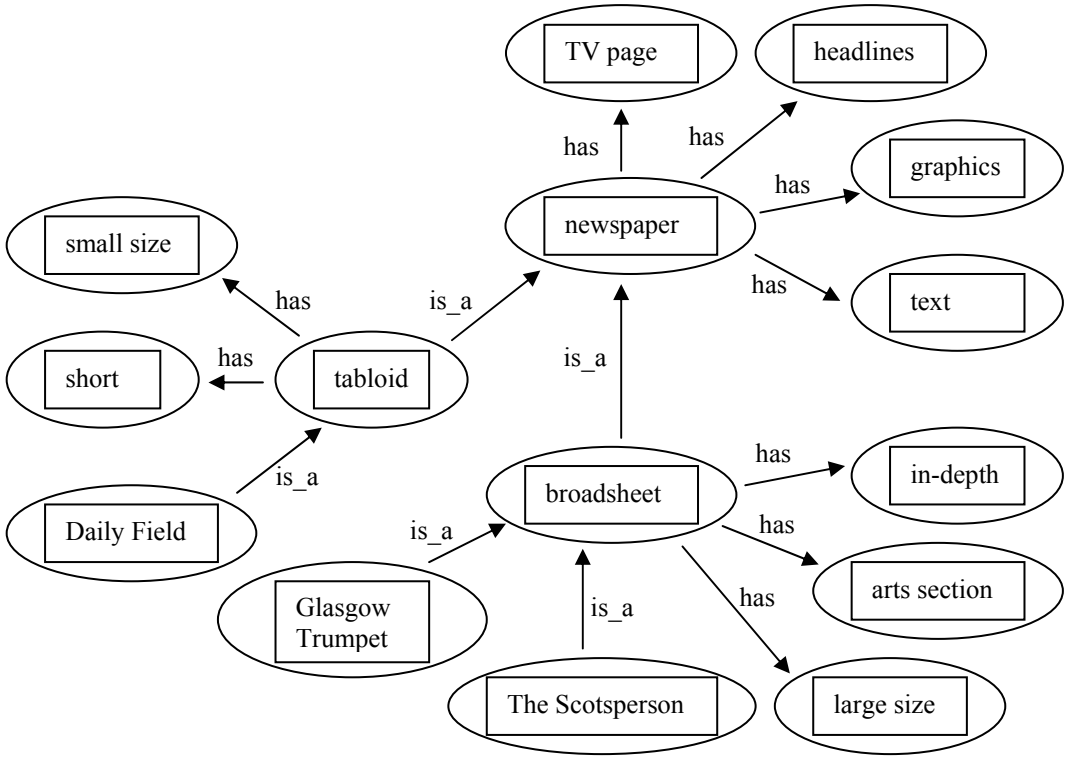
Marks: 1 mark for How justification and 1 mark reason

(e)

- Ease of building the knowledge base.
- Quality of user interface.
- Quality of justification facilities.
- Effect of different search techniques.
- Effect of uncertainty.
- Cost.

Marks: 4 x 1 mark for each criteria. Simply stating the component eg user interface, will gain no marks.

(f)



Marks: 2 marks for the newspaper bit – 1 for arrow, 1 for words.
2 marks for broadsheet section – 1 for arrow, 1 for words.
1 mark tabloid section.

4. **(a)** ([S], [M], [L])

Marks: 1 mark for correct syntax and 1 mark for correct goal state.

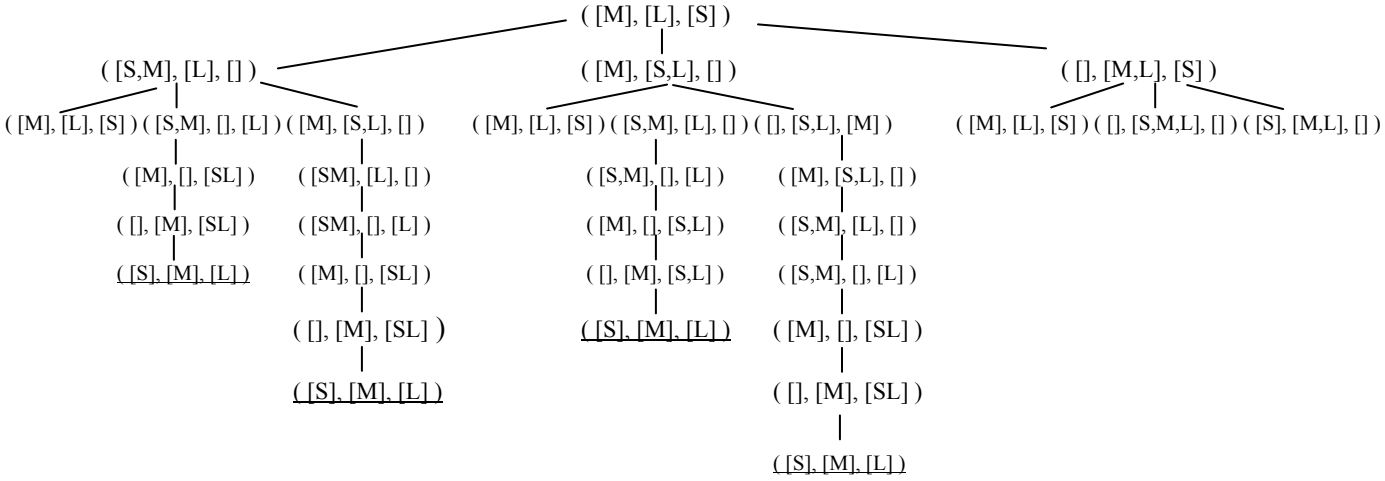
(b)
- Only one acrobat may jump at a time.
- Whenever two acrobats are on the same flagpole, one must be standing on the shoulders of the other.
- An acrobat may not jump if someone is standing on his shoulders.
- A bigger acrobat may not stand on the shoulders of the smaller acrobat.

