

# **Fundamental IT Engineer Examination (Morning) Trial**

Questions must be answered in accordance with the following:

<b>Question Nos.</b>	<b>Q1 - Q80</b>
<b>Question Selection</b>	<b>All questions are compulsory</b>
<b>Examination Time</b>	<b>150 minutes</b>

- Q1.** Which of the following is a decimal number that can be expressed in binary floating-point without any possible rounding (round-off) error?
- a) 0.2                      b) 0.3                      c) 0.4                      d) 0.5
- Q2.** There is a non-zero integer whose number of digits is  $D$  in decimal and  $B$  in binary. Which of the following expressions correctly describes the relationship between  $D$  and  $B$ ?
- a)  $D \doteq 2 \log_{10} B$                       b)  $D \doteq 10 \log_2 B$   
c)  $D \doteq B \log_2 10$                       d)  $D \doteq B \log_{10} 2$
- Q3.** Which of the following numeric values or expressions represents an  $n$ -digit binary number consisting entirely of ones, “1111...111”? Here, a negative number is expressed in two’s complement.
- a)  $-(2^{n-1}-1)$                       b)  $-1$                       c)  $0$                       d)  $2^n - 1$
- Q4.** When addition or subtraction of integers is performed by using a computer, an overflow must be paid attention to. Which of the following combinations list all the operations that can cause the overflow?

	Operation	Operand $x$	Operand $y$
$A$	$x+y$	Positive	Positive
$B$	$x+y$	Positive	Negative
$C$	$x+y$	Negative	Positive
$D$	$x+y$	Negative	Negative
$E$	$x-y$	Positive	Positive
$F$	$x-y$	Positive	Negative
$G$	$x-y$	Negative	Positive
$H$	$x-y$	Negative	Negative

- a)  $A, D, F, G$                       b)  $B, C, E, H$                       c)  $B, E$                       d)  $C, E, H$

- Q5.** The calculation time for solving a system of linear equations on a computer is proportional to the cube (third power) of the number of unknowns in the equations. If it takes 2 seconds on a computer to solve a system of linear equations involving 100 unknowns, how many seconds does it take on a computer with four times the processing speed to solve a system of linear equations involving 1,000 unknowns?
- a) 5                      b) 50                      c) 500                      d) 5,000
- Q6.** There is an 8-bit code whose most significant bit is a parity bit. Which of the following bitwise operations can be used to obtain the lower 7 bits other than the parity bit?
- a) AND with the hexadecimal number 0F  
 b) OR with the hexadecimal number 0F  
 c) AND with the hexadecimal number 7F  
 d) XOR (exclusive OR) with the hexadecimal number FF
- Q7.** As a result of inspecting 100 parts, 11 were found with defect *A*, 7 with defect *B*, and 4 with defect *C*. Moreover, 3 were detected with both *A* and *B*, 2 with both *A* and *C*, and none were found with both *B* and *C*. How many parts were free of defects?
- a) 78                      b) 83                      c) 85                      d) 88
- Q8.** Which of the following truth tables represents the logical formula  $Z = X \bullet \bar{Y} + \bar{X} \bullet Y$ ? Here, “ $\bullet$ ” is used for the logical product, “+” for the logical sum and “ $\bar{A}$ ” for the logical negation of “*A*.”

a)

<i>X</i>	<i>Y</i>	<i>Z</i>
0	0	0
0	1	0
1	0	0
1	1	1

b)

<i>X</i>	<i>Y</i>	<i>Z</i>
0	0	0
0	1	1
1	0	1
1	1	0

c)



<i>X</i>	<i>Y</i>	<i>Z</i>
0	0	0
0	1	1
1	0	1
1	1	1

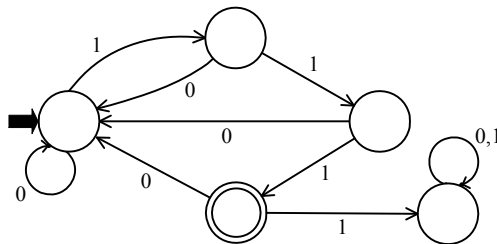
d)

<i>X</i>	<i>Y</i>	<i>Z</i>
0	0	1
0	1	0
1	0	0
1	1	1

**Q9.** How many bits are at least required to uniquely represent the English capital letters (A through Z) and the numeric characters (0 through 9) with the same number of bits?

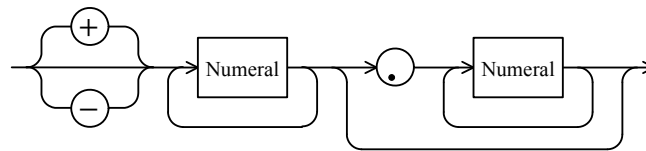
- a) 5                      b) 6                      c) 7                      d) 8

**Q10.** Which of the following character strings is accepted by the finite automaton in the diagram shown below? The symbol  indicates the initial state and the symbol  indicates the accept state.

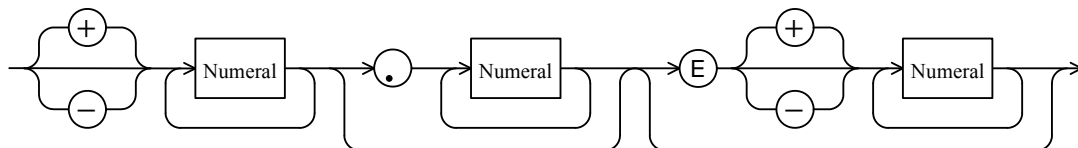


- a) 01011                      b) 01111                      c) 10111                      d) 11110

**Q11.** A particular syntax is described by using the syntax diagram shown below. The numeric representations such as -100, 5.3, and +13.07 conform to this syntax.



Based on this notation, which of the following numeric representations conforms to the syntax specified in the figure shown below?

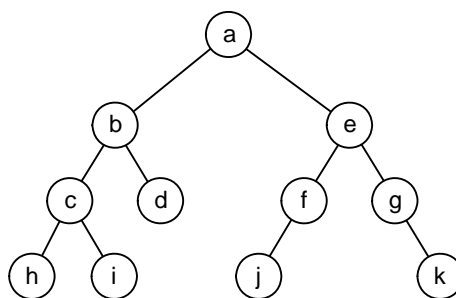


- a) -9                      b) 5.2E-07                      c) 9.89E                      d) +1.E4

**Q12.** In binary tree traversal, there are three different methods depending on the traversal sequence.

- (1) Pre-order: Scans in the order of node, left subtree, and right subtree
- (2) In-order: Scans in the order of left subtree, node, and right subtree
- (3) Post-order: Scans in the order of left subtree, right subtree, and node

When the tree illustrated below is traversed in pre-order, which of the following indicates a sequence of the output node values?



- |                |                |
|----------------|----------------|
| a) abchidefjgk | b) abechidfjgk |
| c) hcibdajfegk | d) hicdbjfkgea |

**Q13.** Two stack operations are defined as follows:

PUSH  $n$  : Pushes data (integer  $n$ ) onto the stack

POP: Pops data off the stack

When the series of stack operations shown below is performed on an empty stack, which of the following results is produced?

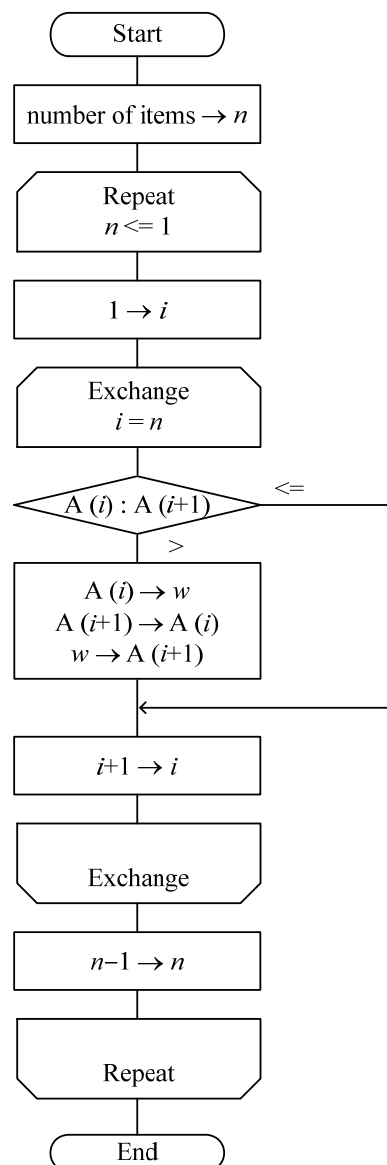
PUSH 1 → PUSH 5 → POP → PUSH 7 → PUSH 6 → PUSH 4 → POP → POP → PUSH 3

- |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
|--|--|---|---|---|--|--|---|---|---|--|--|---|---|---|--|--|---|---|---|
| a) <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td> </td></tr><tr><td>1</td></tr><tr><td>7</td></tr><tr><td>3</td></tr></table> |  | 1 | 7 | 3 | b) <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td> </td></tr><tr><td>3</td></tr><tr><td>4</td></tr><tr><td>6</td></tr></table> |  | 3 | 4 | 6 | c) <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td> </td></tr><tr><td>3</td></tr><tr><td>7</td></tr><tr><td>1</td></tr></table> |  | 3 | 7 | 1 | d) <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td> </td></tr><tr><td>6</td></tr><tr><td>4</td></tr><tr><td>3</td></tr></table> |  | 6 | 4 | 3 |
|  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
| 1  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
| 7  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
| 3  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
|  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
| 3  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
| 4  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
| 6  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
|  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
| 3  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
| 7  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
| 1  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
|  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
| 6  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
| 4  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |
| 3  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |  |  |   |   |   |

**Q14.** Which of the following appropriately describes a characteristic of the hash method used in table searches?

- a) Hashing is another name for a method using binary trees.
- b) Hashing is a method by which collisions do not occur in finding storage locations.
- c) Hashing determines the storage location according to the function value of the key.
- d) The time required for searching is proportional to the size of the entire table.

**Q15.** Which of the following sort algorithms is illustrated in the flowchart below?



- a) Quick sort
- b) Shell sort
- c) Insertion sort
- d) Bubble sort

**Q16.** Which of the following is an appropriate statement concerning flash memory?

- a) It does not require periodic refresh to retain stored information, and all or part of information can be erased and rewritten electrically.
- b) All stored information can be erased using ultraviolet light and rewritten.
- c) Since it can read data at high speed, it is often used as cache memory.
- d) It requires periodic refresh and is widely used as main memory.

**Q17.** Which of the following logical circuits with two inputs and one output can generate 0 for  $X$  only when inputs  $A$  and  $B$  are both 1s?

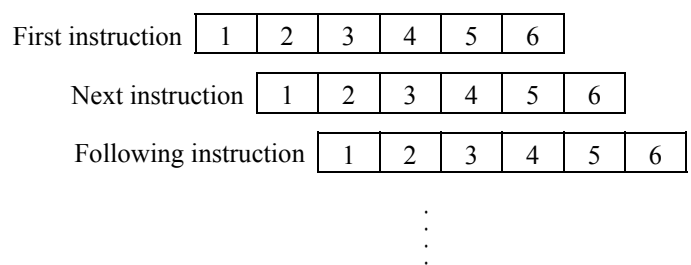


- a) AND circuit
- b) NAND circuit
- c) OR circuit
- d) XOR circuit

**Q18.** In a certain computer, one instruction is executed in the order of steps 1 through 6 in the table shown below. How many nanoseconds are required to execute 6 instructions using pipeline processing in the figure shown below? Here, it takes 10 nanoseconds to execute each step, and there is no instruction, such as branch and jump, that stalls the pipeline processing.

**Table Execution Steps Per Instruction**

Step	
1	Fetch instruction code
2	Decode instruction
3	Fetch address
4	Calculate effective address
5	Fetch data
6	Execute operation



**Fig. Pipeline Processing to Execute Instructions**

- a) 50
- b) 60
- c) 110
- d) 300

**Q19.** Which of the following technologies is suited for a multimedia system that allows one instruction to execute the same operation on two or more data concurrently?

- a) MIMD                      b) MISD                      c) SIMD                      d) SISD

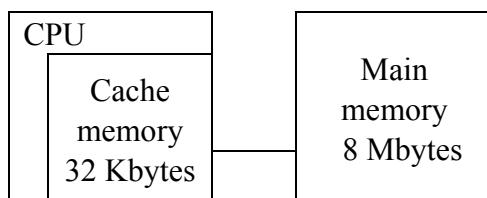
**Q20.** A certain computer's average instruction execution time is  $0.2 \mu\text{sec}$ . What is this computer's performance in terms of MIPS?

- a) 0.5                      b) 1.0                      c) 2.0                      d) 5.0

**Q21.** Which of the following processor interrupts is categorized as an external interrupt?

- a) Operation exception                      b) Timer  
c) Page fault                      d) Invalid instruction code

**Q22.** There are two CPUs *X* and *Y* that are configured in the figure shown below. Both have exactly the same conditions except the access time of the cache memory and main memory in the table shown below. When a certain program runs on both CPUs, processing time is the same for both. In this case, what is the hit ratio of the cache memory? Here, no factors other than CPU processing have an impact on the hit ratio.



**Fig. Configuration**

**Table Access Time**

Unit: nanosecond

	CPU X	CPU Y
Cache memory	40	20
Main memory	400	580

- a) 0.75                      b) 0.90                      c) 0.95                      d) 0.96

**Q23.** Which of the following is an appropriate statement concerning write-through in a cache memory?

- a) Data is written only into the cache memory when CPU performs the write operation.  
b) Data is written simultaneously into both the cache and main memory.  
c) Changes to data in the main memory take place when the data is pushed out of the cache memory.  
d) Because of a relatively low frequency of memory access, the bus occupancy ratio is also low.



- Q24.** On a hard disk, a sequential organization file consists of unblocked fixed length records. A program reads and processes all data in this file sequentially. When the file organization or reading method is changed, which of the following is an appropriate solution to achieve the shortest time in which the program needs to read the data? Here, multiprocessing is not considered.
- a) By dividing and storing the data into separate files and accessing these files sequentially.
  - b) By creating an indexed organization file and reading the data by using a key of each record.
  - c) By creating a direct organization file and reading only the necessary data.
  - d) By blocking records and increasing the number of records acquired in a single physical read operation.
- Q25.** In CD-R/CD-RW, which of the following writing technologies makes it possible to write data in small units, just as when writing on a hard disk?
- a) Disk at once
  - b) Track at once
  - c) Packet writing
  - d) Multi session
- Q26.** Which of the following appropriately describes the features of USB 1.1?
- a) USB 1.1 adopts a high-speed transfer method that is suitable for data to be delivered in real time, such as audio and video. USB 1.1 allows devices to be connected in a daisy-chain or tree topology, and permits connection even in the absence of a PC acting as host.
  - b) Peripheral devices are connected through a PC acting as host. USB 1.1 supports multiple modes of data transfer; generally, a printer or a scanner uses full speed mode, and a keyboard or a mouse uses low speed mode.
  - c) USB 1.1 is a serial interface that is originally designed for connecting modems, but is also used for connecting peripheral devices to a PC.
  - d) USB 1.1 is a parallel interface that connects hard disks, laser printers and other peripheral devices to small computers, including PCs.

**Q27.** Which of the following appropriately describes a characteristic of an OLED display in comparison to LCD?

- a) OLED has a narrow field of view.
- b) OLED is long-lasting.
- c) OLED generates little heat.
- d) OLED emits light itself.

**Q28.** About how many megabytes (or Mbytes) in memory are required to display a screen of 1,024 horizontal pixels and 768 vertical pixels when the video memory stores 24 bits of color information per pixel? Here, 1 Mbyte is  $10^6$  bytes.

- a) 0.8
- b) 2.4
- c) 6.3
- d) 18.9

**Q29.** In basic computer architecture, which of the following is the method that both programs and data are read into the storage device of a computer prior to execution?

- a) Addressing
- b) Virtual memory
- c) Direct program control
- d) Stored program

**Q30.** When three tasks run standalone, their priority levels are shown in the table below, and each operation sequence and processing time of the CPU and I/O devices are also described in the table. How many milliseconds of the CPU idle time are there from the instant all three tasks become executable at a time until the execution of all tasks is completed? Here, no conflict occurs in I/O operations, and the overhead of the OS itself can be ignored.

Priority level	Operation sequence and processing time in standalone mode (unit: millisecond)
High	CPU(3) → I/O(5) → CPU(2) → I/O(5) → CPU(2)
Middle	CPU(2) → I/O(6) → CPU(2) → I/O(5) → CPU(2)
Low	CPU(1) → I/O(5) → CPU(2) → I/O(4) → CPU(1)

- a) 2
- b) 3
- c) 4
- d) 5

**Q31.** Which of the following appropriately describes an expression that represents the relationship between turnaround time, CPU time, I/O time, and process waiting time? Here, all other types of overhead time can be ignored.

- a) Process waiting time = CPU time + Turnaround time + I/O time
- b) Process waiting time = CPU time – Turnaround time + I/O time
- c) Process waiting time = Turnaround time – CPU time – I/O time
- d) Process waiting time = I/O time – CPU time – Turnaround time

**Q32.** Which of the following functions is included in OS task management?

- a) CPU allocation
- b) Spool control
- c) I/O execution
- d) File protection

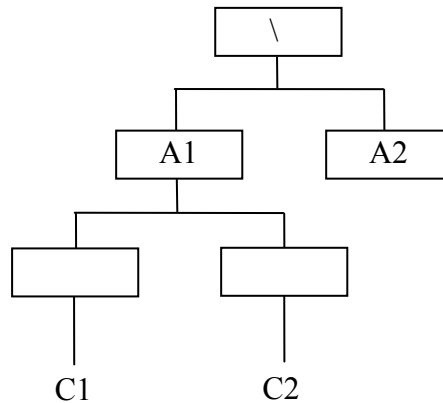
**Q33.** Which of the following appropriately describes the purpose of spooling?

- a) To record operating history information of a computer system
- b) To enable processing on a logical record basis without regard to the physical record
- c) To provide virtual memory larger than real memory by means of an auxiliary storage device
- d) To increase the processing efficiency of a system that is used with low speed I/O devices, by means of an auxiliary storage device

**Q34.** Which of the following appropriately describes the API (Application Program Interface) in an OS?

- a) It is a mechanism that allows application programs to operate hardware directly and to execute various functions.
- b) It is a mechanism that enables application programs to use various functions provided by OS.
- c) It is a mechanism that enables multiple applications to communicate with one another over a network.
- d) It is a mechanism that standardizes menu items of each application program for the convenience of users.

