WYSE – Academic Challenge
Computer Science Test Solutions (Regional) – 2018

1. Correct Answer: D
SOLUTION
Non-routable IPv4 addresses are in these ranges: 10.0.0.0/8, 172.16.0.0/12, and 192.168.0.0/16, leaving 8.8.8.8 (Google public DNS server) as the only option that is routable.

2. Correct Answer: E
SOLUTION
All answers are correct. UDP can be thought of as lighter-weight than TCP, meaning it has less built-in safeguards to handle lost or out-of-order messages. This also means that there is less overhead to use UDP compared to TCP.

3. Correct Answer: E
SOLUTION
Asymmetric key encryption uses a public key and a private key (hence: asymmetric) to secure communications between two devices.

4. Correct Answer: C
SOLUTION
Dynamic Host Configuration Protocol (DHCP) is used when a computer joins a new network to gather information about that network and how to communicate over it. This includes obtaining a unique IP address on that network, as well as the netmask, DNS server addresses, and gateway router.

5. Correct Answer: A
SOLUTION
Converting binary to decimal can be accomplished by multiplying each binary bit by a successive power of two:

$$1101\ 0100 = 1 \cdot 2^7 + 1 \cdot 2^6 + 0 \cdot 2^5 + 1 \cdot 2^4 + 0 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2^1 + 0 \cdot 2^0 = 128 + 64 + 16 + 4 = 212$$

6. Correct Answer: B
SOLUTION
Substituting true for z, we get:

```
x or (!y and true) or (!x and true)
x or (!y) or (!x)                    Anything and'ed with true can
                                     be simplified
x or !x or !y                        Rearrange
true or !y
true
```

7. Correct Answer: B
SOLUTION
The answer can be computed by doing a binary add between the two binary numbers, then convert from two's complement to decimal:

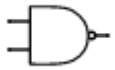
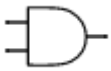
```
Carry          1 1
       0 0 0 0 0 1 1 0
     + 1 1 1 1 0 1 1 1
       1 1 1 1 1 1 0 1
```

Since the most significant bit (left-most) is a 1, we know the value is negative. So, to convert from two's complement, we invert, and add 1, then convert to decimal

```
1111 1101
0000 0010      invert
0000 0011      add 1
```

Converting to decimal yields 3, and since the unconverted number started with a 1, the answer is -3

8. Correct Answer: D
SOLUTION
The logic gate in question is an XOR gate. Here are the logic gate symbols for all possible answers:

| Symbol | Meaning |
|---|---|
|  | NAND |
|  | OR |
|  | NOR |
|  | XOR |
|  | AND |

9. Correct Answer: E
SOLUTION
We can solve the expression by breaking it into smaller groups:

| x | y | z | x or z | !(x or z) | !y | !(x or z) or !y |
|---|---|---|---|---|---|---|
| F | F | F | F | T | T | T |
| F | F | T | T | F | T | T |
| F | T | F | F | T | F | T |
| F | T | T | T | F | F | F |
| T | F | F | T | F | T | T |
| T | F | T | T | F | T | T |
| T | T | F | T | F | F | F |
| T | T | T | T | F | F | F |

