

Introduction to C++ Programming  
Exercises  
Set #1

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**Problem 1.** What is the output of the following C++ code?

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

int main() {
    int m ;
    for(m = 1; m <= 10; m++){
        if(pow(m,2.0) == 25.0) {break;}
    }
    cout << m;
    return 0;
}
```

1. 1
2. 4
3. 5
4. 6

**Problem 2.** Write the output of the following C++ code in the following box.

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

int main() {

    if(true || false){cout << "A" << endl ;}
    else if(true && true){cout << "B" << endl ;}
    else{cout << "C" << endl ;}

    return 0;
}
```

**your answer:**

**Problem 3.** Write the output of the following C++ code.

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

int main(){
    int number = 1 ;
    int var = 0 ;
    double A = var/number + 1.1 ;
    bool flag = false ;
    char K = 'M' ;
    if(flag || (number > var)){
        flag = !flag ;
        var += number ;
        if(flag && pow(10.0,static_cast<double>(var)) > 4.0){
            number ++ ;
            number += sqrt(8 + var) ;
        }
        if(number != 4 || ((3/2 == 1) && flag)){
            number -- ;
            cout << (number*var) << endl ;
        }
        if(static_cast<int>(A) == 1.1){cout << K << endl ;}
    }
    return 0;
}
```

**Problem 4.** Examine the C++ code snippet provided below. It contains a single compile error. Identify this error and provide a brief explanation for its occurrence. Note that there is only one error in the code, and you should list only that one error.

```
#include <iostream>

int main() {

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

    int k1 = 3;
    int c[k1] = { 1,2,3 };

    const int k2 = 3;
    int d[k2] = { 1,2,3 };

    return 0;
}
```

**your answer:**

**Problem 5.** What is the output of the following C++ code?

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

int main(){

    if(true && false){cout << "A" ;}
    if((true && false) || false){cout << "B" ;}
    if(true || false){cout << "C" ;}
    if(false || (false || true)){cout << "D" ;}

    return 0 ;
}
```

1. ABCD
2. BCD
3. CD
4. AC

**Problem 6.** What is the output of the following C++ code?

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

int main(){

    vector<bool> a{false, true, true, false};
    for (int j = a.size()-1 ; j > -1 ; j --){

        if(!a[j]){a.push_back(true);}
    }
    cout << a.size() ;
    return 0 ;
}
```

1. 4
2. 3
3. 6
4. 8

**Problem 7.** What is the output of the following C++ code?

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

bool g(bool a){
    if(a){return a;}
    return false ;
}

int main(){

    bool flag = true ;
    while(g(flag)){

        if(!flag != true){
            cout << 10.0 << " " ;
            flag = false;
            continue ;
        }
        cout << 20.0 << " " ;
    }
    return 0;
}
```

1. 10 20
2. 20 10
3. 10
4. 20



**Problem 8.** What is the output of the following C++ code?

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

int main(){

    vector<int> a{0,2,3,1,4,5};
    vector<double> b{11.0,11.1,11.2,11.3,11.4,11.5};

    for (int i = 0; i < b.size() ; i ++){
        cout << b[a[i]] << " " ;
    }
    return 0;
}
```

1. 11.0 11.1 11.2 11.3 11.4 11.5
2. 11.0 11.2 11.1 11.3 11.5 11.4
3. 11.0 11.2 11.3 11.1 11.4 11.5
4. 11.5 11.4 11.3 11.2 11.1 11.0

**Problem 9.** What is the output of the following C++ code?

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

int main(){

    double sum = 0.0;
    int i = 0;
    bool flag = true;

    while(flag){
        sum += i + 1;
        i ++ ;
        if(i > 2){flag = false;}
    }
    cout << sum << endl ;
    return 0;
}
```

1. 0.0
2. 2.0
3. 4.0
4. 6.0

**Problem 10.** Examine the C++ code snippet provided below. It contains a single compile error. Identify this error and provide a brief explanation for its occurrence. Note that there is only one error in the code, and you should list only that one error.