- Q35.** In the hierarchical file system shown below, when the current directory is B1, which of the following is the relative path name of the file C2? Here, a symbol “..” in the path name indicates a parent directory. A backslash “\” appearing at the head of a path name means the root directory, whereas a backslash “\” in the middle indicates a delimiter of the directories or file names. The boxes in the figure represent directories.



- a) ..\A1\B2\C2                      b) ..\B2\C2  
 c) A1\B2\C2                        d) B1\..\B2\C2
- Q36.** In the function layer of a 3-layer client/server system, which of the following combinations of two functions is processed?
- a) The input of search conditions and the assembling of the data processing conditions  
 b) The input of search conditions and data access  
 c) The assembling of the data processing conditions and data manipulation  
 d) Data access and data manipulation

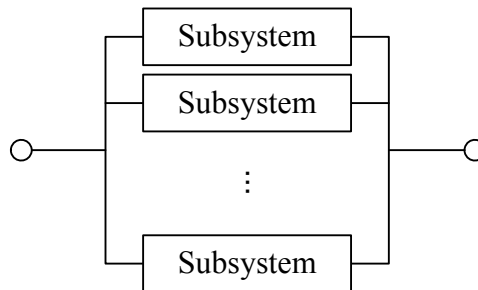
**Q37.** In computer system configuration, which of the following is the appropriate explanation on a tightly coupled multiprocessor system?

- a) The multiple processors share a hard disk, and each processor is controlled by its own OS. Processing power is enhanced by distributing workload on a per-job basis.
- b) The multiple processors share the main memory and are controlled by a single OS. In principle, a task in the system can be executed by any of the processors, so processing power is enhanced by distributing workload in small pieces.
- c) Normally, one of the processors is in the standby state. When a failure occurs in the active system, processing is continued by switching over to the standby processor.
- d) Two parallel connected processors concurrently perform the same processing and compare their results with each other. If one of the processors fails, it is removed and processing is continued.

**Q38.** Which of the following is an appropriate statement concerning system performance evaluation?

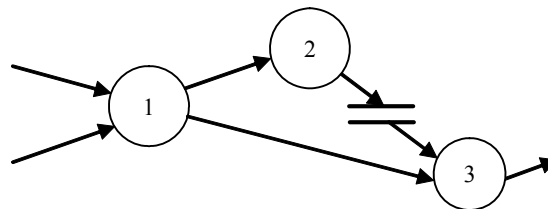
- a) In OLTP (Online Transaction Processing), MIPS values are used to evaluate system performance.
- b) Response time and turnaround time are performance evaluation indexes from the viewpoint of a system operation administrator.
- c) Generally, response time is improved as the utilization ratio of system resources becomes higher.
- d) The number of transactions or jobs that can be processed in a unit of time is important for evaluating system performance.

- Q39.** In a parallel system shown below, at least how many subsystems are required to increase the availability of the entire system to 99% or more? Here, the availability of each subsystem is 70%. The entire system is running as long as one subsystem is running.



- a) 3                      b) 4                      c) 5                      d) 6

- Q40.** In a hierarchical DFD, a part of DFD at a certain level is shown below. Which of the following illustrates the appropriate method for describing the immediately lower level of DFD? Here, the processes in the immediately lower level of Process  $n$  are numbered as follows: Process  $n-1$ , Process  $n-2$ , etc.



- a) 
 Option a shows a process circle labeled '1-1' with one incoming arrow from the left. It branches into two outgoing arrows: one to a process circle labeled '1-2' and another to a process circle labeled '1-3'. Both '1-2' and '1-3' have one outgoing arrow to the right.
- b) 
 Option b shows a process circle labeled '1-1' with one incoming arrow from the left. It has one outgoing arrow to a process circle labeled '1-2'. Process '1-2' has two outgoing arrows: one to a process circle labeled '1-3' and another to the right. Process '1-3' has one outgoing arrow to the right.
- c) 
 Option c shows a process circle labeled '1-1' with two incoming arrows from the left. It has one outgoing arrow to a process circle labeled '1-2'. Process '1-2' has two outgoing arrows: one to a process circle labeled '2-1' and another to the right. Process '2-1' has one outgoing arrow to a process circle labeled '2-2'. Process '2-2' has one outgoing arrow to the right.
- d) 
 Option d shows a process circle labeled '1-1' with two incoming arrows from the left. It has one outgoing arrow to a process circle labeled '1-2'. Process '1-2' has one outgoing arrow to a process circle labeled '1-3'. Process '1-3' has two outgoing arrows to the right.

**Q41.** Which of the following appropriately describes a characteristic of a recursive program?

- a) A recursive program can call itself either directly or indirectly through another program it has called.
- b) A recursive program can be located and executed at any address in the main memory.
- c) A recursive program can produce correct results even if it is simultaneously called by multiple tasks.
- d) A recursive program can be repeatedly executed without reloading.

**Q42.** Which of the following appropriately explains optimization by a compiler?

- a) It generates an intermediate code for an interpreter instead of generating the object code.
- b) It generates an object code that runs on a different type of computer from the computer used for compiling.
- c) It generates an object code that indicates routine names to which control is passed as well as the contents of variables at specified time points during execution of the program.
- d) It analyzes the program code and generates an object code that can be executed with improved processing efficiency.

**Q43.** Which of the following appropriately describes a characteristic of an object-oriented language?

- a) The sequence of computation is specified by data flow, not by control flow. The data used by an instruction is not used by this or the other instructions after that.
- b) The control of computation is sequentially passed from instruction to instruction. The transfer of data between instructions is done indirectly by referencing the memory through “variables.” The instructions and the definition of data are separated.
- c) Data is hidden from the outside world and operated indirectly by a procedure called a “method.” A program is a collection of encapsulations of data and methods.
- d) A program is composed of data and instructions (symbols of operation) that represent nest-structured operational expressions and functions. “Instruction execution” means “calculation (evaluation) of that particular expression or function.”

- Q44.** Which of the following appropriately describes a characteristic of a programming language?
- a) COBOL is suited for business data processing and executed by using an interpreter.
  - b) C is a system description language, and a program written in C needs compiling prior to its execution.
  - c) The language specifications of Java depend on the platform, and Java is executed by using an interpreter.
  - d) Perl is suitable for writing programs that run on a client, and a program written in Perl needs compiling prior to its execution.
- Q45.** Which of the following should be approved after completion of the external design of the system?
- a) Screen layout
  - b) System development plan
  - c) Flowchart
  - d) Physical database specifications
- Q46.** Which of the following appropriately explains reverse engineering concerning software?
- a) Design specifications are extracted from an implemented program.
  - b) A program is designed in the sequence of “output, process, and input.”
  - c) Functions implemented by the software are put into practice as part of the hardware features.
  - d) Development languages and development tools are selected according to the processing contents of programs.
- Q47.** In “module coupling” used as a measurement of “module independence,” the weaker (or lower) the module coupling becomes, the stronger (or higher) the module independence grows. Which of the following module couplings has the highest module independence?
- a) Common coupling
  - b) Stamp coupling
  - c) Data coupling
  - d) Content coupling



**Q48.** Which of the following appropriately explains white box testing that is one of the program testing methods?

- a) The lowest-level modules in the program structure are first tested. Next, they are integrated into the higher-level modules, and the integrated modules are tested. In this way, this method repeats integration and testing at higher level in sequence.
- b) The highest-level module in the program structure is first tested. Next, the lower-level modules called by the highest module are integrated and tested. In this way, this method repeats integration and testing at lower level in sequence.
- c) This testing method focuses attention on the external specifications of a program, and all possible combinations of the input values are tested. This method includes techniques such as equivalence partitioning, boundary value analysis, and cause-effect graph.
- d) This testing method focuses attention on the internal structure of a program. The program logic is examined and tested so that all paths can be executed. This method includes techniques such as instruction coverage and condition coverage.

**Q49.** When a calculation method of check digit shown below is used for appending a check digit to a given data value, which of the following is the correct result? Here, the data value is 7394, the weight factor assigned to each position is “1, 2, 3, 4,” and the base 11 (modulus 11) is assumed.

[Method]

- 1) Multiply each digit of the data by the corresponding digit of the weight factor, and then sum up the results.
- 2) Divide the sum of step 1 by the base to obtain the remainder.
- 3) Subtract the remainder of step 2 from the base, and append the resulting one's place value to the end of the data value as a check digit.

- a) 73940                      b) 73941                      c) 73944                      d) 73947

**Q50.** In a GUI screen, which of the following is the most significant point to remember, in order to provide an efficient user interface both for users who are accustomed to keyboard operations and for those who are not?

- a) Minimizing direct input from the keyboard and enabling selection from lists using the mouse
- b) Placing important items, such as mandatory fields, at the top of the screen, regardless of the format of the input form
- c) Making both mouse and keyboard interfaces available for frequently performed operations
- d) Making it possible to execute frequently used functions by double-clicking the mouse

**Q51.** Which of the following appropriately describes XML?

- a) XML is based on HTML and includes its expanded functions.
- b) A special-purpose text editor is required to input XML documents.
- c) XML integrates the logical structure and display style of a document.
- d) XML allows users to define the attribute information and logical structure of a document by using their own customized tags.

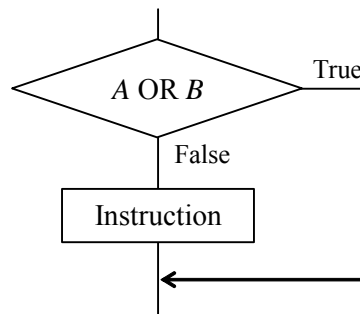
**Q52.** Which of the following appropriately describes how to use stubs in the testing phase?

- a) A stub is used to check whether or not processing is being done correctly by outputting part of registers or main memory every time a specific instruction is executed.
- b) When a program is tested in a top down manner, a temporary lower level module called a stub is created and executed together with the program to check the operations.
- c) During execution of a program, a stub checks and corrects the contents of variables and registers if needed, and then it continues testing follow-on processes.
- d) When a unit test is done for a module that is part of a program, a temporary higher level module, which calls the tested module, is provided in order to check the operations.

**Q53.** A sales company is developing an application that can provide data to sales personnel at branch offices across the country from a server located in the head office, using the company's own intranet. When a system test is done in the LAN environment of the head office, which of the following is a difficult item to verify? Here, the company's internal network consists of LAN in the head office, LANs in the branch offices, and communication lines connecting these offices.

- a) Processing time of the application program
- b) Response time
- c) Screen operations when the server is overloaded
- d) Number of processes running on the server

**Q54.** In the logic test shown below, which of the following test cases is needed to achieve decision condition coverage (branch coverage)?



- a) 

A	B
False	True
- b) 

A	B
False	True
True	False
- c) 

A	B
False	False
True	True
- d) 

A	B
False	True
True	False
True	True

**Q55.** In a system development project, PERT is used to create an implementation plan and find a critical path. Which of the following can be figured out of the critical path?

- a) The activities that require the most attention in terms of system quality
- b) The activities whose implementation sequence can be changed
- c) The activities that are directly connected to delay of the whole project
- d) The most costly activities

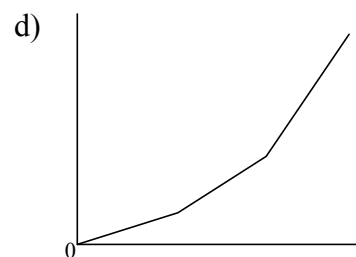
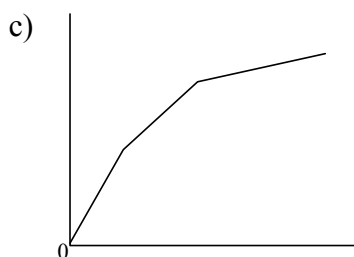
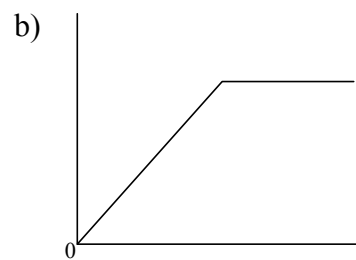
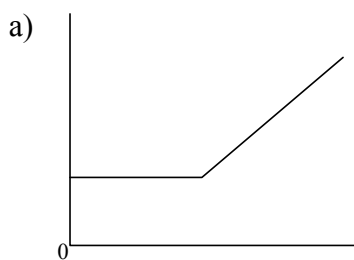
**Q56.** Which of the following appropriately describes the function point method?

- a) The lines of code on a function-by-function basis in the program to be developed are summed up, and the total size of development is estimated.
- b) The work items required in the development project are broken down in detail, and the workload of each work item is estimated at the same time.
- c) The size of development is estimated based on the number and characteristics of external I/O, internal logical files, external inquiries, external interfaces, etc.
- d) The size of development is estimated by searching for similar past cases and analyzing and evaluating actual results and differences.

**Q57.** Which of the following appropriately describes the purpose of appending a check digit to a customer code?

- a) To discover input errors in customer codes
- b) To arrange a list of customer names in the order in which new customers were won.
- c) To make it possible to guess who customers are
- d) To make it possible to categorize customers into regional groups, etc.

**Q58.** The charge for using a computer system is determined in consideration of various criteria such as the usage of resources and the number of users. Which of the following graphs shows a declining metered rate system (or a diminishing charge system)? Here, the horizontal axis indicates the usage amount, and the vertical axis is the usage charge?



**Q59.** Which of the following devices is installed so that a computer system will not shut down due to a sudden failure of the external power supply?

- a) CVCF
- b) UPS
- c) Private electric power generator
- d) Backup power-receiving equipment

**Q60.** In software maintenance, which of the following tests is used to make sure that side effects of corrections or changes are not happening?

- a) Performance test
- b) Endurance test
- c) Regression test
- d) Exception test

**Q61.** Which of the following appropriately describes protocols that are used in the session layer of the OSI basic reference model?

- a) There are protocols for error detection and recovery process for the sequence and loss of transmitted data, multiplexing of data, etc.
- b) There are protocols for remote data access, file transfer, etc.
- c) In order to do transparent, error-free data transfer between adjacent systems, there are protocols for error control, recovery control procedures, send/receive timing, etc.
- d) In order to establish a logical communication path and support orderly data exchange, there are protocols for interoperation control, exception reporting, etc.

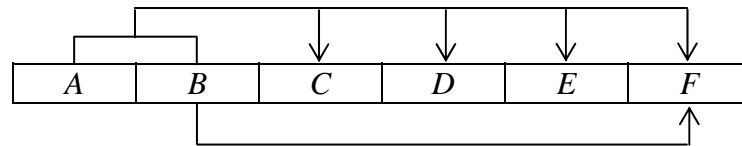
**Q62.** As shown in the figure below, the 16-bit data is arranged in a square of 4 by 4 blocks, and parities are appended to rows and columns. Up to how many bits of error can be corrected by means of this method? Here, the shaded areas in the figure indicate parities.

1	0	0	0	1
0	1	1	0	0
0	0	1	0	1
1	1	0	1	1
0	0	0	1	

- a) 0 (uncorrectable)
- b) 1
- c) 2
- d) 3

- Q63.** When messages consisting of 90 characters each are transferred at a speed of 14,400 bps on the start/stop line, how many messages can be sent in 1 minute? Here, each character consists of 8 bits without parity, and the 1-bit start and 1-bit stop signals are used. The actual usage ratio of the line is 80%.
- a) 12                      b) 16                      c) 768                      d) 960
- Q64.** When a file with an average size of 1,000 bytes is transferred every two seconds between terminals connected through a leased line with a communication speed of 64,000 bps, which of the following is closest to the line usage ratio (%)? Here, during file transfer, control information equivalent to 20% of the transfer amount is appended.
- a) 0.9                      b) 6.3                      c) 7.5                      d) 30.0
- Q65.** When the collision lamp of the 10Base-T hub remains solidly lit, which of the following appropriately describes the status of LAN?
- a) Efficiency of data transmission is being degraded because of traffic congestion on LAN.
- b) The voltage supplied to the hub is dropping because more than the acceptable number of computers are simultaneously connected to the same segment.
- c) One of the connected computers has an extremely high processing speed and is occupying LAN.
- d) Data to be transmitted cannot be delivered because more than the allowable number of hubs are connected in a cascade configuration.
- Q66.** Which of the following appropriately describes LAN-to-LAN connection devices?
- a) The gateway is used for protocol conversion only at lower layers from the first layer through the third layer in the OSI basic reference model.
- b) The bridge relays frames based on the IP address.
- c) The repeater amplifies signals between segments to extend the transmission distance.
- d) The router relays frames based on the address at the MAC layer.

- Q67.** A certain record consists of items *A* through *F*. The combination of items *A* and *B* is the primary key for this record. Moreover, item *F* can be identified by item *B*. Which of the following is in the 3rd normal form of this record?



- a) 

A	B
---	---

C	D	E
---	---	---

B	F
---	---
- b) 

A	B	C	D	E
---	---	---	---	---

B	F
---	---
- c) 

A	B	F
---	---	---

C	D	E
---	---	---

B	F
---	---
- d) 

A	C	D	E
---	---	---	---

B	C	D	E
---	---	---	---

B	F
---	---
- Q68.** Which of the following appropriately describes projection in a relational database operation?
- a) Projection combines the query results of one table with those of another table to form a single table.
- b) Projection extracts from a table the rows that match a specific condition.
- c) Projection extracts only the specific columns from a table.
- d) Projection forms a new table by combining groups that match particular conditions in two or more tables.

- Q69.** Based on the “Product” table shown below, a “Profitable Product” table is created by using [View definition]. Which of the following update processes decreases the number of rows appearing in the “Profitable Product” table?

