



April 2024

Fundamental IT Engineer Examination (Subject B)

Questions must be answered in accordance with the following:

Question Nos.	Q1 – Q20
Question Selection	All questions are compulsory.
Examination Time	12:30 – 14:10 (100 minutes)

Instructions:

1. Use a pencil. If you need to change an answer, erase your previous answer completely and neatly. Wipe away any eraser debris.
2. Mark your examinee information and test answers in accordance with the instructions below. Your answer will not be graded if you do not mark properly. Do not mark or write on the answer sheet outside of the prescribed places.

(1) Examinee Number

Write your examinee number in the space provided, and mark the appropriate space below each digit.

(2) Date of Birth

Write your date of birth (in numbers) exactly as it is printed on your examination admission card, and mark the appropriate space below each digit.

(3) Answers

Mark your answers as shown in the sample question below.

[Sample Question]

Which of the following should be used for marking your answer on the answer sheet?

Answer group

- a) Ballpoint pen b) Crayon c) Fountain pen d) Pencil

Since the correct answer is “d) Pencil”, mark the answer as below:

[Sample Answer]

Sample	<input type="radio"/> a	<input type="radio"/> b	<input type="radio"/> c	<input checked="" type="radio"/>	<input type="radio"/> e	<input type="radio"/> f	<input type="radio"/> g	<input type="radio"/> h	<input type="radio"/> i	<input type="radio"/> j
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**Do not open the exam booklet until instructed to do so.
Inquiries about the exam questions will not be answered.**

Pseudo programming language notations

In algorithm and programming questions that use pseudo programming language, the following notations are used unless otherwise stated:

[Pseudo programming language notations]

Notation	Description
○ <i>procedure</i> (<i>type</i> : <i>arg1</i> , ...)	Declares a <i>procedure</i> and its argument(s) <i>arg1</i> ,
○ <i>ret-type</i> : <i>function</i> (<i>type</i> : <i>arg1</i> , ...)	Declares a <i>function</i> , its argument(s) <i>arg1</i> , ... , and type of return value <i>ret-type</i> .
<i>type</i> : <i>var1</i> , ... <i>type</i> [:] : <i>array1</i> , ...	Declares variables <i>var1</i> , ... and arrays <i>array1</i> , ... by data <i>type</i> such as integer, real, and string.
<i>/* comment */</i>	Describes a comment between <i>/*</i> and <i>*/</i> .
<i>// comment</i>	Describes a comment after <i>//</i> till end of line.
<i>variable</i> ← <i>expression</i>	Assigns the value of the <i>expression</i> to the <i>variable</i> .
<i>procedure</i> (<i>arg1</i> , ...)	Calls a <i>procedure</i> by passing arguments <i>arg1</i> ,
<i>function</i> (<i>arg1</i> , ...)	Calls a <i>function</i> by passing arguments <i>arg1</i> , ... , and receiving the return value.
output <i>arg1</i> , ...	Outputs values of <i>arg1</i> , ... to a printing device.
return <i>ret-val</i>	Finishes a function by passing back a return value <i>ret-val</i> .
<pre> if (<i>condition-i</i>) } *1 <i>process-i</i> elseif (<i>condition-ei</i>) } *2 <i>process-ei</i> else } *3 <i>process-e</i> endif </pre>	<p>Indicates the selection process.</p> <p>*1 If <i>condition-i</i> is true, then execute <i>process-i</i>. Otherwise, proceed to the next elseif or else.</p> <p>*2 If <i>condition-ei</i> is true, then execute <i>process-ei</i>. Otherwise, proceed to the next elseif or else.</p> <p>*3 If all conditions are false, execute <i>process-e</i>. Note: *2 and *3 can be omitted. *2 may exist twice or more.</p>
<pre> for (<i>sequence</i>) <i>process</i> endfor </pre>	<p>Indicates the “for” iteration process.</p> <p>In the order specified in the <i>sequence</i>, execute the <i>process</i> repeatedly.</p>
<pre> while (<i>condition</i>) <i>process</i> endwhile </pre>	<p>Indicates the “while” iteration process.</p> <p>While the <i>condition</i> is true, execute the <i>process</i> repeatedly.</p>
<pre> do <i>process</i> while (<i>condition</i>) </pre>	<p>Indicates the “do - while” iteration process.</p> <p>Execute the <i>process</i> once, and then while the <i>condition</i> is true, execute the <i>process</i> repeatedly.</p>

Pseudo programming language notations (continued)

[Operators and their precedence]

Type of operator	Operators	Precedence	Note
Expression	(), . ⁽¹⁾	<div style="text-align: center;"> High ↑ ↓ Low </div>	⁽¹⁾ accessing member or method
Unary operator	+, -, not ⁽²⁾		⁽²⁾ logical negation
Binary operator	x, ÷, mod ⁽³⁾		⁽³⁾ remainder
	+, -		
	>, <, ≥, ≤, =, ≠		
	and ⁽⁴⁾		⁽⁴⁾ logical product
	or ⁽⁵⁾		⁽⁵⁾ logical sum

