

WYSE – Academic Challenge
Computer Science Test Solutions (State) – 2017

1. Correct Answer: D

SOLUTION:

The constructor is called for every instance of a rectangle. Since there are 8 rectangles (given that the square IS-A rectangle), the constructor is called 8 times.

2. Correct Answer: A

SOLUTION:

Since the ++ operator is only declared for squares, it may not be used with a rectangle. The `getArea` and the `setWidth` are used appropriately. The use of `getWidth` with a square is a bit unconventional and for clarity the `getSide` would be a more appropriate choice, however since it is available to the square class, it may be used and will not cause an error.

3. Correct Answer: D

SOLUTION:

The issues illustrated in the last problem point to a possible confusion in that the `set` and `get` methods for `width` and `length` are available in the `square` class, when `square` has just one side that is the same. This could allow a user to make `length` different from `width` for a square. In order to fix this, those methods should not be available for `square` objects. Making the public items in `rectangle` private will make the `rectangle` class useless. To make the `width` and `length` private will not change the `set` methods and will possibly break other methods in the `square` class. Making the `setWidth` and `setLength` methods protected would fix things for the `square` class, but break them for instances of `rectangle`. Deriving `square` as a protected member of the `rectangle` class would allow `square` to access all of the protected and public items in `rectangle` and then overriding the `getArea` and `getPerimeter` in `square` gives the functionality of those methods back to `square` items.

4. Correct Answer: C

SOLUTION:

The derived `square` inherits the base `rectangle` class. Only `square` objects have access to the ++ polymorphic ++ operator, `rectangle` objects do not inherit the items from `square`. While `rectangle` objects will “correct” attempts to set negative values for the `width` and `length` to 5, the `square` will set them to 2. While `square` class objects cannot directly access any items that are private in `rectangle`, if there were any it would still inherit them. The `square` class would then have to access them through public or protected accessor methods. Because the `rectangle` has the `length` and `width` declared as protected, the `square` items may access them directly within the class.

5. Correct Answer: A

SOLUTION:

The operations appear below with the stack listed after each operation.

PUSH (Z) ;	Z
PUSH (X) ;	ZX
PUSH (M) ;	ZXM
PUSH (Q) ;	ZXMQ
POP () ;	ZXM
PUSH (POP ()) ;	ZXM
PUSH (A) ;	ZXMA
PUSH (B) ;	ZXMAB
POP () ;	ZXMA

6. Correct Answer: E

SOLUTION:

A depth first search continues along a path until it needs to backtrack. Depth first searches can be facilitated with a stack. A breadth first search searches all nodes with a direct connection first before moving away from the current node. The second search is a breadth first search. Breadth first searches can be facilitated with a queue.

7. Correct Answer: B

SOLUTION:

A spanning tree for a graph connects all nodes without creating a loop. For this graph, the minimal spanning tree contains the 5 lowest cost edges. The degree of a node is the number of edges connected to it, which for B is 5, while F and A are the lowest degree edges at 2. The lowest cost path for A to C is 11, of which there are two. There are two paths of cost 10 from B to D with one being direct and another taking two hops.

8. Correct Answer: B

SOLUTION:

Trace the code below.

```
node *head, *n;           // declare new pointers
head = new node;          // create node
head->data = 2;            // put 2 in data part of new node
head->next = new node;     // create a new node
n = head->next;            // point n at the new node, head points to 2
n->data = 8;              // new data element is 8, list currently 2 8
n->next = NULL;           // Null next for new node
n->prev = new node;       // Tricky, make prev for n point to new node
n->prev->data = 4;         // make data element for new node 4
n->prev->prev = head;      // More tricky, new node's prev now points
                           // to head
n->prev->next = n          // new nodes next points to n (8)
head->next = n->prev;      // head's next points to node with 4
                           // list now 2 4 8
head->prev = n;           // head's previous points to end of list
```

9. Correct Answer: A

SOLUTION:

The first block of code will work properly. The second block is missing the { } around the code in the while loop which causes the reassignment of n to fall outside of the loop. This will result in an infinite loop if the list has any elements at all. The last block of code will miss the last element in the list. Also, while the last block of code would work for this list, if this code were to be used on a list that was empty (ie. head == NULL), an error would result as there would be no data element to point to on the first pass in the loop for the do/while. The for and while loops would not start if the head pointed to NULL.

10. Correct Answer: C

SOLUTION:

(AC)' OR (A XOR B)

(T and C)' OR (T XOR F) Insert values for A and B

C' OR T Evaluate the expressions

T Anything ORed with T is T

11. Correct Answer: D

SOLUTION:

All four of the answers are logically equivalent, however the answer d has less terms than the others, so it provides the minimal sum of products expression. Sum of products is used to describe solutions that have terms that are anded together that are then joined with a multi-input or gate. These expressions can be implemented with a two level nand gate structure. The map to the right illustrates the solution with the terms for BD bolded and the terms for B'C' italicized.