Product

Product code	Product name	Model	Sales price	Purchase price
S001	PC T	T2003	1,500	1,000
S003	PC S	S2003	2,000	1,700
S005	PC R	R2003	1,400	800

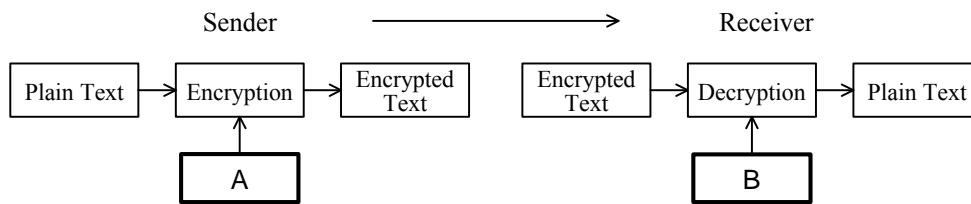
[View definition]

```
CREATE VIEW Profitable_Product
AS SELECT * FROM Product
WHERE Sales_price - Purchase_price >= 400
```

- a) Updating the sales price of model R2003 to 1,300
  - b) Updating the purchase price of model R2003 to 900
  - c) Updating the purchase price of model S2003 to 1,500
  - d) Updating the sales price of model T2003 to 1,300
- Q70.** Which of the following appropriately describes the log file in DBMS?
- a) A log file is created by periodically writing updated data in the main memory onto a disk, so as to shorten database recovery processing time in the event the system goes down.
  - b) A log file is created by constantly writing a copy of the same data into a database on a separate disk or into a database at another site, so that the system can be immediately restored in the event of a disk failure.
  - c) A log file is created by duplicating the content of the database on a per-disk basis, so as to restore the database from disk failure.
  - d) A log file is obtained by writing the data values preceding and following data updates in order to keep records of the database updates, for use in database recovery.



**Q71.** The figure shown below is a conceptual diagram of a public key cryptography. Which of the following is the appropriate combination to be inserted in A and B?



	A	B
a)	Receiver's public key	Receiver's private key
b)	Receiver's private key	Receiver's public key
c)	Sender's public key	Receiver's private key
d)	Sender's private key	Receiver's public key

**Q72.** Which of the following appropriately describes security in use of the Internet?

- Introducing a firewall can prevent important information inside a company from leaking to the outside when the internal e-mail system is connected to the outside over the Internet.
- When a database server is used over the Internet, measures are needed to prevent illegal access to the server and data falsification.
- When an e-mail is sent over the Internet, e-mail encryption enables a user to check the mail delivery.
- It is necessary to register with a user authentication system in order to use the Internet.

**Q73.** Which of the following standards has the objective of achieving customer satisfaction through effective use of a quality management system that includes preventive processes for nonconforming products?

- a) BS 7799                      b) ISMS                      c) ISO 9001                      d) ISO 14001

**Q74.** When the relationship between the preset price and expected demand of a given product is approximated by a linear expression, which of the following is the appropriate value that should be put in the box 

A
---

 below?

- 1) If the preset price is \$3000, demand is 0.
- 2) If the preset price is \$1000, demand is 60,000 units.
- 3) If the preset price is \$1500, demand is 

A
---

 units.

- a) 30,000                      b) 35,000                      c) 40,000                      d) 45,000

**Q75.** Which of the following appropriately describes the role of CIO?

- a) In working out an IT strategy, CIO adopts a plan to optimize the effects of cross-company investment in information assets in accordance with the company's business strategy.
- b) CIO figures out the status of system development and operation and then gives suggestion of specific improvements so that a company-wide information system can function optimally.
- c) CIO examines whether or not the information system is functioning soundly in response to business activities and gives advice to the information systems department.
- d) To ensure the best operation of a company-wide information system, CIO receives reports from the information systems department on inquiries and problems concerning the information system and then gives specific directions.

**Q76.** Some items calculated from a profit and loss statement are included in the table shown below. In this case, how much is the break-even point in dollars?

Unit: \$

Item	Amount
Total sales	10,000
Variable cost	8,000
Fixed cost	1,000
Profit	1,000

- a) 5,000                      b) 7,000                      c) 8,000                      d) 9,000

**Q77.** Which of the following is appropriate as a case to which the Delphi method is applicable?

- a) Cause analysis of system failures that occurred in the past
- b) Segment analysis of current cell phone service users
- c) Analysis of population dynamics in the market sphere
- d) Analysis of technical trends in the communications field of 10 years from now

**Q78.** Which of the following appropriately explains a control chart?

- a) A network diagram is created with arrows connecting the individual activities and indicating their order relationships. This is useful for identifying process bottlenecks and preparing schedules.
- b) A center line and a pair of upper and lower limit lines are drawn, and the characteristic values of products are plotted. This is useful for detecting quality problems and abnormal situations in process, eliminating the causes of problems, and preventing problem recurrences.
- c) The number of product defects and the amount of loss are categorized on a cause-by-cause basis, accumulated and sorted in descending order. This makes it possible to identify items whose improvement is highly effective.
- d) Factors considered possible causes of a problem are arranged in a shape such as a fish skeleton. This makes it possible to identify the root causes of the problem, and is useful in solving it.

**Q79.** In order to compare last year's hiring examination with this year's, the company had a large number of employees to take both examinations. Then, the correlation coefficient and regression line were obtained by plotting their scores from last year's examination on the x-axis and their scores from this year's examinations on the y-axis. Which of the following is the appropriate statement that can be concluded from the results below?

[Results]

The correlation coefficient was 0.8.

The slope of the regression line was 1.1.

The value of the y-intercept of the regression line was 10.

- a) Based on the value of the y-intercept of the regression line, it is understood that a person whose score on this year's exam was 0 could score about 10 on last year's exam.
- b) Based on the slope of the regression line, it is understood that the average score on this year's examination is about 1.1 times that of last year's examination.
- c) Based on the slope and the y-intercept of the regression line, it is understood that scores on this year's examination tend to be higher than those on last year's examination.
- d) Based on the slope of the regression line and the value of the correlation coefficient, it is understood that this year's examination is of high quality.

- Q80.** In a certain factory, three products  $A$ ,  $B$ , and  $C$  are manufactured using the same material  $M$ . Table 1 shows the time required to manufacture 1 kg of each of products  $A$ ,  $B$ , and  $C$ , the necessary amount of material  $M$ , and the profit. Table 2 shows the amounts of resources that can be allocated every month. At this factory, they want to know the quantities of products  $A$ ,  $B$ , and  $C$  that will yield the highest profit. Which of the following is the most appropriate method to solve this issue?

**Table 1 Manufacturing conditions**

Product	$A$	$B$	$C$
Time required to manufacture (hours/kg)	2	3	1
Necessary amount of material $M$ (liters/kg)	2	1	2
Profit (\$/kg)	8	5	5

**Table 2 Allocatable amounts of resources**

Manufacturing time (hours/month)	240
Amount of material $M$ (liters/month)	150

- a) Moving average method                      b) Least squares method  
c) Linear programming method                d) Fixed order quantity system

## Trial Exam

### Answers & Comments on Morning Questions

#### Q1: [Correct Answer] d

“Without any rounding (round-off) error” means that when the correct answer (a decimal number) in the answer group is converted into binary, it becomes a terminating fraction.

We will convert each of the decimal numbers in the answer group into a binary number. To do so, we keep multiplying the fractional part after the radix point (decimal point) by 2 and take out the integer part each time. When the fractional part after the radix point becomes 0, the conversion is terminated.

a)

$0.2 \times 2 = 0.4$	$0.\underline{0}$	
$0.4 \times 2 = 0.8$	$0.0\underline{0}$	
$0.8 \times 2 = 1.6$	$1.00\underline{1}$	
$0.6 \times 2 = 1.2$	$0.001\underline{1}$	
$0.2 \times 2 = 0.4$	$\leftarrow$ repeats since this is "0.4"	

Hence, the underlined part repeats itself as follow:

$$(0.2)_{10} \rightarrow (0.\underline{0011}\cdots)_2$$

b)

$0.3 \times 2 = 0.6$	$0.\underline{0}$	
$0.6 \times 2 = 1.2$	$0.0\underline{1}$	
$0.2 \times 2 = 0.4$	$0.01\underline{0}$	
$0.4 \times 2 = 0.8$	$0.010\underline{0}$	
$0.8 \times 2 = 1.6$	$0.0100\underline{1}$	
$0.6 \times 2 = 1.2$	$0.01001\underline{1}$	
$0.2 \times 2 = 0.4$	$\leftarrow$ repeats since this is "0.4"	

Hence, the underlined part repeats itself as follows:

$$(0.3)_{10} \rightarrow (0.01\underline{0011}\cdots)_2$$

c)

$0.4 \times 2 = 0.8$	$0.\underline{0}$	$\left. \begin{array}{l} \phantom{0.} \\ \phantom{0.} \\ \phantom{0.} \\ \phantom{0.} \\ \phantom{0.} \end{array} \right\} \text{Repeating}$
$0.8 \times 2 = 1.6$	$0.01\underline{1}$	
$0.6 \times 2 = 1.2$	$0.011\underline{1}$	
$0.2 \times 2 = 0.4$	$0.0110\underline{0}$	
$0.4 \times 2 = 0.8$	$\leftarrow \text{repeats since this is "0.8"}$	

Hence, the underlined part repeats itself as follow:

$$(0.4)_{10} \rightarrow (0.\underline{0110}\cdots)_2$$

d)

$0.5 \times 2 = 1.0$	$0.\underline{1}$
$\uparrow$ Nothing after the radix point, so the conversion is terminated.	

Hence, the result is shown as follows:

$$(0.5)_{10} \rightarrow (0.1)_2$$

### Q2: [Correct Answer] d

For example, the maximum 3-digit decimal number is  $999 (= 10^3 - 1)$ , and the maximum 4-digit decimal number is  $9,999 (= 10^4 - 1)$ . In the same way, the maximum D-digit decimal number is  $(10^D - 1)$ .

For binary numbers, the maximum 3-digit (3-bit) number is  $(111)_2 (= 7 = 2^3 - 1)$ , and the maximum 4-bit number is  $(1111)_2 (= 15 = 2^4 - 1)$ . In the same way, the maximum B-bit decimal number is  $(2^B - 1)$ .

Based on the above result, the relationship between a D-digit decimal number and a B-bit binary number is shown as follows:

$$\begin{aligned} 10^D - 1 &\cong 2^B - 1 \\ 10^D &\cong 2^B \end{aligned}$$

Take the base-10 logarithm of both sides of the above equation as follows:

$$\begin{aligned} \log_{10} 10^D &\cong \log_{10} 2^B \\ D \log_{10} 10 &\cong B \log_{10} 2 \quad (\log_a b^n = n \log_a b) \\ \therefore D &\cong B \log_{10} 2 \quad (\log_{10} 10 = 1) \end{aligned}$$

### Q3: [Correct Answer] b

When a negative number is expressed in two's complement, all of the bits turn out to be 1 if and only if it is "-1" in decimal. If you happen to know this fact, the correct answer "b" is immediate.

Let us check this with 8-bit binary numbers. To write a given positive number in two's complement, all of the bits are reversed, and the binary number 1 is added to the result. In addition, note that the result of reversing all the bits is called one's complements.

$$\begin{array}{rcl} (1)_{10} & = & (00000001)_2 \\ & \downarrow & \text{reversing each bit} \\ & 11111110 & \leftarrow \text{1's complements} \\ +) & 1 & \text{1 is added} \\ \hline & (11111111)_2 & = (-1)_{10} \end{array}$$

Now, take the  $n$ -bit binary number with all ones (1's) and convert it into two's complement.

$$\begin{array}{rcl}
 111\dots 11 & & \\
 \downarrow & \text{reversing each bit} & \\
 000\dots 00 & & \\
 +) \quad \quad 1 & \text{1 is added} & \\
 \hline
 000\dots 01 & = (1)_{10} & 
 \end{array}$$

Since the result of converting it into two's complement is  $(1)_{10}$ , the number whose bits are all ones (1's) is  $-1$ .

#### **Q4: [Correct Answer]      a**

An overflow is a phenomenon that occurs when the result of the operation cannot be displayed by means of the given number of digits (bits in an internal representation of a computer). Addition of two positive integers, therefore, has a possibility of overflow since the resulting value increases. The same is true with addition of two negative integers since the absolute value of the result increases.

- A Overflow is possible since the positive value increases when two positive numbers are added.
- B Overflow is not possible since “positive + negative” is “positive + (– positive),” decreasing the positive value.
- C Overflow is not possible since the absolute value of the negative number decreases in “negative + positive.”
- D Overflow is possible since the absolute value of the negative number increases in “negative + negative,” which is “negative + (– positive) = negative – positive.”
- E Overflow is not possible since “positive – positive” is subtraction of positive numbers, reducing the positive value.
- F Overflow is possible since “positive – negative” is “positive – (– positive) = positive + positive,” where the positive value increases.
- G Overflow is possible since “negative – positive” increases the absolute value of the negative value.
- H Overflow is not possible since “negative – negative” is “negative – (– positive) = negative + positive,” which decreases the absolute value of the negative number.

#### **Q5: [Correct Answer]      c**

Since the calculation time is proportional to the cube (third power) of the number of variables (unknowns) in the system of equations, the calculation time  $y$  can be expressed in terms of the number  $x$  of variables and the proportional constant  $k$  as follows:

$$y = kx^3 \quad (1)$$

It takes two (2) seconds to find the solution of a system of linear equations with 100 variables. Then, a computer with four times the processing speed can do this in  $\frac{1}{4}$  of 2 seconds, i.e., 0.5 seconds. Now, substitute  $x = 100$  and  $y = 0.5$  into the equation (1) and find the proportional constant  $k$ .

$$\begin{aligned}
 0.5 &= k \times 100^3 \\
 &= k \times (10^2)^3 \\
 &= k \times 10^6 \\
 \therefore k &= 0.5 \div 10^6 \\
 &= 0.5 \times 10^{-6}
 \end{aligned}$$

Hence, the relation between  $x$  and  $y$  can be expressed as follows:

$$y = 0.5 \times 10^{-6}x^3 \quad (2)$$



Here, since we are solving a system of linear equations with 1,000 variables, we substitute  $x = 1,000 = 10^3$  in the equation (2):

$$\begin{aligned} Y &= 0.5 \times 10^{-6} \times (10^3)^3 \\ &= 0.5 \times 10^{-6} \times 10^9 \\ &= 0.5 \times 10^3 \\ &= 500 \text{ (seconds).} \end{aligned}$$

**Q6: [Correct Answer] c**

“To obtain the lower seven (7) bits other than the parity bit” means that the parity bit is changed to zero (0) and all of the other bits remain unchanged. The key point here is that the logical product (AND) with 0 results in 0 and the logical product with 1 generates the original bit itself.

(AND with 0)	(AND with 1)	
$\begin{array}{r} \text{AND) } \begin{array}{cc} 0 & 1 \end{array} \\ \hline \begin{array}{cc} 0 & 0 \end{array} \end{array}$	$\begin{array}{r} \text{AND) } \begin{array}{cc} 1 & 1 \end{array} \\ \hline \begin{array}{cc} 1 & 1 \end{array} \end{array}$	
← The result is 0.	← The same bit	

Therefore, the answer is to simply perform the logical AND operation with  $(01111111)_2 = (7F)_{16}$ . In the following explanations, “x” means either one(1) or zero (0).

A) 
$$\begin{array}{r} \text{AND) } \begin{array}{cccccccc} x & x & x & x & x & x & x & x \end{array} \leftarrow \text{8-bit code} \\ \hline \begin{array}{cccccccc} 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \end{array} = (0F)_{16} \\ \begin{array}{cccccccc} 0 & 0 & 0 & 0 & x & x & x & x \end{array} \end{array}$$

Here, only the lower four (4) bits are produced.

B) 
$$\begin{array}{r} \text{OR) } \begin{array}{cccccccc} x & x & x & x & x & x & x & x \end{array} \leftarrow \text{8-bit code} \\ \hline \begin{array}{cccccccc} 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \end{array} = (0F)_{16} \\ \begin{array}{cccccccc} x & x & x & x & 1 & 1 & 1 & 1 \end{array} \end{array}$$

Here, only the higher four (4) bits are produced, and the lower four (4) bits are all 1s.

C) 
$$\begin{array}{r} \text{AND) } \begin{array}{cccccccc} x & x & x & x & x & x & x & x \end{array} \leftarrow \text{8-bit code} \\ \hline \begin{array}{cccccccc} 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{array} = (0F)_{16} \\ \begin{array}{cccccccc} 0 & x & x & x & x & x & x & x \end{array} \end{array}$$

Here, the most significant bit (parity bit) is zero (0), and the lower seven (7) bits stay the same.

D) This logical operation reverses all the bits. Here is an example:

$$\begin{array}{r} \text{XOR) } \begin{array}{cccccccc} 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ \hline 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{array} = (FF)_{16} \\ \begin{array}{cccccccc} 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 \end{array} \end{array}$$

**Q7: [Correct Answer] b**

The set of defect-free parts is described as follows:

$$\text{Set of defect-free parts} = \overline{(A \cup B \cup C)}$$

$(A \cup B \cup C)$  is the set of parts with defect A, defect B, or defect C. Hence, the set of defect-free parts is the complement of this set, and so the answer can be calculated by subtracting the number of parts included in  $(A \cup B \cup C)$  from the total number 100.

Let us denote the number of elements in the set  $(A \cup B \cup C)$  as  $n(A \cup B \cup C)$ . We then have the following expression:

$$n(A \cup B \cup C) = n(A) + n(B) + n(C) - n(A \cap B) - n(A \cap C) - n(B \cap C) + n(A \cap B \cap C) \quad (1)$$

Now, we substitute the numbers given in the question.

$$n(A) = 11 \quad (\text{parts with defect A; may also have defects B and/or C})$$

$$n(B) = 7 \quad (\text{parts with defect B; may also have defects A and/or C})$$

$$n(C) = 4 \quad (\text{parts with defect C; may also have defects A and/or B})$$

$$n(A \cap B) = 3 \quad (\text{parts with defects A and B; may also have defect C})$$

$$n(A \cap C) = 2 \quad (\text{parts with defects A and C; may also have defect B})$$

$$n(B \cap C) = 0 \quad (\text{parts with defects B and C; may also have defect A})$$

Substitute these values in the equation (1), and we get

$$\begin{aligned} (A \cup B \cup C) &= 11 + 7 + 4 - 3 - 2 - 0 + n(A \cap B \cap C) \\ &= 17 + n(A \cap B \cap C). \end{aligned}$$

Now, since  $n(B \cap C) = 0$ ,  $(B \cap C)$  is the empty set. Hence,  $(A \cap B \cap C)$  is also the empty set, and we conclude that  $n(A \cap B \cap C) = 0$ .

$$\therefore n(A \cup B \cup C) = 17.$$

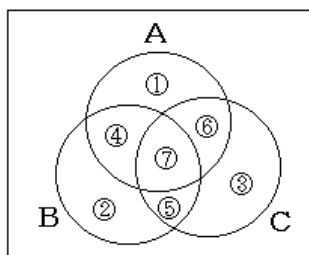
Therefore, the number of defect-free parts is obtained as follows:

$$\begin{aligned} n(A \cup B \cup C) &= 100 - 17 \\ &= 83 \text{ (parts).} \end{aligned}$$

Since the number of defect-free parts is 83, the correct answer is (b).