[Boolean-type constants]

true, false

[Array reference]

	1-dimensional array	2-dimensional array	Array of arrays
Array declaration	<i>type</i> []: <i>name</i> ...	<i>type</i> [,]: <i>name</i> ...	<i>type</i> [][]: <i>name</i> ...
Example	<div>integer []: a1</div> <div><div><div>1</div><div>2</div><div>3</div><div>4</div><div>5</div></div><div><div>1</div><div>3</div><div>5</div><div>7</div><div>9</div></div></div>	<div>integer [,]: a2</div> <div><div><div>1</div><div>2</div><div>3</div></div><div><div>1</div><div>11</div><div>12</div><div>13</div></div><div><div>2</div><div>14</div><div>15</div><div>16</div></div><div><div>3</div><div>17</div><div>18</div><div>19</div></div></div>	<div>integer [][]: aa</div> <div><div><div>1</div><div>2</div><div>3</div></div><div><div>1</div><div>21</div><div>22</div><div></div></div><div><div>2</div><div>23</div><div>24</div><div>25</div></div><div><div>3</div><div>26</div><div></div><div></div></div></div>
Data reference	Data 7 is referred to by a1[4]	Data 16 is referred to by a2[2,3]	Data 25 is referred to by aa[2][3]
Notation of array contents	{1, 3, 5, 7, 9}	{{11, 12, 13}, {14, 15, 16}, {17, 18, 19}}	{{21, 22}, {23, 24, 25}, {26}}

Note: The indexes of example arrays start at 1.

[undefined state]

`undefined` is a state in which no value is set to a variable (or an element of an array).
By setting `undefined` to a variable, the variable is transformed into `undefined` state.

Q1. From the answer group below, select the correct combination of answers to be inserted into

A

 through

C

 in the program.

A school determines the letter grade that a student will receive based on the score, which is an integer value between 0 and 100, as follows:

Score	Letter grade	Description
80 – 100	D	Pass with distinction
50 – 79	P	Pass
0 – 49	F	Fail

The function grade receives a score (non-negative integer value between 0 and 100) and returns the letter grade as a character.

[Program]

```

O character: grade(integer: score)
  character: ret
  if (score 

|   |
|---|
| A |
|---|

 80)
    ret ← "D"
  elseif (score 

|   |
|---|
| A |
|---|

 50)
    ret ← 

|   |
|---|
| B |
|---|


  else
    ret ← 

|   |
|---|
| C |
|---|


  endif
  return ret

```

Answer group

	A	B	C
a)	=	"P"	"F"
b)	=	"F"	"P"
c)	>	"P"	"F"
d)	>	"F"	"P"
e)	≥	"P"	"F"
f)	≥	"F"	"P"

Q2. From the answer group below, select the correct answer to be inserted into in the program.

A bus company operates buses between two cities. The standard ticket price is 20 US dollars and the discount ticket price for passenger aged 10 and under or aged 60 and over is 10 US dollars. Additionally, registered members of all ages always get the ticket at the discount price.

The function `ticketPrice` receives the arguments `age` (a non-negative integer value) and `isMember` (a boolean indicating that the passenger is a member if the value is true), which returns the value `ret` as the ticket price (in US dollars).

[Program]

```
O integer: ticketPrice(integer: age, boolean: isMember)
  integer: ret
  if ()
    ret ← 10
  else
    ret ← 20
  endif
  return ret
```

Answer group

- a) $((age \leq 10) \text{ and } (age \geq 60)) \text{ and } isMember$
- b) $((age \leq 10) \text{ and } (age \geq 60)) \text{ or } isMember$
- c) $((age \leq 10) \text{ or } (age \geq 60)) \text{ and } isMember$
- d) $((age \leq 10) \text{ or } (age \geq 60)) \text{ or } isMember$

Q3. From the answer group below, select the correct answer to be inserted into in the program.

The program outputs the even numbers between 1 and 100. Subsequently, it prints the sum of those even numbers. Note that division is performed for data type integer, that is, $a \div b$ is the quotient of a divided by b .

[Program]

```
integer: i
integer: sum ← 0

for(increase i from 1 to 100 by 1)
  if()
    output i
    sum ← sum + i
  endif
endfor
output sum
```

Answer group

- | | |
|--------------------|-----------------------|
| a) $i \div 2 = 0$ | b) $i \div 2 \neq 0$ |
| c) $i \bmod 2 = 0$ | d) $i \bmod 2 \neq 0$ |
| e) $i = 2$ | f) $i \neq 2$ |

Q4. From the answer group below, select the correct combination of answers to be inserted into

A

 and

B

 in the program.

The function `sumDigits` receives a non-negative integer value `num` as argument, and returns the sum of the digits of `num`.

