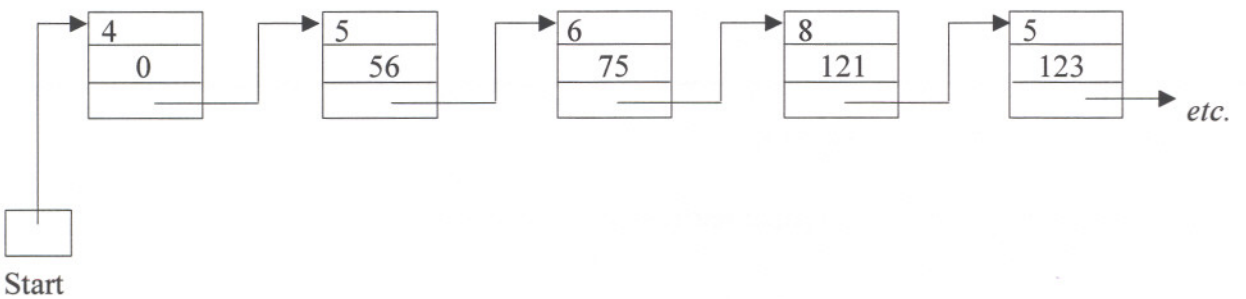
1. The temperature of a river (to nearest degree) for one day is being recorded, and the data is stored in a linked list. Readings are taken every one minute. If the temperature is different from the last reading, it is added to the list, together with the time, measured as minutes since midnight.

Here is an example of the first few *nodes* of the *list*:



In this example the river's temperature was 5°C when read at 56 minutes after midnight and remained so (to the nearest degree) until 75 minutes after midnight, when it was recorded as 6°C.

(a) In the above diagram, state how many minutes the river temperature was 4°C. *[1 mark]*

(b) Outline why a *list* is used, rather than an *array*. *[3 marks]*

(c) Describe the data structure required for each *node* of the *list*. *[4 marks]*

(d) Construct an algorithm for a function that will accept a temperature reading, search through the *list*, find the total time that the river was at that temperature and return the total time to the calling function. *[9 marks]*

(e) Construct an algorithm for a procedure that will return the minimum and maximum temperatures for the day. Call your procedure `MIN_MAX`. *[7 marks]*

(This question continues on the following page)

(Question 1 continued)

(f) Using your algorithms from parts (d) and (e), construct an algorithm to transfer the data from a complete *list* for the day into a two-dimensional *array* "Temp" which stores each temperature in ascending order, and the total time the river has been at that temperature. For example, part of the *array* might look like:

Temp	(Temperature) [1]	(Time) [2]
[1]	4	383
[2]	5	58
[3]	6	32
[4]	8	1
[5]	10	72
:	: *etc.*	:
:	999	0

[6 marks]

This question requires the use of the Case Study.

2. (a) Discuss the *processor* and *storage* needs of producing CT-scans. *[4 marks]*

(b) An enlarged detail of a CT-scan is in 8-bit grey scale and has 512×512 pixels.

(i) Calculate the number of shades of grey available. *[1 mark]*

(ii) Determine the storage required for this image. *[2 marks]*

(c) Not all computer abuse is illegal. Using the Case Study as an example, describe the difference between computer crime and computer abuse, giving an example of each. *[6 marks]*

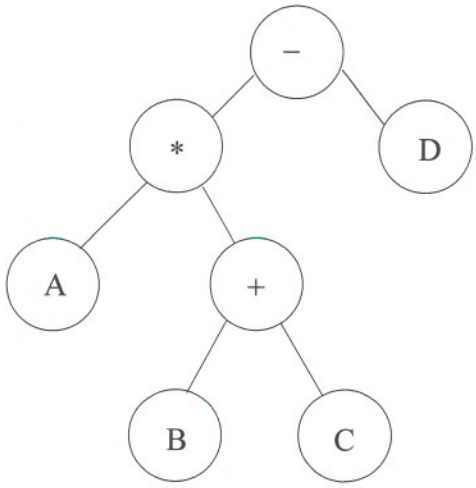
(d) Define the term *data compression* and explain the **two** uses of data compression in the Case Study. *[6 marks]*

(e) CT-scans are transferred over national lines from the medical scanner set-up to the University.

Draw a suitable system flowchart to achieve this. You may wish to refer to the Case Study, page 3, paragraphs 2 and 3, and figure 5 page 13. *[8 marks]*

(f) Discuss the extent to which major advances in computer technology have affected scientific research. *[3 marks]*

3. A computer program converts an arithmetic expression into a binary tree putting the operators and operands in reverse order of precedence. For example the expression `A*(B+C)-D` is converted to



Note: + has the highest precedence (priority) of all the operators because it is in brackets. The priorities required in this question are:
1st priority: expressions in brackets
2nd priority: * /
3rd priority: + –

(a) (i) State the expression from the *post-order traversal* of the tree above. *[1 mark]*

(ii) State the expression from the *in-order traversal* of the tree above. *[1 mark]*

(b) Construct the tree for the expression `(A-B)*C+(D-E)/F`. *[4 marks]*

(c) Describe a record structure that could be used to store a node for such a tree. *[3 marks]*

(d) Construct the recursive algorithm to output the results of a:

(i) *post-order traversal*; *[5 marks]*

(ii) *pre-order traversal*. *[1 mark]*

4. An address generated by the *processor* is mapped to the physical location of the required data as part of the *memory management function* of an *operating system*. This location may be in cache memory, RAM (main memory) or on disk. The data at this address is then located and read.

(a) If the data being read is an *instruction*, state the step from the *Machine Instruction Cycle* that is being carried out. *[1 mark]*

(b) If the data is being read from disk as if it were held in RAM (that is, as an extension to RAM):

(i) state the concept that is being used. *[1 mark]*

(ii) compare **two** aspects of *access time* when reading data from RAM with reading data from a disk. *[6 marks]*

(iii) describe how a *hash algorithm* may be used to access data on the disk in this case, and why it may be used rather than using an *index*. *[3 marks]*

(c) Outline **two** further functions of an *operating system* apart from *memory management*. *[4 marks]*

5. A computer is used to enter, store, display and send instructions to machines in a factory. Because of dirt and physical damage it is continuously breaking down. A systems analyst has been asked to make a recommendation to improve the situation.

At the moment:
1. input is via the keyboard which gets clogged up
2. ouput is via screen which gets smashed
3. storage, which needs to be portable, is on diskette which gets dirty
4. the communications link is often disrupted
5. the CPU is top of the range to run a GUI

The computer has to remain in the current place in case of an emergency.

(a) State **one** advantage and **one** disadvantage of observing / interviewing current users to collect data about the current system. *[2 marks]*

(b) State **one** advantage and **one** disadvantage of using questionnaires to collect data. *[2 marks]*

(c) State the name of the report produced by the systems analyst at the end of the analysis stage and identify **two** features (sections) within it. *[3 marks]*

(d) State and explain **four** suggestions you would make to improve the situation. *[8 marks]*