	C'D' 00	C'D 01	CD 11	CD' 10
A'B' 00	<i>1</i>	<i>1</i>	0	0
A'B 01	0	1	1	0
AB 11	0	1	1	0
AB' 10	<i>1</i>	<i>1</i>	0	0

12. Correct Answer: C

SOLUTION:

The largest 8 bit two's complement numbers is 127. The top bit carries with it a negative value. So the 8 bits would carry the values below for the two numbers

$$\begin{aligned}10111011 &= (-1)*2^7 + 0*2^6 + 1*2^5 + 1*2^4 + 1*2^3 + 0*2^2 + 1*2^1 + 1*2^0 \\&= -127 + 32 + 16 + 8 + 2 + 1 \\&= -69\end{aligned}$$

$$\begin{aligned}11111011 &= (-1)*2^7 + 1*2^6 + 1*2^5 + 1*2^4 + 1*2^3 + 0*2^2 + 1*2^1 + 1*2^0 \\&= -127 + 64 + 32 + 16 + 8 + 2 + 1 \\&= -5\end{aligned}$$

$$-69 - -5 = -64$$

Note that subtracting a negative from a negative or subtracting a positive from a positive will never result in overflow

13. Correct Answer: E

SOLUTION:

The largest biased value would be 11111111 which is 255 minus the bias of 127 which is 128. The smallest would be 00000000 which is zero minus 127 which is -127. -125 would be represented by 2 (00000010) minus 127. Zero would be 127 (01111111) – 127, not 00000000. A six bit biased number would have a bias of $2^5 - 1 = -31$.

14. Correct Answer: A

SOLUTION:

SQL injection is a type of script attack that malicious users can inject SQL commands into an SQL statement via web page input. Using a web page that asks for a userid as an example, the malicious user could input the following for the userid:

105 or 1=1

This input then would be added to a SQL statement such as this:

SELECT * FROM Users WHERE UserId = 105 or 1=1

This statement would then return all users from the Users table, as 1=1 will always be true.

15. Correct Answer: C

SOLUTION:

Virtualization software allows a single physical computer to act as two or more separate and independent computers. This allows data centers to make better use of their physical hardware as well as saving on electricity and HVAC. Examples of virtualization software include VirtualBox, VMware, and Hyper-V.

16. Correct Answer: B

SOLUTION:

The table below has the ranges for the first octet of IPv4 network addresses.

Class	1 st Octet Decimal Range
A	1 – 126
	127*
B	128 – 191
C	192 – 223
D	224 – 239
E	240 – 254

*Class A addresses beginning with 127 are not used for addressing. Those addresses are used for loopback and diagnostic functions.

17. Correct Answer: D

SOLUTION:

Sequence is when one statement follows another. There is no control statement used for this structure. Selection statements cause a program to selectively execute one or more statements. Examples of this structure are IF and CASE.

Repetition, or loop, statements cause a program to execute a group of statement from zero to many times. Examples of this structure are DO and FOR.

18. Correct Answer: B

SOLUTION:

The << operator in this case is the left bitwise shift operator. For signed and positive a, the value of

$a \ll b$

is

$a * 2^b$

The << operator is also used as the insertion operator in an output stream. An example of this usage is:

```
cout << a;
```

19. Correct Answer: E

SOLUTION:

The << operator used on line 3 will shift the bits in m i positions to the left. A trace of the code follows.

i	m before line 3 (decimal)	m before line 3 (binary)	m after line 3 (decimal)	m after line 3 (binary)
2	4	00000100	16	00010000
3	16	00010000	128	10000000

20. Correct Answer: B

SOLUTION:

By changing the for loop's iteration expression to $i+=2$, the for loop will only execute one time

i	m before line 3 (decimal)	m before line 3 (binary)	m after line 3 (decimal)	m after line 3 (binary)
2	4	00000100	16	00010000

21. Correct Answer: C

SOLUTION:

`myfunc1()` will be called when `i` is odd. The trace of the code follows.

i	i % 2	return value from my_func1	return value from my_func2	j
0	False	n/a	0	0
1	True	1	n/a	1
2	False	n/a	-4	-3
3	True	9	n/a	6

22. Correct Answer: C

SOLUTION:

See above trace.

23. Correct Answer: E

SOLUTION:

The trace of the code follows.

i	i % 2	return value from my_func1	return value from my_func2	j
0	False	n/a	0	0
1	True	1	n/a	1
2	False	n/a	-4	-3
3	True	9	n/a	6
4	False	n/a	8	-2
5	True	25	n/a	23

24. Correct Answer: E

SOLUTION:

When the switch condition evaluates to 2, control will be transferred to the case label on line 6, which has a constant expression of 2. As there is no break statement associated with this case label, control will fall through to the statement(s) associated with the next case label, and line 9 will then be executed.

When the switch condition evaluates to 3, control will be transferred to the case label on line 8, which has a constant expression of 3. Line 9 will then be executed.

25. Correct Answer: A

SOLUTION:

When the switch condition does not evaluate to an existing case label's constant expression, control will be transferred to the default case label, if it exists. When `n % 4` evaluates to 0, there is no case label with a constant expression equal to 0, therefore control is passed to the default case label and line 12 is then executed.

26. Correct Answer: E

SOLUTION:

The trace of the code follows.

i	tot before call to my_func	n % 4	case label(s) of code that is executed	return value from my_func	tot after call to my_func
0	0	0	default	0	0
1	0	1	1	2	2
2	2	2	2, 3	16	18
3	18	3	3	9	27
4	27	0	default	0	27
5	27	1	1	10	37

27. Correct Answer: D

SOLUTION:

The output would not change. A trace of the code follows.

i	tot before call to my_func	n % 4	case label(s) of code that is executed	return value from my_func	tot after call to my_func
0	0	0	0	0	0
1	0	1	1	2	2
2	2	2	2, 3	16	18
3	18	3	3	9	27
4	27	0	0	0	27
5	27	1	1	10	37

28. Correct Answer: B

SOLUTION:

The first call to `my_func1` will print every element in the array. Therefore the output is 4 8 12 16

29. Correct Answer: C

SOLUTION:

The second call to `my_func1` will print the first 3 elements in the array. However, the call to `my_func2` changed the value of the second element in the array (`a[1]`) to 4. Therefore, the output is 4 4 12

30. Correct Answer: D

SOLUTION:

Using `endl` in an output stream is functionally equivalent to putting a `\n` into the output sequence and then calling `cout.flush()`.