University Interscholastic League

Computer Science Competition

Number 113 (Invitational A - 2009)

General Directions (Please read carefully!):

1) DO NOT OPEN EXAM UNTIL TOLD TO DO SO.

2) **NO CALCULATORS OF ANY KIND MAY BE USED.**

3) There are 40 questions on this contest exam. You have 45 minutes to complete this contest. If you are in the process of actually writing an answer when the signal to stop is given, you may finish writing that answer.

4) Papers may not be turned in until 45 minutes have elapsed. If you finish the test before the end of the allotted time, remain at your seat and retain your paper until told to do otherwise. Use this time to check your answers.

5) All answers must be written on the answer sheet/Scantron card provided. Indicate your answers in the appropriate blanks provided on the answer sheet or on the Scantron card. Clean erasures are necessary for accurate Scantron grading.

6) You may place as many notations as you desire anywhere on the test paper, but not on the answer sheet or Scantron card which are reserved for answers only.

7) You may use additional scratch paper provided by the contest director.

8) All questions have ONE and only ONE correct (BEST) answer. There is a penalty for all incorrect answers. **All provided code segments are intended to be syntactically correct, unless otherwise stated. Ignore any typographical errors and assume any undefined variables are defined as used.**

9) A reference to commonly used Java classes is provided at the end of the test, and you may use this reference sheet during the contest. You may detach the reference sheets from the test booklet, but DO NOT DO SO UNTIL THE CONTEST BEGINS.

10) Assume that any necessary import statements for standard Java packages and classes (e.g. `.util`, `ArrayList`, etc.) are included in any programs or code segments that refer to methods from these classes and packages.

Scoring:

1) All questions will receive **6 points** if answered correctly; no points will be given or subtracted if unanswered; **2 points** will be deducted for an incorrect answer.

QUESTION 1

What is the sum of 10101_2 and 111_2?

A. 11100_2 B. 1110_2 C. 11111_2 D. 11000_2 E. 10001_2

QUESTION 2

What is output by the code to the right?

A. 5 B. 7 C. 8

D. -3 E. 6

```
int x = 5;
int y = x + 2;
x++;
System.out.println( y );
```

QUESTION 3

What is output by the code to the right?

A. 16 B. 0 C. 32

D. 10 E. 15

```
int count = 0;
for(int i = 0; i < 15; i++){
  count++;
}
System.out.print( count );
```

QUESTION 4

What is output by the code to the right?

A. matlab B. ma C. mat

D. atlab E. tlab

```
String lang = "matlab";
String res = lang.substring(2);
System.out.println( res );
```

QUESTION 5

What is output by the code to the right?

A. 5 B. 4 C. 2

D. 3 E. 6

```
int[] nums = {5, 12, -7, 4, 5, 2};
System.out.print( nums[4] );
```

QUESTION 6

What is output by the code to the right?

A. 0 B. 0.25 C. 2.5

D. 4.5 E. 5.0

```
double a = 2.5;
a += 5 / 2;
System.out.print( a );
```

QUESTION 7

How many combinations of values for the `boolean` variables `a`, `b`, and `c` will result in `d` being set to `true`?

A. 1 B. 4 C. 7

D. 0 E. 3

```
boolean a, b, c;
//code to initialize a, b, and c

boolean d = ( a || b || c );
```

QUESTION 8

What is output by the code to the right?

A. 2 B. 12 C. 123

D. 13 E. 3

```
int u = 5;
double v = 5.5;
if( v > u )
  System.out.print( 1 );
if( (int)v > u )
  System.out.print( 2 );
else
  System.out.print( 3 );
```

QUESTION 9

What replaces **<*1>** in the code to the right so that the `Pizza` class inherits from the `Food` class?

A. `implements`

B. `inherits`

C. `final`

D. `static`

E. `extends`

Assume **<*1>** is filled in correctly.

QUESTION 10

What replaces **<*2>** in the code to the right to concatenate to result the value stored in the variable `cost`?

