2020 Academic Challenge

COMPUTER SCIENCE TEST – REGIONAL

Computer Science Test Production Team

Kevin Schaefer, Independent Contractor – Author

GENERAL DIRECTIONS

Please read the following instructions carefully. This is a timed test; any instructions from the test supervisor should be followed promptly.

The test supervisor will give instructions for filling in any necessary information on the answer sheet. Most Academic Challenge sites will ask you to indicate your answer to each question by marking an oval that corresponds to the correct answer for that question. One oval should be marked to answer each question. Multiple ovals will automatically be graded as an incorrect answer.

Be sure ovals are marked as ⬤ , not ⊙ , ◍ , ◑ , etc.

If you wish to change an answer, erase your first mark completely before marking your new choice.

You are advised to use your time effectively and to work as rapidly as you can without losing accuracy. Do not waste your time on questions that seem too difficult for you. Go on to the other questions, and then come back to the difficult ones later if time remains.

Time: 40 Minutes   Number of Questions: 30

DO NOT OPEN TEST BOOKLET UNTIL YOU ARE TOLD TO DO SO!

1. Which of the following best describes the round-trip time (RTT)?

    A. The time it takes for data to be sent from host A to host B, then back to host A

    B. The time it takes for data to be sent from host A to host B, and an achnowledgement from host B back to host A

    C. The time it takes for data to be sent from host A to host B and then persisted to non-volatile storage

    D. The time it takes for data to be sent from host A to host B, and then from host B to host C

    E. None of the above

2. Assume an array `arr` contains 5 integers declared as follows:

   ```
   int arr[] = { 7, 3, 5, 1, 3 };
   ```

   Which of the following code snippets prints the average of the array as 3.8?

    A.
    ```
    int sum = arr[0];
    for(int i = 1; i < 5; i++)
       sum += arr[i];
    cout << sum / 5.0;
    ```

    B.
    ```
    int avg = 0;
    for(int i = 0; i < 5; i++)
       avg = (avg + arr[i]) / 5.0;
    cout << avg;
    ```

    C.
    ```
    int sum = 0;
    int i = 4;
    do {
       sum += arr[i];
    } while(i--);
    cout << sum / 5;
    ```

    D.
    ```
    int sum = arr[1];
    for(int i = 1; i < 5; i++)
       sum = sum + arr[i];
    cout << sum / 5;
    ```

    E. None of the above

3. Which of the following provides a mechanism for determining the link-layer address associated with a given internet layer address?

    A. DNS

    B. DHCP

    C. ARP

    D. TCP

    E. RDP

4. Convert -7 to binary in Two's Complement notation.

    A. `0000 0111`

    B. `1000 0111`

    C. `1111 1000`

    D. `0x07`

    E. `1111 1001`

5. Which of the following best describes type-casting?

    A. Converts numbers between different radixes

    B. The process of copying data between variables

    C. The process of obtaining a pointer to a variable

    D. Changes data types

    E. None of the above

6. A storage medium can hold 32 GB (2^{32} bytes). How many pictures could be stored, assuming an average size picture is 25 MB (2^{20} bytes) and assuming negligible filesystem overhead?

    A. 2^{20}

    B. $2^{(32/20)}$

    C. 2^{12}

    D. None of the above

    E. There is not enough information provided

7. What is the largest number that can be represented with an 8-bit binary value using One's Complement notation?

    A. 256

    B. 255

    C. 126

    D. 128

    E. 127

Use the following code for questions 8 through 11:

```
1  #include <iostream>
2  using namespace std;
3
4  int main()
5  {
6     int i = 0.7;
7
8     for(int j = 3; j > i; j--) {
9        cout << j;
10    }
11
12    return 0;
13 }
```