[Program]

```

O integer: sumDigits(integer: num)
  integer: sum ← 0
  while (num > 0)
    sum ← 

|   |
|---|
| A |
|---|


    num ← 

|   |
|---|
| B |
|---|


  endwhile
  return sum

```

Answer group

	A	B
a)	$\text{sum} + \text{num} \bmod 10$	$\text{num} \bmod 10$
b)	$\text{sum} + \text{num} \bmod 10$	integer part of $(\text{num} \div 10)$
c)	$\text{sum} \times 10 + \text{num} \bmod 10$	$\text{num} \bmod 10$
d)	$\text{sum} \times 10 + \text{num} \bmod 10$	integer part of $(\text{num} \div 10)$
e)	$\text{sum} + \text{integer part of } (\text{num} \div 10)$	$\text{num} \bmod 10$
f)	$\text{sum} + \text{integer part of } (\text{num} \div 10)$	integer part of $(\text{num} \div 10)$
g)	$\text{sum} \times 10 + \text{integer part of } (\text{num} \div 10)$	$\text{num} \bmod 10$
h)	$\text{sum} \times 10 + \text{integer part of } (\text{num} \div 10)$	integer part of $(\text{num} \div 10)$

Q5. From the answer group below, select the correct combination of answers to be inserted into A and B in the program.

The function `division` receives two integer values `a` and `b` and returns the quotient of `a` divided by `b`. The function `modulus` receives two integer values `a` and `b` and returns the remainder of `a` divided by `b`. The procedure `convert` receives the value of seconds as the input argument and outputs that value in the form of hours, minutes, and seconds. For example, when the procedure `convert` is called as `convert(5450)` the output is “1, 30, 50”. Here, suppose that the range of input values satisfy $0 \leq \text{input} < 86400$.

[Program]

```

○ convert(integer: input)
  integer: hour, minute, second
  second ← modulus(input, 60)
  minute ← A
  hour ← B
  output hour, minute, second

○ integer: division(integer: a, integer: b)
  integer: u
  u ← integer part of (a ÷ b)
  return u

○ integer: modulus(integer: a, integer: b)
  integer: u
  u ← a mod b
  return u

```

Answer group

	A	B
a)	<code>division(modulus(input, 60), 60)</code>	<code>division(input, 3600)</code>
b)	<code>division(modulus(input, 60), 60)</code>	<code>division(modulus(input, 60), 60)</code>
c)	<code>division(modulus(input, 60), 60)</code>	<code>modulus(division(input, 60), 60)</code>
d)	<code>modulus(division(input, 60), 60)</code>	<code>division(input, 3600)</code>
e)	<code>modulus(division(input, 60), 60)</code>	<code>division(modulus(input, 60), 60)</code>
f)	<code>modulus(division(input, 60), 60)</code>	<code>modulus(division(input, 60), 60)</code>

Q6. From the answer group below, select the correct answer to be inserted into in the program.

The function `count1` receives the `bit8` type (8-bit type) argument `byte`, and returns the number of bits 1 in the argument. For example, when the function `count1` is called as `count1(11001011)`, the return value is 5.

Here, operator `&` represents a bitwise logical product, operator `|` represents a bitwise logical sum; operator `>>` represents a logical shift to the right, and operator `<<` represents a logical shift to the left. For example, `v << n` performs a logical shift of the value of `v` by `n` bits to the left.

[Program]

```
integer: count1(bit8: byte)
  bit8: rbyte ← byte
  integer: r ← 0
  integer: i
  for (increase i from 1 to 8 by 1)
    if (() ≠ 00000000)
      r ← r + 1
    endif
  endfor
  return r
```

Answer group

- a) `rbyte & (00000001 << (i - 1))`
- b) `rbyte & (00000001 << i)`
- c) `rbyte & (00000001 << (i + 1))`
- d) `rbyte | (00000001 << (i - 1))`
- e) `rbyte | (00000001 << i)`
- f) `rbyte | (00000001 << (i + 1))`

Q7. From the answer group below, select the correct combination of answers to be inserted into and in the program.

The Fibonacci sequence is a sequence in which each number is equal to the sum of the two preceding numbers. In this question, the sequence starts with 0 and 1. The first 10 values in the sequence are 0, 1, 1, 2, 3, 5, 8, 13, 21, 34. For example, the 8-th number 13 is the sum of the two preceding numbers 5 and 8.

The function `fibonacci` takes an integer value `n` as the argument and returns the value at the `n`-th position. Here, `n` reflects the position of the number in the sequence, starting with 1 (one). When `n` is 9, the function returns 21.

