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| CSCI 103      Introduction to Programming      Spring 2015 |
| <b>Midterm Exam</b>  |

For this exam, you are allowed to use a one-sided cheatsheet (8.5"x11") written in your own handwriting.

No calculators, computers, or textbooks are allowed.

Most of the programs inside omit their `#include` and `using` statements and the declaration/return from `main`. They are only omitted for brevity. Please assume that they are included.

Print your name, print your email address, and select your lecture section now.

Your Name: \_\_\_\_\_

Your USC e-mail: \_\_\_\_\_

Your Lecture Section: \_\_\_\_\_

|       |          |                 |
|-------|----------|-----------------|
| 29991 | 2PM MW   | David Pritchard |
| 29902 | 11AM TTh | David Pritchard |
| 29906 | 2PM TTh  | David Pritchard |

| Problem      | Value     | Score |
|--------------|-----------|-------|
| 0*           | 1         |       |
| 1            | 9         |       |
| 2            | 6         |       |
| 3            | 10        |       |
| 4            | 9         |       |
| 5            | 12        |       |
| 6            | 6         |       |
| 7            | 9         |       |
| 8            | 8         |       |
| <b>Total</b> | <b>70</b> |       |

\* Problem 0: fill out this cover page.

## 1 Expressions (9 points)

What is the type and value of each of the following expressions? If it would not compile, write X in both boxes. One entry is filled in for you.

| Expression                                | Type             | Value |
|---|------------------|-------|
| <code>((double) 1 + 1) / 4</code>         |                  |       |
| <code>1 * 2 + 3 / 4</code>                |                  |       |
| <code>2 &gt; 1 &amp;&amp; 1 &gt; 2</code> |                  |       |
| <code>true + true</code>                  | <code>int</code> |       |
| <code>4 &gt; 3 &gt; 2</code>              |                  |       |

## 2 Short Programs (6 points)

(a) What is the output of the following program?

```
int i;
for (i=0; i<5; i++) {
    /* do nothing in loop body */
}
cout << i;
```

---

(b) What is the output of the following program?

```
char buffer[80] = "go";
cout << strlen(buffer) << endl;
char* p = buffer + strlen(buffer);
strcpy(p, "to"); // copy "to" into p
cout << buffer << endl;
```

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### 3 C Strings (10 points)

#### Part I. True/False

Circle each correct answer.

- (a) The C string "Hello" can be stored in an array of 5 chars.

true

false

- (b) What is the value of `result` at the end of this program?

```
char a[] = "baa";
char b[] = "baa";
bool result = (a == b);
```

true

false

#### Part II. Code Tracing

Suppose that `stringthing.cpp` contains the following program.

```
int main(int argc, char* argv[]) {
    for (int i=1; i<argc; i++)
        cout << argv[i] << " ";
    cout << endl;

    for (int i=1; i<argc; i++)
        for (int j=1; j<argc; j++)
            argv[i][j] = argv[j][i];

    for (int i=1; i<argc; i++)
        cout << argv[i] << " ";
    cout << endl;
}
```

If we run `./stringthing ABCD EFGH IJKL`, what are the 6 outputs of the program?

|       |       |       |
|-------|-------|-------|
| _____ | _____ | _____ |
| _____ | _____ | _____ |

## 4 Debugging (9 points)

The following buggy program is intended to answer the following questions:

- if we roll a 6-sided die 100 times, in how many trials is the number *even*?
- if we roll a 6-sided die 100 times, in how many trials is the number *less than 3*?

```
1: int roll() { return rand() % 6 + 1; }
2: int main() {
3:     srand(time(0));
4:     int count_even = 0;
5:     int count_small = 0;
6:     for (int i = 0; i > 100; i++) {
7:         die = roll();
8:         if (die % 2 == 0) // check if even
9:             count_even++;
10:        else if (die < 3) // check if small
11:            count_small++;
12:    }
13:    cout << "even " << count_even << " ";
14:    cout << "small " << count_small << endl;
15: }
```

The program has 3 bugs. Describe each one and how to fix it (be brief, try to use at most 10 words). Each fix is a simple change on a single line.

- (a) When we try to compile the program it gives us a “scope” error. What is causing this?

Bug is on line number: \_\_\_\_\_

To fix this error: \_\_\_\_\_  
\_\_\_\_\_

- (b) After fixing this, the program runs, but always prints `even 0 small 0`.

