

## Instructions

For a each topic (if applicable) there are 5 sections:

### Short Answer

Answer each question as well as you can.

### Circle the Variables' Scopes

Circle the scope of the given variables – i.e., circle the part of the code in which each variable “exists”. A good test, if you’re not sure, is: if you inserted a statement to `cout` the variable at a given point in the code, would any errors be produced?

### Fill in the Memory

Fill in (or draw) a picture representing the computer memory, showing how the variables might be allocated, and whether they have an assigned value, or are uninitialized (use ? for “uninitialized”).

### Fix the Broken Code

Modify the code in the cleanest (and shortest) way possible, so that it will compile and run without errors or warnings.

### Trace the Working Code

Trace through the execution of the code, keeping track of the value of each variable at each point in time, and the final output that the program produces.

# 1 Variables and Assignment

## Short Answer

### Question

Describe undeclared variables, uninitialized variables, and initialized variables.

### Answer

### Question

Describe what we mean when we refer to a variable's scope.

### Answer

## Circle the Variables' Scopes

```
#include <iostream>
using namespace std;

int main() {
    int a = 3, b = 3, c = 3;

    {
        int a = 5, b = 5;
        c = b;

        {
            int a = 7;
            b = a;
        }
    }

    return 0;
}
```

## Fill in the Memory

memory

address:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

value:

```
#include <iostream>
using namespace std;

int main() {
    int a = 3, b = 3, c = 3;

    {
        int a = 5, b = 5;
        c = b;

        {
            int a = 7;
            b = a;
        }
    }

    return 0;
}
```

## Fix the Broken Code

```
#include <iostream>
using namespace std;

int main() {
    int a = 5;
    int b = 7;

    cout << "before swapping: " << a << " " << b << endl;

    // swap
    int temp = int a;
    int a = int b;
    int b = int temp;

    cout << "after swapping: " << a << " " << b << endl;

    return 0;
}
```

```
#include <iostream>
#include <string>
using namespace std;

int main() {
    int    i = '5' + 4.7;    // '5' == 53
    char   c = 42;           // '*' == 42
    bool   b = 10;
    double d = 7;
    string s = "hello world!";

    int u;

    cout << i << " " << c << " " << b << " "
         << d << " " << s << " " << u << endl;

    return 0;
}
```

## Trace the Working Code

```
#include <iostream>
using namespace std;

int main() {
    cout << "a b temp\n" << "-----\n";

    int a = 5;    cout << a << endl;
    int b = 7;    cout << a << " " << b << endl;

    int temp = a; cout << a << " " << b << " " << temp << endl;
    a = b;        cout << a << " " << b << " " << temp << endl;
    b = temp;     cout << a << " " << b << " " << temp << endl;

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    cout << "a b c d\n" << "-----\n";

    int a, b, c;

    a = b = c = 3;  cout << a << " " << b << " " << c << endl;
    b = c = 5;      cout << a << " " << b << " " << c << endl;
    c = 7;          cout << a << " " << b << " " << c << endl;

    int d = b;      cout << a << " " << b << " " << c << " " << d << endl;

    return 0;
}
```



```
#include <iostream>
using namespace std;

int main() {
    int a = 3, b = 3;
    cout << "a: " << a << "  b: " << b << endl;
    {
        int a = 5;
        b = a;
        cout << "a: " << a << "  b: " << b << endl;
    }
    cout << "a: " << a << "  b: " << b << endl;

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    int a = 3, b = 3, c = 3;
    cout << "a: " << a << "  b: " << b << "  c: " << c << endl;
    {
        int a = 5, b = 5;
        c = b;
        cout << "a: " << a << "  b: " << b << "  c: " << c << endl;
        {
            int a = 7;
            b = a;
            cout << "a: " << a << "  b: " << b << "  c: " << c << endl;
        }
        cout << "a: " << a << "  b: " << b << "  c: " << c << endl;
    }
    cout << "a: " << a << "  b: " << b << "  c: " << c << endl;

    return 0;
}
```

## 2 Data Types and Expressions

### Short Answer

#### Question

What are the 5 main datatypes we studied during this course, and what is each typically used for?