[Program]

```

integer: fibonacci(integer: n)
  if ()
    return n - 1
  else
    return 
  endif

```

Answer group

	A	B
a)	<code>n = 1</code>	<code>fibonacci(n-1) + 1</code>
b)	<code>n = 1</code>	<code>fibonacci(n-1) + n</code>
c)	<code>n = 1</code>	<code>fibonacci(n-1) + fibonacci(n-2)</code>
d)	<code>n > 1</code>	<code>fibonacci(n-1) + 1</code>
e)	<code>n > 1</code>	<code>fibonacci(n-1) + n</code>
f)	<code>n > 1</code>	<code>fibonacci(n-1) + fibonacci(n-2)</code>
g)	<code>(n = 1) or (n = 2)</code>	<code>fibonacci(n-1) + 1</code>
h)	<code>(n = 1) or (n = 2)</code>	<code>fibonacci(n-1) + n</code>
i)	<code>(n = 1) or (n = 2)</code>	<code>fibonacci(n-1) + fibonacci(n-2)</code>

Q8. From the answer group below, select the correct combination of answers to be inserted into through in the program. Here, the array index starts at 1.

The program implements a stack. The stack implementation only accepts positive integers. The function `empty` checks whether the stack is empty. The function `full` checks whether the stack is full. If the stack is not full, the function `push` pushes an element with a specified value onto the stack. If the stack is not empty, the function `pop` removes an element from the stack and returns its value. In the program, areas outside of the array must not be referenced.

[Program]

```
global: integer [: content
        ← {undefined, undefined, undefined, undefined}
global: integer: index ← 1
global: integer: max ← 4 /* max size of the stack */
```

```
○ boolean: empty()
  if (index = 1)
    return true
  else
    return false
  endif
```

```
○ boolean: full()
  if ()
    return true
  else
    return false
  endif
```

```
○ boolean: push(integer: i)
  if (not full())
    content[index] ← i
    index ← 
    return true
  else
    return false
  endif
```

```
○ integer: pop()
  if (not empty())
    index ← 
    return content[index]
```

```

else
    return -1
endif

```

Answer group

	A	B	C
a)	$\text{index} > \text{max}$	$\text{index} - 1$	$\text{index} + 1$
b)	$\text{index} > \text{max}$	$\text{index} + 1$	$\text{index} - 1$
c)	$\text{index} \geq \text{max}$	$\text{index} - 1$	$\text{index} + 1$
d)	$\text{index} \geq \text{max}$	$\text{index} + 1$	$\text{index} - 1$
e)	$\text{index} < \text{max}$	$\text{index} - 1$	$\text{index} + 1$
f)	$\text{index} < \text{max}$	$\text{index} + 1$	$\text{index} - 1$
g)	$\text{index} \leq \text{max}$	$\text{index} - 1$	$\text{index} + 1$
h)	$\text{index} \leq \text{max}$	$\text{index} + 1$	$\text{index} - 1$

- Q9.** From the answer group below, select the correct combination of answers to be inserted into A through C in the program. Here, the array index starts at 1.

The procedure preorder traverses a binary tree and outputs the value of each node by following the sequence: root, left subtree, and right subtree using a stack (Last In, First Out). Each node of the binary tree is represented by the class Node. The table shows the description of the class Node. The Node-type variable holds a reference to an instance of the class Node. The argument root holds a reference to the root of the binary tree, which is an instance of the class Node. In the program, areas outside of the array must not be referenced.

Table Class Node

Member variable	Type	Description
info	character	Character type value to be stored in a node of a binary tree.
left	Node	A reference to the left child of a binary tree. If there is no left child, the status is undefined
right	Node	A reference to the right child of a binary tree. If there is no right child, the status is undefined

[Program]

```

○ preorder(Node: root)
  Node []: stack ← {undefined, ..., undefined}
                    // an array with sufficient number of elements

  Node: v
  integer: sp ← 1 // The stack pointer
  stack[sp] ← root // Push root to the stack
  while (sp is not A)
    v ← stack[sp] // Pop an element from the stack
    output v.info
    sp ← sp - 1
    if (B is not undefined)
      sp ← sp + 1
      stack[sp] ← B
    endif
    if (C is not undefined)
      sp ← sp + 1
      stack[sp] ← C
    endif
  endwhile

```

Answer group

	A	B	C
a)	0	v.left	v.right
b)	0	v.right	v.left
c)	-1	v.left	v.right
d)	-1	v.right	v.left

Q10. From the answer group below, select the correct combination of answers to be inserted into

A

 and

B

 in the program.

The procedure Insert inserts an integer number given by the argument after the last element of the linear circular linked list. Each element of the linear circular linked list is represented by the class ListElement. The figure shows the description of the class ListElement. The ListElement-type variable holds a reference to an instance of the class ListElement. The global variable listHead holds a reference to the head element of the linear circular linked list. Remember that in the circular linked list the last element points to the listHead. Here, if the list is empty, listHead is set to undefined.

Member variable	Type	Description
val	integer	The value of an element.
next	ListElement	Reference to the instance that holds the next element in the list.

Constructor	Description
ListElement(integer: newItem)	Initialize the member variable val with the argument newItem.