I. `super.cost`
II. `super.getCost()`
III. `getCost()`

A. I only

B. II only

C. III only

D. Both I and II

E. Both II and III

```
public class Food{
  private int cost;

  public Food(int c){
    cost = c;
  }

  public int getCost(){
    return cost;
  }
}

public class Pizza <*1> Food{
  private int size;

   public Pizza(int cost, int sz){
    super(cost);
    size = sz;
  }

  public String toString(){
    String result = "sz: " + size;
    result += ", cost: " + <*2>;
    return result;
  }
}
```

QUESTION 11

What is output by the code to the right?

A. 47 B. 32 C. true

D. 15 E. false

```
int m = 15;
int n = 32;
System.out.print( m | n );
```

QUESTION 12

What is output by the code to the right?

A. 9 B. 9.0

C. 4 D. 4.0

E. There is no output due to a syntax error.

```
int num = 3;
System.out.print( Math.pow(num, num - 1) );
```

QUESTION 13

What is output by the code to the right?

A.
```
One
Two
Three
```

B.
```
One
TwoThree
```

C.
```
OneTwo
Three
```

D. `123`

E. `OneTwoThree`

```
System.out.print("One");
System.out.println("Two");
System.out.println("Three");
```

QUESTION 14

What is output by the code to the right?

A. `33.10` B. `33.1000` C. `33.100`

D. `4.2f` E. `33.10000`

```
System.out.printf("%4.2f", 33.1);
```

QUESTION 15

What is returned by the method call `basic(3)`?

A. `3` B. `16` C. `0`

D. `10` E. `34`

```
public int basic(int x){
  x = x * x;
  x++;
  return x;
}
```

QUESTION 16

The code to the right does not compile. Which line contains the syntax error?

A. `Line A` B. `Line B`

C. `Line C` D. `Line D`

E. `Line E`

```
Object[] things = new Object[10];
things[0] = "cat"; // line A
things[1] = new Integer(12); // line B
things[12] = new Character('A'); // line C
char c2 = things[0].charAt(1); // line D
System.out.print( things[1] );  // line E
```

QUESTION 17

What are the possible outputs for the code to the right?

I. 0
II. 1
III. 3

A. I only B. II only C. III only

D. I and II E. I, II, and III

```
int x, y, z;
// code to initialize x, y, and z
String result = "";
if ( x > 10 )
  result += "a";
else if( y > 10 )
  result += "a";
else if( z > 10 )
  result += "a";
else
  result += "a";
System.out.println( result.length() );
```

QUESTION 18

What is output by the code to the right?

A. `DC3DC3NY` B. `DC` C. `DCDCNY`

D. `3DC3DCNY` E. `DCDCDCDCDCDCNY`

```
String temp = "DC";
temp += 3;
temp += temp + "NY";
System.out.print( temp );
```

QUESTION 19

What is output by the code to the right?

A. 0 B. 3 C. 9

D. There is no output due to a syntax error.

E. There is no output due to a runtime error.

```
String[] subjs = {"Chem", "Bio", "CS"};
int total = 0;
for( String st : subjs )
  total += st.length();
System.out.print( total );
```

QUESTION 20

What replaces **<*1>** in the code to the right so that the value stored in `LIMIT` cannot be changed?

A. `local` B. `const` C. `static`

D. `final` E. `this`

```
public int check(int x){
  <*1> double LIMIT = Math.sqrt(x);

  // rest of the method not shown
}
```

QUESTION 21

What is output by the code to the right?

A. 12 B. 11 C. 14

D. 8 E. 10

```
int v = 5;
int w = --v * 2;
System.out.print(w);
```

QUESTION 22

What is output by the client code to the right?

A. 6 B. 2 C. 10

D. 5 E. 4

QUESTION 23

Which searching algorithm does method `indexOf` use?

A. `Binary` B. `Quick` C. `Merge`

D. `Bubble` E. `Sequential`

```
public int indexOf(int start, int[] data,
                                    int tgt){
  int result = -1;
  for(int i = start; i < data.length; i++){
    if( tgt == data[i] ){
      result = i;
      break;
    }
  }
  return result;
}

//client code
int[] scores = {0, -5, 10, 240, 10, 10};
System.out.print( indexOf(3, scores, 10) );
```

QUESTION 24

What is output by the code to the right?