Marks: 2 marks for all 4 constraints, 1 mark 3 constraints.

(c) ([M], [L], [S]) ⟶ ([M], [S,L], [])
([M], [L], [S]) ⟶ ([], [M,L], [S])

Marks: 2 x 1 mark for each

(d) **(i)**



Marks: 2 for correct syntax throughout the tree, 2 marks for correct third line of tree.

(ii) ***Marks: 2 marks for any of the branches taken to a solution.***

(iii) ***Marks: Correct markings with key where appropriate – 1 mark for each. Award no marks if key is not shown.***

(e) Memory – depth first search typically requires less memory than a breadth first search (1) – depth first search keeps only the current node pus backtrack points in its memory (1) whereas breadth first search has to store all nodes up to the current level (1).
Time – depth first search requires less internal housekeeping than a breadth first search hence a higher rate of node coverage (1). With a small tree like this one depth first search may well find a solution more quickly than that of a breadth first search (1).
Nature of the first solution – depth first search will discover the solution that is on or nearest to the leftmost branch before it finds other solutions (1). Breadth first search always finds the solution closest to the root (1). For the acrobat problem this means the first solution found by breadth first search is the 'best' solution ie fewest moves (1).

Marks: All three areas must be covered – award 1 mark for each relevant point made. Max 7 marks if acrobat problem not mentioned.

(f) **(i)** It may not succeed because the tree for this problem will be very large and there may not be enough memory for an exhaustive search (1). Also search time is finite and so time may run out before the search is completed (1).

Marks: 2 x 1 marks as illustrated.

(ii) A heuristic search requires information about the relative values of individual states ie a state evaluation function.

Marks: 1 mark.

(iii) In **hill-climbing** one move is selected and the rest are discarded and not considered again. Hill-climbing stops if there are no successor states that have better values than the current state.
In **best-first** one move is selected but the others are kept around so that they can be used if the selected path becomes less promising. Also the best available state is selected even if that state has a lower value than the value of the state that has just been explored.
Any other acceptable answer.

Marks: No marks for naming heuristic – 2 x 1 mark for each point about it's operation.

(iv) Heuristic methods can succeed because they only cover part of the search tree (1) and thus the search may be viable within the computer's available resources (1).

Marks: 2 marks as illustrated.

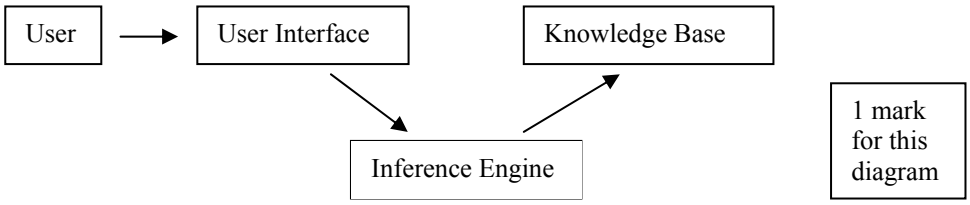
(g) **(i)** For AND the min of 2 Cfs are taken, for OR it is the maximum. For NOT maximum CF-B OR –B.
Candidates may just say that for AND the individual certainty factors are multiplied, for OR they are added and for NOT they are subtracted. Any reasonable answer that makes the OR value the biggest, and the NOT the smallest is acceptable.

Marks: 3 x 1 mark for each operator.

(ii) The knowledge engineer will have to spend time acquiring from the expert not just facts and rules but the CFs for these (1). More time required to enter CFs (1). Also the organisation, testing, debugging and validation of the knowledge will be made more complex (1).

Marks: 3 x 1 marks for each valid point.

5. **(a)** **(i)**



Marks: 1 mark for initial diagram – 3 x 1 mark for CF, justificaton, search strategy in right place. CF should be in both KB and IE, justifcation in the UI, search strategy in IE.

