

Exam. 2 hours, open book.

**Exercise 1 (1pt)**

a) What is the output when the following code fragment is executed?

```
1    int n;  
2    int k = 7;  
3    int l = 9  
4    n = ((k%l)==3)?l/k:l*k;  
5    cout << "n = " << n << "      k = " << k << endl;
```

b) What is the exact output of the program below?

```
2    #include <iostream>  
3    using namespace std;  
4    main()  
5    {  
6        int n = 7, k = 8;  
7        cout << ++n << endl;  
8        cout << n << endl;  
9        cout << n++ << endl;  
10       cout << n << endl;  
11       cout << -n << endl;  
12       cout << n << endl;  
13       cout << --n << endl;  
14       cout << n << endl;  
15       cout << n-- << endl;  
16       cout << n << endl;  
17       cout << n + k << endl;  
18       cout << n << endl;  
19       cout << k << endl;  
20       cout << n << " " << k << endl;  
21       cout << "n" << endl;  
22       cout << " n * n = ";  
23       cout << n * n << endl;  
24    }
```

**Exercise 2 (1pt)**

The following code is someone's first effort to print the marks of ten students. It compiles without error but does not generate the expected output (actual output shown below). Correct the code.

```
1    #include <iostream>  
2  
3    int data[]={8,14,25,31,45,54,65,73,86,96};  
4    int main()  
5    {  
6        for(int i=1; i<=10; i++)  
7            std::cout << data[i] << " ";  
8            std::cout << std::endl;  
9            return 0;  
10    }
```

output

14 25 31 45 54 65 73 86 96 4264820

### Exercise 3 (2pt)

What is the output of the following program ?

```
1  #include <iostream>
2  using namespace std;
3  main()
4  {
5      enum color_type {red, orange, yellow, green, blue, violet};
6      color_type shirt, pants;
7      shirt = red;
8      pants = blue;
9      cout << shirt << " " << pants << endl;
10     return 0;
11 }
```

### Exercise 4 (3pt)

- a) Write a program that ask the user to input 10 integer, that must be stored in an array. The program must then find and print the highest integer in the array as well as it's index (position)
- b) Write a function called factorial, that take one integer  $n$  as an input, and return the factorial of  $n$
- c) The function *mean* is declared the following way.

```
1 double mean(int *val, int n);
```

where *val* is a pointer to the beginning of an array and *n* the size of the array. The return value is the mean value of the values inside the array.

For example it can be use in the following main program :

```
1 int main(){
2     int a[] = {1,2,5,6,7}
3     std::cout << mean (a, 5) << std::endl;
4 }
```

Write an implementation of the mean function.

### Exercise 5 (2pt)

- a) The following function won't compile. Explain why.

```
1 void addone(const int & a){
2     a+=1;
3     return;}
```

- b) Write the output of the following program. Explain the difference between the functions add1 add2 and add3

```
1 #include <iostream>
2 void add1(int a){
3     a+=+1;
4     std::cout << a <<std::endl;
5 };
6 void add2(int &a){
7     a+=1;
```

```

8      cout << a << endl;
9  };
10 void add3(int *a){
11     (*a) +=1;
12     cout << *a << endl;
13 };
14 int main(){
15     int a =1;
16     std::cout << a << std::endl;
17     add1 ( a);
18     std::cout << a << std::endl;
19     add2 (a);
20     std::cout << a << std::endl;
21     add3(&a);
22     std::cout << a << std::endl;
23 }

```

### Exercise 6 (1pt)

What is the output of the following program ? Explain the statement (\*pb) --; on line 5

```

1  #include <iostream>
2  int main(){
3      int a = 5;
4      int * pb = &a;
5      (*pb) --;
6      std::cout << a << std::endl;
7  }

```

### Exercise 7 (3pt)

Write a function named "eliminate\_duplicates" that takes an array of integers in random order and eliminates all the duplicate integers in the array. The function should take two arguments:

- (1) a pointer to an array of integers;
- (2) an integer that tells the number of cells in the array.

The function should not return a value, but if any duplicate integers are eliminated, then the function should change the value of the argument that was passed to it so that the new value tells the number of distinct integers in the array.

Here is an example. Suppose the array passed to the function is as shown below, and the integer passed as an argument to the function is 11.

58 | 26 | 91 | 26 | 70 | 70 | 91 | 58 | 58 | 66

Then the function should alter the array so that it looks like this:

58 | 26 | 91 | 70 | 66 | ?? | ?? | ?? | ?? | ??

and it should change the value of the argument so that it is 5 instead of 11 . The question marks in the cells after the 5th cell indicate that it does not matter what numbers are in those cells when the function returns.

### Exercise 8 (3pt)

The following class, defined in the file vector2d.h, is used to describe vector in a two dimensional space. Write an implementation of the constructor and of the three members function on line 4, 5, 6 in a separate .cc file. operator + should return the sum of two vectors, operator – the difference of two vector2d, and operator \* should return the scalar product of two vector2d.

Write then a main program that call each of this functions.

```

1      class vector2d {
2      public:
3          vector2d(const double & x, const double & y);
4          vector2d operator + (const vector2d & v) const;
5          vector2d operator - (const vector2d & v) const;
6          double operator * (const vector2d &v) const;
7      private:
8          double x, y;
9      };

```

### Exercise 9 (2 pts).

- a) Explain what is a derived class, and describe how to implement one in c++.
- b) Explain what is a virtual function.
- c) Here is a simple class hierarchy, made of a base class call *base* and a derived class *deri*.

```

1      #include <iostream>
2      using namespace std;
3      class shape {
4      public:
5          virtual int corner() =0
6      };
7
8      class square : public shape {
9      public:
10         int corner()  { return 4; }
11     };
12     class hexagone : public shape {
13     public:
14         int corner()  { return 6; }
15     };

```

This class hierarchy is used in the following main program :

```

1      int main() {
2          square sq;
3          hexagone hex;
4          shape *psh = &sq
5          cout << psh->corner();
6          psh = &hex;
7          cout << psh->corner();
8      }

```

What is the output of the program ?

### Exercise 10 (2 pts)

- b) What is a function template ?
- c) Here is a simple function template :

```

1      template <class myType>
2      bool Equal (myType a, myType b) {
3          return (a==b?1:0);
4      };

```

- What are the requirements on the template parameter myType for the function Equal to be use for a given type ?
- Write a main program that use the function Equal to compare two double.