A. `[3, 3]` B. `[2, 0, 2]`

C. `[3, 1, 3]` D. `[3, 1, 1]`

E. There is no output due to a runtime error.

```
ArrayList<Integer> laps;
laps = new ArrayList<Integer>();
laps.add(2);
laps.add(0, 1);
laps.add(0, 3);
laps.set(2, laps.get(1) );
System.out.print( laps );
```

QUESTION 25

What is returned by the method call `many(4)`?

A. 10 B. 9 C. 12

D. 5 E. 14

```
public int many(int n){
  if(n == 1)
    return 5;
  else
    return n + many(n - 1);
}
```

QUESTION 26

What is output by the code to the right when given this input?

```
5.2.1.2\2\2.2
```

A. 10 B. 16 C. 14

D. 5 E. 8

```
Scanner sc = new Scanner(System.in);
sc.useDelimiter("\\.");

int sum = 0;
while( sc.hasNextInt() )
  sum += sc.nextInt();
System.out.print( sum );
```

QUESTION 27

What replaces **<*1>** in the code to the right so method `numVowels` generates an exception and ends if the precondition is not met?

A. `return` B. `catch` C. `end`

D. `throw` E. `assert`

```
// pre: s != null, s.length() > 0
public boolean same(String s){
  if( s == null || s.length() <= 0 )
    <*1> new IllegalArgumentException();

  int last = s.length() - 1;
  return s.charAt(0) == s.charAt(last);
}
```

QUESTION 28

Which sorting algorithm does method `sort` implement?

A. Quicksort B. Insertion sort

C. Merge sort D. Radix sort

E. Selection sort

QUESTION 29

What is the Big O of method `sort` given an `ArrayList` of `Integers` already sorted in descending order? Pick the most restrictive correct answer.

A. $O(N^2)$ B. $O(N)$

C. $O(1)$ D. $O(N^3)$

E. $O(N \log N)$

```
// post: sort elements into desending order
public void sort(ArrayList<Integer> data){
  int max, temp;
  int lim = data.size() - 1;
  for(int i = 0; i < lim; i++){
    max = i;
    for(int j = i + 1; j < data.size(); j++)
      if( data.get(j) > data.get(max) )
        max = j;
    if( i != max ){
      temp = data.remove(i);
      data.add(i, data.remove(max - 1) );
      data.add(max, temp);
    }
  }
}
```

QUESTION 30

Which of the following can replace **<*1>** in the code to the right without causing a syntax error?

A. `new HashSet<Integer>()`

B. `new List<Integer>()`

C. `new LinkedList<Integer>()`

D. `new int[10]`

E. More than one of these are correct.

```
List<Integer> times;
times = <*1>;
```

QUESTION 31

What is output by the code to the right?

A. 12 B. 5 C. 7

D. 8 E. null

```
PriorityQueue<Integer> pq;
pq = new PriorityQueue<Integer>();
int[] toAdd = {12, 5, 7, 5, 8};

for(int i : toAdd)
  pq.add(i);
pq.remove();
System.out.println( pq.peek() );
```

QUESTION 32

What is output by the code to the right?

A. obj B. null

C. There is no output due to a syntax error.

D. There is no output due to a runtime error.

E. The output can not be determined until runtime.

```
Object obj = new Object();
System.out.println( obj.toString() );
```

QUESTION 33

If N equals `rds.length` what is the Big O of method `process`? Pick the most restrictive correct answer.

A. O(NlogN) B. O(N!) C. $O(N^2)$

D. $O(N^2 \log N)$ E. $O(N^3)$

```
public int process(int[] rds){
  int total = 0;
  int lim = rds.length;
  for(int i = 0; i < lim; i++){
    for(int j = 1; j < lim; j *= 2)
      total += rds[i] * rds[j];
    for(int j = i; j < lim; j++)
      total += rds[i] + rds[j];
  }
  return total;
}
```

QUESTION 34

The height of a tree is the number of links from the root of the tree to the deepest leaf in the tree. The following values are inserted one at a time in the order shown into a binary search tree using the traditional insertion algorithm. What is the height of the resulting tree?

`12, 52, 100, 13, 50, -10`

A. 0 B. 1 C. 3 D. 4 E. 2

QUESTION 35

What is output by the code to the right?