(b) **(i)** Forward chaining deduces all implications which may follow from a given state – it modifies the initial state until a goal state is reached.
Backward chaining involves reasoning backward from the goal state to determine what starting facts are required and then to check that these facts exist and are true.

Marks: 2 x 1 mark for each description.

(ii) Backward chaining would be more efficient for expert systems for diagnosing, prescribing or debugging when the problem starts by forming a hypothesis and then checking if hypothesis can be proved – it is more efficient if there are few goal states and only a few paths by which they may be reached.
Forward chaining would be more efficient for expert systems for planning, monitoring, control or interpretation – it works best when the problem starts by gathering data and then finding what information can be inferred from it.

Marks: 2 x 2 marks for each full description.

(iii) If forward chaining is used **green** will be matched against working memory.
If backward chaining is used **walk** will be matched against working memory.

Marks: 2 x 1 mark for each

(c) **(i)**

- *The need for a solution must justify the costs involved in development.* There must be realistic assessment of the costs and benefits involved.
- *Human expertise is not available in all situations where it is needed.* If the "expert" knowledge is widely available it is unlikely that it will be worth developing an expert system. However, in areas like oil exploration and medicine there may be rare specialised knowledge which could be cheaply provided by an expert system, as and when required, without having to fly in your friendly (but very highly paid) expert.
- *The problem can be solved using symbolic reasoning technique.* It shouldn't require manual dexterity or physical skill.
- *The problem is well structured and does not require (much) common sense knowledge.* Common sense knowledge is notoriously hard to capture and represent. It turns out that highly technical fields are easier to deal with, and tend to involve relatively small amounts of well-formalised knowledge.
- *Cooperative and articulate experts exist.* For an expert system project to be successful it is essential that the experts are willing to help, and don't feel that their job is threatened! You also need any management and potential users to be involved and have positive attitudes to the whole thing.
- *The problem is of proper size and scope.* Typically you need problems that require highly specialised expertise, but would only take a human expert a short time to solve (say an hour, max).
- Any other appropriate answer.

Marks: 4 x 1 mark for each description.

(ii) The domain expert needs to be cooperative, articulate and know their stuff.
The knowledge engineer needs to be competent in translating subject matters expertise into KB content, develop a working knowledge of the problem domain and be good at formulating appropriate questions.

Marks: 2 x 1 mark for each description.

(iii) <u>Expert system shell</u>
Advantage

- The inference engine is already there
- Reduced development time and design time

Disadvantage

- Relatively inflexible
- Few standards exist which could limit portability
- KRL is usually a very HLL and can be relatively slow or heavy on memory

<u>General purpose programming language</u>
Advantage

- Complete flexibility
- Standards do exist so portability will be possible
- Established programmers will have experience of GPPL

Disadvantage

- Not specially adapted for KBS so will have to build system from scratch
- Longer development and design time

Marks: 2 x 1 mark for each advantage and 2 x 1 mark for each disadvantage. Do not allow simple opposites.

(d) **(i)** A particular frame has a number of attributes or slots (1) where these slots may be filled with particular values (1).

Marks: 2 x 1 mark for each well made point about frames.

(ii)

United States of America	
States	50
Area	Over 9 million sq kms
Population	260 million
Lowest Point	Death Valley
Highest Point	Summit of Denali
Anthem	The Star-Spangled Banner
Currency	Dollar
Most Southern State	Florida

Florida	
Area	170,000 sq kms
Population	13 million
Climate	Humid sub-tropical
Largest city	Jacksonville
Capital	Tallahassee
Economy	Tourism Agriculture Manufacturing industry

Tourism in Florida	
Based on	Beach resorts Winter holidays
Biggest attraction	Disney World
Popular with	Families Retired people

Marks: 3 x 1 mark for tables with all slots correct, 1 mark for links.

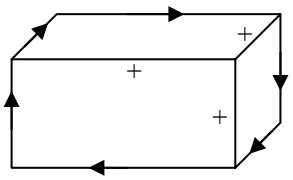
(e) **(i)** The interpretation of complex scenes, 3D/2D, amount of data.
Problems of ambiguity, motion.

Marks: 2 x 1 mark for each description.

(ii) This is a method of recognising shape (1) by labelling edges of the shape (1) according to whether the edges are concave, convex or an obscuring edge (1).

Marks: as indicated.

(iii)



Marks: 1 for arrows
1 mark for concave edges (+s)

SECTION II – Part B – Computer Systems

6. (a) (i) Intel 80286
AX register – general purpose, accumulator used for storing result of arithmetic calculations.
CX register – general purpose, count register used to control loops.
CS – stores segment address of the code segment.

Marks: 2 x 1 for name, 2 x 1 for description.

(ii) Occurrence of zero.
Occurrence of negative.
Occurrence of overflow.

Marks: 2 x 1 mark each correct answer.

