CFHS Competitive CS Mid-Term Diagnostic
February 2024 Name: _____

This diagnostic exam will have three portions: a written multiple-choice quiz, a written free-response exam, and a practical implementation problem set. The multiple-choice portion will be timed at only 30 minutes, but you may take as much time as you wish on the free-response and practical portions, provided they are both completed within club hours (before 4:30 PM).
Answer the following questions to the best of your ability. No points will be removed for incorrect answers, so answer as many as you can. Remember that the purpose of this exam is to guage what you know. This test does not affect your qualification for invitation-only teams, and many of the topics covered on this exam may not have been covered in weekly lectures throughout the year.

1 Multiple Choice Questions

Evaluate the following excerpts of Java source code. This section is intended to test your base knowledge of the Java Standard Programming Language, Version 17. Assume that all necessary class structure, imports, and other preamble information is already in place and that all programs are syntactically correct unless otherwise stated.

1. (1 point) What is the value of the expression `14|11&9`

   A. True

   B. False

   C. 225

   D. 15

   E. 9

2. (1 point) What is the output of this code segment?

```
String[] arr = { "1", "2", "3", "4" };
System.out.println(Arrays.stream(arr)
  .mapToInt(Integer::parseInt)
  .sum());
```

   A. `3`

   B. `7`

   C. `10`

   D. `4`

   E. *Error, No Output*

3. (1 point) What is the sum of 64_8 and 55_8?

   A. 111_2

   B. 11001_2

   C. 1100001_2

   D. 111001_2

   E. 1100111_2

4. (1 point) Evaluate the following code segment.

```
System.out.println(Math.pow(0x5,02));
```

   A. `8.0`

   B. `25`

   C. `15.0`

   D. `0x10`

   E. `25.0`

5. (1 point) Determine the output of the following program excerpt.

```
public int count(String[] data) {
  int result = 0;
  try {
    for (String s: data)
      result += s.length();
  }

  catch {
    result *= -1;
  }

  return result;
}

int v = count(new String[] { "AA", "B", null, "CA", null, "CCC" });
System.out.println(v);
```

A. `0`

B. `-1`

C. `3`

D. `-3`

E. `8`

6. (1 point) Which of the following can replace <*1> in the code segment below so that method `sort(int[], int)` correctly sorts the elements of `data` into ascending order?

```
public void sort(int[] data) {
  sort(data, 0);
}

public void sort(int[] data, int i) {
  if (i < data.length - 1) {
    int j = get_min_index(data, i);
    int temp = data[j];
    data[j] = data[i];
    data[i] = temp;
    <*1>
  }
}

public int get_min_index(int[] data, int i) {
  if (i == data.length - 1)
    return i;
  int j = get_min_index(data, i + 1);
  if (data[i] < data[j])
    return i;
  return j;
}
```

I. `sort(data, i+1)`

II. `sort(data, i^2)`

III. `sort(data, i >> 1)`

A. I only

B. II only

C. III only

D. I and II

E. I, II, and III

7. (1 point) What character value denotes the end of a string? (*Hint: NULL*)

   A. 0

   B. -1

   C. Character.MAX_VALUE

   D. Character.MIN_VALUE

   E. 1

8. (1 point) Stack S contains $[4, 5, 8, 3, 8, 9]$. What would be returned by $pop(S)$ after the following operations (in order): $pop(S)$, $push(S, 10)$, $pop(S)$, $pop(S)$, and $push(8)$. *Assume that all operations are done to the end of the array-like stack, at position N.*

   A. 4

   B. 8

   C. 3

   D. 5

   E. 9

9. (1 point) Given the definition of method `abc(int)`, What is the output of `abc(0)`?

```
public static int abc(int x) {
  if (x > 10)
    return x - 3;
  else {
    x *= 3;
    return x + abc(x + 2);
  }
}
```

   A. 51

   B. 96

   C. 24

   D. 53

   E. 30

10. (1 point) What is the output of the following code segment?

```
int number = 20;

switch (number) {
  case 10:
    System.out.println("10");
    break;

  case 20:
    System.out.println("20");
    break;

  case 30:
    System.out.println("30");

  default:
    System.out.println("Not in 10, 20 or 30");
}
```

A. `20`
   `30`

B. `20`

C. `10`
   `30`

D. `30`

E. `Not in 10, 20 or 30`

11. (1 point) Which of the following is the signed 8-bit two's complement representation of -54?