Below, we explain why the equation (1) holds.

Consider the Venn diagram shown below.  $n(A)$ ,  $n(B)$ , and  $n(C)$  can be expressed as follows:



$$n(A) = ① + ④ + ⑥ + ⑦$$

$$n(B) = ② + ④ + ⑤ + ⑦$$

$$n(C) = ③ + ⑤ + ⑥ + ⑦$$

Thus,  $n(A) + n(B) + n(C)$  can be expressed as follows:

$$\begin{aligned} n(A) + n(B) + n(C) &= ① + ④ + ⑥ + ⑦ + ② + ④ + ⑤ + ⑦ + ③ + ⑤ + ⑥ + ⑦ \\ &= (① + ② + ③ + ④ + ⑤ + ⑥ + ⑦) + ④ + ⑤ + ⑥ + ⑦ + ⑦ \end{aligned}$$

On the other hand,  $n(A \cup B \cup C)$  is the sum of ① through ⑦, so we get  $n(A) + n(B) + n(C)$  as below:

$$\begin{aligned} n(A) + n(B) + n(C) &= (① + ② + ③ + ④ + ⑤ + ⑥ + ⑦) && : n(A \cup B \cup C) \\ &+ (④ + ⑦) && : n(A \cap B) \\ &+ (⑤ + ⑦) && : n(B \cap C) \\ &+ (⑥ + ⑦) && : n(A \cap C) \\ &- ⑦ && : n(A \cap B \cap C) \end{aligned}$$

This gives us the formula:

$$\begin{aligned} n(A) + n(B) + n(C) &= n(A \cup B \cup C) + n(A \cap B) + n(A \cap C) + n(B \cap C) - n(A \cap B \cap C) \\ \therefore n(A \cup B \cup C) &= n(A) + n(B) + n(C) \\ &\quad - n(A \cap B) - n(A \cap C) - n(B \cap C) + n(A \cap B \cap C) \end{aligned}$$

**Q8: [Correct Answer]      b**

The logical formula  $Z = X \bullet \bar{Y} + \bar{X} \bullet Y$  is the exclusive logical sum (also called exclusive OR). The result of its logical operation is 0 if the logical variables  $X$  and  $Y$  have the same value and 1 if  $X$  and  $Y$  are different.

Hence, the truth table for the logical expression  $Z = X \bullet \bar{Y} + \bar{X} \bullet Y$  is as follows:

$X$	$Y$	$Z$
0	0	0
0	1	1
1	0	1
1	1	0

If you cannot recognize the formula soon as the exclusive logical sum, you can also actually do the operation  $Z = X \bullet \bar{Y} + \bar{X} \bullet Y$  and verify the answer.

$X$	$Y$	$\bar{X}$	$\bar{Y}$	$X \bullet \bar{Y}$	$\bar{X} \bullet Y$	$Z = X \bullet \bar{Y} + \bar{X} \bullet Y$
0	0	1	1	0	0	0
0	1	1	0	0	1	1
1	0	0	1	1	0	1
1	1	0	0	0	1	0

This table means that the correct answer is (b).

- a) The result of the operation is 1 when  $X$  and  $Y$  are both 1; otherwise, it is 0. This is the logical product.
- c) The result of the operation is 1 when at least one of  $X$  and  $Y$  is 1; otherwise, it is 0. This is the logical sum.
- d) The result of the operation is 1 when  $X$  and  $Y$  are the same; otherwise, it is 0. This is the equivalence operation.

**Q9: [Correct Answer]      b**

There are 26 English capital letters (A through Z) and 10 numeric characters (0 through 9), a total of 36 characters. Hence, we have only to calculate the number of bits that can represent 36 characters.

In general, using  $n$ -bit binary numbers, we can express values ranging from 0 through  $2^n - 1$  if we do not take negative numbers into consideration. In this question, we need 36 characters, so we can do the following calculations.

$$2^n - 1 = 36$$

$$2^n = 37$$

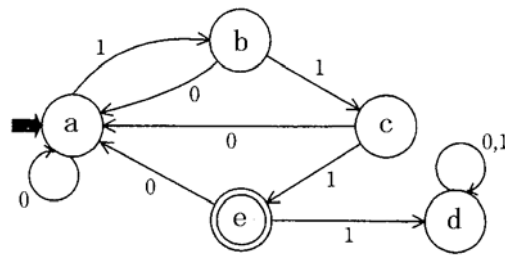
It is a bit complicated to calculate this exponentiation exactly, so here is an easier way as follows:



$$2^5 = 32 < 37 < 2^6 = 64$$

Based on the above result, 6 bits are sufficient to express 36 different patterns.

**Q10: [Correct Answer] c**

You do not need to know anything about automata. Simply follow the character string as instructed by the question. Let us label the states tentatively as a, b, c, d, and e, as shown below.



A character string is accepted if it begins at the initial state (  ) and ends at the accept state (  ). Consider each of the character strings in the answer group.

a)

State before input	Input Character	State after input
a→	0	→a
a→	1	→b
b→	0	→a
a→	1	→b
b→	1	→c

← Not accepted

b)

State before input	Input Character	State after input
a→	0	→a
a→	1	→b
b→	1	→c
c→	1	→e
e→	1	→d

← Not accepted

c)

State before input	Input Character	State after input
a→	1	→b
b→	0	→a
a→	1	→b
b→	1	→c
c→	1	→e

← Accepted

d)

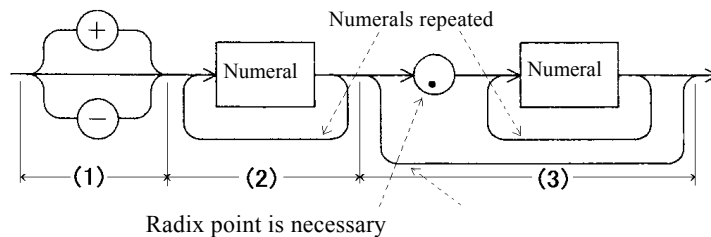
State before input	Input Character	State after input
a→	1	→b
b→	1	→c
c→	1	→e
e→	1	→d
d→	0	→d

← Not accepted

**Q11: [Correct Answer]      b**

A syntax diagram expresses the rules of a programming language by using a state transition diagram. Unlike BNF (Backus Naur Form), there is no recursive expression, so it is considered easier to understand than BNF.

The diagram is followed from left to right; for example, the first syntax diagram in the question indicates that the character string does not have to begin with + or – and that a numeral can be repeated after that. The radix point “.” is never located at the beginning.



The first syntax diagram shown in the question is interpreted as follows:

- (1) A string may start with +, –, or no signs. Therefore, as shown in (2), it may begin with a numeral.
- (2) The leading + or – must be followed by a numeral (or a string must start with a numeral if there is no leading sign), and the numeral can be repeated. Thus, the number –100 listed as an example in the question conforms to the syntax. The integer part of 5.3, which is 5, and the integer part of +13.07, which is +13, also conform to the syntax.
- (3) The numeral string as in (2) can end there, or the string may be followed by a radix point “.”; however, if there is the radix point, at least one numeral must follow that.

Thus, –100 conforms to the syntax. Since there can be multiple numerals after the radix point, the fractional part of 5.3, which is .3, and the fractional part of +13.07, which is .07, also conform to the syntax.

For these reasons, –100, 5.3, and +13.07 do conform to the syntax shown in the example.

In the second syntax diagram given in the question, since the order “(+, –, or nothing) → numeral(s) → radix point” is specified, there must be a numeral before the radix point. Further, another part shows the order “E → (+, –, or nothing) → numeral(s),” so “E” must be followed by +, –, or a numeral. Taking this fact into consideration, you can check up each expression listed in the answer group.

- a) The radix point “.” must be preceded by a numeral, but “–” exist instead of a numeral.
- b) Since 5.2 conforms to the order “numeral(s) → radix point → numeral(s)” and + or – is omitted at the beginning, it conforms to the syntax. Further, E–07 is of the order “E → – → numeral(s),” so it conforms to the syntax also. Hence, 5.2E–07 conforms to the syntax.
- c) “E” must be followed by +, –, or a numeral.
- d) “E” cannot be immediately preceded by a radix point.

**Q12: [Correct Answer]      a**

Pre-order traversal goes in the order of “node, left subtree, and right subtree,” so first it begins with the root “a.” Then, it proceeds to the left subtree and reads node “b.” It then goes on to node “c” of the left subtree. Among the options in the answer group, (a) is the only one that processes in the order of “a → b → c.”

For your reference, we will also explain the in-order and post-order traversal methods also.

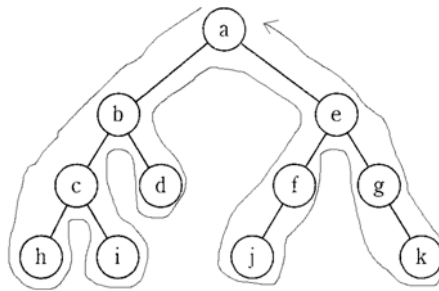
In-order traversal goes in the order of “left subtree, node, and right subtree,” so entering at “a,” it scans

the left subtree, follows the path  $a \rightarrow b \rightarrow c$ , and reaches “h.” After “h,” it scans node “c” and proceeds to its right subtree “i.” Hence, the scan runs “ $h \rightarrow c \rightarrow i \rightarrow \dots(hcibdajfegk)$ ,” which is the answer option (c).

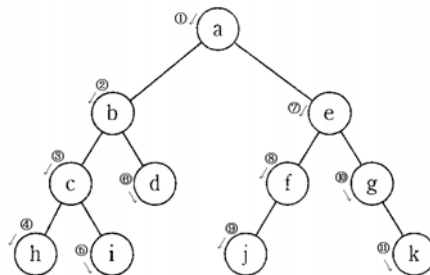
Post-order traversal goes in the order of “left subtree, right subtree, and node,” so it runs “ $h \rightarrow i \rightarrow c \rightarrow \dots(hicdbjfkgea)$ ,” which is the answer option (d).

Pre-order, in-order, and post-order traversal methods are called depth-first traversal; when scanning a binary tree under these methods, the following patterns hold:

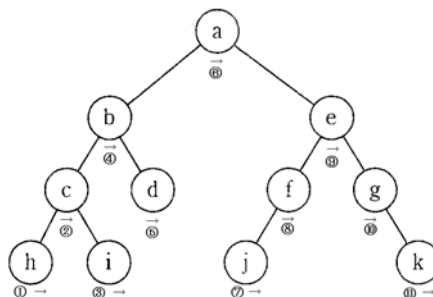
In a binary tree as shown below, if the values are output as you pass on the left side of the nodes, it is pre-order traversal. If they are output when you pass under the nodes, it is in-order traversal. If they are output when you pass on the right side of the nodes, it is post-order traverse.



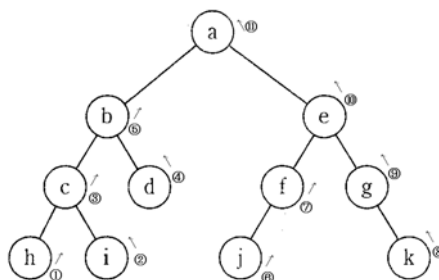
In pre-order traversal, the output is as follows:  $a \rightarrow b \rightarrow c \rightarrow h \rightarrow i \rightarrow d \rightarrow e \rightarrow f \rightarrow j \rightarrow g \rightarrow k$ .



In in-order traversal, the output is as follows:  $h \rightarrow c \rightarrow i \rightarrow b \rightarrow d \rightarrow a \rightarrow j \rightarrow f \rightarrow e \rightarrow g \rightarrow k$ .



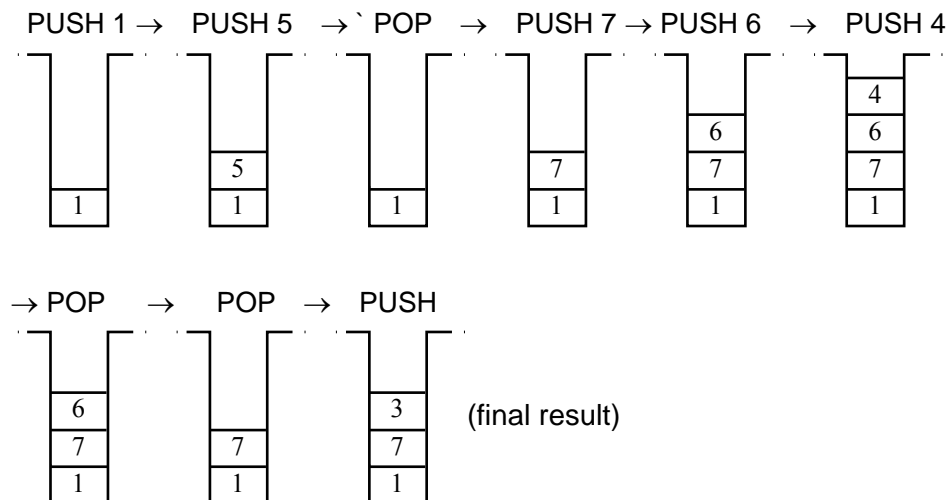
In post-order scanning, the output is as follows:  $h \rightarrow i \rightarrow c \rightarrow d \rightarrow b \rightarrow j \rightarrow f \rightarrow k \rightarrow g \rightarrow e \rightarrow a$ .



**Q13: [Correct Answer] c**

Stack supports a LIFO (Last-In First-Out) data structure. In other words, the item stored last is the first item retrieved.

Based on this rule, the stack in the question changes as shown below.



**Q14: [Correct Answer] c**

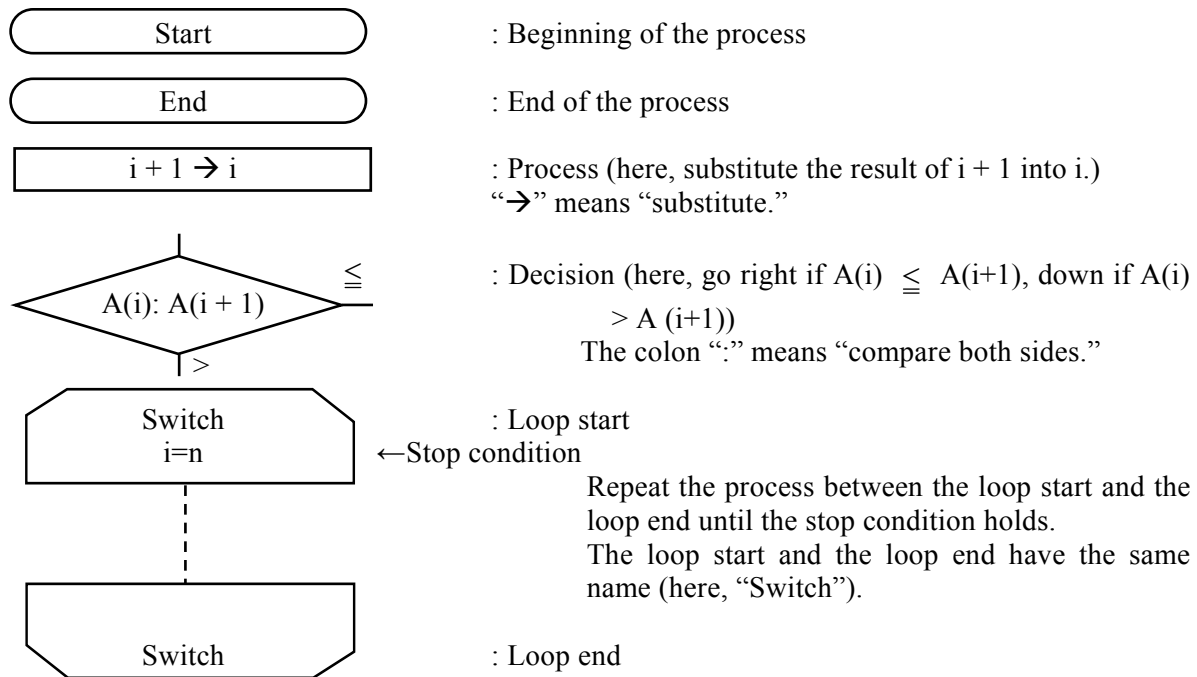
Hashing is a method to determine the storage location based on a particular data item. The particular data item may be, for example, something like employee ID. A certain operation is performed on each employee ID, and its result is used for the storage address. The data item subject to the hash operating is called a key item, and the function used to obtain the address is called a hash function, and the value obtained is called a hash value.

- a) Hashing is a method for determining the storage location; it is unrelated to what is used as the data structure.
- b) There are occasions in which hashing gives the same address for different key values. This is called a collision. In hashing, collisions cannot be prevented. If a collision happens, the data already stored there is called home, and the data that caused the collision is called a synonym.
- d) The data is converted to the address using a hash function, so the conversion can be done in the same amount of time. In other words, it does not depend on the size of the table (the number of elements in the table). If a collision occurs, re-hashing takes place, and the method of re-hashing does impact the time required for search.

**Q15: [Correct Answer]      d**

Flowchart questions on a morning examination are almost always basic algorithms which are relatively easy to follow. If you remember the meanings of flowchart symbols, it is sufficient to only follow the flowchart carefully.

First, we explain the various symbols used in flowcharts.



Next, we follow the flowchart of the question. The initial value of “i” is 1 ( $i \rightarrow 1$ ), and “i” is increased by 1 each time (by “ $i + 1 \rightarrow i$ ” in the loop) until “ $i = n$ ,” at which point the process escapes the loop. Further, understand “ $A(i): A(i + 1)$ ” to mean that both sides of this array are compared to each other. For example, if “ $i = 1$ ,”  $A(1)$  and  $A(2)$  are compared. If “ $i = 2$ ,” then  $A(2)$  and  $A(3)$  are compared. Comparing the neighboring elements and swapping them if they are out of sequence are characteristics of the bubble sort algorithm.

**Q16: [Correct Answer]      a**

Flash memory belongs to the family of EEPROM (Electrically Erasable and Programmable ROM) and is also called “flash EEPROM.” It is a type of semiconductor-element ROM, on which data is written and erased electrically. Data on EEPROM must be entirely erased before re-written, whereas flash memory can erase or write in full or on a block basis. The erase and write operations can be performed repeatedly many times (actually limited to tens of thousands of times). Since it is a type of ROM, no backup power is required (it can retain data even in power-off).