(iii) CMP AX, BX Compare the contents of the AX and BX register and set flags accordingly.
CLC Clears the carry flag ie sets it to 0.

Marks: 1 mark for instruction, 1 mark for corresponding explanation.

(iv) 80286 has 24 bit address bus, 16 bit data bus, discrete set of lines in control bus for read, write, etc.
or
6502 has address bus (16 bits) and a data bus (8 bits) and the remaining lines/pins make up the control bus consisting of read, write (read/write – only 1 mark), NMI.

Marks: 1 mark for naming all 3 buses and 1 mark for each description.

(b) (i) Implements find maximum (2) by setting the first item in the array to the maximum (1) stored in Q and then through the remaining items and replacing the value in Q (1) each time it finds a larger value. The offset of the maximum is stored (1) in Y register (1).

Marks: as indicated.

(ii) If line 4 is removed, result will be dependent on the value in Q. If line 13 is removed then the program stores the position of the maximum rather than its value.

Marks: 2 or 0, for either answer.

(iii)
- Optimize code for speed/make code as small as possible.
- No HLL language compiler/interpreter exists for the processor.
- No suitable HLL language exists for the task.
- Direct control over hardware and registers.

Marks: 2 x 1 for each reason.

(iv) A Remove internal commentary
Replace Macro with defined instructions etc
Create table required to resolve forward addresses
Identify syntax errors.

Marks: 3 x 1 for each task

B It represents a forward address (1) and the assembler needs to encounter this address before it can calculate the relative address (1) for the machine code version of the BRGT instruction.

Marks: as indicated.

(c) **Windows**

Create shortcuts to different files/applications
Alter desktop patterns
Change screen displays
Change mouse speed and tracking
Change monitor resolutions
Change the method of viewing files eg small icons
Alter system fonts
Alter sound alerts
Numerous features available through Accessibility feature such as sticky keys, toggle keys

Linux Security

Uses pluggable authentication modules to enable the system to verify entry rights
Passwords stored in an encrypted file
Single users can have access through a user identifier uid
Groups of users can have access through group identifiers gid
Directories and files are protected by an access control mechanism which uses a protection mask to specify the kind of access that is permitted to different categories of users.

Marks: 8 x 1 mark for each point related to security or customising user interface. Candidates must make at least 1 point for each OS for each feature. If no OS named markers should try to distinguish answers but do not award marks unless clearly defined.

7. (a) (i) Intel –
immediate, operand contains the data to be processed, MOV AX, 3C15
direct, operand contains address of data, ADC AX, val1
indirect, operand contains the address of the location which holds the address of the data, MOV AX, [val2]

6502 –
immediate, operand contains data to be processed, ADC #03
direct, operand contains the address of the data LDA &3C15
implied, the address of data is implied in the opcode, TAX

Marks: 1 mark for naming 3 modes, 3 x 1 for description of addressing technique, 3 x 1 mark for appropriate example.

(ii) A Backward compatibility

Marks: 1 mark.

B Do not remove instructions from the instruction set (1). Doing so would mean either the binary code for the instruction would be meaningless or would have changed meaning (1). OR
Only add additional registers. OR
Make older registers accessible in the new processor eg AX and EAX.

Marks: 2 x 1 mark each point.

(iii) Inclusion of cache memory (1) since the access times of memory are critical to performance (1) and this small, fast access memory closer to the processor means shorter response times (1).
Pipelining (1), allowing stages of the fetch/execute cycle to happen simultaneously (1). Instructions will all be of the same length (1).

Marks: 1 mark for name, 2 marks each supporting point x 2 methods.

(iv) FLOPS the number of floating point operations varies from program to program and so the figure varies depending on the nature of the program.
MIPS – a particular task might require 10 instructions on one processor and on another 20 (RISC) but if task is completed in the same time the RISC chip has a far better MIPS.
MIPS value varies on the same computer executing two different programs ie varies depending on the nature of the task.
One processor may take two floating point operations to do a task while another may only take one. If the task takes the same amount of time the first processor will have the better FLOPS value.
Benchmarks – good for an entire system (RAM, disk subsystem, motherboard) but poor for measuring CPU performance.

Marks: 1 mark description, 3 marks for comparison points. Marker can award 2 marks for a particularly full description and 2 marks for the comparison.

(b)

```
            MOV     AX, value
            CMP     AX, 49
            JA      Pass
            MOV     result, 0
            JMP     NextLabel
Pass        MOV     result, 1
NextLabel   ……
```

Marks: 1 mark for the compare
2 x (1 mark for jump and one for jumping to the correct place)
1 mark for assignment.

(c) **(i)** combining separate object code (1) into a single exe file (1)
loads library files (1)

Marks: as illustrated.

(ii) Allows you to create separate obj file for using in other programs.
Allows large tasks to be subdivided.
Allows for use of module libraries.
Allows inclusion of previously compiled code.