#### Answer

#### Question

Give examples of what we mean by “order of operations” – why does it matter? What is the order of operations for the following common operators:

!=, ==, =, <, >=, +, &&, ||, \*, (), >, /, <=, -, %.

#### Answer

## Fix the Broken Code

```
#include <iostream>
using namespace std;

int main() {
    int a = 3;
    cout << "One third is: " << (1 / a) << endl;

    double b = 5;
    cout << "One fifth is: " << (1 / b) << endl;

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    // formula (in math notation):  $C = (F-32)*(5/9)$ 

    double fahrenheit = 100; // getting close to summer!

    cout << "The temperature is:\n";
    cout << "    " << fahrenheit << " degrees Fahrenheit\n";
    cout << "    " << fahrenheit-32 * 5/9
        << " degrees Celcius\n";

    return 0;
}
```

## Trace the Working Code

```
#include <iostream>
using namespace std;

int main() {
    int a = 3, b = 5, c = 7;

    cout << ( 23%17 || ( -c && c != a && !!11 >= -a ) || 11/3 ) << endl;

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    int a = 3, b = 5, c = 7;

    cout << ( b == +a == b <= !c > !(13%17) <= +c - ( a == c ) ) << endl;

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    // 'a' == 97
    cout << ('a' + 5) << endl;
    cout << char('a' + 5) << endl;

    cout << 7 << endl;
    cout << (7/3) << endl;
    cout << double(7) << endl;

    cout << 3.14159265359 << endl;
    cout << int(3.14159265359) << endl;
    cout << char( 100 + int(3.14159265359) ) << endl;

    cout << (!53) << endl;
    cout << bool(5) << endl;

    cout << "this is a string" << endl;

    cout << (3 + 5 * 3 + 5 / 2) << endl;

    cout << (10 < 5 < 7) << endl;

    return 0;
}
```



### 3 If and If-Else

#### Fix the Broken Code

```
#include <iostream>
using namespace std;

int main() {
    int a = 3;

    if (0 < a < 2)
        cout << "true" << endl
    else
        cout << "false" << endl;

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    int a = 3;

    if (a = 5)
        cout << "true" << endl;
    else
        cout << "false" << endl;

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    int a = 3;

    if (a = 5)
        cout << "true" << endl; a++;
    else
        cout << "false" << endl; a--;

    cout << "a = " << a << endl;

    return 0;
}
```

## Trace the Working Code

```
#include <cstdlib>
#include <ctime>
#include <iostream>
using namespace std;

int main() {
    srand(time(NULL));

    int a = rand()%10, b = rand()%10, c = rand()%10;

    cout << "a = " << a << ", b = " << b << ", c = " << c << endl;

    if (a <= b && a <= c)
        cout << "a is smallest" << endl;

    return 0;
}
```

```
#include <cstdlib>
#include <ctime>
#include <iostream>
using namespace std;

int main() {
    srand(time(NULL));

    int a = rand()%10, b = rand()%10, c = rand()%10;
    int smallest = 0;

    cout << "a = " << a << ", b = " << b << ", c = " << c << endl;

    if (b < c)
        smallest = b;

    if (c < b)
        smallest = c;

    if (a <= b && a <= c) {
        smallest = a;
        cout << "a is smallest" << endl;
    }

    return 0;
}
```

```
#include <cstdlib>
#include <ctime>
#include <iostream>
using namespace std;

int main() {
    srand(time(NULL));

    int a = rand()%10, b = rand()%10, c = rand()%10;

    cout << "a = " << a << ", b = " << b << ", c = " << c << endl;

    if (a <= b && a <= c)
        cout << "a is smallest" << endl;
    else if (b <= a && b <= c)
        cout << "b is smallest" << endl;
    else
        cout << "c is smallest" << endl;

    return 0;
}
```

```
#include <cstdlib>
#include <ctime>
#include <iostream>
using namespace std;

int main() {
    srand(time(NULL));

    int a = rand()%10, b = rand()%10, c = rand()%10;
    int smallest;

    cout << "a = " << a << ", b = " << b << ", c = " << c << endl;

    if (a <= b && a <= c) {
        smallest = a;
        cout << "a is smallest" << endl;
    } else if (b <= a && b <= c) {
        smallest = b;
        cout << "b is smallest" << endl;
    } else {
        smallest = c;
        cout << "c is smallest" << endl;
    }

    cout << "smallest = " << smallest << endl;

    return 0;
}
```

```
#include <cstdlib>
#include <ctime>
#include <iostream>
using namespace std;

int main() {
    srand(time(NULL));

    int a = rand()%10, b = rand()%10, c = rand()%10;
    int smallest;

    cout << "a = " << a << ", b = " << b << ", c = " << c << endl;

    if (a <= b && a <= c) {
        smallest = a;
        cout << "a is smallest" << endl;
    } else if (b <= a && b <= c) {
        smallest = b;
        cout << "b is smallest" << endl;
    } else if (c <= a && c <= b) {
        smallest = c;
        cout << "c is smallest" << endl;
    }

    cout << "smallest = " << smallest << endl;

    return 0;
}
```