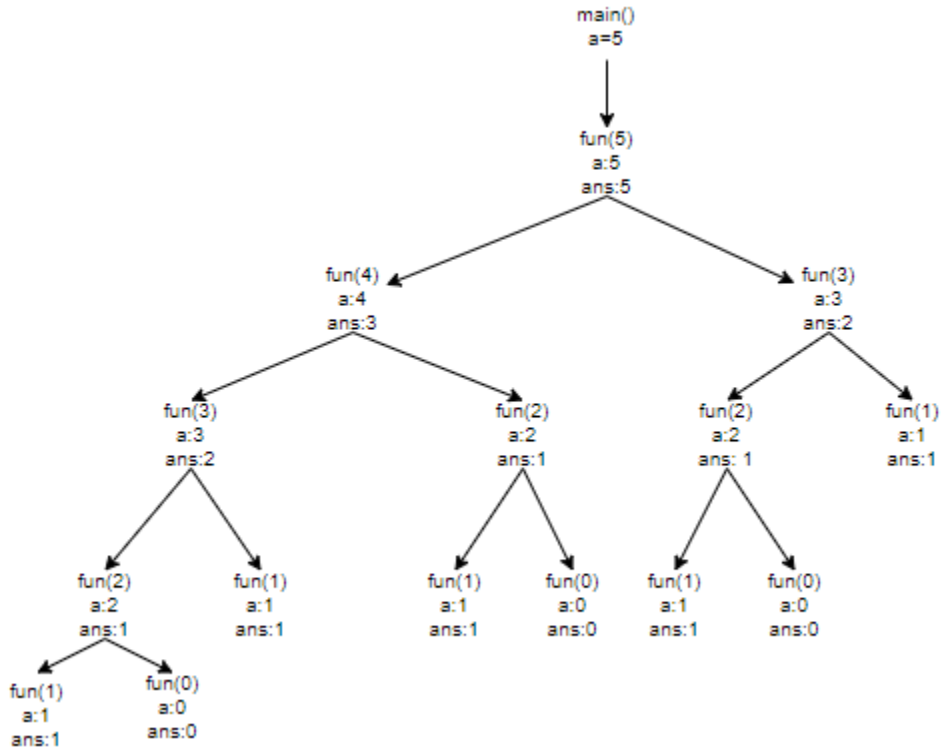
The answer is equivalent to choice E

10. Correct Answer: B
SOLUTION
Post order traversal can be determined by starting at the root node, then visit the left sub tree, right sub tree, then current node.

```
Node  Traversal  Comment
C                Start at root node
A                Visit left subtree of node C
F                Visit left subtree of node A
F     F          No subtrees, so visit current node
H     F          Visit right subtree of node A
H     FH         No subtrees, so visit current node
A     FHA        Visited both subtrees, so visit current node
D     FHA        Visit right subtree of node C
B     FHA        Visit left subtree of node D
B     FHAB       No subtrees, so visit current node
D     FHABD      Visited left subtree, and no right subtree, so visit
                 current node
C     FHABDC     Visited both subtrees, so visit current node
```

11. Correct Answer: D
SOLUTION
Trees are graphs with no cycles. A balanced binary tree is a tree if the height of the left and right subtrees differ by at most 1, and if both the left and right subtrees are also balanced. The tree has a height of 3, as the maximum number of nodes which must be visited from the root to any given node in the tree is 3. The tree also has 6 total nodes, and 5 edges.

12. Correct Answer: C
SOLUTION
Function `fun` recursively calls itself with a base case of `a <= 1`. Here is a graph of the calls, with the value of `a`, and the answer/result of each function:




This call graph illustrates how recursion is not always the best choice for implementing an algorithm, as the algorithm calculates the same result multiple times (`fun(3)` is computed twice, `fun(2)` is computed 3 times, `fun(1)` is computed 5 times, and `fun(0)` is computed 3 times).

13. Correct Answer: E
SOLUTION
Using the call graph from the previous solution, `fun` is called 15 total times.

14. Correct Answer: A
SOLUTION
There are no ternary operators in the function. The only ternary operator in the C++ language is the inline if statement: `? :`

15. Correct Answer: A
SOLUTION
`gcd` is a recursive function, as it calls itself, and has a base case of `b == 0`

16. Correct Answer: C
SOLUTION
`gcd(4, 2)`
`gcd(2, 0)`
Answer is 2

The function `gcd` was called two times

17. Correct Answer: B
SOLUTION
Using the solution to the previous answer, the answer is 2

18. Correct Answer: C
SOLUTION
Unary operators include ++ (post-increment), ++ (pre-increment). The << (stream insertion operator), = (assignment), ? : (tertiary if), > (greater than) are not considered unary operators