A. [5]

B. [5, 11]

C. [5, 7, 13]

D. [13, 5, 7]

E. There is no way to determine the output until runtime.

```
TreeSet<Integer> t1 = new TreeSet<Integer>();
TreeSet<Integer> t2 = new TreeSet<Integer>();
t1.add(5);
t1.add(11);
t2.add(13);
t2.add(5);
t2.add(7);
t1.retainAll(t2);
System.out.println(t1);
```

QUESTION 36

What is output by the code to the right when method `testA` is called?

A. 14 B. 11 C. 17

D. There is no output due to a syntax error in method `testA`.

E. There is no output due to an `ArrayIndexOutOfBoundsException`.

QUESTION 37

What is output by the code to the right when method `testB` is called?

A. 22 B. 19 C.

D. There is no output due to a syntax error in method `testB`.

E. There is no output due to an `ArrayIndexOutOfBoundsException`.

```
public int sum(int[][] mat, int pos){
  int result = 0;
  for(int i = 0; i < mat.length; i++){
    result += mat[i][pos];
    result += mat[pos][i];
  }
  return result;
}

public void testA(){
  int[][] mA = {{5,1,3},{1,5,3},{1,2,2}};
  System.out.print( sum(mA, 1) );
}

public void testB(){
  int[][] mB = {{3,1,4},{1,6,2},{2,3,5},
                                {2,5,1}};
  System.out.print( sum(mB, 2) );
}
```

QUESTION 38

What replaces **<*1>** in the code to the right to make that block of code the default constructor for the `Structure` class?

A. `Structure()` B. `new Structure()`

C. `()` D. `Structure`

E. `void Structure()`

Assume **<*1>** is filled in correctly.

QUESTION 39

What is output by the following client code?

```
Structure s = new Structure();
s.add("A");
System.out.println( s.get(0) );
```

A. `A` B. `null`

C. `start` D. `temp`

E. There is no output due to a `NullPointerException`.

QUESTION 40

What type of data structure do the `Node` and `Structure` classes implement?

A. A linked list B. A binary tree

C. A min heap D. A hash table

E. A max heap

```
public class Node{
  public Object data;
  public Node next;
}

public class Structure{
  private Node start;

  public <*1>{
    start = new Node();
  }

  public void add(Object obj){
    Node temp = start;
    while( temp.next != null )
      temp = temp.next;
    temp.next = new Node();
    temp.next.data = obj;
  }

  public Object get(int pos){
    Node temp = start.next;
    for(int i = 0; i < pos; i++)
      temp = temp.next;
    return temp.data;
  }

  public void remove(int pos){
    Node temp = start;
    for(int i = 0; i < pos; i++)
      temp = temp.next;
    temp.next = temp.next.next;
  }
}
```

Computer Science Answer Key
UIL Invitational A 2009

1. A	11. A	21. D	31. B
2. B	12. B	22. E	32. E
3. E	13. C	23. E	33. C
4. E	14. A	24. D	34. C
5. A	15. D	25. E	35. A
6. D	16. D	26. E	36. C
7. C	17. B	27. D	37. E
8. D	18. A	28. E	38. A
9. E	19. C	29. A	39. A
10. E	20. D	30. C	40. A

Notes:
The clause "Choose the most restrictive correct answer." is necessary because per the formal definition of Big O, an algorithm that is $O(N^2)$ is also $O(N^3)$, $O(N^4)$, and so forth.

6. The expression `5/2` results in integer division because both operands are `int`s. The result is `2` which is then converted to `2.0` and that is added to `a` resulting in a holding the value `4.5`.

10. A descendant class does not have access to the private instance variables in ancestor classes. Choice I is not correct.

16. The declared type of things[0] is `Object`. The `Object` class does not have a `charAt` method so line D results in a syntax error. Line C will cause a runtime error, but it is caught at compile time.

29. The outer loop executes N times. Inside the loop there are 5 elements that are each O(N). The inner loop, the two calls to remove, and the two calls to add. So the work of the body of the inner loop is 5N. Even though the approach used to swap values is slow in it does not change the overall Big O of the algorithm.

32. The `toString` method in the `Object` class prints out the class name and the object's `hashcode`. The result `Object`'s `hashcode` method "is typically implemented by converting the internal address of the object into an integer" which means the output can vary from one run of the program to the next. Thus the output cannot be determined at compile time.