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

int main() {

    int m = 10;

    for (m = 1; m < 3; m++) {
        int variation = m;
    }

    cout << variation << endl;
    cout << m << endl;

    return 0;
}
```

**your answer:**

**Problem 11.** What is the output of the following C++ code?

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

double f(double a, double b){
    if(a > b){return a;}
    return b;
}

double g(double a){
    return f(a, 2*a) ;
}

int main(){
    cout << f(12, g(12)) ;
    return 0;
}
```

1. 0
2. 12
3. 24
4. 48

**Problem 12.** What is the output of the following C++ code?

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

int f(int a){
    return a - 1;
}

int g(){
    return 3;
}

int main() {

    for(int j = g() ; j > 3/2 ; j = f(j)){
        cout << j << " " ;
    }
    return 0;
}
```

1. 3 2 1 0
2. 3 2 1
3. 3 2
4. 0 1 2

**Problem 13.** What is the output of the following C++ code?

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

void f(double &b){
    b = 2.0;
}

double g(double b, double &c, double d){
    b = 2.0 ;
    d = 2.0 ;
    f(c) ;
    return b ;
}

int main(){

    double a1 = 3, a2 = 3, a3 = 3;

    a1 = g(a1,a2,a3);

    cout << a1 << " " << a2 << " " << a3 << endl;
    return 0;
}
```

1. 2 2 3
2. 2 2 2
3. 3 3 3
4. 2 3 3

**Problem 14.** What is the output of the following C++ code?

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

double f(double x);
double g(double x);

int main(){

    double x = -2.0;
    while(true){
        if(g(x) == 0.0){
            x = sqrt(f(x));
            break;
        }
        x = x + 1.0;
    }
    cout << x ;
    return 0;
}

double f(double x){
    if(x > 0.0){return x;}
    return -x;
}

double g(double x){
    return x + pow(x,2.0);
}
```

1. -1.0
2. 0.0
3. 1.0
4. 2.0

**Problem 15.** What is the output of the following C++ code?

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

double f(double x = 2.0){
    return x*x ;
}

double f(double x , double y){
    return x*y ;
}

double g(double x){
    return -x ;
}

int main(){

    double x = 1.0 ;

    while(true){
        if(f(x) == f(f(),g(x))){break;}
        x -= 1.0 ;
    }
    cout << x ;
    return 0;
}
```

1. 1.0
2. 0.0
3. -1.0
4. -2.0



**Problem 16.** What is the output of the following C++ code?

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

double f(double a, double b, double c){
    if(a < b){return a;}
    if(b > c){return b;}
    return c;
}

double g(double a){
    return f(a, 2.0*a , 3.0*a) ;
}

int main(){
    cout << f(12.0, g(12.0), g(g(12.0))) ;
    return 0;
}
```

1. 0
2. 12
3. 24
4. 36

**Problem 17.** What is the output of the following C++ code?

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

int main(){

    vector<int> a{1, 2, 3, 4, 5};
    vector<int> b{-1, 2, 3, 4, -5};

    for(int i = 0 ; i < a.size() ; i ++){

        if(a[i] != b[i]){
            int c = a[i] ;
            a[i] = b[i] ;
            b[i] = c ;
        }
    }

    cout << b[1] << " " << b[4] ;
    return 0;
}
```

1. 1 4
2. 2 5
3. -1 4
4. 2 -5

**Problem 18.** What is the output of the following C++ code?

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

void f(int &a){
    a += 2 ;
}

int main(){

    int i;

    for(i = 0; i < 2; f(i)){

        f(i);
    }

    cout << i ;
    return 0;
}
```

1. 0
2. 2
3. 4
4. 6

**Problem 19.** Write the output of the following C++ code.

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

int main(){

    vector<string> a{"Python", "C++", "Math", "Java"};
    a.pop_back() ;
    a[a.size()-2].push_back('b') ;
    cout << a[a[0].length() - a.size()].length() ;
    return 0 ;
}
```

**Problem 20.** How many compile errors does the following code encounter? Catch them.

```
#include <iostream>

int main(){
    int n = 0 ;
    for(int i = 0; i < 4; i ++){
        n ++ ;
    }

    for(int i = 0; i < 3; i ++){
        n -- ;
    }

    int i = 1 ;
    for(int j = 0; j < 2; j++){
        n += i + j ;
    }
    return 0 ;
}
```