Marks: 3 x 1 marks for 3 clear points. 2 marks can be allocated to 1 point if particularly well made.

(iii) loading (1) – placing a program into memory (1) and in preparation for transferring control to the first instruction (1)

Marks: as illustrated.

8. **(a)** **(i)** Fixed partition – memory is divided into partitions of a fixed size (1) but not necessarily the same size (1).
Variable partition – process is assigned the exact portion of memory required (1), when a process completes that portion of memory becomes available to other processes (1).

Marks: 2 x 1 for each valid type – 2 x 1 for each description.

(ii) Fixed partition – process can be too big for partition (1), internal fragmentation – partition of memory is larger than the process but that space is unavailable to other processes (1).
Variable partition – external fragmentation occurs ie gaps in memory that are too small to be realistically assigned to another process (1), compaction (relocating processes) uses processor time (1),
simple paging – internal fragmentation occurs but it is small, page faults can occur.

Marks: 2 x 2 marks for limitation of each method giving 4 marks.

(b) **(i)** In pre-emptive scheduling the OS can decide to halt a process and schedule a different process to be running.
An interrupt could cause a process to be suspended to attend to a higher priority process.

Marks: 2 x 1 mark each situation.

(ii) A process description is stored (1) which includes contents of registers (1) ie PC, status register, stack pointer and whether process is in memory or swapped out (1 for any example of content process descriptor).

Marks: award three marks for detailed description without the term process descriptor or similar.

(c) **(i)** Virtual memory (1)
Allows more processes to be run than RAM will allow.
Allows larger processes to be run than RAM will allow.
Disadvantage – page faults occur and page replacement is slow, a process is not given enough real memory will spend its time thrashing.

Marks: 1 mark advantage, 1 mark disadvantage.

(ii) Processes can be placed anywhere in memory (1) instead of the same section of memory each time they are run (1). Absolute addresses are not allowed (1), instead data and branch/jump instructions are in places relative (1) to the segment in which they are stored.

Marks: as indicated.

(d) **(i)** A lightweight process within a process that shares the same memory.

Marks: as indicated.

(ii) takes less time to create a new thread in an existing process
less time to switch between two threads in the same process
do not need entire new process for multiple instances of the same application/process

Marks: 2 x 1 marks for each advantage.

(e) Files have extensions (1) which Windows uses to determine which icon to use and which program files are associated with (1) – file associations can be edited.
A directory's contents are stored in file with the extension .dir (1) which is linked to the folder icon. When you double-click on a folder the file is opened (1) and each entry is shown on screen using the icon associated with the file extension (1). Each cluster has an entry in the FAT32. When you load a file the file directory contains the starting cluster and these are chained. The last cluster has an end of file marker.

Marks: 5 x 1 mark for each relevant point.

(f) **Intel**

Processor	Speed	Register size	Bus width	Address Space	Cache
8086	8 Mhz	16	16	1MB	None
80286	12.5	16	16	16MB	None
80386	20	32	32	4GB	None
80486	25	32	32	4GB	8KB
Pentium	60	32	64	4GB	16KB

Motorola 68000 Family

Processor	Speed	Register size	Bus width	Address Space	Cache
68000	10-20	32	24 AB, 16DB	16MB	None
68030	25-40	32	32 AB, 32DB	4GB	2 x 256 bytes
68060	40-66	32	32 AB, 32DB	4GB	2 x 8 KB

Marks: 6 x 1 for accurate values for 3 characteristics of 2 processors.

SECTION II – Part C – Data Communications

9. (a) (i) Answers may include IEEE, IETF, ISO, ITU-T – many others acceptable.

IEEE – responsible for Ethernet standards
IETF – defines standard Internet operating protocols such as TCP/IP
ISO – fosters the OSI model
ITU-T – responsible for various modem standards

Marks: 1 mark awarded for both the name of the organisation and its purpose, 0 for name only – NB many other organisations exist and candidates should be awarded marks if they correctly name and explain the purpose of another not listed above.

(ii) To allow for compatibility, successful transmission of data and connection of equipment. Prevent proprietary systems becoming too important, by allowing multiple vendors to work to same standards/protocols.

Marks: 2 x 1 marks given for each reason.

(iii) An engineer or company sbumits an Internet Draft to the Internet Engineering Task Force (IETF) which describes the technical details of any suggested protocol. This submission is checked by the IETF and if they believe it to be worthwhile they allocate it a Request for Comment (RFC) number and post it on their website. Other people can then refer to the RFC for details and any amendments/changes can be submitted to them and a new RFC number is allocated. RFC's are then referred to as standards if they become popular and their use is widespread. Specifications that become Internet Standards evolve through a set of maturity levels known as the **standards track.** These maturity levels are "Proposed Standard", "Draft Standard", and "Standard".

Marks: Full description 2 marks, limited reference to RFC's and IAB or ISOC.