Figure Class ListElement

[Program]

```
global: ListElement: listHead ← undefined
```

```

O Insert(integer: newItem)
  ListElement: tmp, newNode
  newNode ← ListElement(newItem)
  if (listHead is undefined)
    listHead ← newNode
    listHead.next ← listHead
  else
    tmp ← listHead
    while (tmp.next is not 

|   |
|---|
| A |
|---|

)
      tmp ← 

|   |
|---|
| B |
|---|


    endwhile
    tmp.next ← newNode
    newNode.next ← listHead
  endif

```

Answer group

	A	B
a)	newNode	listHead.next
b)	listHead	tmp.next
c)	tmp	listHead
d)	listHead	newNode.next

Q11. From the answer group below, select the correct combination of answers to be inserted into through in the program. Here, the array index starts at 1.

The program sorts the data in ascending order using the selection sort algorithm. The algorithm repeatedly selects the smallest element from the unsorted portion of the array and swaps it with the first element of the unsorted portion until the entire array is sorted.

[Program]

```
integer [: data ← {12, 11, 13, 5, 6}
integer: i, j, temp, minPos
integer: size ← the number of elements in data
for (increase i from 1 to (size - 1) by 1)
  minPos ← i
  for (increase j from  to size by 1)
    if (data[j]  data[minPos])
      minPos ← j
    endif
  endfor
  temp ← 
   ← data[minPos]
  data[minPos] ← temp
endfor
```

Answer group

	A	B	C
a)	1	<	data[i]
b)	1	<	data[i + 1]
c)	1	>	data[i]
d)	1	>	data[i + 1]
e)	i + 1	<	data[i]
f)	i + 1	<	data[i + 1]
g)	i + 1	>	data[i]
h)	i + 1	>	data[i + 1]

Q12. From the answer group below, select the correct answer to be inserted into in the program.

A string of character(s) is called a palindrome if it reads the same forwards and backwards. Here the input string consists of only the uppercase Roman alphabet. As an example, the string "MADAM" is a palindrome as it remains the same when written backwards (right to left). The procedure `isPalindrome` receives a string `str` as a parameter and outputs whether the string `str` is a palindrome or not. The procedure should use the minimum number of iterations for any number of characters in the string. Note that division is performed for data type integer, that is, $a \div b$ is the quotient of a divided by b .

[Program]

```
OisPalindrome(string: str)
  integer: i, j, len
  boolean: flag
  flag  $\leftarrow$  true
  len  $\leftarrow$  number of characters in str
  i  $\leftarrow$  1
  j  $\leftarrow$  len
  while ()
    if (the i-th character of string str  $\neq$  the j-th character of string str)
      flag  $\leftarrow$  false
      exit the while block
    endif
    i  $\leftarrow$  i + 1
    j  $\leftarrow$  j - 1
  endwhile
  if (flag)
    output str, " is a palindrome."
  else
    output str, " is not a palindrome."
  endif
```

Answer group

- a) $i < j - 1$
- b) $i < (\text{len} \div 2) + 1$
- c) $i < (\text{len} \div 2) - 1$
- d) $i < \text{len} \div j$
- e) $i < j \div 2$

Q13. From the answer group below, select the correct combination of answers to be inserted into

A

 through

C

 in the program. Here, the array index starts at 1.

The function `are_brackets_balanced` checks for balanced brackets. It parses the given array of characters and when an opening bracket ("`(`", "`[`", "`{`") is encountered, this is pushed onto the stack. When a closing bracket ("`)`", "`]`", "`}`") is encountered, an element is popped from the stack and tested if it corresponds to the opening bracket. If the closing bracket matches its corresponding opening bracket, the process continues. Otherwise, it fails and the function returns `false`. After all characters have been processed, it returns `false` if any characters remain on the stack, otherwise it returns `true`. For simplicity, only brackets are considered as arguments to the function. The table shows examples of arguments provided to `are_brackets_balanced` and the return values.

Table Examples of arguments provided to the function
`are_brackets_balanced` and the return values

Function call	Return value
<code>are_brackets_balanced({"(", "{", "}", ")", "[", "]"})</code>	<code>true</code>
<code>are_brackets_balanced({"(", "{", "}", "[", "]"})</code>	<code>false</code>
<code>are_brackets_balanced({"(", "{", ")", "}", "[", "]"})</code>	<code>false</code>

The function `are_brackets_balanced` uses class `Stack`. The figure describes class `Stack`.

Constructor	Description
<code>Stack()</code>	Initialize a stack.

Method	Return value	Description
<code>push(character: arg)</code>	<code>None</code>	Pushes <code>arg</code> onto the stack.
<code>pop()</code>	<code>character</code>	Returns the value popped from the stack.
<code>isEmpty()</code>	<code>boolean</code>	Returns <code>true</code> if the stack is empty.

Figure Class `Stack`

[Program]

```
global: character [][]: brackets ← {
    {"(", ")"},
    {"{", "}"},
    {"[", "]" }
}
```

```

○ boolean: are_brackets_balanced(character[]: expr)
  Stack: stack ← Stack()
  character: c, stacked_bracket

  for (c in expr)
    if (is_opening_bracket(c))
      stack.push(c)
    else
      if (stack.isEmpty())
        return false
      endif
      stacked_bracket ← stack.pop()
      if (get_closing_bracket(stacked_bracket) A)
        return false
      endif
    endif
  endfor
  return B

```

```

○ boolean: is_opening_bracket(character: c)
  character []: chars
  for (chars in brackets)
    if (chars[1] = c)
      return true
    endif
  endfor
  return false

```

```

○ character: get_closing_bracket(character: c)
  character []: chars
  for (chars in brackets)
    if (chars[1] = c)
      return C
    endif
  endfor
  return undefined

```

Answer group

	A	B	C
a)	= c	not stack.isEmpty()	chars[1]
b)	= c	not stack.isEmpty()	chars[2]
c)	= c	stack.isEmpty()	chars[1]
d)	= c	stack.isEmpty()	chars[2]
e)	≠ c	not stack.isEmpty()	chars[1]
f)	≠ c	not stack.isEmpty()	chars[2]
g)	≠ c	stack.isEmpty()	chars[1]
h)	≠ c	stack.isEmpty()	chars[2]

Q14. From the answer group below, select the correct answer to be inserted into in the description. Here, the array indexes start at 1.

The function `calcSim` takes two vectors (arrays) as input, calculates their similarity, and returns a value that characterizes the similarity. A large similarity indicates that the vectors are similar, and a small similarity indicates that the vectors are dissimilar. For example, to quantify the similarity between two documents, you can create a vector of occurrences of some words for each of the two documents and input them into `calcSim`. When the function `calcSim({2, 2, 1, 0, 4}, {3, 1, 1, 1, 2})` is called, the return value rounded to the first decimal place is .

[Program]

```
// Assume that arrays v1 and v2 have the same number of one or more elements
// and that the arrays are not all-zero.
O real: calcSim(integer []: v1, integer []: v2)
  integer: i, x, y
  integer: sxx ← 0
  integer: syy ← 0
  integer: sxy ← 0
  for (increase i from 1 to the number of elements in v1 by 1)
    x ← v1[i]
    y ← v2[i]
    sxx ← sxx + x × x
    syy ← syy + y × y
    sxy ← sxy + x × y
  endfor
  return sxy ÷ (square root of (sxx × syy))
```

Answer group

- | | | | |
|--------|--------|--------|--------|
| a) 0.1 | b) 0.2 | c) 0.3 | d) 0.4 |
| e) 0.5 | f) 0.6 | g) 0.7 | h) 0.8 |
| i) 0.9 | j) 1.0 | | |

Q15. From the answer group below, select the correct combination of answers to be inserted into and in the program. Here, the array index starts at 1.

N-grams are continuous sequences of words, symbols, or tokens in a document. N-grams of texts are extensively used in text mining and natural language processing tasks. An n-gram model is built by counting how often word sequences occur in corpus text and then estimating the probabilities. The figure shows an example of the unigrams, bigrams, and trigrams of the example sentence “**ITPEC includes members from 6 countries.**”

unigram	ITPEC	includes	members	from	6	countries
bigram	ITPEC includes	includes members	members from	from 6	6 countries	
trigram	ITPEC includes members	includes members from	members from 6	from 6 countries		

Figure Example of unigrams, bigrams, and trigrams

The procedure NGRAMS generates n-grams from text and outputs them. If the argument for n is 1, the procedure outputs the unigram result. If n is 2, the procedure outputs the bigram result and so on. The input text is a string of words separated by a space, so it is needed to split the string to generate n-grams. The table shows the description of the functions used in the program. In this question, the operator “+” is used for both arithmetic calculation of integer data type and concatenation of one or more strings into one string. In the program, areas outside of the array must not be referenced.

Table Functions

Function	Return value	Description
split(string: str)	string []	Returns the words that are separated with a space in the text str

[Program]

```

O NGRAMS(integer: n, string: text)
  string []: words ← split(text)
  string: s
  integer: i, j, length
  length ← the number of elements in words
  for (increase i from 1 to () by 1)
    s ← ""
    for (increase j from i to () by 1)
      s ← s + words[j] + " "
    endfor

```

```
    output s
endfor
```

Answer group

	A	B
a)	length	n
b)	length	i + n
c)	length	i + n - 1
d)	length - n	n
e)	length - n	i + n
f)	length - n	i + n - 1
g)	length - n + 1	n
h)	length - n + 1	i + n
i)	length - n + 1	i + n - 1

Q16. From the answer group below, select the correct combination of answers to be inserted into A and B in the program.