**Problem 21.** What is the output of the following C++ code?

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

void g(double &z){
    z -= 1.0 ;
    return ;
}

void f(vector<double> &y, int x = 1, bool flag = true){

    if(flag){
        g(y[x]);
    }
    return ;
}

int main(){

    vector<double> b = {1.0, 2.0, 3.0} ;
    f(b) ;
    cout << b[1] << " " << b[2] ;
    return 0 ;
}
```

1. 1 2
2. 0 2
3. 1 3
4. 2 3

**Problem 22.** What is the output of the following C++ code (note that it is not the same as the previous problem.)?

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

void g(double z){
    z -= 1.0 ;
    return ;
}

void f(vector<double> &y, int x = 1, bool flag = true){

    if(flag){
        g(y[x]);
    }
    return ;
}

int main(){

    vector<double> b = {1.0, 2.0, 3.0} ;
    f(b) ;
    cout << b[1] << " " << b[2] ;
    return 0 ;
}
```

1. 1 2
2. 0 2
3. 1 3
4. 2 3

**Problem 23.** Write the output of the following C++ code.

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

void g(string A, string &B, const string &C, const vector<string> &D){

    B.push_back(A.at(0));
    B.push_back(C[0]) ;
    B.push_back(D[D.size()-1].at(D[D.size()-1].length()-1)) ;
    return ;
}

int main(){

    string a1 = "A" ;
    string a2 = "AB" ;
    string a3 = "ABC" ;
    vector<string> a4 = {a2,a3} ;
    g(a1,a2,a3,a4) ;
    cout << a1 << " " << a2 << " " << a3 ;

    return 0 ;
}
```



**Problem 24.** Examine the C++ code snippet provided below. It contains a single compile error. Identify this error and provide a brief explanation for its occurrence. Note that there is only one error in the code, and you should list only that one error.

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

int main() {

    const string name = "ABCD" ;
    name.pop_back() ;

    return 0;
}
```

**your answer:**

**Problem 25.** What is the output of the following C++ code?

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

int main(){

    vector<int> a = {0,2,3,1,4,5};
    vector<string> b = {"a","b","c","d","e","f"};

    for (int i = 0; i < b.size() ; i ++){
        cout << b[a[i]] ;
    }
    return 0;
}
```

1. fedcba
2. abcdef
3. acdbfe
4. acdbef

**Problem 26.** What is the output of the following C++ code?

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

int f(const int &a);
int g(const int &a);

int main(){

    cout << f(5) << endl;
    return 0;
}

int f(const int &a){
    if(a==1){return a;}
    return g(a) ;
}

int g(const int &a){
    return f(a-1) ;
}
```

1. 5
2. 4
3. 1
4. 0

**Problem 27.** How many compile errors are in the following code?

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

int main(){
    int k = 0 ;
    for(int j = 1; j < 3; j ++){
        k ++ ;
    }

    int n = 0 ;
    for(int j = 0; j < 2; j ++){
        n -- ;
    }

    int j = 1 ;
    for(int i = 0; i < 2; i++){
        n += j + i + k ;
    }
    return 0 ;
}
```

1. zero
2. one
3. two
4. four

**Problem 28.** The following code encounters neither a warning nor a compile error.

- True
- False

```
#include <iostream>

int f(int x){
    if(x > 0){return x ;}
    if(x == 0){return x ;}
    if(x < 0){return -x ;}
}

int main(){
    return 0 ;
}
```

**Problem 29.** The following code encounters neither a warning nor a compile error.

- True
- False

```
#include <iostream>

int f(int x){
    if(x > 0){return x ;}
    else{return x ;}
}

int main(){
    return 0 ;
}
```

**Problem 30.** Which sentence is true about the following code?

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

int myAbsolute(int x){
    if(x > 0){return x ;}
    if(x == 0){return x ;}
    if(x < 0){return -x ;}
}

int main(){
    return 0 ;
}
```

1. This code encounters neither a compile error nor a warning because the `myAbsolute` function is not called inside the `main` function.
2. This code encounters a compile error or a warning, even though the `myAbsolute` function is not called inside the `main` function.
3. This code does not encounter any compile errors or warnings, whether or not the `myAbsolute` function is called inside the `main` function.
4. This code encounters a compile error or a warning because we do not call the `myAbsolute` function inside the `main` function.