(iv) Proprietary standard is a "standard" which has been developed by a single vendor and whose details are not open for wider use eg Appletalk, NetBeui.

Marks: 1 mark for description and 1 mark for any vendor specific protocol.

(b) candiates may give examples of:

thick coaxial - 10/100Mbps – 500m
thin coaxial - 10/100Mbps – 185m
optical fibre - 10/100/1000Mbps – 2km, can go up to 80km
twisted pair - cat 5 supports 10/100/1000Mbps – 100m
These rates and distances change and therefore professional judgement will have to be used. Answers referring to wireless technology should be accepted.

Marks: 2 x 3 marks awarded for a full answer to each transmission medium. Award 1 mark if just 3 names.

(c) Candidates must clearly describe access to the network settings of a particular platform and OS. Eg in the case of a Windows 9X machine the description of selecting Network Neighbourhood properties, installing protocols and services from a CD followed by details of the configuration of two parametrs. The two parameters may include: IP address, Subnet mask address, Default Gateway address, DNS server address, Proxy server address, giving the station a name, workgroup name.

Marks: 2 x 2 marks for a full and clear description, maximum of two if only examples of parameters which would require setting are given.

(d) Candidates should describe an emerging wireless technology. Hardware discussed must refer to wireless enabled NIC's. Wireless NIC's on their own are only sufficient to implement small peer to peer networks and so a Wireless Access Point should be mentioned to allow integration into larger wired networks with dedicated servers, mention could also be made of wireless routers for Internet access. Protocols described are most likely to be Bluetooth – 1 Mbps over approximately 10m or Ethernet 802.11 (a, b or g) – approximately 100m between access points indoors and 300-400m outdoors. Bandwidth – if using 802.11b then 11Mbps with 802.11g giving 54Mbps. If anything else described is suitable, marks should be awarded accordingly.

Marks: 6 marks should be awarded for a full answer describing a wireless technology, stating distances, speed, bandwidth and devices required.

(e) **(i)** Reason behind need for 2 servers should explain that SMTP can no longer fully support e-mail as all computers are not on and connected to the Internet at all times, hence the need for mailboxes. However SMTP is still used to send e-mail messages over the Internet to your e-mail server and allows it to be forwarded to the receivers e-mail servers. SMTP is only suitable for text messages. POP3 – allows you to receive incoming messages. The POP3 server holds messages until you ask for it. You log onto the POP3 server by giving a username and password and you download your mail to your own computer.

Marks: 2 marks for description of need, 2 marks for description of SMTP and 2 marks for description of POP3. However if further details of protocols are given the division of marks can be altered.

(ii) SMTP can only transmit ASCII characters. Files such as images, audio, video etc must be encoded into ASCII. The Multipurpose Internet Mail Extension (MIME) addresses this difficulty and can support multimedia e-mail. MIME encodes attachments into ASCII and maintains information in its header about the original file format and the type of encoding used. This allows the receiving software to translate the file back to its original form and use a suitable package or player to display it.

Marks: 4 marks for a full answer stating the requirement for ASCII and how MIME overcomes this.

(iii) May include:
Do not put correct e-mail address into forms on web pages.
Always click on box requesting NOT to receive information when you have used correct e-mail address in forms.
Never click on a link in SPAM e-mail to "un-register".
Set your e-mail client to block specified senders of SPAM mail.
Purchase anti-spam software.
Set up filter rules.

Marks: 1 mark each for each reason given.

10. (a)

Peer to Peer	Client Server
All network nodes have the same status, which includes the power to allow resource and file sharing.	Only dedicated systems operate as servers and the rest are clients.
Access to services tends not to be fully secured, for example, a single password for everyone or no control at all.	Server controls access therefore security is better. Users have a username and password which can be used to define access rights to various services.
Access to shared resources is in the control of the user who has made the service available.	Normally needs a network manager (administrator) to control the network.
Backup strategy and implementation is in the hands of the individual users.	More reliable and structured backup of data.
Can be implemented with very little expense, a bus connection and NIC's on each machine is all the hardware requirements and almost all modern OS's have built in support for peer to peer.	Requires dedicated servers in addition to client stations, servers must run a network server OS (or server software for a specific service).

Marks: 4 full marks awarded for a full answer and containing comparisons similar to above

(b) Candidates are free to recommend a **suitable** network for the given scenario in terms of bandwidth, standards, hardware components and topology, decisions must be justified. Preferred answers should be along the lines of:

Bandwidth: Internally to the school I would recommend that at least 100Mbps (Ethernet) network be installed. The biggest load on the network as described is probably the application service that could mean 30 computers are all wanting a 20 Megabyte (or larger) application sent across the network at the same time, if only 100Mbps was being used this could be slow, very slow if it was across a bus network. Although gigbit Ethernet over CAT5 is possible, the most common NIC's currently in use will operate at 10 or 100 Mbps, as long as care is taken to ensure all devices can operate at 100 Mbps then that will be the speed used. The possibility of 30 computers also sharing a single Internet connection would mean that neither a standard modem of even ISDN2 is really sufficient. Minimum therefore would be megabit ADSL or better.