- b) This is an explanation of EPROM (Erasable and Programmable ROM).
- c) This is an explanation of SRAM (Static RAM).
- d) This is an explanation of DRAM (Dynamic RAM).



**Q17: [Correct Answer]      b**

The operation that can generate 1 only when both inputs A and B are 1s is the logical product, and this is its logical negation. The logical negation of AND is called NAND (logical negation of logical product). Let us check this using a truth table.

A	B	A AND B	$\overline{A \text{ AND } B}$ (A NAND B)
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

If you do not recognize the logical product, you may carry out the logical operations of the answer group and check the results.

A	B	a) A AND B	b) $\overline{A \text{ AND } B}$ (NAND)	c) A OR B	d) A XOR B (Exclusive OR)
0	0	0	1	0	0
0	1	0	1	1	1
1	0	0	1	1	1
1	1	1	0	1	0

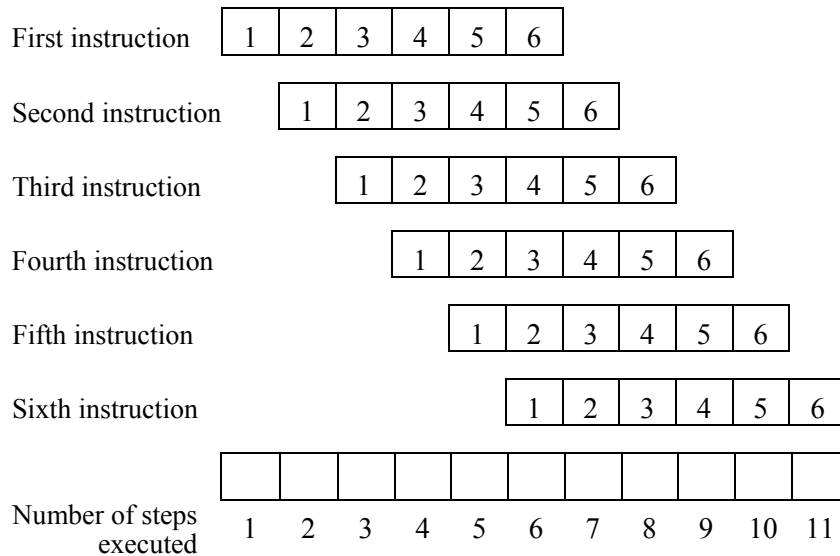
**Q18: [Correct Answer]      c**

Pipeline processing is a technology for speeding up CPUs. It divides up an instruction into several steps and, as shown in the question, each step is delayed by the duration of one step as the steps are executed. The assumption that "there is no instruction, such as branch and jump, that stalls the pipeline processing" means that all the instructions are executed sequentially.

As shown in the diagram in the question, the first instruction requires an execution time of 6 steps, but each of the other instructions is delayed by one step, so you can consider an execution time of only one step. Here, since six instructions are executed, the first instruction takes duration of 6 steps while each of the other five instructions takes only duration of one step, a total of 5 steps. Hence, it takes a total execution time of 11 steps to complete the process.

$$\begin{aligned}\text{Execution time for 6 instructions} &= 11 (\text{steps}) \times 10 (\text{nanoseconds/step}) \\ &= 110 (\text{nanoseconds})\end{aligned}$$

You can verify the result by using the figure illustrated below.



Indeed, you can verify that 11 steps are executed.

### Q19: [Correct Answer]      c

The computer architecture technologies are classified into the four groups described in the answer group, depending on the flow of instructions and data.

- a) MIMD (Multiple Instruction Multiple Data stream) is a technology in which multiple independent instructions process different data. This includes multi-processor system that can support parallel processing and pipeline control.
- b) MISD (Multiple Instruction Single Data stream) is a technology in which multiple instructions concurrently process the same data. This includes computers that can perform pipeline control.
- c) SIMD (Single Instruction Multiple Data stream) is a technology in which one instruction processes multiple data concurrently. This includes computers that can perform parallel processing such as vector processors (array processors).
- d) SISD (Single Instruction Single Data stream) is a technology in which sequential processing is performed. This includes von Neumann-type computers.

### Q20: [Correct Answer]      d

MIPS (Million Instructions Per Second) is a unit of computing power equal to one million instructions per second. The average instruction execution time is how long it takes to execute one instruction; here, it is 0.2 microseconds ( $0.2 \times 10^{-6}$  seconds). The number of instructions that can be executed per second is the reciprocal number of this average instruction execution time.

$$\begin{aligned}
 \text{Number of instructions per second} &= \frac{1}{\text{Average instruction execution time}} \\
 &= \frac{1}{0.2 \times 10^{-6} \text{ (seconds/instruction)}} \\
 &= \frac{1}{0.2} \times 10^6 \text{ (seconds/instruction)} \\
 &= 5.0 \times 10^6 \text{ (instructions/sec.)} \\
 &\rightarrow 5.0 \text{ MIPS}
 \end{aligned}$$

**Q21: [Correct Answer]      b**

An interrupt is used to suspend the currently executed program temporarily for some reason and to transfer control to the OS in order to execute a necessary processing program. There are external interrupts that are caused by an external signal or specific hardware conditions and internal interrupts intentionally caused by calling the OS in a program.

If the CPU detects an interrupt, the OS stores the status of the program being executed prior to the interrupt into PSW (Program Status Word). Then, it investigates the cause of the interrupt and transfers control to the processing routine. Another interrupt may also occur during an interrupt processing, so multiple interrupts are controlled by assigning each processing priority, depending on the type of interrupt.

Cause and type of interrupts		Examples of cause
External interrupt	Machine check interrupt (Abnormal interrupt)	Malfunction of processing unit, power or voltage failure, main memory failure
	Clock mechanism interrupt (Timer interrupt)	Expiration of specific time (Interval timer), specific time stamp
	I/O interrupt	I/O completed, I/O unit status change (printer out of paper, etc.)
	External signal interrupt	Due to instructions from the system console or external signals
Internal interrupt	Program interrupt (exceptional interrupt)	Overflow, invalid instruction code (undefined instruction code), divide-by-zero (operation exception), memory protection exception
	Interruption for calling control program (instruction interrupt)	I/O operation request, task switching, page fault, calling the control program function (supervisor call: SVC)

The answers a), c), and d) in the answer group are classified as internal interrupts.

**Q22: [Correct Answer]      b**

The hit ratio is the probability that the part of the program necessary for execution exists in the cache memory. Let  $t_c$  be the access time of the cache memory,  $t_m$  be the access time of the main memory, and  $h$  be the hit rate. Then, the average access time (denoted as  $t$ ) is as follows:

$$t = h \times t_c + (1 - h) \times t_m$$

Here, we are to find the average access time for CPUs X and Y. All access times for the cache memory and the main memory are given in nanoseconds ( $10^{-9}$ ), but this unit is omitted in the following calculations since it is the same throughout.

$$\begin{aligned} \text{Average access time for CPU X: } t_X &= h \times 40 + (1 - h) \times 400 \\ &= 40h + 400 - 400h \\ &= -360h + 400 \end{aligned}$$

$$\begin{aligned} \text{Average access time for CPU Y: } t_Y &= h \times 20 + (1 - h) \times 580 \\ &= 20h + 580 - 580h \\ &= -560h + 580 \end{aligned}$$

In the question, the condition “ $t_X = t$ ” is given.

$$\begin{aligned} -360h + 400 &= -560h + 580 \\ 200h &= 180 \\ \therefore h &= 180 \div 200 = 0.90 \end{aligned}$$

**Q23: [Correct Answer]      b**

Write-through is the method whereby, if a block that is in the cache memory is modified, the same block is written to the main memory at the same time. In this method, when loading a block that has newly become necessary into the cache memory, the system can write over the block of the cache memory that has become unnecessary.

a) and c) are explanations of write-back.

d) Write-through requires access to the main memory every time the cache memory is updated, so the frequency of access to the main memory is higher compared to write-back, where the main memory is updated when data is pushed out of the cache memory. Hence, this describes write-back.

**Q24: [Correct Answer]      d**

A file of unblocked fixed length records means one block is one record. I/O devices read data in block units, so the unit of reading is one record at a time. If you recognize the reason for using “blocking” in a sequential file, you can immediately find that (d) is the correct answer.

a) Even if the data is stored in separate files and accessed sequentially, ultimately all of the records still have to be read in order. In other words, it still takes the same amount of time to read. One might think that it takes less time to read if the separate files are read in parallel, but here the question says “multiprocessing is not considered.” So we can exclude parallel reading.

b) To access indexed organization files in the order of the keys, the data is read in as the keys are referenced. It takes time to reference these keys, so the processing time increases.

c) If only the necessary records are read by calculating the record addresses using the key values, the time may be somewhat shortened. However, we do not know how many records are to be read. In the worst scenario, perhaps all of the records must be read, in which case the processing time increases because of the calculation of record addresses.

d) If the number of records stored in one block is increased, one physical reading can read multiple records, so the processing time is shortened.

**Q25: [Correct Answer]      c**

CD (Compact Disc) is a type of optical disc; this is originally used to store music, but it is also used as a storage medium for computers. The capacity is large at approximately 700MB. It can be recorded (pressed/burned) at a low cost, so it is used to distribute software and to store dictionaries, encyclopedias, and image data.

Type	Characteristics
CD-ROM	CD-Read Only Memory
CD-R	CD-Recordable: writing only
CD-RW	CD-Rewritable: after complete erasure, re-writing is allowed

a) Disc at once (DAO) is a way of writing on CD-R and CD-RW. It can write data on the entire disc all at once. No additional writing is allowed.

b) Track at once (TAO) is a way of writing on CD-R. It can write data in track units. After data is written, additional writing is allowed.

c) Packet writing is a way of writing on CD-R. Whereas the writing unit for normal CD-R and CD-RW is a track, this method divides data into smaller blocks for writing. Since writing is done in smaller units, CD-R can be used in the same manner as a floppy disk or MO.

d) Multi-session is a way of writing on CD-R and CD-RW. It can write data in multiple sessions. To write using multi-session, the CD-R drive must support writing by the TAO method. A session is an area in which multiple tracks are joined together.

**Q26: [Correct Answer]      b**

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USB 1.1 is a serial interface standard between a PC and peripheral devices. Through a hub, up to 127 devices can be connected in a tree topology. The data transfer speed can be the full-speed mode at 12 Mbps or the low-speed mode at 1.5 Mbps. It is used to connect relatively low speed devices. Printers and scanners are connected in full-speed mode while keyboards and mice are connected in low-speed mode.

Hence, (b) is the correct description of USB 1.1.

The reasons that the other options in the answer group are not correct are as follows:

- a) Audio and video require high-speed transfer, but USB 1.1 connects relatively low speed devices. Daisy chain is applied to SCSI. Connection in a tree topology without a host PC and corresponds to 10BASE-T.
- c) This is an explanation of RS-232C.
- d) This is an explanation of SCSI.

**Q27: [Correct Answer]      d**

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LCD (Liquid Crystal Display) is a display device that takes advantage of the property that a substance classified somewhere between solid and liquid and called liquid crystal changes the molecular structure as well as the light-polarizing surface when a voltage is applied. The liquid crystal itself does not emit light, but the screen is displayed by using reflected light in bright areas and by using backlight placed behind the device in dark areas. LCDs may use the simple matrix method such as STN and DSTN or the active matrix method such as TFT. LCDs are thinner and lighter than other display devices such as CRT displays and PDP. Because of low power consumption and less heat generation, LCDs are used in mobile computers, space-saving desktop PCs, etc.

The TFT (Thin Film Transistor) method is one in which the screen dots are controlled by thin film transistor (TFT). It has superior contrast, grayscale, and response speed. The STN (Super Twisted Nematic) method has a simple structure, so the manufacturing costs are low; however, its display quality is inferior to the quality of TFT. The DSTN (Dual-scan Super Twisted Nematic) method is an upgrade of STN with a higher response speed.

Organic light-emitting diode (OLED or Organic Electroluminescence display (OEL)) is a display using an organic substance that emits light when a voltage is applied. Compared with LCDs, OLEDs have a wider field of view, higher contrast, higher response time (about 1000 times that of LCD), and they are thinner and lighter. Since OLEDs emit light themselves, backlight is no longer required. In fact, they can be used as backlight for LCDs. The challenge for expanding use of OLEDs is the life and manufacturing costs.

The following table shows a relative comparison between LCDs and OLEDs. A circle means the superior one.

	Thinness	Large panel	Field of view	Power consumption	Life	Manufacturing costs
LCD		About the same			○	○
OLED	○		○	○		

**Q28: [Correct Answer]      b**

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Video memory stores character and figure data to be displayed on the PC display screen. A pixel (picture element) is a unit that constitutes digital images and is a colored dot. A digital image displays one picture by laying out these pixels horizontally and vertically.

Since each pixel is 24 bits and there are 1,024 horizontal and 768 vertical pixels, the memory capacity required for screen display is as follows:

$$\text{Memory required for screen display} = 1,024 \times 768 \times 24 \text{ (bits)}$$

Here, 1 byte is 8 bits. Therefore, we can convert the memory capacity required for screen display into bytes as follows:

$$\begin{aligned} \text{Memory capacity required for screen display} &= 1,024 \times 768 \times 24 \div 8 \\ &= 1,024 \times 768 \times 3 \\ &= 2,359,296 \text{ (bytes)} \\ &= 2.359296 \text{ (Mbytes, } 1\text{M} = 10^6) \\ &\cong 2.4 \text{ (Mbytes) (Rounded to the tenth)} \end{aligned}$$

**Q29: [Correct Answer]      d**

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Most computers today store both programs and data in the main memory or virtual memory, and they fetch and execute instructions from memory one by one.

- a) The addressing method is a classification by the number of addresses designated by the operand field of the instruction. Depending on the number of addresses that can be designated, there are 0-address instructions, 1-address instructions, 2-address instructions, 3-address instructions, and so on.
- b) Virtual memory is a memory management method that uses an auxiliary memory such as a hard disk to provide memory space larger than the capacity of the physically implemented main memory.
- c) The direct program control is a method that CPU transfers data by directly controlling the I/O devices according to the instructions given by the program. The control hardware can be small. However, CPU monitors the entire I/O operations from the beginning to the end, and it cannot perform any other processes during the time period of the I/O operations. As a result, the efficiency of CPU usage is reduced, so today this method is hardly ever used.
- d) In the stored program method, the program is stored as data in memory, and the control unit fetches and executes instructions by one by one. Most computers today use this stored program method. It is also known as “von Neumann computer” because John von Neumann, American mathematician, first proposed it.

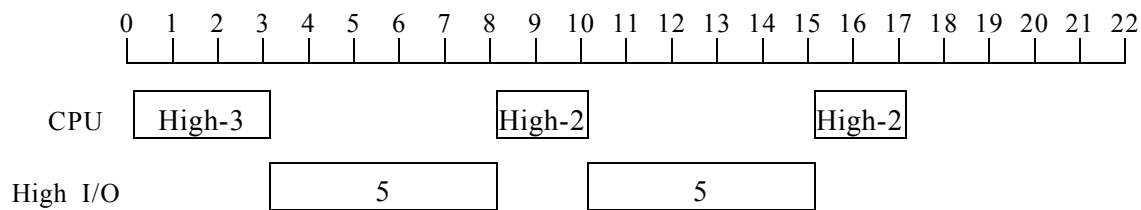
**Q30: [Correct Answer]      c**

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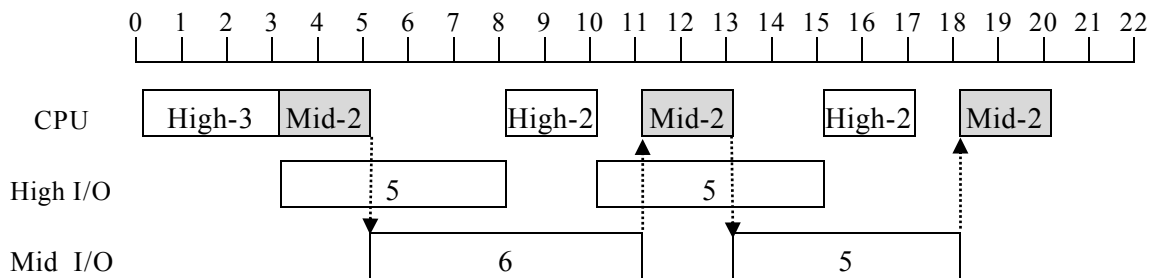
Overhead is the amount of time which is not directly required for application processes during the runtime of the OS. For example, overhead includes the time required for loading a program, switching tasks, and paging in a virtual memory system. Here, we can ignore the overhead, so the time required for switching to I/O from CPU is considered to be zero (0).

Since no conflict occurs in the I/O operation of each task, first we illustrate a time chart for the task with “high” priority. During the idle time of CPU, we add a time chart for the task with “middle” priority. Then, during the idle time of CPU, we further add a time chart for the task with “low” priority. In the time charts illustrated below, the numbers are indicated in milliseconds.