19. Correct Answer: A
SOLUTION

```
      Main
      A     b
      12    10
                        funA(&a, b)
                        &a    b
      12    10          12    10
      12    10          12    2       b = a % b
      13    10          13    2       a++
      14    10          14    2       since b <= 3, execute ++a on
                                      the return line
                                      Return a = 14
print "14 "
print "14 "
print "10"
```

Therefore, the correct answer is “14 14 10”

20. Correct Answer: C
SOLUTION

```
      main
      a     b
      15    10
                        funA(&a, b)
                        &a    b
      15    10          15    10
      15    10          15    5       b = a % b
      16    10          16    5       a++
                        Return 0, since b > 3
print "0 "
print "16 "
print "10"
```

Therefore, the correct answer is “0 16 10”

21. Correct Answer: A
SOLUTION
Here is a trace of the code:

```
a     i     comment
0     ?     assignment of a
0     -4    assignment of i
-4    -4    a += i
-4    -2    i += 2
-6    -2    a += i
-6    0     i += 2
-6    0     a += i
-6    2     i += 2
-4    2     a += i
-4    4     i += 2
0     4     a += i
0     6     i += 2
```

At the end, a = 0

22. Correct Answer: E
SOLUTION

```
a    i    comment
0    ?
0    0
0    0    a += i
0    2    i += 2
2    2    a += i
2    4    i += 2
6    4    a += i
6    6    i += 2
```

At the end, a = 6.

23. Correct Answer: E
SOLUTION
Using the trace from the previous solution, `i` contains the value 6 after running.

24. Correct Answer: C
SOLUTION

| arr1 | arr2 | x | y | Comment |
|---|---|---|---|---|
| {1, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | ? | ? | init arrays |
| {1, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | 0 | ? | x = 0 |
| {1, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | 0 | 0 | y = x |
| {6, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | 0 | 0 | arr1[0] += arr2[0] |
| {6, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | 0 | 1 | y++ |
| {10, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | 0 | 1 | arr1[0] += arr2[1] |
| {10, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | 0 | 2 | y++ |
| {13, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | 0 | 2 | arr1[0] += arr2[2] |
| {13, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | 0 | 3 | y++ |
| {15, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | 0 | 3 | arr1[0] += arr2[3] |
| {15, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | 0 | 4 | y++ |
| {16, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | 0 | 4 | arr1[0] += arr2[4] |
| {16, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | 0 | 5 | y++ |
| {16, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | 1 | 5 | x++, since y >= 5 |
| {16, 2, 3, 4, 5} | {5, 4, 3, 2, 1} | 1 | 1 | y = x |
| {16, 6, 3, 4, 5} | {5, 4, 3, 2, 1} | 1 | 1 | arr1[1] += arr2[1] |
| {16, 6, 3, 4, 5} | {5, 4, 3, 2, 1} | 1 | 2 | y++ |
| {16, 9, 3, 4, 5} | {5, 4, 3, 2, 1} | 1 | 2 | arr1[1] += arr2[2] |
| {16, 9, 3, 4, 5} | {5, 4, 3, 2, 1} | 1 | 3 | y++ |
| {16, 11, 3, 4, 5} | {5, 4, 3, 2, 1} | 1 | 3 | arr1[1] += arr2[3] |
| {16, 11, 3, 4, 5} | {5, 4, 3, 2, 1} | 1 | 4 | y++ |
| {16, 12, 3, 4, 5} | {5, 4, 3, 2, 1} | 1 | 4 | arr1[1] += arr2[4] |
| {16, 12, 3, 4, 5} | {5, 4, 3, 2, 1} | 1 | 5 | y++ |
| {16, 12, 3, 4, 5} | {5, 4, 3, 2, 1} | 2 | 5 | x++, since y >= 5 |
| {16, 12, 3, 4, 5} | {5, 4, 3, 2, 1} | 2 | 2 | y = x |
| {16, 12, 6, 4, 5} | {5, 4, 3, 2, 1} | 2 | 2 | arr1[2] += arr2[2] |
| {16, 12, 6, 4, 5} | {5, 4, 3, 2, 1} | 2 | 3 | y++ |
| {16, 12, 8, 4, 5} | {5, 4, 3, 2, 1} | 2 | 3 | arr1[2] += arr2[3] |
| {16, 12, 8, 4, 5} | {5, 4, 3, 2, 1} | 2 | 4 | y++ |
| {16, 12, 9, 4, 5} | {5, 4, 3, 2, 1} | 2 | 4 | arr1[2] += arr2[4] |
| {16, 12, 9, 4, 5} | {5, 4, 3, 2, 1} | 2 | 5 | y++ |
| {16, 12, 9, 4, 5} | {5, 4, 3, 2, 1} | 3 | 5 | x++, since y >= 5 |
| {16, 12, 9, 4, 5} | {5, 4, 3, 2, 1} | 3 | 3 | y = x |
| {16, 12, 9, 6, 5} | {5, 4, 3, 2, 1} | 3 | 3 | arr1[3] += arr2[3] |
| {16, 12, 9, 6, 5} | {5, 4, 3, 2, 1} | 3 | 4 | y++ |
| {16, 12, 9, 7, 5} | {5, 4, 3, 2, 1} | 3 | 4 | arr1[3] += arr2[4] |
| {16, 12, 9, 7, 5} | {5, 4, 3, 2, 1} | 3 | 5 | y++ |
| {16, 12, 9, 7, 5} | {5, 4, 3, 2, 1} | 4 | 5 | x++, since y >= 5 |
| {16, 12, 9, 7, 5} | {5, 4, 3, 2, 1} | 4 | 4 | y = x |
| {16, 12, 9, 7, 6} | {5, 4, 3, 2, 1} | 4 | 4 | arr1[4] += arr2[4] |
| {16, 12, 9, 7, 6} | {5, 4, 3, 2, 1} | 4 | 5 | y++ |
| {16, 12, 9, 7, 6} | {5, 4, 3, 2, 1} | 5 | 5 | x++, since y >= 5 |

