Name(s):

Complete these activities to the best of your abilities without using the internet or your computers. You will not be graded on correctness of your answers or on syntactic correctness. This exercise is to see where your c++ memory is.

1 C++ & Objects Questions

1. What is an object?

2. What is a struct? How are objects and structs different from one another?

3. Define a struct `Node` to be used in a linked list.

4. When we are writing programs in c++, what purpose does a header file serve?

5. What are the differences between the following three variable declarations? `int x = 2;`, `int &y = x;`, and `int *y = &x;`

6. What are the differences between the `main` definitions `int main()`, `int main(int argc, char* argv[])`, and `int main(int argc, char **argv)`?

7. Why do you think that these two ways to define `main` exist?

8. What type does the `main` function return? What do different values indicate?

9. What is a pointer? Where is one place you would use one?

10. Recall that `cout` in the `iostream` library is used to print text to standard out. Write a c++ hello world program.

2 Code Comprehension

1. `ex1a.cpp`

```cpp
#include <iostream>

using namespace std;

struct Thing {
    int a;
    double b;
};

int main() {
    Thing t1;
    cout << t1.a << endl;
}
```

What is the output of the given code snippet?

2. `ex1b.cpp`

```cpp
#include <iostream>

using namespace std;

struct Thing {
    int a;
    double b;
};

int main() {
    Thing t1;
    t1.a = 5;
    t1.b = 1.5;
    cout <<  t1.a + t1.a / t1.b << endl;
}
```

What is the output of the given code snippet?

3. `ex2.cpp`

```cpp
#include <iostream>

using namespace std;

int main(int argc, char* argv[]) {
    cout << argv[0] << endl;
    cout << argv[1] << endl;
}
```

This code snippet was compiled using the command `g++ -std=c++11 -Wall ex2.cpp -o ex2`. Write two commands to run the produced executable from the command line; one that does not produce an error and one that does produce an error.

4. `ex3.cpp`

```cpp
#include <iostream>

using namespace std;

int main(int argc, char* argv[]) {
    cout << argv[0] << endl;
    cout << argv[1] << endl;
}
```

Modify the given code so that it will not produce a segmentation fault, even if the user runs it with the incorrect number of command line parameters.

5. `ex4.cpp`

```cpp
#include <iostream>

using namespace std;

void Swap1(int x, int y) {
    int tmp = x;
    x = y;
    y = tmp;
}

void Swap2(int &x, int &y) {
      int tmp = x;
      x = y;
      y = tmp;
}

int main(int argc, char **argv) {
      int a = 5;
      int b = 10;

      Swap1(a, b);
      cout << "a: " << a << "; b: " << b << endl;

      a = 5;
      b = 10;
      Swap2(a, b);
      cout << "a: " << a << "; b: " << b << endl;
      return EXIT_SUCCESS;
}
```

What is the output of the given code?

6. `ex5.cpp`

```cpp
#include <iostream>
#include <cstdlib>
#include <math.h>

using namespace std;

void Mystery(int x) {
    int u = (int)sqrt((double)x);
    bool *a = new bool[x + 1];

    memset(a, 0, sizeof(bool) * (x + 1));      // sets all entries in a to 0

    // loop 1
    for (int m = 2; m <= u; m++) {
        if (!a[m]) {
              // loop 2
            for (int k = m * m; k <= x; k += m) {
                a[k] = true;
            }  // end loop 2
        }
    }  // end loop 1

    // loop 3
    for (int m = 2; m <= x; m++) {
        if (!a[m]) {
            cout << m << " ";
        }
    } // end loop 3

    delete [] a;
}

int main(int argc, char* argv[]) {
    Mystery(atoi(argv[1]));
    return EXIT_SUCCESS;
}
```

(a) What type is `a`?

(b) How many elements does the array hold in relation to `x`?

(c) If `x` is 10, what is the value of `u`?

(d) If `x` is 10, what is the value of `a` after the end of loop 1?

(e) What is the purpose of loop 3?

(f) What does the `Mystery` function do?