Standards: Layer 1 and 2 services are best supplied by the installation of Ethernet. Ethernet is the most common type of LAN installation and harware devices to suit are cheap (relatively) and the Ethernet standard is well established. The initial installtion should use UTP cabling (as opposed to wireless) as CAT5 or 5e cables are readily available, reliable and reasonably cheap. TCP/IP should be the standard protocols used for layer 3 and 4 as this guarantees conformity with the Internet access and is easily implemented in all OS and hardware platforms currently in use, this is important as many schools have a mix of PC and Apple computers. The Ethernet standard 802.11b (or g) will allow flexibility of additional computers access points being added without further cabling, although this will sacrifice some bandwidth.

Hardware: All computers must have an Ethernet network card installed (100 Mbps). At least 1 if not 2 or 3 servers will be required to supply the desired functions (WWW access, e-mail, applications), their existence will also allow better security and control of the computers use in a school environment. I would recommend: an e-mail server, an applications server, a file server and a proxy server. Ethernet networks can be implemented as bus or star topologies and I would recommend a star (or tree) topology is implemented, this means that 2 or more switches should be purchased (switches allow layer two switching based on MAC addresses that will preserve bandwidth). Internet access via the proxy server will require an ADSL modem or a router attached to a leased line.

Topology: Ethernet can be implemented as a bus or a star network. The star configuration is preferred as the use of switches allows bandwidth is preserved rather than split between all computers, although a heavy load on a server across its connection will still cause some delays. The cost of switches is ever decreasing and most need little or no management. Star configurations are also much easier to troubleshoot as problems are easier to isolate. Some more cabling will be required than if a bus was created however it is unlikely that any computer would have to be placed more than 100m from a switch and so no repeaters would be required where in a bus a bridge or repeater may well have to be used. It should be noted that the need for more than 1 switch (24 ports is the most likely configuration, and the school will need around 40 minimum, 30 computers, 4 servers and probably several printers).The final topology is sometimes referred to as a tree.

Marks: All 4 topics must be covered, each with a notional 3 marks for each valid point, however more marks can be awarded for fuller description of one area.

(c) **(i)** Static IP address – machine has a fixed IP address entered into the appropriate configuration software by user/technician at the client machine.
dynamic IP address – machine is allocated an IP address automatically using DHCP when it 'logs on'.
These IP addresses are part of a pool of addresses maintained by a DHCP server. When computers are switched off the IP address can be re-used.

Marks: 1 mark for static and 2 for dynamic.

(ii) Class C addresses use the first 3 octets for the network and the 4th octet for the hosts. This gives 2^21 (accept 2^24) networks each with 2^8 hosts.

Marks: 1 mark for bit allocation to network ID OR the number of possible networks and 1 mark for host ID OR number of possible hosts.

(iii) The major weakness in terms of waste is that once a network ID is allocated there is no guarantee, or even likelihood that all the potential host ids will be needed. Therefore a large number of IP addresses will never be used.

Marks: 1 mark for reasonable description.

(d) When a link is clicked:

- a URL embedded within the HTML code is sent to the browser
- if this URL is for a web page then it will start with http:, thus indicating the protocol to be used
- the http protocol will then send a GET request to the server specified in the next section of the URL, eg www.ncsa.edu.
- an http daemon residing on this server will be listening for such requests
- the http server will use the remaining section of the URL to identify the page to be transmitted
- the http server will then send an acknowledgement of the request and the web page and associated files as required to the client OR if the file is not found it will send an appropriate error message.

Marks: 1 mark for each of the above steps or similar, credit should be given to pupils who discuss the use of TCP to open connection to server etc.

(e) **(i)** Although file transfers have increased dramatically over the years FTP programs are not the only option to implement file transfers.
The program most Internet users are familiar with is a browser which can be used to deliver e-mail (webmail) information access and file transfer. A lot of possible file transfers therefore are available as http downloads, both from secure and standard web sites. Browsers themselves also give access to ftp sites and can download files from these sites without the requirement for a purpose built FTP client. Another change relates to the development of remote access, file transfer is one function of remote access and its availability throught the use of protocols like SSH means that business people who are accessing their workplace remotely may well use remote access and initiate file transfers from within it.

Marks: 1 mark for each valid suggestion of alternative file transfer options, or a more detailed description of why http downloads operate would also justify marks.

(ii) File transfers through http are not as reliable as FTP transfers. FTP is better suited than http if you are uploading or deleting files from a server to which you have sufficient access rights. May also accept easier to initiate batch transfers and more reliable error recovery.

Marks: 1 mark for any valid point.