**Problem 31.** Which code does **not** encounter any compile error?

1.

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

void f(int n){ cout << n ;}

int main(){
    cout << f(2) << endl ;
    return 0 ;}
```

2.

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

int add(int a, int b){return a+b ;}
double add(int a, int b){return 0.1*(a+b) ;}

int main() {
    return 0 ;}
```

3.

```
#include <iostream>
using namespace std;
int main(){
    const double number = 2.0 ;
    int n = 1 ;
    number += static_cast<double>(n) ;
    return 0 ;}
```

4.

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

void f(double &x){ x *= x ;}

int main(){
    double x = -1.0 ;
    f(x) ;
    return 0 ;}
```



**Problem 32.** What is the output of the following C++ code?

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

int main(){

    vector<string> a{"MATH", "C++", "Java"} ;
    a.push_back("Math") ;
    a[a.size()-1].pop_back() ;
    cout << a[a[3].length() - a.size() + 1].length() ;
    return 0 ;
}
```

1. 3
2. 4
3. 5
4. 6

**Problem 33.** What is the output of the following C++ code?

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

int g(int b);
void f(int &b);

int main(){

    int j = 0;

    for(j = g(j); j < 5; f(j)){

        f(j);
    }

    cout << j ;
    return 0;
}

int g(int b){
    return 2 ;
}

void f(int &b){
    b += 2 ;
}
```

1. 2
2. 4
3. 5
4. 6

**Problem 34.** Which code encounters an infinite loop?

1.

```
#include <iostream>
int main() {
    int j = 2023 ;
    while(true){
        if(j%3 == 0){break ;}
        j -- ;
    }
    return 0 ;}
```

2.

```
#include <iostream>
int main() {
    bool flag = true ;
    double sum = 1.0 ;
    for(int i = 1 ; i < 20 && flag ; i ++){
        sum += 2.0*i ;
        if(sum > i){flag = !flag ;}
    }
    return 0 ;}
```

3.

```
#include <iostream>
#include <string>
using namespace std;
int main(){
    string s = "ABCD" ;
    for(int i = 0 ; i < s.length() ; i ++){
        s.push_back(s[i]) ;
    }
    return 0 ;}
```

4.

```
#include <iostream>
int main(){
    bool flag = true ;
    while(true && (false || (flag && (true && (true || false))))) {
        flag = !flag ;
    }
    return 0 ;}
```

**Problem 35.** What is the output of the following C++ code?

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

int main(){

    string s1 = "abcd" ;
    string s2 ;
    for(int i = 1 ; i < s1.length() - 1 ; i ++){
        s2 += s1.substr(i,i+1) ;
    }
    cout << s2 ;
    return 0 ;
}
```

1. abcd
2. abccd
3. bccd
4. bcdd

**Problem 36.** What is the output of the following C++ code?

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

double g(double x = 1.0){
    return 2.0*x ;
}

double g(double x, double y){
    return x + y ;
}

double f(double x){
    return x ;
}

int main(){

    double x = 2.0 ;
    int j = 0 ;
    while(g(g(),f(x)) == g(x)){
        cout << j << " " ;
        j ++ ;
        x += 1.0 ;
    }
    return 0 ;
}
```

- 1.
2. 0
3. 0 1
4. 0 1 2

**Problem 37.** What is the output of the following C++ code?

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

int f(int &b, int c = 4){
    b = 4 ;
    return c ;
}

void g(int b, int c, int &d){
    b = f(b,c) ;
    c = f(d) ;
    return ;
}

int main(){

    int a1 = 3, a2 = 3, a3 = 3;

    g(a1,a2,a3);

    cout << a1 << " " << a2 << " " << a3 << endl;
    return 0;
}
```