8. What is printed to standard output?

        A. 123

        B. 012

        C. 321

        D. 210

        E. The code does not compile

9. How many times does the `cout` statement get executed in the `for`-loop?

        A. 0

        B. 1

        C. 2

        D. 3

        E. Infinite

10. How many times does the `j > i` condition get executed in the `for`-loop?

        A. 0

        B. 1

        C. 2

        D. 3

        E. 4

11. How is the value `0.7` assigned to the variable `i`?

        A. It is type-casted to an integer

        B. It is passed by-reference

        C. It cannot be assigned and results in a compile-time error

        D. It cannot be assigned and results in a run-time error

        E. both A and B

12. Which of the following best describes Dijkstra's Algorithm?

    A. An algorithm for finding the shortest path between two nodes of a graph

    B. An algorithm for calculating the greatest common divisor (GCD) of two integers

    C. An algorithm for finding the height of a tree

    D. An algorithm for sorting a list of values

    E. An algorithm for performing floating-point division

13. How many looping control structures are there in C++?

    A. 0

    B. 1

    C. 2

    D. 3

    E. 4

14. What is the result, in binary, of adding the two binary numbers `01101001` and `11011101`?

    A. 19

    B. `1 0100 0110`

    C. 326

    D. `-0100 0110`

    E. None of the above

15. Which of the following is true regarding derived classes?

    A. Derived classes have an "is-a" relationship with their base classes

    B. Base classes have an "has-a" relationship with their derived classes

    C. Derived classes are an example of abstraction

    D. Both A and C

    E. None of the above

16. What are preprocessor directives?

    A. Command line arguments passed to the C++ compiler

    B. Program control statements, such as `if` or `goto`

    C. Comments that start with `//` or `/* ... */`

    D. Lines of code that begin with a number sign (#), which include statements such as `#ifdef` or `#include`

    E. None of the above

17. What are the standard streams available to read/write data from/to?

    A. Standard I/O, file I/O

    B. Standard input, standard output

    C. Standard input, standard error

    D. Standard input, special input, standard output

    E. Standard input, standard output, standard error

Use the following code for questions 18 and 19:

```
1  #include <iostream>
2  using namespace std;
3
4  int fun(int a)
5  {
6    return a <= 0 ? 1 : fun(a - 1) + 2 * fun(a - 2);
7  }
8
9  int main()
10 {
11   cout << fun(4);
12
13   return 0;
14 }
```

18. What is printed to standard output?

    A. *infinite loop*

    B. 21

    C. *no output*

    D. 11

    E. 5

19. Which of the following is the base case of `fun`?

    A. When `a` is 0

    B. When `a` is a positive number

    C. There are no base cases

    D. The code does not compile

    E. When `a` is 0 or a negative number

20. Which of the following would be a good header for a class representing a rectangle in C++?

A.
```
class rectangle {
  private:
    number width;
    number height;
  public:
    number getWidth    ();
    number getHeight   ();
    void setWidth      (number);
    void setHeight     (number);
};
```

B.
```
class rectangle {
  private:
    int width;
    int height;
  public:
    int getWidth();
    int getHeight();
    void setWidth(int);
    void setHeight(int);
};
```

C.
```
class rectangle {
  private:
    int side;
  public:
    int setSide();
    void getSide (int);
};
```

D.
```
class rectangle {
  protected:
    int getHeight();
    int getWidth();
    void setHeight(int);
    void setWidth(int);
  public:
    int height;
    int width;
};
```

E.
```
class rectangle {
  public:
    int width;
    int height;
    int getWidth();
    int getHeight();
    void setWidth(int);
    void setHeight(int);
};
```

21. Which of the following can accomodate for at least 1 hard drive failure without losing data?

    A. RAID 0

    B. RAID 1

    C. SATA

    D. Both A and B

    E. None of the above

22. Which of the following data structures uses pointers to point to each successive element?

    A. Array

    B. Stack

    C. String

    D. Linked List

    E. For-loop

23. Which of the following represents an NAND gate?

A.

A	B	Result
0	0	0
0	1	1
1	0	1
1	1	1

B.

A	B	Result
0	0	0
0	1	0
1	0	0
1	1	1

C.

A	B	Result
0	0	1
0	1	1
1	0	1
1	1	0

D.

A	B	Result
0	0	0
0	1	1
1	0	1
1	1	0

E.

A	B	Result
0	0	1
0	1	0
1	0	0
1	1	0

24. Which of the following are examples of unary operators?

        A. ++ (postfix/prefix increment)

        B. !

        C. ->

        D. <<

        E. Both A and B

Use the following code for questions 25 through 28:

```
1  #include<iostream>
2  using namespace std;
3
4  int Fun1(int &a, int b);
5  int Fun2(int b, int a);
6
7  int main()
8  {
9    int a = 0;
10   int b = 5;
11
12   cout << "Fun1: " << Fun1(a, b) << endl;
13   cout << "Fun2: " << Fun2(a, b) << endl;
14
15   return 0;
16 }
17
18 int Fun1(int &a, int b)
19 {
20   return a++ + b++;
21 }
22
23 int Fun2(int b, int a)
24 {
25   return b >> a;
26 }
```

25. What are lines 4 and 5 called?

        A. Forward declaration

        B. Preprocessor directive

        C. Class header

        D. Function body

        E. None of the above

26. How is the variable `a` passed to `Fun1`?

      A. Implicitly

      B. Recursively

      C. By reference

      D. As a constant

      E. None of the above

27. What is printed to standard output?

      A. Fun1: 7
         Fun2: 0

      B. Fun1: 5
         Fun2: 0

      C. Fun1: 5
         Fun2: 3

      D. Fun1: 5
         Fun2: 6

      E. Fun1: 7
         Fun2: 6

28. What is the return value of this function call: `Fun1(4, 2)`?

      A. A compile-time exeption

      B. 6

      C. 8

      D. 7

      E. None of the above

Exam continues on next page

Use the following graph for questions 29 and 30:
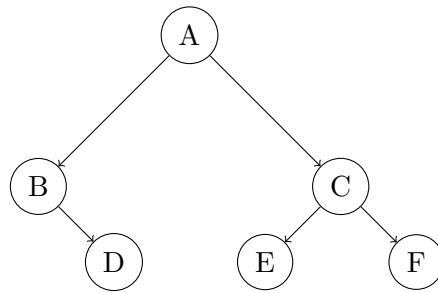
29. Which of the following represents a pre-order traversal of the graph to the right?

    A. ABCDEF

    B. BDAECF

    C. ABDCEF

    D. DBEFCA

    E. The graph cannot be traversed

30. Which of the following statements is true regarding the graph?

    A. The graph is also a tree

    B. The graph is a balanced binary tree

    C. The graph is fully connected

    D. The graph has no loops

    E. All of the above