Bug is on line number: \_\_\_\_\_

To fix this error: \_\_\_\_\_  
\_\_\_\_\_

- (c) After fixing this, the program runs, but the second count is too small. For example, it prints `even 49 small 15`, but it should be more like `even 51 small 32`.

Bug is on line number: \_\_\_\_\_

To fix this error: \_\_\_\_\_  
\_\_\_\_\_

## 5 Pointers (12 points)

### Part I. True/False

Circle each correct answer.

- (a) The amount of memory needed to store a pointer to a `char` is the same as the amount of memory needed to store a pointer to an `int`.

true

false

- (b) If `buf` is a `char*` and `nums` is an `int*`, then it is valid in C++ to write `nums = buf`;

true

false

### Part II. Short Answer

Suppose we define

```
int a[] = {3, 6, 9, 12, 15};
int* addr = &(a[0]);
```

- What is the value of `(*addr)+4`? \_\_\_\_\_
- What is the value of `*(addr+4)`? \_\_\_\_\_

### Part III. Code Tracing

What values does the array `a` contain at the end of the following code fragment?

```
int a[7] = {5, 3, 4, 7, 8, 3, 1};

int* p = a;
int* q = &(a[6]); // address of last item

while (p != q) {
    *q += *p;
    p++;
    q--;
}
```

a[0]: \_\_\_\_\_ a[1]: \_\_\_\_\_ a[2]: \_\_\_\_\_ a[3]: \_\_\_\_\_ a[4]: \_\_\_\_\_ a[5]: \_\_\_\_\_ a[6]: \_\_\_\_\_

## 6 Passing Semantics (6 points)

Consider the following program.

```
int g(int x) {
    int tmp = x + 1;
    return x * tmp;
}

int f(int x, int y) {
    x += y;
    return g(x);
}

int main() {
    int x = 3;
    cout << g(x) << endl;
    cout << f(x, 1) << endl;
    cout << f(x, 2) << endl;
}
```

What three lines of output does this program produce?

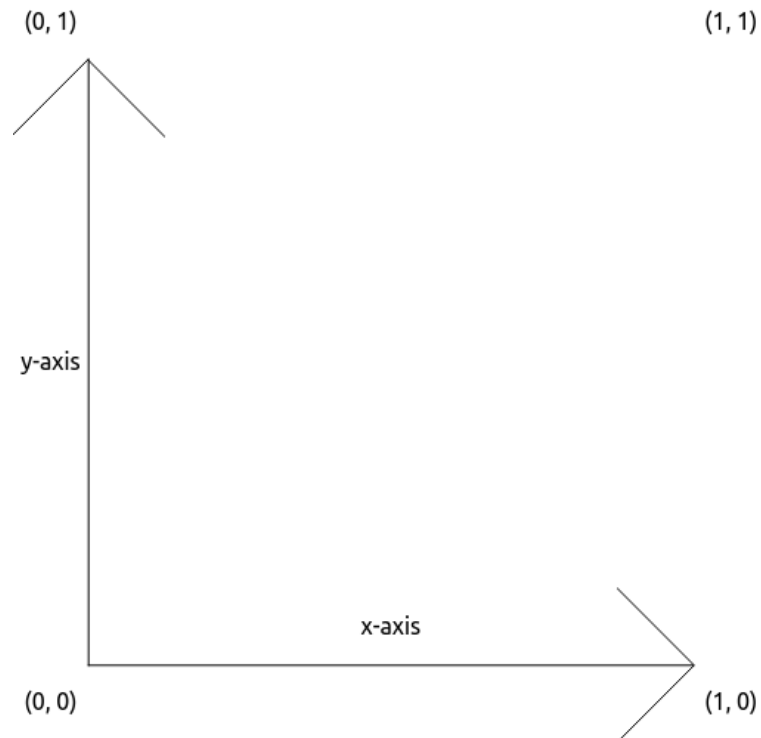
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*This page is meant to help you with the next problem. If you choose, you may carefully tear it out of the exam (without destroying the staple, please!). You do not have to return the page with your exam unless it has scratch work that you think is important. If you do return it, write your name on it.*

For your convenience, here is the coordinate map for the `draw` library:



Additionally, here is a reminder of the API for the `line` function in the `draw` library:

```
// draw line from (x0, y0) to (x1, y1)
void line(double x0, double y0, double x1, double y1);
```