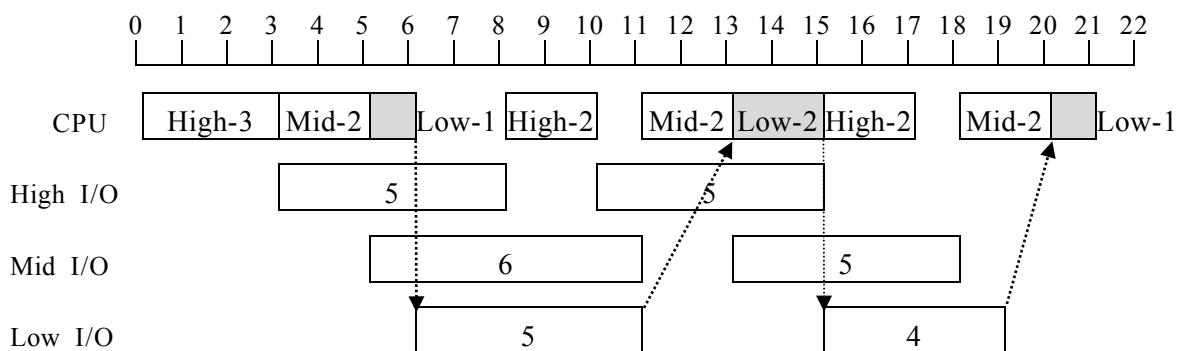
(1) Time chart for the task with “high” priority



(2) Time chart including the task with “middle” priority

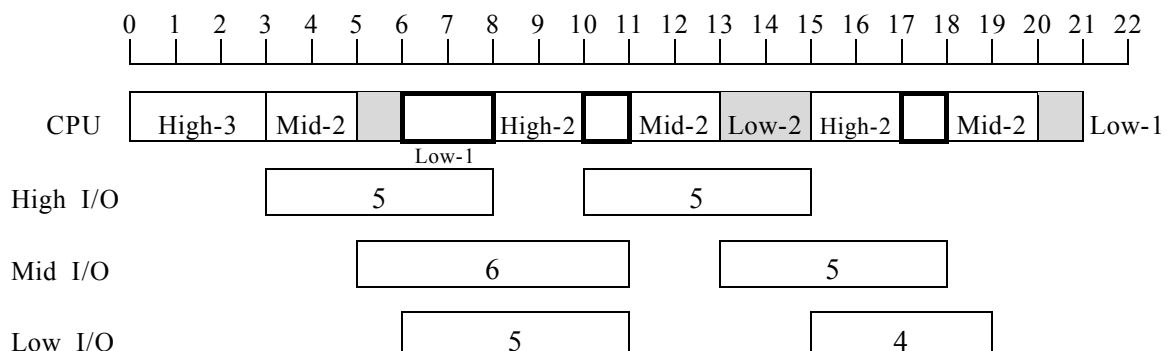


(3) Time chart including the task with “low” priority



(4) Final time chart

Consequently, the time chart is illustrated below. Here, the boxes with thick lines for CPU usage indicate the idle time.



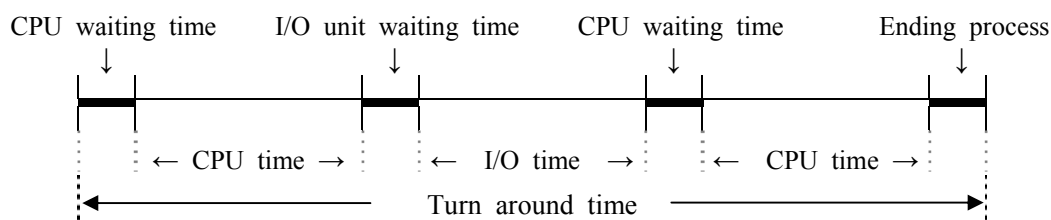
Hence, in the time scale shown in the chart, the CPU idle time is 2 milliseconds between 6 and 8, 1 millisecond between 10 and 11, and 1 millisecond between 17 and 18; that is, a total of 4 milliseconds is the idle time.

**Q31: [Correct Answer]      c**

Process waiting time of a job is the amount of time spent waiting to be processed. For instance, if CPU is being used, the waiting time is the duration of waiting until it becomes available.

Turnaround time (TAT) is the time interval from the time when a job is submitted until the time when the results are received. CPU time is the time when CPU is being used, and I/O time is the time when I/O units are used.

During CPU time and I/O time, CPU and I/O units are actually being used, so they are not part of the process waiting time. On the other hand, TAT does include process waiting time (waiting for CPU, waiting for I/O units) since TAT is the interval time between the submission of the job and the reception of the results.



The thick lines indicate process waiting time.

Therefore, process waiting time can be calculated by subtracting CPU time and I/O time from turnaround time as follows:

$$\text{Process waiting time} = \text{Turnaround time} - \text{CPU time} - \text{I/O time}$$

**Q32: [Correct Answer]      a**

Task management is one of the functions of the OS, and it includes task creation, task deletion, resource allocation (CPU, main memory, I/O units, etc.), and interrupt control.

- b) This is a function of job management.
- c) This is a function of data management.
- d) This is a function of data management.

**Q33: [Correct Answer]      d**

Spooling is a function that carries out an I/O process of a job in parallel, independent of the program execution. If the output data is directly transferred to a printer during program execution, the processing efficiency decreases because of the low processing speed of the printer. So, instead of sending the output data directly to the printer, the data is written into a file designed to store output data, which is called a spool file and located in auxiliary memory. The contents stored in the spool file are printed by a service program specifically designed for output after the program is completed.

- a) This is an explanation of a log (journal).
- b) This is a function of data management, one of the functions of the OS.
- c) This is an explanation of a virtual memory system.



**Q34: [Correct Answer]      b**

---

API (Application Program Interface) is a mechanism for using various functions of the OS from applications. It is an interface that guarantees compatibility at the source program level, so it is used to call OS functions from applications, such as display of windows and detection of mouse motion. The applications take advantage of various features (such as subroutines and functions) of the OS through the API. By using the API, the productivity of programs is enhanced. Further, even if the CPU has different architecture, the use of the API improves portability as long as the same OS is used.

- a) The use of device drivers enables applications to use the hardware, but applications do not take direct control because the OS stands between device drivers and applications. Whereas the API is a mechanism for using functions of the OS, it does not allow applications directly to operate hardware.
- c) This describes pipe file, which sends and receives data between tasks, and DDE (Dynamic Data Exchange), which opens non-displayed windows when messages are exchanged between multiple tasks, but these are not functions of the API. Also, clipboard is a mechanism of communication between tasks even though it is manually operated. From the standpoint of “over a network,” it is difficult to pinpoint exactly what it is, but processing by a loosely coupled multi-processor system does have the function described here. Furthermore, CORBA, common specifications for exchanging messages between objects in a distributed system environment also fits the description.
- d) Again, it is difficult to pinpoint exactly what it is, but it describes standardization of human interfaces. To unify displayed items, such as a menu, is user-friendly and makes the system easier to understand. In the sense of standardizing display formats, this description explains the concept “look-and-feel” also. Look-and-feel is the overall impression the computer gives, referring to the appearance of the control screen of the computer and the sense of controllability; this includes the window design, layout of icons, and operation methods and their related screens and/or responses with sound. Normally, Look-and-feel is basically standardized in the OS or the window system, so any application software that runs on the same window system can be operated with almost identical feel. Currently, the display screens and operation methods as presented by Microsoft Windows and MacOS are established as the standards for GUI look-and-feel.

**Q35: [Correct Answer]      b**

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The root directory is the highest-level directory. The current directory is the one currently in use. If the current directory is B1 and we are to designate C2 that is a file under the directory B2, we move the directories as follows:

Directory B1 → Directory A1 → Directory B2 → File C2

- (1) Directory B1 → Directory A1

To move Directory B1 up one level to A1, we can simply designate the parent directory as follows:

“..”

- (2) Directory A1 → Directory B2

To move Directory A1 one level down to B2, we can designate Directory B2 after “\” as follows:

“..\B2”

- (3) Designation of File C2 under Directory B2

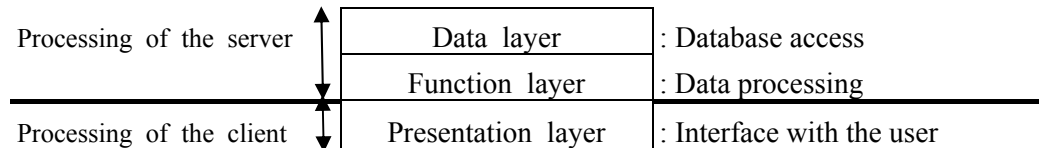
To designate File C2 under Directory B2, we can designate File C2 after “\” as follows:

“..\B2\C2”

- a) “..” indicates the parent directory, which is Directory A1. The next part “\A1” points to Directory A1 under Directory A1, but there is no such directory in this figure.
- c) “A1” points to Directory A1 under the current directory B1, but there is no such directory in this figure.
- d) “B1” points to Directory B1 under the current directory B1, but there is no such directory figure in this figure.

**Q36: [Correct Answer] c**

A 3-layer client/server system (3-layer architecture) is a system in which client/server type applications are divided into three layers: presentation layer, function layer (application layer), and data layer (database access layer). By functional separation, this system aims to improve the system performance and maintenance efficiency. Since is manipulated on the server side, the amount of data communication is reduced between the server and clients, so one of the characteristics of this system is that the response performance does not get much worse even in case of a low speed communication line or a large number of clients. Further, from the standpoint of development efficiency, dividing the system into 3 layers functionally makes it easier to do parallel work in development and to change specifications.

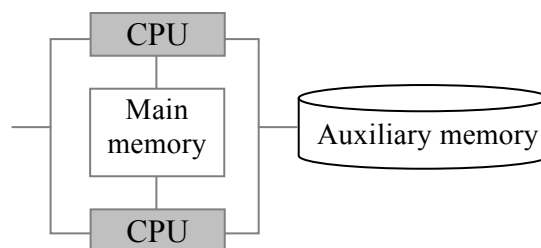


In the function layer, search conditions sent from the presentation layer are assembled as the processing conditions to access the database and sent to the data layer. Then, the response from the data layer is manipulated to meet the request of the presentation layer and then sent to the presentation layer.

- a) Search conditions are sent to the presentation layer, and the data manipulation conditions are assembled in the function layer.
- b) Search conditions are sent to the presentation layer, and data access takes place in the data layer.
- d) Data access takes place in the data layer, and data is manipulated in the function layer.

**Q37: [Correct Answer] b**

A tightly coupled multiprocessor system (TCMP) is a system configuration in which multiple processors, under a single OS, share resources such as the main memory and disks and communicate with one another to select and execute tasks waiting to be processed. Since processing can be performed by any of the processors, the load can be distributed. If one processor fails, other processors can perform processes; it is a system configuration with high reliability and high throughput.



- a) This is an explanation of an incomplete loosely coupled multiprocessor system.
- c) This is an explanation of a duplex system.
- d) This is an explanation of a dual system.

**Q38: [Correct Answer]      d**

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Indexes for evaluating system performance include MIPS, FLOPS, clock, instruction mix, response time, throughput, turnaround time, TPS, etc. Methods for evaluating system performance include benchmark, monitoring, etc.

- a) OLTP (OnLine Transaction Processing) is the processing mode in which transactions are sent to the host computer from multiple terminals connected to the host computer online, the host computer performs a series of processes including database access according to the transactions sent, and the results of the processing are immediately returned to the terminals. The performance is evaluated by the number of transactions processed per unit of time (TPS: Transaction Per Second). On the other hand, MIPS is a unit for measuring the hardware (CPU) performance.
- b) Response time and turnaround time are process-time intervals of jobs. If the response time or the turnaround time is long, the system becomes hard to use. Therefore, these are performance evaluation indexes from the standpoint of the user and not from the standpoint of the system operation administrator.
- c) A high utilization ratio of system resources suggests that the time when resources are unused is short, which in turn implies that conflict between resources is more likely to occur, thus making the response time longer. Hence, the response time does not get better but worse.
- d) If the number of transactions and jobs that can be processed within a unit of time is large, it means that processing power is high. High processing power entails high system performance. Hence, it can be a good index for system evaluation.

**Q39: [Correct Answer]      b**

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In a subsystem configuration in which  $n$  subsystems are connected in parallel, if the system as a whole is available whenever at least one of the subsystems is available, the availability can be expressed as follows:

$$\text{Availability of an } n\text{-subsystem parallel configuration} = 1 - (1 - p)^n$$

(p: availability of each subsystem)

In this formula, the probability that every subsystem is unavailable is subtracted from the whole (probability 1).

We substitute  $p = 0.7$  (70%) into the equation for availability and calculate the availability of this  $n$ -subsystem parallel configuration (call it A).

$$\begin{aligned} A &= 1 - (1 - 0.7)^n \\ &= 1 - 0.3^n \end{aligned}$$

We want the availability A to be at least 99% (0.99), so the following inequality holds.

$$1 - 0.3^n \geq 0.99$$

$$1 - 0.99 \geq 0.3^n$$

$$0.01 \geq 0.3^n$$

$$\therefore 0.3^n \leq 0.01$$

This inequality involves an exponential function, so it takes a long time to calculate it by hand. Therefore, plug in integers, starting at  $n = 2$ , and see if the condition is satisfied.

$$n = 2: 0.3^2 = 0.09 > 0.01$$

$$n = 3: 0.3^3 = 0.027 > 0.01$$

$$n = 4: 0.3^4 = 0.0081 < 0.01$$

Hence, when  $n = 4$ , the inequality  $0.3^n \leq 0.01$  holds. As a result, at least 4 subsystems are required.

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**Q40: [Correct Answer]      b**

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In DFD, the processes (circles) get broken down in order. Hence, when they are broken down, multiple processes at a higher level cannot be merged together at a lower-level.

In the DFD given in this question, note that Process 1 has two input dataflow arrows and two output dataflow arrows.

- a) Although Process 1 has two input dataflow arrows, each of its child processes has only one input dataflow arrow.
- b) Child process 1-1 has one input dataflow arrow, and so does child process 1-2. The total is 2. As for output dataflow, there is one arrow from child process 1-1 and another from child process 1-3, a total of 2. Hence, this is considered to be a break-down of the DFD in the question.
- c) Since DFD breaks down one process, combinations like {(1-1), (1-2)} and {(2-1), (2-2)} are acceptable. However, a combination like {(1-1), (1-2), (2-1), (2-2)}, in which multiple processes at an upper level are combined, is not allowed.
- d) The numbers of input dataflow arrows and output dataflow arrows are correct respectively. However, although every process must have at least one input dataflow and at least one output dataflow, there is no input dataflow for Process 1-2.

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**Q41: [Correct Answer]      a**

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When a certain procedure is defined, the procedure itself can be used in its definition. This is called recursion. A recursive program is a program in which a function or a subroutine uses the function or subroutine itself.

- b) This is an explanation of a relocatable program.
- c) This is an explanation of a reentrant program.
- d) This is an explanation of a reusable program.

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**Q42: [Correct Answer]      d**

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Optimization of a compiler is the process of checking for the redundancy of an object program (object module). It moves constants in a loop to outside the loop, deletes and integrates common formulas, and generates the object code that improves processing efficiency at the time of execution.

- a) This is a method used in a Java virtual machine.
- b) This is an explanation of a cross compiler.
- c) This can be done by embedding debugging instructions into the program. However, this is not related to compiler optimization. This particular option explains a tracer.

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**Q43: [Correct Answer]      c**

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An object-oriented programming language (object-oriented language) is a programming language that writes programs as combinations of objects. An object is an encapsulation of data along with the procedures (called methods) to manipulate the data. By encapsulation, the data is hidden, and the objects indirectly manipulate data through methods.

- a) This states that data used by execution of an instruction is not used by this or the other instructions after that. Although this does not describe anything exactly, it is close to an explanation of a logical programming language.
- b) This is an explanation of a procedural programming language.
- d) This is an explanation of a functional programming language.

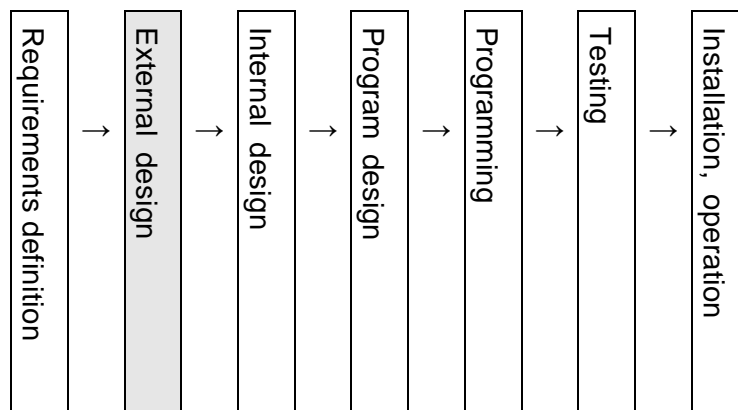
**Q44: [Correct Answer]      b**

Programming languages come in a variety of types; compiler languages, interpreter languages, etc. A program written in a compiler language is converted to a machine language program by a compiler. A program written in an interpreter language is translated and executed one line of code at a time, so the processing speed is slower compared to a compiler language program.

- a) COBOL (Common Business Oriented Language) is suitable for business processes, and it is a compiler language, not an interpreter language.
- b) C is a programming language that was originally developed to write UNIX. Today it is used in a variety of fields, but it is a programming language originally for system description. In addition, it needs a compiler.
- c) A program written in Java is converted by a compiler to an intermediate language, which runs in the interpreter mode on a virtual machine. Therefore, the language specifications do not depend on the platform. A platform means an OS or a computer environment on which software runs. For applications, the platform means the OS, and for the OS, the platform means the environment in which the OS is operating on the hardware. For PCs, the application platform is Windows, and for Windows, the platform is the environment in which Windows is operating on the hardware.
- d) Perl (Practical Extraction Report Language) is a language suitable for processing text files. It is processed in an interpreter mode, so no compiler is required for Perl.

**Q45: [Correct Answer]      a**

The external design phase in the waterfall model is positioned as shown below.



The external design is the system design without regard to a computer. It involves the definition and deployment of subsystems, designs of the screen and reports, code design, and logical data design. Then, an external design documents are prepared.

- b) System development plans are deliverables of requirements definition.
- c) A flowchart is a graphic expression of the program algorithm, and it is a part of deliverables of program design and programming.
- d) The physical database specifications are a part of file design, and they are deliverables of internal design.



**Q49: [Correct Answer]      a**

[Step 1] Multiply each digit by the corresponding weight, and sum up the results as shown below.

Data :	<table><tr><td>7</td><td>3</td><td>9</td><td>4</td></tr><tr><td>×</td><td>×</td><td>×</td><td>×</td></tr></table>				7	3	9	4	×	×	×	×								
7	3	9	4																	
×	×	×	×																	
Weight :	<table><tr><td>1</td><td>2</td><td>3</td><td>4</td></tr></table>				1	2	3	4												
1	2	3	4																	
Sum :	<table><tr><td colspan="2">  </td><td colspan="2">  </td><td colspan="2">  </td><td colspan="2">  </td></tr><tr><td>7</td><td>+</td><td>6</td><td>+</td><td>27</td><td>+</td><td>16</td><td>= 56</td></tr></table>												7	+	6	+	27	+	16	= 56
7	+	6	+	27	+	16	= 56													

[Step 2] Divide the sum by the base (11) and find the remainder as follows:

$$56 \div 11 = 5 \text{ remainder } 1$$

[Step 3] Subtract the remainder from the base (11). The digit in the resulting one's place is the check digit as follows:

$$11 - 1 = 10$$

↑  
Check digit

Hence, the result of appending the check digit to the given data is 73940.