A. 00110110_2

B. 11001001_2

C. 11001000_2

D. 01001001_2

E. 11001010_2

12. (1 point) After inserting the following values into a binary search tree in order, what is the value of the left-most node?

    90, 20, 66, -2, 393, 8675, 10, 5

    A. -2

    B. 393

    C. 5

    D. 10

    E. 66

13. (1 point) Which of the following class declaration signatures best represents the relationship between animal classes?

    A. `class Dog extends Pet implements Mammal, Feline`

    B. `class Dog extends Mammal implements Pet, Canine`

    C. `class Dog extends Canine implements Mammal, Pet`

    D. `class Dog extends Mammal implements Pet, Feline`

    E. `class Dog implements Mammal, Pet, Canine`

2 Free Response Questions

Read, analyze, and respond to the following questions. These questions may have multiple correct answer choices. This section is intended to test your understanding of applying fundamental competitive programming topics as shown throughout the year.

Remember, not all of the content covered in any portion of this exam has been covered during a lecture, and this exam is simply to guage how much you each have grown. Simply try your best, and answer as many questions as you can to the best of your ability.

Unless told otherwise, solve every problem by writing either complete Java code or pseudocode. Make sure to be concise, and avoid writing boilerplate class implementations or input code.

14. (1 point) Rank the following operators by precedence: `+`, `<<`, `&`, `|`, `!=`, `/`, `=`, `++`, `<=`, and `^`

15. (1 point) Fill in the table for the width of each integer type in both bits and bytes.

Type	Bits	Bytes
boolean		
char		
byte		
short		
int		
long		
float		
double		

16. (1 point) Given array $A = [3, 9, 2, 9, 0, 10, 1]$,

    (A) Write every permutation of A that would be generated by an *inconsistent size* permuting algoritm.

    (B) Write every permutation of A that would be generated by a *consistent size* permuting algorithm.

17. (1 point) Highlight the error(s) in the following code segment, and explain both (a) why they are errors and (b) what type of error they are.

```
public static int hello() {
  int a = 5;
  int b = 8;

  if (a > b) {
    return a;
  }

  else {
    return b;
  }

  return a;
}
```

18. (1 point) Write the pseudocode for the Bubble Sort algorithm.

19. (1 point) Write a class structure with the methods $pop()$ and $push(X)$ that uses only 2 stacks yet emulates a queue's behavior (FIFO)

20. (1 point)

21. (5 points) The values $[23_4, -3_5, 18_{16}, 19_8, 1101_2, -10_{10}, 11_2]$ are inserted into a Priority Queue Q in order. *Assume all values are stored in base 10.*

    (A) Draw the current state of Q in tree form.

    (B) Draw the current state of Q in array form.

    The following operations are performed on A in the following order: $pop(Q)$, $pop(Q)$, $pop(Q)$, $push(Q, 13_4)$, $push(Q, 10_2 >> 2)$, $push(Q, -8_2)$, $pop(Q)$, $pop(Q)$

    (C) Draw the new state of Q in tree form.

    (D) Draw the new state of Q in array form.

    (E) What value would be returned by another call of $pop(Q)$?

3 Personal Questions

These questions are simply for us officers (namely Mufaro) to understand how to best serve the computer science club in the future and self-evaluate our performance in training the rest of the club. This section will not count towards your score.

22. How strongly, on a scale of 1 to 10 (10 being the strongest) has your understanding of computer science (in general) improved as a result of your participation in the competitive computer science club this year?

    State your reasoning for this score.

23. What was the most useful/best thing(s) that was done/offered in through the computer science club that helped you understand competitive computer science?

24. What criticisms/suggestions do you have for the current curriculum/club?

25. Consider what you were intending to major/specialize in during your college/career at the beginning of the year. (a) What was it before, (b) what is it now, and (c) has it changed?

26. Is there anything else that you would like to tell us?