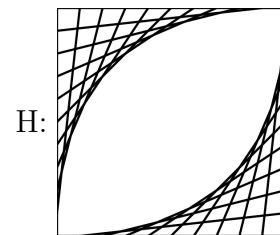
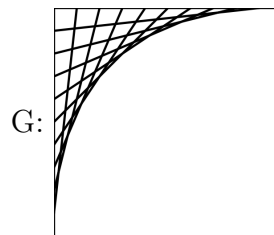
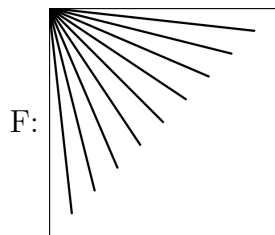
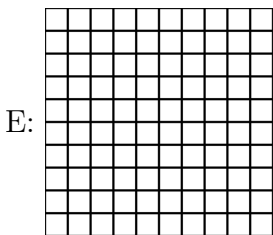
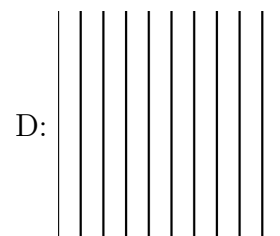
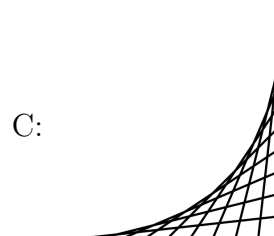
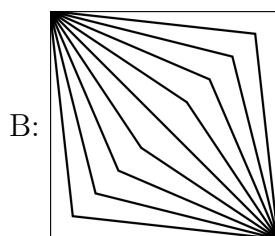
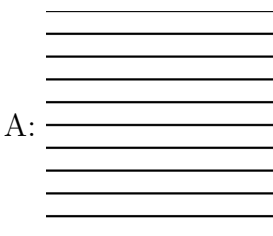
## 7 Draw Library (9 points)

The following is the skeleton of a program with the loop body missing:

```
for (double t = 0; t <= 1; t += 0.1) {
    _____ // missing loop body
}
```

Six possible loop bodies are given below, and 8 pictures. For each possible body, determine what picture the program would draw if that were the loop body. In each row, write a letter from A to H indicating which picture would be produced. *Some letters may be used more than once or not at all.*

| Missing Loop Body  | Letter of Resulting Image |
|--|---------------------------|
| <code>draw::line(t, 0, 1, t);</code>                         |                           |
| <code>draw::line(t, t, 0, 1);</code>                         |                           |
| <code>draw::line(t, 0, t, 1);</code>                         |                           |
| <code>draw::line(1, t, t, 0);</code>                         |                           |
| <code>draw::line(0, t, 1, t); draw::line(t, 0, t, 1);</code> |                           |
| <code>draw::line(0, t, t, t); draw::line(1, t, t, t);</code> |                           |





## 8 Redirection, I/O and Piping (8 points)

**Part I.** Consider the following program, `one.cpp`.

```
int main(int argc, char* argv[]) {
    int x = atoi(argv[1]);
    int y;
    cin >> y;
    cout << x + y;
}
```

If `data.txt` contains 12,

- What is the output of `./one 8 < data.txt`? \_\_\_\_\_
- What is the output of `./one 8 < data.txt | ./one 5`? \_\_\_\_\_

**Part II.** Consider the following program, `two.cpp`.

```
int main(int argc, char* argv[]) {
    int pos1 = 0, pos2 = 0, len1 = argc-1, len2, next2;
    cin >> len2 >> next2;
    cout << len1 + len2 << " ";
    while (pos1 < len1 || pos2 < len2) {
        bool use1 = (pos2 == len2);
        if (!use1)
            use1 = (pos1 < len1) && (atoi(argv[1+pos1]) < next2);
        if (use1) {
            cout << argv[1+pos1] << " ";
            pos1++;
        } else {
            cout << next2 << " ";
            pos2++;
            if (pos2 < len2)
                cin >> next2;
        }
    }
}
```

If `nums.txt` contains 1 5,

- What is the output of `./two 3 < nums.txt`? \_\_\_\_\_
- What is the output of `./two 3 < nums.txt | ./two 1 2 4`?  
\_\_\_\_\_

**PRINT your name here:** \_\_\_\_\_

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