## 4 Functions

### Short Answer

#### Question

What is a function? What is a predefined function? Why do we care?

#### Answer

#### Question

What library contains the `pow()` function? What are two other functions this library contains?

#### Answer

## Fix the Broken Code

```
#include <cmath>
#include <iostream>
using namespace std;

int main() {
    // 6 incorrect operators
    // 6 incorrect delimiters

    int a = 3, b = 5, c = 7;

    cout >> a >> '^' >> b >> ' (mod ' >> c >> ') = '
        >> int(pow(a,b)) % c >> endl;

    return 0;
}
```

```
#include <cmath>
#include <iostream>
using namespace std;

int main() {
    // 4 mistakes

    int a = 3,  b = 5
        c = 7,  d == 11;
    double e = 13.3, f = 17.7;

    cout << "the sin of " << a << " is " << sin(a) << endl
        << "the cosine of " << b << " is " << sin(b) << endl
        << "the tangent of " << c << " is " << sin(c) << endl;

    << "the natural log of " << d << " is " << log(d) << endl
    << "the ceil of " << e << " is " << ceil(e) << << endl
    << "the floor of " << f << " is " << floor(f) << endl;

    return 0;
}
```

```
#include <cmath>
#include <iostream>
using namespace std;

// This function prints "hello world!"
//
// Arguments: none
// Return value: void
void print_hello() {
    cout << "hello world!" << endl;
}

int main() {
    // 1 mistake

    cout << "now we are going to print \"hello world!\"\\n";

    print_hello;

    return 0;
}
```

## 5 Loops

### Short Answer

#### Question

What are the three types of loops in C++? Explain what each does, or what you might use it for.

#### Answer

#### Question

Is it ever okay to have an infinite loop? What usually causes unintentional infinite loops?

#### Answer

## Circle the Variables' Scopes

```
#include <iostream>
using namespace std;

int main() {
    int a = 3;

    for (int i = 7; i > a; i--) {

        for (int j = 11; j > i; j--) {

            cout << "*";

        }

        cout << endl;

    }

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    int a = 3;

    int i = 7;
    while (i > a) {

        int j = 11;
        while (j > i) {

            cout << "*";
            j--;

        }

        cout << endl;
        i--;

    }

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    // have to be a little careful with do-while loops:
    // it's not always possible to write one that means the
    // same thing as the corresponding for or while loop

    int a = 3;

    int i = 7;
    do {

        int j = 11;
        do {

            cout << "*";
            j--;

        } while (j > i);

        cout << endl;
        i--;

    } while (i > a);

    return 0;
}
```



## Fix the Broken Code

```
#include <iostream>
using namespace std;

int main() {
    cout << "i = ";
    for (int i=0; i<5; i+1) {
        cout << i << ", ";
    }
    cout << endl;

    cout << "i*2 = ";
    for (int i=0; i<5; i+1) {
        cout << i*2 << ", ";
    }
    cout << endl;

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    int a = 0;
    while (a < 5) {
        cout << "a = " << a << endl;
    }

    return 0;
}
```