**Q50: [Correct Answer]      c**

Users who are accustomed to keyboard operations will find that the keyboard is a more efficient input device than the mouse. However, those who are not accustomed to keyboard operations will find that the mouse is much easier than the keyboard to use as an input device. Therefore, ideally, if both interfaces are available, the system will be easy to use for many users.

- a) If an image of the keyboard is displayed on the screen and the user has to click the key top using the mouse on a character-by-character basis, this is generally considered annoying. The keyboard is much faster to enter English letters, numerals, etc.
- b) There is a general understanding about screen design; indeed, items requiring input are on the top left, and optional items where input can be omitted are on the bottom right. However, if the input form used in business is different from the screen layout, the input operation gets confusing.
- d) For frequently used functions, mouse-click or double-click execution is more convenient and more efficient than input by menu number on the keyboard. However, in particular, taking it into considerations that the user interface should be efficient for even users who are accustomed to keyboard operations, the description (d) itself is correct but not related to the user's skill level.

**Q51: [Correct Answer]      d**

XML (eXtended Markup Language) extends the functions of HTML, eliminates unnecessary functions of SGML, and optimizes the language for the Internet. Just as HTML, XML is used on the Internet; however, whereas HTML has fixed tags, XML supports DTD (Document Type Definition), which enables the users to define their own tags.

- a) XML is based more on SGML than on HTML.
- b) There are tools (editors) exclusive for XML, but word-processing software can be used for input as well. General text editors can also be used for input. In that case, it is necessary to directly create XML data.
- c) Not only the logical structure and style but attribute information (attribute names, attribute types, etc.) can also be defined.

**Q52: [Correct Answer]      b**

A stub is used to simulate the functions of lower-level modules for the module being tested. It is used in a unit test and a top-down test.

- a) This is an explanation of snapshot.
- c) This is an explanation of an interactive debugging tool.
- d) This is an explanation of a driver.

**Q53: [Correct Answer]      b**

In actual operations, the company's network is used to exchange data with branch offices across the country. However, the test environment uses LAN in the head office. Hence, there is a difference between the performance of the company's network and that of LAN in the head office. This performance difference between the company's network and LAN affects the response time.

- a) Processing time of an application program depends on the server performance. It also depends on the number of terminals operating at the same time, but this can easily be solved by connecting the same number of terminals to LAN in the test environment.
- c) The number of terminals connected to the network does affect this, but as explained under (a) above, this is easily solved by connecting the same number of terminals to LAN in the test environment.
- d) The number of processes running on the server depends on the server performance. It is hardly affected by the network performance.

**Q54: [Correct Answer]      c**

Decision condition coverage (branch coverage) is one of the techniques of white box testing, and it tests combinations of true/false conditions. In the decision “A OR B” in the flowchart, we need to prepare two sets of test data, one for a case where this is true and the other where this is false. To decide true/false for the combinations in the answer group, we can replace “false” with 0 and “true” with 1 and execute the logical sum (A OR B).

- a) In this case, there is only one test case, so a test by decision condition coverage cannot be done. In addition,, the decision turns out to be true, so the instruction is not even executed.

A	B	A OR B
F	T	T
0	1	1

- b) Both of these test cases turn out to be “true,” so we do not have two different results: true and false.

A	B	A OR B
F	T	T
0	1	1
T	F	T
1	0	1

- c) Two sets of test data are prepared: a true case and a false case. These can be used for branch coverage.

A	B	A OR B
F	F	F
0	0	0
T	T	T
1	1	1



- d) All three sets of data give true cases, so we do not have two different results: true and false.

A	B	A OR B
F	T	T
0	1	1
T	F	T
1	0	1
T	T	T
1	1	1

**Q55: [Correct Answer]      c**

PERT (Program Evaluation and Review Technique) is a schedule planning method used in large-scale projects. An arrow diagram is used to make a schedule.

A critical path is a path connecting activities where there is no leeway in the arrow diagram. If any one of these activities on the critical path is delayed, the whole project will be delayed.

- a) These activities can be identified by ABC analysis using a Pareto diagram.
- b) Arrow diagrams can identify the chronological relationship of activities and the number of days required for each activity, but they cannot identify which implementation sequence of activities can be changed.
- d) The cost of each activity in an arrow diagram can be figured out, so we can identify which activity costs the most. However, this is not identified by a critical path.

**Q56: [Correct Answer]      c**

The function point method (FP method) is a cost model that reduces the size of software in terms of the function units included in the software, not in terms of the number of steps in the program. This is based on the concept that what the user really needs is not the program itself but the information (screen or ledger sheet) that the software outputs.

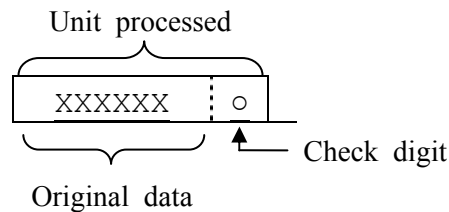
In the FP method, functions are classified into the following five categories, and for each function, function points are calculated. Then, the workload is estimated by comparing the resulting number of function points and the past actual values.

Function	Explanation
External input	The number of points determined by means of the type and complexity degree of the external input
External output	The number of points determined by means of the type and complexity degree of the external output
External inquiry	The number of points determined by means of the type and complexity degree of the external inquiry
Internal logic file	The number of points determined by means of the type and complexity degree of the file accompanying access
External interface file	The number of points determined by means of the type and complexity degree of interface linked to another system

- a) This is an explanation of the program step method.
- b) This is an explanation of the bottom-up estimation method.
- d) This is an explanation of the similarity method.

**Q57: [Correct Answer] a**

A check digit is a character appended to an original data in order to prevent fill-in errors and input errors of numerical and other data.

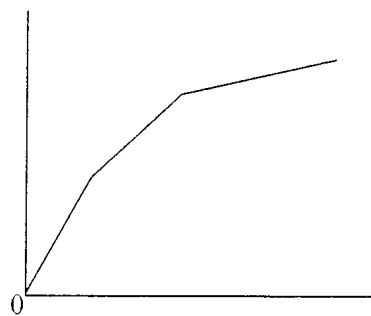


The check digit is obtained by performing a certain operation to the original data. When the data is entered, the entire unit including the check digit is entered. The computer then uses the same operation used to create the check digit to verify the check digit entered. If the calculated check digit matches the check digit entered, the input is determined to be valid.

Check digits are generally used to check codes. If the original code has 5 digits, a check digit is appended, and the data is processed as 6-digit code.

- b) This is an explanation of the array function for codes. If customer codes are assigned in consecutive numbers, the customers can be listed in the order in which they were entered.
- c) This is an explanation of the identification function for codes. For example, if customer codes are given like “MINATO-011,” then it is immediately obvious that the customer is in “MINATO.” Another example may be a product code “TV-001,” which immediately identifies the product as a television.
- d) This is an explanation of the classification function for codes. For example, if customer codes are of the form “1-100,” where the leading digit is a region code, the data can be geographically classified.

**Q58: [Correct Answer] c**



“Diminishing” means that the amount or the quantity goes down gradually as time passes. A diminishing charge system is a fee-charge system in which the unit price of the charges goes down as the usage increases or the number of users increases. In this system, the rate of increase of the usage charge decreases as the amount of usage increases. Therefore, a graph of a diminishing charge system is one where, if the horizontal axis indicates the usage and the vertical axis indicates the usage charge, the rate of increase in the y-value goes down as the x-value increases.

Graphs (a) and (d) are the opposite of a diminishing charge system since the rate of increase of the usage charge increases as well.

Graph (b) cannot be right because the rate of increase goes down in a diminishing charge system; the charge does not become constant.

**Q59: [Correct Answer]      b**

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A sudden failure of power means a sudden loss of electricity (power outage) or a momentary power failure. Devices like illumination lights are not affected as much, but a computer system may experience hardware failure and other troubles. Since a program being executed is suddenly stopped, files and databases may just happen to be damaged.

- a) CVCF (Constant Voltage and Constant Frequency) is a device that provides electric power with stable voltage and frequency. If power suddenly fails, this unit stops supplying power.
- b) UPS (Uninterrupted Power Supply) is a backup power supply unit that prevents computer data loss by a blackout or a sudden power failure of a commercial power source. When power suddenly fails, the power supply switches from the commercial power supply to a battery so that the voltage fluctuation can be kept minimum. The computer can operate approximately for 5 to 120 minutes after the power supply failure. Normally, UPS is also equipped with the CVCF function.
- c) A private electric power generator is a necessary item if the power failure lasts for a long time. Since a generator takes some time to start up, it cannot supply power to a computer system immediately after a power failure. Until a stable voltage can be provided, the power is supplied by UPS, so UPS and a private generator complement each other. In addition, a generator is not suitable for short-term power failures due to its large size and high price.
- d) A backup power-receiving equipment is a double of a power-receiving facility. When the normal commercial power supply is not available, power is received from a backup power supply. A backup power-receiving equipment has reserve power stored in it when power is received from a power company. This is used as a backup for illumination, etc. in a power outage. Switching takes time, so this is not suitable for short-time power failures.

**Q60: [Correct Answer]      c**

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Since we are testing whether or not corrections or changes are affecting other properly functioning parts, this is not a test conducted in the process of system development. It is a test conducted in the maintenance phase.

- a) Performance test is a test to verify that the developed system is satisfying the system performance targets. Response time and TPS are tested for an online system whereas throughput and processing time are measures for batch processes.
- b) Endurance test (or durability test) is a test to verify that the system operates in a stable manner even after a long period of continuous operation. Sometimes it is referred to as a load test.
- c) Regression test is a test conducted during system maintenance. When an error is corrected or a part of specifications is modified on an existing system, after checking that the changes were correctly made, this test is used to verify that the change did not affect the parts that were not modified.
- d) Exception test is a test to enter exceptional data, such as data out of the possible range of data values and data that cannot be entered (invalid value), and to verify that the system and program can properly process error data.

**Q61: [Correct Answer] d**

The OSCI basic reference model is as shown below.

Layer 7	Application layer	Exchanging information between applications
Layer 6	Presentation layer	Expressive form of information for transfer
Layer 5	Session layer	Management of interactive mode
Layer 4	Transport layer	Quality assurance of data transfer between processes
Layer 3	Network layer	Definition of the data unit
Layer 2	Data link layer	Definition of the frame unit
Layer 1	Physical layer	Definition of physical conditions and electrical conditions

- From error control of lost data (flow control) and multiplexing of data, this description can be interpreted as an explanation of the transport layer.
- From remote access and file transfer, this can be interpreted as an explanation of the application layer.
- From transparent transfer between adjacent systems and timing control of send/receive, this can be interpreted as an explanation of the data link layer.
- From establishment of a logical communication path, management of interoperations (synchronization point control), and exception reporting, this can be interpreted as an explanation of the session layer. In exception reporting, an error report is sent to the presentation layer without releasing the session connection.

**Q62: [Correct Answer] b**

Parity check can detect and correct a 1-bit error by setting parity for both rows and columns. A 2-bit error can be detected but not corrected.

In the figure shown in this question, the number of bits that are 1's is even, both horizontally and vertically; therefore, the parity is even. For a 3-bit error, error detection works as shown below.

Assume that the bits in the following three thick-line boxes are erroneous.

0	1	0	0	1	
0	0	1	0	0	← The total number of 1's is odd.
0	0	1	0	1	
1	1	0	1	1	
0	0	0	1		

↑  
The total number of 1's is odd.

This situation is just like a 1-bit error; if one box is corrected as shown below, the whole thing becomes “correct.” Hence, an error can be detected but not corrected.

0	1	0	0	1	
1	0	1	0	0	
0	0	1	0	1	
1	1	0	1	1	
0	0	0	1		

As a result, this parity check can detect and correct up to 1 bit error.

**Q63: [Correct Answer]      c**

---

In the start/stop transmission (start/stop synchronization) method, each character consists of 8 bits, but 1 bit is appended at the beginning and another at the end. So, each character has 10 bits.

One message consists of 90 characters ( $90 \times 10 = 900$  bits), so the transmission time for one message is calculated as follows:

$$\begin{aligned}\text{Transmission time for one message} &= \frac{90 \text{ bytes} \times 10 \text{ bits/byte}}{14,400 \text{ bits/sec}} \\ &= \frac{9 \times 10^2}{144 \times 10^2} \\ &= \frac{9}{144} (\text{sec})\end{aligned}$$

Hence, the number of messages that can be sent per second is as follows:

$$\begin{aligned}\text{The number of messages that can be sent per second} &= \frac{1}{\text{Transmission time for one message}} \\ &= \frac{144}{9} (\text{messages})\end{aligned}$$

The number of messages that can be sent per minute is as follows:

$$\begin{aligned}\text{The number of messages that can be sent per minute} &= \text{The number of messages that can be sent per second} \times 60 \\ &= \frac{144}{9} \times 60 = 960 (\text{messages})\end{aligned}$$

However, the usage ratio of the line is 80%, so the effective number of messages that can be sent per minute is:  $960 \times 0.8 = 768$  (messages).

**Q64: [Correct Answer]      c**

---

Line usage ratio is the ratio of the actual amount of data transferred to the transfer capacity of the line (equal to the transmission speed). It is calculated as follows:

$$\text{Line usage ratio} = \frac{\text{Amount of data transferred}}{\text{Transmission speed}} \times 100 (\%)$$

(1) Calculation of the amount of data transferred

Files with an average size of 1,000 bytes are transferred here, but control information whose amount is 20% of the amount of data transferred is added to each file. A file is sent every two seconds, so the amount transferred per second is as follows:

$$\begin{aligned}\text{Amount transferred per second} &= \frac{1,000 \times (1 + 0.2)}{2} \\ &= \frac{1,200}{2} \\ &= 600 (\text{bytes/sec})\end{aligned}$$

Each byte is 8 bits, so the number of bits transferred per second is as follows:

$$\text{The number of bits transferred per second} = 600 \times 8$$

$$= 4,800 \text{ (bits/sec)}$$

(2) Calculation of the line usage ratio

The communication speed is 64,000 bits/sec and the amount of data transferred is 4,800 bits/sec, the line utilization rate is calculated as follows:

$$\begin{aligned} \text{Line utilization rate} &= \frac{4,800 \text{ (bits/sec)}}{64,000 \text{ (bits/sec)}} \times 100 \\ &= \frac{48}{640} \times 100 \\ &= 0.075 \times 100 \\ &\rightarrow 7.5 (\%) \end{aligned}$$

---

**Q65: [Correct Answer]      a**

10BASE-T is a CSMA/CD type of LAN; it is a star network with a hub in the middle. The hub is sometimes equipped with a collision lamp, which lights up when a collision occurs.

- b) There is no limit for the number of computers that can be connected in 10BASE-T; however, the cascade connection to the hub is limited to 4 levels. If this limit is exceeded, data does not reach some computers, but the collision lamp does not light up.
- c) In the CSMA/CD method, the connection is, as a rule, 1-to-1, and the computer processing time is irrelevant. If data is transferred and received, the collision lamp does not light up.
- d) If the hub exceeds 4 levels in cascade connection, data sent and received do not reach some computers. However, the collision lamp does not light up.

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**Q66: [Correct Answer]      c**

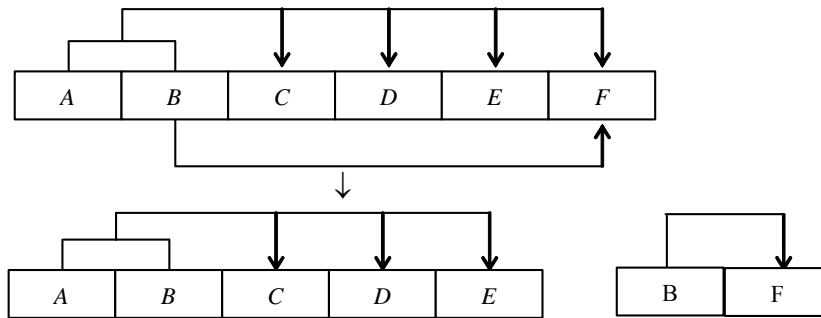
- a) A gateway is a unit or software that connects networks in all layers (mainly Layer 4 and above) in the OSI basic reference model.
- b) A bridge connects LANs using the protocol of the second layer (data link layer) of the OSI basic reference model. Since it is the data link layer, the connection relays frames based on the MAC address. A router is used to relay frames based on the IP address.
- c) A repeater connects LANs using the protocol of the first layer (physical layer) of the OSI basic reference model. It amplifies signals and extends the transmission distance.
- d) A router connects LANs using the protocol of the third layer (network layer) of the OSI basic reference model. Since it is the network layer, the connection relays frames based on the IP address. A bridge is used to relay frames based on the MAC address.

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**Q67: [Correct Answer]      b**

The third normal form is the form in which all items that are not the primary key items are directly derived by the whole primary key items. In the record given in this question, the primary key is (A, B), which derives C, D, E, and F. But, F is also derived from B. This is induction from a part of the primary key, so this must be eliminated. This means that F is derived by (A, B) but is also derived by (B) alone, which is just a part of the primary key. When a part of the primary key derives an item that is not a primary-key item, it is referred to as partial functional dependency; on the other hand, induction by the entire primary key is called full functional dependency.

Now, we separate the records so that F can become fully functionally dependent. More specifically, we can obtain the third normal form as follow:



This is identical to the option (b).

### Q68: [Correct Answer] c

Projection extracts the specific columns from a table.

- a) This is an explanation of a union.
- b) This is an explanation of a selection.
- d) This is an explanation of a join.

### Q69: [Correct Answer] d

The SQL statement given is interpreted as follows:

```
CREATE VIEW Profitable_Product          : Creates a view called "Profitable Product."
AS                                     : AS is followed by a SELECT statement in VIEW definition.
SELECT *                             : All items are extracted.
FROM Product                          : Items are extracted from the Product table.
WHERE Sales_price – Purchase_price >= 400 : (Sales price - Purchase price) >= 400
```

This SQL statement calculates the difference (sales price – purchase price) for each of the products in the Product table and extracts the rows where the value is 400 or more. When this SQL is executed, two rows are extracted as shown in the following table.