1. 3 3 4
2. 3 4 4
3. 3 3 3
4. 4 3 4

**Problem 38.** What is the output of the following C++ code?

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

int main(){

    vector<bool> a{true, true, false};
    for (int j = a.size() ; j > 0 ; j --){

        if(!a[j-1]){a.push_back(true);}
    }
    cout << a.size() ;
    return 0 ;
}
```

1. 3
2. 4
3. 5
4. 6

**Problem 39.** What is the output of the following C++ code?

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

bool g(bool a, int k){
    if(k%3 == 0){
        return !a ;
    }
    return a ;
}

int main(){
    bool flag = true ;
    int summation = 1 ;
    for(int i = 4 ; g(flag,i) ; i ++){
        summation *= i ;
    }
    cout << summation ;
    return 0 ;
}
```

1. 4
2. 9
3. 20
4. 36



**Problem 40.** What is the output of the following C++ code?

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

void g(bool &x, vector<int> &y){

    if(x){
        y[y.size()-1] = 3 ;
        x = !x ;
    }

    return ;
}

vector<int> f(bool &z, int x = 1, int y = 2){

    vector<int> a(y,x) ;
    g(z,a) ;
    return a ;
}

int main(){

    bool flag = true ;
    vector<int> b = f(flag) ;

    if(flag){
        cout << b[0] << " " ;}
    else{
        cout << b[b.size()-1] ;
    }
    return 0 ;
}
```

1. 1
2. 3
3. 2 1
4. 3 2

**Problem 41.** Write the output of the following C++ code in the following box.

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

int main() {

    cout << "welcome " ;

    return 0 ;

    cout << "home!" ;
}
```

**your answer:**

**Problem 42.** Write the output of the following C++ code in the following box.

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

int main() {

    double a = 5 ;
    int b = 2.5 ;
    cout << a/b << endl ;

    return 0;
}
```

**your answer:**

**Problem 43.** Write the output of the following C++ code in the following box.

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

int main() {

    int i = 10 ;

    for (int i = 0; i < 3; i++) {
        int variation = i ;
    }

    cout << i ;
    return 0;
}
```

**your answer:**

**Problem 44.** Write the output of the following C++ code in the following box.

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

int g(int &x) {
    return x + 1 ;
}

int g(const int &x) {
    return x + 3 ;
}

int main() {

    int x = 2 ;

    cout << g(x) << endl ;
    cout << g(2) << endl ;
    cout << g(x+2) << endl ;
    cout << g(2*x) << endl ;

    return 0 ;
}
```

**your answer:**

**Problem 45.** Write the output of the following C++ code in the following box.

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

int g(int &x) {
    return x + 1 ;
}

int g(int x) {
    return x + 3 ;
}

int main() {

    int x = 2 ;

    cout << g(x) << endl ;
    cout << g(2) << endl ;
    cout << g(x+2) << endl ;
    cout << g(2*x) << endl ;

    return 0 ;
}
```

**your answer:**

**Problem 46.** Write the output of the following C++ code in the following box.

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

int main() {

    int i = 10 ;

    for (i = 0; i < 3; i++) {
        int variation = i ;
    }

    cout << i ;
    return 0;
}
```

**your answer:**

**Problem 47.** Write the output of the following C++ code in the following box.

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

int main() {

    string a = "ABCD" ;
    string *b = &a ;
    (*b).pop_back() ;

    cout << (*b) << endl ;
    cout << a.length() << endl ;

    return 0;
}
```

**your answer:**



**Problem 48.** Write the output of the following C++ code in the following box.

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

void g(int &z) {
    z ++ ;
    return;
}

void g(vector<int> &vec, int x = 2, bool flag = true) {

    if (flag) {

        g(vec.at(x));
    }

    return;
}

int main() {

    vector<int> vec = { 1, 2, 3};

    g(vec);

    cout << vec[1] << endl;
    cout << vec[2] << endl;

    return 0;
}
```

**your answer:**

**Problem 49.** Write the output of the following C++ code in the following box.

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

struct Person {
    private:
        string name;
        int age;
    public:
        Person(string person_name, int person_age) {
            name = person_name;
            age = person_age; }

        string getName() const {
            return name; }

        int getAge() const {
            return age; }
};

void f(Person &x, Person &y) {
    Person temp = x ;
    x = y ;
    y = temp ;
}

int main() {

    Person Lucy("Lucy", 24), Mary("Mary", 32) ;
    f(Lucy, Mary);
    cout << Lucy.getName() << endl ;
    cout << Mary.getAge() << endl ;
    return 0 ;
}
```