(f) Steps taken may include:

- Introductory training in web and e-mail use to both staff and pupils.
- An acceptable use policy will be created and pupils (and parents) and staff made aware of it and only given access to services when the agreement is signed.
- Use of filtering software to limit access to web page content.
- Use a firewall to block specific IP addresses or applications (ports) being used.
- Use dynamic data reading on the content of e-mails to search for inappropriate words.
- Regularly monitor individuals e-mail and web history.

Marks: 3 x 1 mark for each suggestion.

11. (a) (i) Token Ring:

- A token (small data packet) circulates around the ring, being passed from host to host.
- A host can only transmit if it is holding the token.
- There is a time limit on how long any host can hold the token before passing it on.
- Some hosts can be given higher priorities than others and so they may get access to the token more often.

CSMA/CD

- CS: All hosts on the network listen to the shared line.
- MA: If the line is free then any host may transmit.
- CD: When a host transmits it continues to listen to the line and is therefore aware of any data collisions.
- If a collision is detected then it ceases transmission and waits for a random amount of time before trying again.

Marks: 4 x 1 mark for each of the 4 points.

(ii) X.25, Point to Point Protocol (PPP), may also accept Serial Line Internet Protocol (SLIP).

Marks: 1 mark for any suitable suggestion.

(iii) Parity bit:

- the sender and receiver agree to use odd or even parity
- thereafter each 7 bit code has an eighth bit set to ensure an even or odd number of 1's and 0's exist in the byte.
- Will miss 'double' errors.

Marks: 2 x 1 mark for each valid point.

Cyclic Redundancy Check (CRC) or Checksum:

- the transmitting computer preforms a calculation on the data frame being sent and includes it in the frame header
- the receiving computer carries out an identical calculation and compares its answer with the one in the header.

Marks: 1 mark for each of the 2 points (total of 4 for whole question).

(b) Routers:

- Operate at layer 3: Network.
- Used to route packets, normally using IP addresses, across internetworks.
- Routers build up routing tables, which allows them to select which host they should forward a packet to in order to reach its final destination. It may monitor transmission speeds between attached hosts and use this information to intelligently select a route.

Gateways:

- Can operate at all layers possibly all the way up to layer 7: Application.
- Gateways link either WAN's or LAN's of dissimilar networks.
- A Gateway operates at the Transport Layer and above and it typically translates each source layer protocol into the appropriate destination layer protocol. A mainframe gateway may translate all OSI Model layers.

Switches:

- Operate at layer 2: Data Link
- They offer routing of data around a LAN and implements what is essentially a star topology.
- They compile a table of MAC addresses to identify which port any host is attached to. When data for that host is received it is only transmitted on the one specific port. Internally the switch operates very quickly and so bandwidth between multiple pairs of communicating hosts can be maintained.

Marks for each device: ***1 mark for correct number OR name of layer***
1 mark for a correct statement of function
Up to 2 marks for a description of their operation depending on detail.

(c) **(i)** Response should name the application they are using and thereafter identify:

- The method of entering the server name and making the connection.
- Entry of user name and password OR anonymous and either blank password or e-mail address.
- Navigation to the correct folder and file.
- Use of get command or method of initiating the file transfer in a GUI.

Marks: It is essential that the application being used is named and that the requirement for logging in is clear before full marks are awarded. Otherwise allocate 1 mark for each separate step.

(ii) TCP:

- Will open a session with a handshake to the receiving computer and negotiate the number to be given to the first packet, the maximum size of packet and the number of packets it may send before getting an acknowledgement is required.
- The senders end TCP will split the data into packets and add a sequence number to each packet along with a checksum.
- At the receiver end it will check each package, and if the checksums do not match then request restransmission and re-collate the packets correctly using their sequence number.

IP:

- Will add an IP header to the TCP packets which will contain the sender and receiver IP addresses.
- The IP address is then used by routers, or other layer 3 devices, to route the packet to the receiving device.

Marks: 3 marks are allocated to the role of TCP and 2 for IP, the points above are indications of desired response and some variation is acceptable. However more detailed subdivision of the marks eg 1 for adding the sequence number and 1 for checksum is not.

(iii) The working shown should be along the lines of:

- number of packets required = 928000/1450 = 640 packets
- total data to be transmitted = 640*1500 = 960000 bytes
- total bits to be transmitted = 960000*8 = 7680000 bits
- time taken – 7680000/48000 = 160 secs or 2 mins 40 secs.

Marks: 1 mark for each step or equivalent eg may change transmission rate to bytes per second.

(iv) JPEG, this is a lossy form of compression defined by the Joint Photographic Experts Group which will compress photographic style images whilst minimising the loss of quality to the human eye. It supports 16 million colours and users can often specify the level of compression required, thus placing the onus of the quality/size relationship on them.

Marks: 1 mark for identifying JPEG and 1 mark for any 2 of the underlined points.

[*END OF MARKING INSTRUCTIONS*]