Product code	Product name	Sales price	Purchase price	Sales price – Purchase price	Extraction result
S001	T2003	1500	1000	500	Extracted
S003	S2003	2000	1700	300	
S005	R2003	1400	800	600	Extracted

- a) When the sales price of model R2003 is updated to 1300, (sales price – purchase price) becomes as follows:  
 $(\text{sales price} - \text{purchase price}) = 1300 - 800 = 500 \geq 400$   
 This was already extracted before the change and will be extracted after the change, so the number of rows extracted will not change.
- b) When the purchase price of model R2003 is updated to 900, (sales price – purchase price) becomes as follows:  
 $(\text{sales price} - \text{purchase price}) = 1400 - 900 = 500 \geq 400$   
 This was already extracted before the change and will be extracted after the change, so the number of rows extracted will not change.
- c) When the purchase price of model S2003 is updated to 1500, (sales price – purchase price)

becomes as follows:

$$(\text{sales price} - \text{purchase price}) = 2000 - 1500 = 500 \geq 400$$

This was not extracted before the change and will be extracted after the change, so the number of rows extracted will increase.

- d) When the sales price of model T2003 is updated to 1300, (sales price – purchase price) becomes as follows:

$$(\text{sales price} - \text{purchase price}) = 1300 - 1000 = 300 < 400$$

This was extracted before the change but will not be extracted after the change, so the number of rows extracted will decrease.

---

**Q70: [Correct Answer]      d**

The log file in a database system (also referred to as the log or the journal) is a file that records the contents of the database records before updating (information before updating, “before image”), contents after updating (information after updating, “after image”), and contents of transactions. When a failure occurs in the database, the database is recovered based on the contents of the log file.

- a) This is an explanation of a checkpoint file.
- b) This is an explanation of file mirroring, in which the same file is created on separate disks; when one disk fails, the file on the other disk is used to carry on the operation.
- c) This is an explanation of backup.

---

**Q71: [Correct Answer]      a**

In a public key encryption method, a plain text is encrypted using the receiver's public key, and the receiver decodes the encrypted text using the receiver's private key.

---

**Q72: [Correct Answer]      b**

The Internet is an open network, so exchanging confidential documents requires a measure such as encryption. An organization needs to install a firewall at its connection point with the Internet so that unauthorized access from the outside can be prevented.

- a) A firewall is a system or a computer that protects an internal network such as a company LAN from unauthorized access. It is installed to shut out unauthorized access from the outside to a network system such as a company LAN connected to an outside network such as the Internet.

The purpose of a firewall is to prevent unauthorized access from the outside; prevention of leakage from the inside is not its purpose. Leak of critical information from within the company cannot be prevented automatically. Hence, some other measure is required.

- b) Once access is granted through the Internet, it is impossible to predict how the network is used. Hence, it is necessary to take measures to prevent unauthorized access to database and falsification of data.
- c) Checking e-mail arrival and encryption are different subjects altogether. Checking the arrival of an e-mail is simply to check that the e-mail has reached the recipient. It has nothing to do with the contents of the e-mail. In contrast, encryption is a measure taken so that data contents cannot be read by someone else.
- d) The Internet is an open network and can be used by anyone. If one registers with an Internet service provider for connection, one can use the Internet. There is no need to register with a user authentication system.



**Q73: [Correct Answer] c**

“Effective use of a quality management system” means that quality management is effectively implemented. The purpose is to achieve customer satisfaction by implementing sufficient quality management. This is not assessment of standards or quality of each product manufactured; rather, it is assessment of the quality management system.

- a) BS7799 is a standard on information security management issued by the BSI (British Standards Institution). A standard very similar to BS7799 has been internationally standardized by ISO as ISO/IEC 17799.
- b) ISMS (Information Security Management System) is a comprehensive framework for companies and other organizations to manage information properly and protect confidentiality. It is a total risk-management system including not only security measures for computer systems but also basic security policies in handling information, specific plans based on the policies, implementation and operation of the plans, and reviews of the policies and plans on a periodic basis. Due to an increase in unauthorized access, computer viruses, and information leak, interest of companies in information management is on the rise, and more companies are obtaining ISMS certification.
- c) ISO 9001 is the standard for certification among the ISO 9000 series concerning the quality assurance system of companies, established by ISO. The ISO 9000 series is an overall title for multiple international standards concerning quality assurance systems. ISO 9001 is the guidelines for certification, and other standards are guidelines to obtain the ISO 9001 certification. This is not a product standard; rather, it is international recognition that the company or the organization conforms to the following items.
  - The organization has the ability to provide products that meet the customers' requirements and applicable legal requirements.
  - The organization is making efforts to improve customer satisfaction.

ISO 9000	Fundamentals and vocabulary of quality management system
ISO 9001	Quality management system General requirements, Documentation requirements Management responsibility (customer focus, quality policy, review, etc.) Resource management (provision of resources, human resources, work environment, etc.) Product realization (planning of product realization, customer-related processes, design and development, etc.) Measurement, analysis, and improvement (monitoring and measurement, control of nonconforming product)
ISO 9004	Guidelines for performance improvements

ISO 9001 was revised in December 2000; requirements that had been distributed before were organized into four categories as follows:

- Management responsibility
- Resource management
- Product realization
- Measurement, analysis, and improvement

It is characterized by items such as the concept of quality management systems and its continuous improvement.

- d) ISO 14001 is the international standard established by ISO so that corporations and organizations can carry on business activities while taking the global environment into consideration. It certifies the results of the organization's environment management, such as human resource development and system establishment, to reduce the burden on the environment  
ISO 14001 is a standard for certification; third-party organizations (certification bodies) registered with the government are performing the assessment.

**Q74: [Correct Answer]      d**

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Since the relationship between the preset price and expected demand can be approximated by a linear expression, if we let  $x$  be the preset price and  $y$  the expected demand, we have the following equation:

$$y = ax + b \quad (a \neq 0) \quad \dots\dots[1]$$

Substituting the values of (1) and (2) given in the question into the equation [1] above, we can find  $a$  and  $b$ .

- (1) Since  $x = 3000$  and  $y = 0$ , we get

$$0 = a \times 3000 + b$$

$$\therefore 3000a + b = 0$$

$$\therefore b = -3000a$$

As a result, the equation [1] can be changed as follows:

$$y = ax - 3,000a \quad \dots\dots[2]$$

- (2) Since  $x = 1000$  and  $y = 60000$ , substitute these into the equation [2], and we get the following:

$$60000 = 1000 \times a - 3000a$$

$$= 1000a - 3000a$$

$$= -2000a$$

$$\therefore a = -\frac{60000}{2000} = -30$$

Hence, we can now find  $b$  as follows:

$$b = -3000a$$

$$= -3000 \times (-30)$$

$$= 90000$$

Thus, the equation [1] is changed as follows:

$$y = -30x + 90000 \quad \dots\dots[3]$$

- (3) Substitute  $x = 1500$  into the equation [3] to find the expected demand.

$$y = -30 \times 1500 + 90000$$

$$= -45000 + 90000$$

$$= 45000 \text{ (units)}$$

**Q75: [Correct Answer]      a**

---

CIO (Chief Information Officer) is the highest-ranking officer in charge of total management of information systems. Normally, the officer in charge of the information systems department becomes CIO. CIO is not only required to have knowledge on information systems but is also held responsible for establishing computerization strategies, so he or she must have a wide range of understanding including the industry, the company's business, and administrative work.

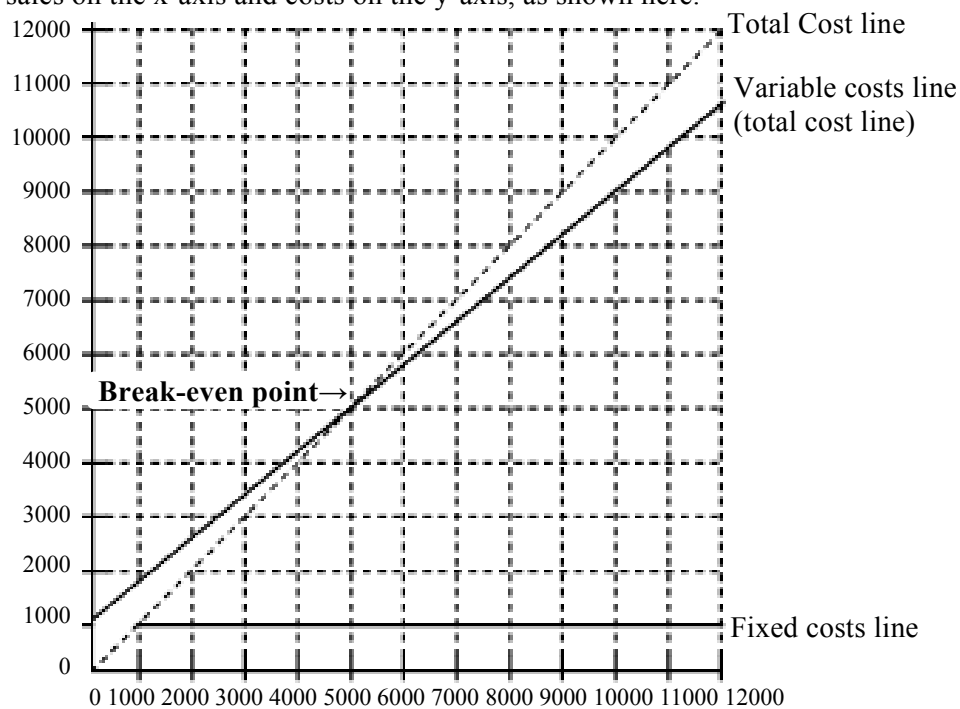
Hence, the role of the CIO is, in working out an IT strategy, to adopt a plan to optimize the effects of cross-company investment in information assets in accordance with the company's business strategy.

**Q76: [Correct Answer] a**

A break-even point is the point where the sales and costs are equal to each other. If the sales during a certain period are less than the break-even point, the result is a loss; if the sales exceed the break-even point, it makes a profit. The break-even point sales are calculated as follows:

$$\begin{aligned}\text{Break-even point sales} &= \frac{\text{fixed costs}}{1 - \frac{\text{variable costs}}{\text{sales}}} \\ &= \frac{1,000}{1 - \frac{8,000}{10,000}} = 5,000.\end{aligned}$$

If you do not know this formula, you can still answer the question using the coordinate plane, plotting the total sales on the x-axis and costs on the y-axis, as shown here.



**(1) Draw the fixed costs line.**

The fixed costs are constant (\$1,000), so this is a line parallel to the x-axis.

Fixed cost line:  $y = 1,000$

**(2) Calculate the variable costs.**

Variable costs are costs that are directly proportional to the quantity sold. If the variable costs are  $y$  and the total sales are  $x$ , we have the following equation:

Variable costs:  $y = \alpha x$  ( $\alpha$  is the constant of proportionality.) .....(A)

From the table given in the question, we see that when  $x$  (total sales) is \$10,000,  $y$  (variable costs) is \$8,000. Substituting these values into the equation (A), we can get the result as follows:

$8,000 = \alpha \times 10,000$ .  $\therefore \alpha = 8,000 \div 10,000 = 0.8$

**(3) Draw the total costs line.**

The total costs are the sum of the variable costs and fixed costs. The total costs line is then obtained by adding the expressions of (1) and (2) above.

Variable costs line (total costs line):  $y = 0.8x + 1,000$  .....(B)

**(4) Draw the total sales line.**

Draw the total sales line so that the line can make a 45-degree angle with the x-axis.

Total sales line:  $y = x$  .....(C)

**(5) Calculate the break-even point sales.**

The break-even point sales volume is the x value of the intersection point of the variable costs line (total costs line) and the total sales line. Hence, we can set (B) = (C).

$$0.8x + 1,000 = x \quad \therefore x = 5,000$$

**Q77: [Correct Answer]      d**

The Delphi method is a logical projection technique used in long-term future projection and technology projection. It was developed by the Rand Corporation of the United States and is classified under intuitive methods. Intuitive methods are methods of projection or prediction based on human experience and knowledge.

The Delphi method takes advantage of the feedback characteristic. In this method, opinions of a large sample of people are collected and analyzed through questionnaires, and the results of the survey are summarized, shown to the respondents, and then the survey process is repeated. This method has many advantages. First, as it employs an intuitive method, it is effective when applied to discontinuous changes of technology. It can also help avoid being influenced by the group dynamics that tend to come from regular face-to-face meeting, etc. In addition, when a comment collected from the survey is different from the majority's opinion, invaluable new ideas can be obtained from reasons added by the respondent. Hence, the setting for questions to ask is an important key to success of this method.

- a) Cause analysis is to pick out and analyze the root causes of problems found in operations and systems. There is no particular set method for this, but at least in this case, it does not repeat the same survey as in the Delphi method.
- b) A segment is a unit that has been minutely partitioned. A segment of cell phone service users may be defined by classification according to gender or age group. In segment analysis, the frequency of service use is studied for each of the finely segmented classes. For example, the analysis may survey all cell phone service users based on their age as shown below:

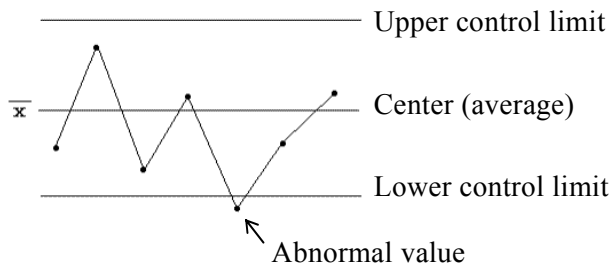
Age	Service 1	Service 2	Service 3	Service 4
Total	10%	20%	50%	20%
20 yrs. and under	20%	15%	25%	40%
21 to 30 yrs.				
31 to 40 yrs.				
41 to 50 yrs.				
51 yrs. or older				

The survey is done only once, and no repetitive surveys are necessary as in the Delphi method.

- c) Analysis of population dynamics is the study of population change from various perspectives. For instance, it may study the number of childbirths and number of deaths. In this case, it will be time-series analysis, so the survey is not repeated to the same subjects as in the Delphi method.

**Q78: [Correct Answer]      b**

A control chart is a chart used to check if processes are in stable conditions and/or to maintain the processes in stable conditions. A pair of lines are drawn to indicate control limits (one for upper control limit and one for lower control limit), and points are plotted to indicate quality or process conditions. If the points are between the two control limit lines and if they do not have a characteristically abnormal pattern, the processes are considered to be in stable conditions. If the points go outside of the control limit lines or if there is some abnormal pattern in the way they line up, we conclude that there is some reason that should not be ignored. If this is the case, we are to analyze the cause and take measures to ensure that it will not occur again in order to maintain the processes in stable conditions.



- a) A network diagram with arrows connecting individual activities and indicating their order relationships is also known as an arrow diagram. Process bottlenecks are identified by analyzing the activities along a critical path.
- b) ABC analysis is suitable here.
- d) Cause and effect diagram (or fishbone diagram) can be used.

**Q79: [Correct Answer]      c**

Since the correlation coefficient is 0.8, there is a strong correlation.

Regression line approximates the relation between  $x$  and  $y$  as a straight line, taking the last year's score along the  $x$ -axis and this year's score along the  $y$ -axis. Hence, the regression line is represented as follows:

$$y = ax + b \quad (a \neq 0) \quad (1)$$

Here, the slope is 1.1, which means  $a = 1.1$ ; since the  $y$ -intercept (the intersection of the line with the  $y$ -axis) is 10, we know  $b = 10$ . Applying these to the equation (1), we can get the following regression line:

$$y = 1.1x + 10$$

- a) This year's score being 0 means  $y = 0$ . Then, the value of  $x$  (last year's score) is as follows:

$$0 = 1.1x + 10$$

$$1.1x = -10$$

$$\therefore x = -9.090\dots$$

$$\cong -9.1 \text{ (rounded to the nearest tenth).}$$

Hence, the last year's score is -9.1, not 10

- b) The average score needs to be calculated by adding individual scores. For instance, if the last year's average is 50, i.e.,  $x = 50$ , then we can see the relationship between  $x$  and  $y$  as follows:

$$y = 1.1 \times 50 + 10$$

$$= 65$$

$$\therefore \frac{y}{x} = \frac{65}{50} = 1.3$$

Regardless of the individual scores, the average score is not 1.1 times the score last year.

- c) As seen under (b) above, the person who scored 50 last year would have scored 65 this year. Hence, we can conclude that points were easier to earn on this year's exam than on last year's.
- d) The analysis is only about the scores, and we cannot evaluate the contents of the examinations. Further, the statement that “this year's exam scores were good” does not necessarily mean that points were easier to earn.

**Q80: [Correct Answer]      c**

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- a) The moving average method is the method in which the average is calculated for a certain number of consecutive items before and after a given value in a time-series data set, and then the resulting average values are listed to find a pattern or a tendency. It is used in inventory evaluation, for example. If weights are assigned to the values to find the average values, it is called the weighted average method. For example, suppose that a time-series data set gives one value for each month for the period of one year and that the values are  $y_1, y_2, \dots, y_{11}, y_{12}$ . Then, the moving averages for any given three-month period will be as follows:

$$Y_2 = (y_1 + y_2 + y_3) / 3$$

$$Y_3 = (y_2 + y_3 + y_4) / 3$$

$$Y_4 = (y_3 + y_4 + y_5) / 3$$

....

$$Y_{11} = (y_{10} + y_{11} + y_{12}) / 3$$

These values,  $Y_2, Y_3, Y_4, \dots, Y_{11}$  are called the moving averages.

- b) The least squares method is used to estimate the relation correlation between two quantities. For instance, if there is a fact that those who score high in mathematics also score high in science, then science and mathematics test scores are plotted in a scatter diagram, with many sample points. From the scatter diagram, one can obtain a relational expression between the scores of mathematics and science. Once the equation is found, when you know the score of one test, either mathematics or science, you can predict the other score.
- c) Linear programming (LP) is a method of operations research in which an objective function is expressed as a linear expression and constraints are expressed as linear inequalities or linear equations so that the profits can be maximized under the given constraints. Under given conditions, if we let the quantities to be manufactured be  $a, b$ , and  $c$  for products A, B, and C, respectively, for maximum profits, the following constraint inequalities hold:

$$2a + 3b + c \leq 240$$

$$2a + b + 2c \leq 150$$

Under these constraints, we can find the values of  $a, b$ , and  $c$  that maximize the value of the objective function

$$8a + 5b + 5c$$

- d) The fixed order quantity system is a method of ordering in which the quantity to be ordered remains constant but the time of ordering varies depending on the fluctuation of the demand. It is the idea of letting the fluctuation of the demand be absorbed in the fluctuation of ordering intervals. An order is placed when the inventory goes down below a certain level, so it is also called the order point method.