**your answer:**

**Problem 50.** Examine the C++ code snippet provided below. It contains a **single compile error**. Identify this error and provide a brief explanation for its occurrence.

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

struct Product {
    private:
        string name;
        int price = 400;
    public:
        Product(string product_name) {
            name = product_name;
        }
        void setNewPrice(int new_price) {
            price = new_price;
        }
};

int main() {

    Product Apple("Apple");
    Apple.setNewPrice(1200);
    cout << Apple.price;
    return 0;
}
```

**your answer:**

**Problem 51.** A student implemented the following C++ code to build a *Movie* class, including `movie.h`, `movie.cpp`, and `main.cpp` files. However, there is a single compile error. This error is related to how the constructor of the class was implemented. Briefly explain what the issue is with the constructor's implementation.

`movie.h`

```
#ifndef MOVIE_H
#define MOVIE_H

#include <iostream>

class Movie{
    private:
        int rating;
    public:
        Movie(int movie_rating = 7);
        int getRating() const;
};
#endif
```

`movie.cpp`

```
#include "movie.h"

Movie::Movie(int movie_rating = 7){
    rating = movie_rating ;}

int Movie::getRating() const {
    return this->rating ;}
```

`main.cpp`

```
#include "movie.h"
int main(){
    return 0 ;
}
```

**your answer:**

**Problem 52.** The C++ code provided below cannot be compiled. Briefly explain the reason. Note that there is only one specific reason that you should address and discuss.

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

struct Student {
    private:
        string name;
        double GPA;
    public:
        Student(string student_name, double student_GPA) {
            name = student_name;
            GPA = student_GPA;
        }
        double getGPA() {
            return GPA;
        }
};

double convertGPA(const Student &x) {

    return x.getGPA()*25.0 ;
}

int main() {

    Student Emma("Emma", 4.0), Erin("Erin", 3.9) ;
    return 0 ;
}
```

your answer:

**Problem 53.** Write the output of the following C++ code in the following box.

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

int main() {

    vector<int> a = {4,3,1,1,0};
    vector<int> b = {2,3,1,0,0};
    int sum = 0;
    for (int j = 1; j < a.size() - 2; j++) {
        sum -= a.at(b[j]) + b[a.at(j)];
    }
    cout << sum;
    return 0;
}
```

**your answer:**

**Problem 54.** Write the output of the following C++ code in the following box.

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

int main() {

    vector<bool> a = {true,false,false,true};
    for (int j = 1; j < a.size(); j++) {
        if (!a[j] || a[j - 1]){ a.pop_back() ;}
    }
    cout << a.size();
    return 0;
}
```

**your answer:**

**Problem 55.** Write the output of the following C++ code in the following box.

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

void f(int& a, int& b) {
    int variable = a;
    a = b;
    b = variable;
    return;}

void g(vector<int>& vec) {
    for (int i = 0; i < vec.size() - 1; i++) {
        for (int j = 0; j < vec.size() - 1 - i; j++) {
            if (vec[j] < vec[j + 1]){
                f(vec[j], vec[j + 1]);
            }
        }
    }
    return;}

void h(const vector<int>& vec) {
    for (int i = 0; i < vec.size(); i++) {
        cout << vec.at(i) << " ";
    }
    cout << endl;
    return;}

int main() {
    vector<int> q = {4,1,3,2,4,4};
    g(q);
    h(q);
    return 0;}
```

**your answer:**



**Problem 56.** Write the output of the following C++ code in the following box.

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

void f(bool z, double& x) {
    if(z){ x += 1; }
    return;
}

double f(double x, double z = 1) {
    return x + z;
}

double f(double x, bool z) {
    if(z){ return f(x, x); }
    f(z,x);
    return f(x);
}

int main() {
    double z = 1;
    f(true, z);
    cout << f(f(z, true), f(z, !true));
    return 0;
}
```

your answer:

**Problem 57.** Write the output of the following C++ code in the following box.

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

struct Student {
    private:
        string name;
        double GPA;
    public:
        Student(string student_name, double student_GPA) {
            name = student_name;
            GPA = student_GPA;
        }
        double getGPA() const {
            return GPA;
        }
};

void f(Student x = Student("Sarah",3.9)) {
    cout << x.getGPA() << endl;
}

int main() {
    Student Emma("Emma", 4.0);
    f();
    f(Emma);
    return 0;
}
```

**your answer:**

**Problem 58.** The C++ code provided below cannot be compiled. Briefly explain the reason. Note that there is only one specific reason that you should address and discuss.

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

struct Student {
    private:
        string name;
        double GPA;
    public:
        Student(string student_name, double student_GPA) {
            name = student_name;
            GPA = student_GPA;
        }
        double getGPA() const {
            return GPA;
        }
        void setNewGPA(double new_GPA) {
            GPA = new_GPA;
        }
};

int main() {

    const Student Emma("Emma", 4.0);
    Emma.setNewGPA(3.9);
    return 0;
}
```

**your answer:**

**Problem 59.** The C++ code provided below cannot be compiled. Briefly explain the reason. Note that there is only one specific reason that you should address and discuss.

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

struct Car{
    private:
        string name, model;
        int price;
    public:
        Car(string car_name, int car_price) {
            name = car_name; price = car_price;
        }
        Car(string car_name, int car_price, string car_model="BMW") {
            name = car_name; model = car_model; price = car_price;
        }
        string getModel() const {
            return this->model;
        }
        int getPrice() const {
            return this->price;
        }
};

int main() {
    Car Tesla("Tesla", 120000);
    return 0;
}
```

**your answer:**

**Problem 60.** Examine the C++ code snippet provided below. It contains a single compile error. Identify this error and provide a brief explanation for its occurrence. Note that there is only one error in the code, and you should list only that one error.

```
#include <iostream>

int main() {

    int sum;

    for(int j = 0; j < 3; j ++){
        sum += j ;
    }

    return 0;
}
```

**your answer:**

**Problem 61.** Examine the C++ code snippet provided below. It contains a single compile error. Identify this error and provide a brief explanation for its occurrence. Note that there is only one error in the code, and you should list only that one error.

```
#include <iostream>

void f(int &x){
    return ;
}

int main() {

    f(2);

    return 0;
}
```

**your answer:**

**Problem 62.** Examine the C++ code snippet provided below. It contains a single compile error. Identify this error and provide a brief explanation for its occurrence. Note that there is only one error in the code, and you should list only that one error.

```
#include <iostream>

void f(int x) {
    return;
}

int f(int x, bool flag = true) {
    return x;
}

int main() {
    int num = f(2);
    return 0;
}
```

**your answer:**

**Problem 63.** Examine the C++ code snippet provided below. It contains a single compile error. Identify this error and provide a brief explanation for its occurrence. Note that there is only one error in the code, and you should list only that one error. If you mention more than one error, you will receive zero credit for this problem.

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

int main() {

    const vector<int> a = {1,2,3} ;
    a.push_back(4) ;

    return 0;
}
```

**your answer:**



**Problem 64.** Write the output of the following C++ code in the following box.

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

struct Student {
    private:
        string name;
        double GPA;
    public:
        Student(string student_name, double student_GPA) {
            name = student_name;
            GPA = student_GPA;
        }
        double getGPA() const {
            return GPA;
        }
};

int main() {
    Student Emma("Emma", 4.0), Ella("Ella", 3.7), Stan("Stan", 3.9);
    vector<Student> team = {Emma, Ella, Stan} ;
    cout << team[1].getGPA() << endl ;
    return 0;
}
```

**your answer:**