Therefore, after the code executes, the contents of `arr1` will be `{16, 12, 9, 7, 6}`.

25. Correct Answer: D
SOLUTION
There are generally two ways to print a newline character to the screen: `endl` or '`\n`'. Using the '`\n`' simply inserts a newline character. Using `endl`, however, inserts a '`\n`' and flushes the output stream.

26. Correct Answer: D
SOLUTION
Using the trace of the code, the values of x and y are 5 and 5, respectively.

27. Correct Answer: A
SOLUTION
Since the for loops throughout the code only access elements 0 through 4 in the arrays, array element 5 would never get modified. Therefore, elements 0 through 4 would get modified exactly as they do in the trace for question 24, and element 5 would remain unchanged. This would result in the answer being:
`{16, 12, 9, 7, 6, 6}`

28. Correct Answer: D
SOLUTION
Both A and B are correct, since `numValues` and `suits` are both private members of the class, they are not accessible to anything except for other members within the class. Additionally, `getNumValue` and `getSuitValue` are both examples of encapsulation as the data is hidden behind methods that control access to the data. Since `shuffle()` is a private member, it would not be accessible to anything except other members of the `cardDeck`. It would need to be declared as protected or public to be accessible to a derived class.

29. Correct Answer: E
SOLUTION
Answers B, C, and D would all cause compile-time errors. B would cause a compile-time error because it is trying to access `numValues` directly, which is a private member on the class. Answer C would result in a compile-time error because using `new cardDeck(true)` would return a pointer to an instance of `cardDeck`, which is not assignable to `c`, which is of type `cardDeck`. Answer D would result in a compile-time error because `FACES` is also a private member. Answer A would be the only answer that would not result in a compile-time error, although it is possible it could result in a runtime exception, depending on how the class is implemented (i.e., if there are appropriate bounds checks on the `getSuitValue` function).

30. Correct Answer: D
SOLUTION
Abstraction, inheritance, polymorphism, and encapsulation are all aspects of Object Oriented Programming. Recursion is not an aspect of OOP.