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. What is the output of the following C++ code?

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

int main() {

   double a = 2.0 ;
   double b = 4.0 ;
   cout << a / b + 1.0 ;

   return 0;
}
```

1. 3.0
2. 0.4
3. 1.0
4. 1.5

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. Catch compile errors in the following code.

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

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

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

int main() {

   int sum;
   for(int i = 0 ; i < 2 , i++){
       sum += i ;
   }

   int n = 12 ;
   cout << f(n) << endl ;
   g(2) ;
   string s = "UCLA" ;
   string b = s.push_back('b') ;
   return 0;
}
```

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. Catch compile errors in the following code.

```
#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() {

   double a = pow(10.0, 2) ;
   const double b ;
   const int c = 10 ;
   int count = 0 ;
   while(count < 3){
       c -- ;
       count ++ ;
   }

   if(10 => 5){
       cout << "UCLA" << ;
   }else(10 < 5){
       cout >> "Programming" ;
   }
   return 0;
}
```

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{"UCLA", "C++", "PIC10A", "Midterm"};
   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. What is the output of the following C++ code?

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

int main(){

    string s1 = "1234" ;
    string s2 ;
    for(int i = 0 ; i < s1.length() - 1 ; i ++){
       s2 += s1.substr(i,i+1) ;
    }

    cout << s2 ;
    return 0 ;
}
```

1. 1234
2. 4321
3. 12343
4. 12334

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{"UCLA", "C++", "PIC10A"} ;
   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 = "UCLA" ;
    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. Write the output of the following C++ code in the following box.

```
#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) {
            name = car_name; model = car_model; price = car_price;
        }
        string getModel() const {
            return this->model;
        }
        int getPrice() const {
            return this->price;
        }
};

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

int main() {
    Car BMW("BMW", 160000), Benz("Benz", 150000, "SUV");
    f(BMW, Benz);
    cout << Benz.getModel() ;
    return 0;
}
```

your answer: