

WYSE – Academic Challenge
Computer Science Test (Regional) – 2016

1. **Correct Answer: D**

Answer A relates to encapsulation.
Answer B relates to abstraction.
Answer C relates to polymorphism.
All four concepts make up the principals of Object Oriented Programming.

2. **Correct Answer: C**

Collections or templates allow the same code to work with multiple types of data. It is important that if the code uses certain types of operators (such as > for comparisons when sorting), that the operator be overloaded for the object in question. Both provide examples of polymorphism. Algorithmic symmetry is a term that was created for this question. The principal of least privilege is often used in functions or classes to indicate that the code in question does not alter a given variable or object. This can make it easier to debug code later. Abstraction, which is one of the principals of OOP is not listed. The author of the exam would argue that the STL provides a more direct relationship with polymorphism, however it could also be argued that the details of how the STL or Collection Container do their work are hidden to the user, which is an example of abstraction. However, abstraction is not one of the possible answers.

3. **Correct Answer: B**

. or the dot operator is used to access the public elements of a class. In order to observe the principal of encapsulation, data elements should only be accessed with get or set methods, unless the data element is a constant and cannot change. If the element is a pointer to an object and not an object itself, it may use the → operator. The *, + or && operators may be used with the data returned by the methods from the class or within the class itself, but they cannot be used to access the items within the class.

4. **Correct Answer: E**

Break the number up into numbers that are powers of two. Other methods exist for converting numbers from decimal to binary. Using modulo division and integer division is also a very popular method.

$$\begin{aligned} 111 &= 64 + 32 + 8 + 4 + 2 + 1 \\ &= 0*2^7 + 1*2^6 + 1*2^5 + 0*2^4 + 1*2^3 + 1*2^2 + 1*2^1 + 1*2^0 \\ &= 1101111 \text{ (in binary)} \end{aligned}$$

5. **Correct Answer: D**

The functions are given below in the truth table.

A	B	C	A'B'	BC	BC'	B'	B' or BC
F	F	F	T	F	F	T	T
F	F	T	T	F	F	T	T
F	T	F	F	F	T	F	F
F	T	T	F	T	F	F	T
T	F	F	F	F	F	T	T
T	F	T	F	F	F	T	T
T	T	F	F	F	T	F	F
T	T	T	F	T	F	F	T

6. **Correct Answer: B**

The logic gates are as follows in this order: NOT, OR, NAND (not and), XOR (exclusive or), and AND.

The NOT is the only one that accepts just one input, the XOR requires two and the rest two or more inputs.

7. **Correct Answer: A**

In order to convert hexadecimal into binary, it should be noted that each set of four binary digits is equivalent to one hexadecimal digit. So, rewriting the number with those groupings in mind, the result may be obtained fairly quickly.

101	1101	0101
5	D	5

8. **Correct Answer: E**

First, the list must be sorted to use a binary search. If there are 10 elements, the element being searched for may be the first one checked, so it may take as few as 1 comparison to identify the element. However, it may take as many as 4 comparisons to either find or determine that the element in question is not in the list.

Example: Use the list, 1 2 3 5 6 7 10 11 12 20 and search for 10

1 2 3 5 6 7 10 11 12 20	// check 6, eliminating bottom half of list, 1 comparison
1 2 3 5 6 7 10 11 12 20	// check 11, eliminate top half of list, 2 comparisons
1 2 3 5 6 7 10 11 12 20	// check 7, 3 comparisons
1 2 3 5 6 7 10 11 12 20	// verify that the last element is 10, 4 comparisons

9. Correct Answer: B

A tree can add elements to many parts of the structure at any given time.

The Stack is a last in-first out structure.

The queue is a first in-first out (FIFO) structure.

A linked list may be used to implement a stack or queue, but it can add elements at various points of the list at any given time.

A hash is an associative array that uses the data itself to calculate the position of the data element in the list. The order in which items are entered and removed is not dependent upon the position in the hash.

10. Correct Answer: E

At 12 elements, the first requires $12^3 + 2$ (1730) and the second $12^3 + 1$ (1729), but at 13 it is $12 \cdot 13 \cdot 13 + 2$ (2030) compared to $13 \cdot 13 \cdot 13 + 1$ (2198). So for very small numbers of elements, the second is more efficient, but for values of 13 or larger, the first is better. Note that while a calculator was not allowed on the exam, the comparisons are fairly straightforward without one.

Clearly:

$$12^3 + 2 > 12^3 + 1$$

And then we need to determine:

$$12 \cdot 13 \cdot 13 + 2 <? 13 \cdot 13 \cdot 13 + 1$$

So start with

$$12 \cdot 13 \cdot 13 + 13 \cdot 13 = 13 \cdot 13 \cdot 13$$

add 1 to both sides

$$12 \cdot 13 \cdot 13 + 13 \cdot 13 + 1 = 13 \cdot 13 \cdot 13 + 1$$

Understand that $2 < 13 \cdot 13 + 1$

$$12 \cdot 13 \cdot 13 + 2 < 13 \cdot 13 \cdot 13 + 1$$

11. Correct Answer: A

There are 128 bits in an IPv6 address.

There are 32 bits in an IPv4 address.

IPv6 is being introduced to provide more IP addresses, as the world has effectively exhausted the supply of IPv4 addresses.

12. Correct Answer: B

The Domain Name System (DNS) converts host names into IP addresses.

DHCP will automatically configure the Internet Protocol (IP) address and other TCP/IP settings on network computers.

One function of Microsoft's Active Directory is to provide a directory service that contains domains.

13. Correct Answer: C

A substitution cipher substitutes all instances of one character with another. For example, the letter G could be substituted for all instances of the letter A, the letter S could be substituted for all instances of the letter c, and so on.

A polyalphabetic cipher is a type of substitution cypher. Instead of performing only one substitution (monoalphabetic), a polyalphabetic cypher will perform two or more substitutions. For example, the letter G could be substituted for all instances of the letter A. Once all substitutions have been made, a second round of substitutions would be performed.

Steganography is the process of hiding a message in another medium.

A running key cipher is a practical application of a substitution cipher applied to a real message that is usually many times longer than the encryption key.

One time pads are similar to a running key cipher, but with two important differences. When using a one-time pad, the key is as long as the message. Additionally, it is used only once and then destroyed.

14. Correct Answer: D

Biometrics refers to metrics related to human physical or behavioral characteristics.

Examples of physical biometrics are fingerprints, facial patterns, and iris scans.

Other ways to identify a user include something that they must know (passwords and answers to challenge questions) or something they must have in their possession (smart card).

A userid is used to identify a user, not to authenticate the user. A userid is frequently used in conjunction with some form of authentication.

15. Correct Answer: E

-> is the arrow operator that is used to access items within an object that a pointer points to.

% is the modulus operator that returns the remainder of integer division.

?: is the only ternary operator (using 3 operands) and functions as an if then else.

&& is the logical and.

^^ is not an operator. In some languages ^ is used to indicate exponentiation. In C++ and Java, the single ^ is used for bitwise or.

16. Correct Answer: E

The trace of the code follows below.

list contents	i	
0 0 0 0 0 0 0 0 0 0	0	everything is set to 0. {0} insures all elements in list are 0.
0 0 0 0 0 0 0 0 0 0	1	start of for
0 1 0 0 0 0 0 0 0 0	1	set list[1]
0 1 0 0 0 0 0 0 0 0	3	i+=2
0 1 0 9 0 0 0 0 0 0	3	set list[3]
0 1 0 9 0 0 0 0 0 0	5	i+=2
0 1 0 9 0 25 0 0 0 0	5	set list[5]
0 1 0 9 0 25 0 0 0 0	7	i+=2
0 1 0 9 0 25 0 49 0 0	7	set list[7]
0 1 0 9 0 25 0 49 0 0	9	i+=2
0 1 0 9 0 25 0 49 0 81	9	set list[9]
0 1 0 9 0 25 0 49 0 81	11	i+=2 for loop stops
// this is the position at line 4, continue trace		
0 1 0 9 0 25 0 49 0 81	0	i is reset to 0
0 1 0 9 0 25 0 49 0 81	1	with while pre-increment and then compare to 1
0 1 0 9 0 25 0 49 0 81	2	first display list[1] (1) and then post-increment to i to 2
0 1 0 9 0 25 0 49 0 81	3	with while pre-increment and then compare to 3
0 1 0 9 0 25 0 49 0 81	4	display list[3] (9) and then post-increment to i to 4
0 1 0 9 0 25 0 49 0 81	5	with while pre-increment and then compare to 5
0 1 0 9 0 25 0 49 0 81	6	display list[5] (25) and then post-increment to i to 6
0 1 0 9 0 25 0 49 0 81	7	with while pre-increment and then compare to 7
0 1 0 9 0 25 0 49 0 81	8	display list[7] (49) and then post-increment to i to 8
0 1 0 9 0 25 0 49 0 81	9	with while pre-increment and then compare to 9
0 1 0 9 0 25 0 49 0 81	10	display list[9] (81) and then post-increment to i to 10
0 1 0 9 0 25 0 49 0 81	11	with while pre-increment and then compare to 11 and stop
0 1 0 9 0 25 0 49 0 81	11	display i of 11

17. Correct Answer: C

Three are used:

- the assignment, =
- the comparison, >
- a second assignment, +=.

18. Correct Answer: A

See the trace above.

19. Correct Answer: E

The modulus operator will return the remainder of integer division. Zero is treated as false and non-zero data is treated as true. So, if $i\%j$ has a non-zero remainder, or is greater than zero, but not equal to zero, the if statement will be evaluated as true.

20. Correct Answer: C

The trace of the code is below:

i	j	sum	
?	?	0	
?	5	0	
1	5	0	if is true as $1\%5 = 1$, but $1/5$ is zero so sum does not increase
2	5	0	same as above
3	5	0	
4	5	0	
5	5	0	Now the statement is false
6	5	0	
6	5	1	Now $6\%5$ is 1 and $6/5$ which is 1 is added to sum
7	5	1	
7	5	2	$7\%5$ is 2 and then 1 is added to sum
8	5	2	
8	5	3	
9	5	3	
9	5	4	
10	5	4	for loop terminates and 4 is displayed for sum

21. Correct Answer: B

The loop will execute 9 times and terminate when i reaches 10. The loop will execute with the -2 as the divisor for the modulo division. The modulus will still return a positive remainder and the integer division will return negative values or zero if the dividend is not large enough.

22. Correct Answer: D

func1 raises a number (x) to a given power (n).

4^3 is equal to 64

The trace of the code follows:

Line # of code	x	n	xx	i	
1	4	3	---	---	x and n are initialized from the function call
3	4	3	1	---	xx declared and set to 1
4	4	3	1	1	i is declared and set to 1
5	4	3	4	1	xx is multiplied by itself
4	4	3	4	2	i is incremented
5	4	3	16	2	xx is multiplied by itself
4	4	3	16	3	i is incremented
5	4	3	64	3	xx is multiplied by itself
4	4	3	64	4	i is incremented and the for loop terminates
6	4	3	64	---	xx is returned to the caller

23. Correct Answer: B

The return value is determined on line 1 when the function is declared.

24. Correct Answer: C

See the code trace above.

25. Correct Answer: E

This function is a recursive version of func1. It also raises a number (x) to a given power (n).

The trace of the code follows:

Line # of code	Depth of recursion	x	n	
1	1	2	5	x and n are initialized from the function call
4	1	2	5	execute recursive call func2(2, 5-1)
1	2	2	4	x and n are initialized from the recursive call
4	2	2	4	execute recursive call func2(2, 4-1)
1	3	2	3	x and n are initialized from the recursive call
4	3	2	3	execute recursive call func2(2, 3-1)
1	4	2	2	x and n are initialized from the recursive call
4	4	2	2	execute recursive call func2(2, 2-1)
1	5	2	1	x and n are initialized from the recursive call
4	5	2	1	execute recursive call func2(2, 1-1)
1	6	2	0	x and n are initialized from the recursive call
6	6	2	0	reached the base case; return 1
4	5	2	1	return 2 * 1
4	4	2	2	return 2 * 2
4	3	2	3	return 2 * 4
4	2	2	4	return 2 * 8
4	1	2	5	return 2 * 16

26. Correct Answer: A

A recursive function normally has a base case and at least one recursive case. The recursive case is a call to itself, line 4 in this function. The base case ends the recursive calls and normally returns a trivial value. Line 6 is the base case for this function.

27. Correct Answer: A

See the code trace above

28. Correct Answer: B

func3 computes the average of the numbers in an array. x[] is the array and n is the number of items in the array.

x[] = {2.0, 3.0, 4.0, 5.0, 6.0}
n = 5

Line # of code	xx	i	x[i]	
8	0	---	---	xx is declared and initialized to 0
9	0	0	2	i is declared and initialized to 0
10	2	0	2	xx has x[i] added to it
9	2	1	3	i is incremented
10	5	1	3	xx has x[i] added to it
9	5	2	4	i is incremented
10	9	2	4	xx has x[i] added to it
9	9	3	5	i is incremented
10	14	3	5	xx has x[i] added to it
9	14	4	6	i is incremented
10	20	4	6	xx has x[i] added to it
9	20	5	---	i is incremented and for loop terminates
11	20	---	---	xx / n is returned (20/5)

29. Correct Answer: C

See trace above.

30. Correct Answer: D

If a call is made to a function before the function is declared, a function prototype must be coded. Line 1 is a function prototype for func3.