The function `m_sin` calculates and returns the approximate value of $\sin(x)$ for the argument x using the Maclaurin expansion. The program calculates $\sin(x)$ using the approximate formula below:

$$\sin(x) = x/1! - x^3/3! + x^5/5! - \dots + (-1)^n \times (x^{(2n+1)}/(2n+1)!)$$

Here, $!$ is the factorial symbol, and n is the first integer for which $|x^{(2n+1)} / (2n+1)!| \leq 10^{-7}$ is satisfied.

[Program]

```

O real: m_sin(real: x)
  real: vn ← x
  real: k ← 1
  real: sum ← vn
  real: epsi ← 1×10-7
  while (abs(vn) A) // abs(vn) returns the absolute value of vn
    k ← k + 2
    vn ← B
    sum ← sum + vn
  endwhile
  return sum

```

Answer group

	A	B
a)	$\leq \text{epsi}$	$- \text{vn} \times x \div k$
b)	$\leq \text{epsi}$	$- \text{vn} \times x^2 \div k^2$
c)	$\leq \text{epsi}$	$- \text{vn} \times x^2 \div ((k - 1) \times k)$
d)	$\leq \text{epsi}$	$- \text{vn} \times x^k \div k^2$
e)	$\leq \text{epsi}$	$- \text{vn} \times x^k \div ((k - 1) \times k)$
f)	$> \text{epsi}$	$- \text{vn} \times x \div k$
g)	$> \text{epsi}$	$- \text{vn} \times x^2 \div k^2$
h)	$> \text{epsi}$	$- \text{vn} \times x^2 \div ((k - 1) \times k)$
i)	$> \text{epsi}$	$- \text{vn} \times x^k \div k^2$
j)	$> \text{epsi}$	$- \text{vn} \times x^k \div ((k - 1) \times k)$

Q17. From the answer group below, select the correct combination of answers to be inserted into and in the description.

An information systems company S has a guideline related to any issue for workers doing their daily job. The company has an information security team responsible for related issues and updates workers' knowledge on information security.

One morning, a company worker who had just started his daily job and successfully signed into the company's enterprise system received the following email:

From: Administration Department Staff
To: To whom it may concern
Subject: Action Required: Please update your bank account information.

This email has been sent to employees who failed to receive their paychecks because their bank account information is incorrect. Please use the link below to update your account information ASAP. Please complete the update by noon today to receive your next paycheck in time.

Link: <https://www.example.com/company-s/paycheck¶m=xnt6a5mv9YeKK1>

Soon, the worker realized that something wrong. He followed the guideline instead of clicking on the link in the email because he suspected this is a attack, and it is typically conducted through . He also informed the company's information security team to deal with the issue.

A few days later, the worker received an email from the information security team leader. The email was to notify that the issue was resolved, thanking the worker for his responsibility in handling the case according to the guideline.

Answer group

	A	B
a)	man in the middle	email with incorrect digital signatures
b)	man in the middle	links with malicious HTTP request parameters
c)	phishing	email directing someone to a spoofed web site
d)	phishing	email with incorrect digital signatures
e)	SQL injection	email directing someone to a spoofed web site
f)	SQL injection	links with malicious HTTP request parameters

Q18. From the answer group below, select the most appropriate combination of answers to be inserted into through in Table 1.

Company X is a small trading company. The company is about to provide a new e-commerce web site for customers to make purchases online. The company will also hosts its own email service for the employees to conduct business with partners and customers. Company X will utilize public key infrastructure (PKI) to provide security for both the web server and email service. PKI uses public key cryptography to manage the identity of servers or persons and is widely used on the Internet.

Mr. T, the IT support person of company X is assigned to prepare the web server and email service in accordance with the following requirements:

- The e-commerce web application will run on the web server that is certified by a third-party certification authority. All connections to the web server will be secured using HTTPS.
- The staff directory along with the contact information will be published on the web site to enable business partners and customers to use the information to securely communicate with employees of company X.

The actions taken by Mr. T are shown in Table 1.

Table 1 Actions taken by Mr. T

No	Action
1	To enable secure and trusted connections to the web server, Mr. T submits the web server certificate along with the <input type="text" value="A"/> to the third-party certification authority. The certification authority signs the certificate with its own private key. Then, he installs the signed certificate on company X's web server.
2	To allow business partners and customers to send encrypted email messages to particular contacts in company X, Mr. T publishes the <input type="text" value="B"/> along with the employee's information in the staff directory on company X's web site.
3	To send digitally signed email messages to partners and customers, the employees of company X are required to install the <input type="text" value="C"/> on their email clients. Therefore, Mr. T provides support to the employees who require assistance.

Answer group

	A	B	C
a)	web server's private key	Employees' private key	customers' private key
b)	web server's private key	Employees' private key	customers' public key
c)	web server's private key	employees' private key	employee's public key
d)	web server's public key	employees' public key	customers' private key
e)	web server's public key	employees' public key	customers' public key
f)	web server's public key	employees' public key	employee's private key

Q19. From the answer group below, select the most appropriate combination of answers to be inserted into and in the following description.