## Trace the Working Code

```
#include <iostream>
using namespace std;

int main() {
    int a = 3;

    for (int i = 7; i > a; i--) {

        for (int j = 11; j > i; j--) {

            cout << "*";

        }

        cout << endl;

    }

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    int a = 3;

    int i = 7;
    while (i > a) {

        int j = 11;
        while (j > i) {

            cout << "*";
            j--;

        }

        cout << endl;
        i--;

    }

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    // have to be a little careful with do-while loops:
    // it's not always possible to write one that means the
    // same thing as the corresponding for or while loop

    int a = 3;

    int i = 7;
    do {

        int j = 11;
        do {

            cout << "*";
            j--;

        } while (j > i);

        cout << endl;
        i--;

    } while (i > a);

    return 0;
}
```

## 6 Arrays

### Fill in the Memory

memory

address:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

value:

```
#include <iostream>
using namespace std;

int main() {
    int a[5];

    int b[3] = {};

    int c[7] = {1,2,3};

    return 0;
}
```

memory

address:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
value:															

```
#include <iostream>
using namespace std;

int main() {
    int a[2][3] = {};

    int b[2][3] = {1, 2, 3, 4, 5, 6};

    return 0;
}
```

memory

address:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
value:															

```
#include <iostream>
using namespace std;
```

```
int main() {
    int a[2][3] = { {1, 2, 3}, {4, 5, 6} };

    int b[2][4] = { {1, 2}, {3, 4} };

    return 0;
}
```



memory

address:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

value:

```
#include <iostream>
using namespace std;
```

```
int main() {
    int a[2][3][2] = { { {1, 2}, {3, 4}, {5, 6} },
                        { {7, 8}, {9, 0}, {1, 2} } };

    return 0;
}
```

memory

address:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

value:

```
#include <iostream>
using namespace std;

int main() {
    int a[2][3][2] = { {1}, {2} };

    return 0;
}
```

## Fix the Broken Code

```
#include <iostream>
using namespace std;

int main() {
    // 2 mistakes

    a[7] = {1, 3, 5, 7, 9, 11, 13};

    cout << "a = { ";

    for (int i=0; i<=7; i++)
        cout << a[i] << ", ";

    cout << "};\n";

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    // 2 mistakes

    a[7] = {1, 3, 5, 7, 9, 11, 13};

    int b = a[7];

    cout << "b = " << b << endl;

    return 0;
}
```

## Trace the Working Code

```
#include <iostream>
using namespace std;

int main() {
    int a[7];

    for (int i=0; i<7; i++)
        a[i] = (i*7)%5;

    // print the array
    cout << "a = { ";
    for (int i=0; i<7; i++)
        cout << a[i] << ", ";
    cout << "};\n";

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    int a[7];

    for (int i=0; i<7; i++)
        cin >> a[i];

    // print the array (to see what the user entered)
    cout << "a = { ";
    for (int i=0; i<7; i++)
        cout << a[i] << ", ";
    cout << "};\n";

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    // declare and initialize the array
    int a[7];
    for (int i=0; i<7; i++)
        a[i] = (i*7)%5;

    // print the array
    cout << "a = { ";
    for (int i=0; i<7; i++)
        cout << a[i] << ", ";
    cout << "};\n";

    // --- find the sum and print the average ---

    int sum = 0;
    for (int i=0; i<7; i++)
        sum += a[i];

    cout << "the average of these elements is " << sum/7.0 << endl;

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main() {
    // declare and initialize the array
    int a[7];
    for (int i=0; i<7; i++)
        a[i] = (i*7)%5;

    // print the array
    cout << "a = { ";
    for (int i=0; i<7; i++)
        cout << a[i] << ", ";
    cout << "};\n";

    // --- find and print the max and min values ---

    int min = a[0];
    int max = a[0];

    for (int i=1; i<7; i++) {

        if (a[i] < min)
            min = a[i];

        if (a[i] > max)
            max = a[i];
    }

    cout << "the smallest of these elements is " << min << endl;
    cout << "the largest of these elements is " << max << endl;

    return 0;
}
```