Company Y is an online retailer providing e-commerce web applications for customers to make purchases online and also allows customers to post product reviews. The web application was developed and maintained in-house. The properties of the e-commerce web application are shown in Figure 1.

- The web application resides on the web server in the demilitarized zone (DMZ), and the database used by the web application resides on the database server in the internal network.
- The firewall is properly configured, the customers can only access the web server in the DMZ, and the database can only be accessed from the web server.
- The web server allows access only through the HTTPS service, and the certificate is properly configured.
- The customers can login using their registered email address and password.
- The password is hashed and stored on the database.
- The customer is locked out and notified by email with a recovery link if there are 5 consecutive incorrect login attempts.
- Third-party payment gateways are used to perform financial transactions. The credit card information of customers is not stored in the database.
- There is a password recovery system which allows the customer to reset the password through a password recovery link sent to the registered email address.

Figure 1 Properties of the e-commerce web application

Due to recent incidents with multiple customers reporting that their accounts were compromised, the management tasked the IT team to investigate and address the issues. The IT team found that many customer accounts logins were unnoticed by the actual account owners, and some of the accounts were used to post fake reviews. The IT team also discovered unauthorized access to the database with illegal queries executed with no trace of administration login.

The IT team concluded that the incidents are most likely caused by using the same password on other leaked sites and . They proposed to implement 2-factor authentication and to mitigate respective issues in the future. The management then agreed to the plan, and the solutions was implemented accordingly.

Answer group

	A	B
a)	connection tapping	database encryption
b)	connection tapping	web application firewall
c)	online brute force attacks	CAPTCHA
d)	online brute force attacks	more complex password policy
e)	SQL injection	database encryption
f)	SQL injection	web application firewall

Q20. From the answer group below, select the correct combination of answers to be inserted into through in the description.

A **zone** is a group of interfaces that have similar functions or features. Zones establish the security borders of a network. A zone defines a boundary where traffic is subjected to policy restrictions when crossing into another region of a network. An inspection policy is applied to traffic moving between zones. Inter-zone policies offer considerable flexibility. Hence, different inspection policies can be applied to multiple host groups connected to the same router interface.

Company Z, intends to apply a zone-based policy firewall in their datacenter. Thus, they develop the network topology shown in Figure 1.

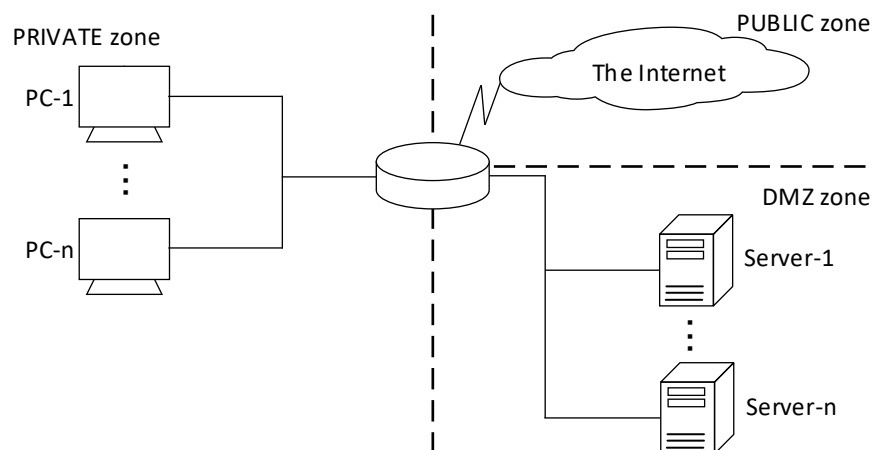


Figure 1 Network topology

These zones have the following characteristics:

- The **DMZ** zone represents a zone where servers accessed from the Internet are located. Even if a server in the DMZ zone is breached, direct access to the internal PCs of the datacenter is prevented.
- The **PUBLIC** zone represents the entire network outside the datacenter.
- The **PRIVATE** zone represents the internal network. All datacenter PCs are located in this zone.

The security policy for the datacenter should be:

- Hosts in the zone cannot connect to hosts in the zone.

- Hosts in the zone can only access the DNS service on all hosts in the zone and HTTP/HTTPS service on limited hosts in the zone to retrieve software updates.
- Hosts in the zone can connect to hosts in the zone on all TCP, UDP and ICMP services.
- Hosts in the zone can reach the zone but not vice versa.
- Hosts in the zone can reach HTTPS service on hosts in the zone. This policy will restrict access to other services available on each server.

Answer group

	A	B	C
a)	DMZ	PUBLIC	PRIVATE
b)	DMZ	PRIVATE	PUBLIC
c)	PRIVATE	DMZ	PUBLIC
d)	PRIVATE	PUBLIC	DMZ
e)	PUBLIC	DMZ	PRIVATE
f)	PUBLIC	PRIVATE	DMZ

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