1.124 Quiz 1

Thursday October 8, 1998

Time: 1 hour 15 minutes
Answer all questions. All questions carry equal marks.

Question 1. The following code is to be built and run as follows:

Compile as	g++ -c Point.C g++ -c myprog.C
Link as	g++ -o myprog myprog.o Point.o
Run as	myprog

Would you expect to see
(a) a compile-time error?
(b) a link-time error?
(c) a run-time error?
(d) none of the above errors.

Explain briefly.

Answer:

A link-time error.

The global object *a* is not defined anywhere.

Point.h

```
class Point {
   private:
  int x, y;
   public:
  Point() {}
  void set_coords(int x, int y);
};
```

Point.C

```
#include "Point.h"

void Point::set_coords(int x, int y) {
  // Assume that this sets the private data.
}
```

myprog.C

```
#include "Point.h"
extern Point a;

int main() {
  a.set_coords(2,3);
  return 0;
}
```

Question 2. Fill in the body of the member function, *set_coords*, so that it properly sets the private member data in class *Point*.

Answer:

```
void Point::set_coords(int x, int y) {

    this->x = x;   // or Point::x = x;
    this->y = y;   // or Point::y = y;

}
```

Question 3. Write a member function, *access_x*, that can be used **either to set or to get** the value of the private member, *x*. Your function should work with the following code:

```
class Point {
   private:
  int x, y;

   public:
  Point() {}
```

Answer:

```
  int& access_x() {
     return x;
  }
```

```
};


int main() {
  Point a;
  int i;

  a.access_x() = 5;
  i = a.access_x();
  return 0;
}
```

Question 4. Is the following class declaration valid? Explain briefly.

```
class Point {
   private:
  int x, y;
  Point a;

   public:
  Point() {}
};
```

Answer:

No.

A class cannot contain a member of the same data type. In this example, the compiler has no way to determine the size of a *Point* object.

Question 5. Examine the following code carefully and explain the **exact** sequence of constructor calls.

```
class Point {
   private:
  int x, y;

   public:
  Point() { x = y = 0; }                          // Constructor #1
  Point(int ix, int iy) { x = ix; y = iy; }       // Constructor #2
  Point(const Point& p) { x = p.x; y = p.y; }     // Constructor #3
  ~Point() {}
};

Point foo(Point p) {
  static Point c(p);
  return c;
}

int main() {
  Point a(2,3);
  Point b;

  b = foo(a);
  a = foo(b);
  return 0;
}
```

Answer:

Constructor #	Reason
2	Definition of object *a*.
1	Definition of object *b*.
3	Pass by value into *foo()*.
3	Definition of object *c*.
3	Return by value from *foo()*.
3	Pass by value into *foo()*.
3	Return by value from *foo()*.

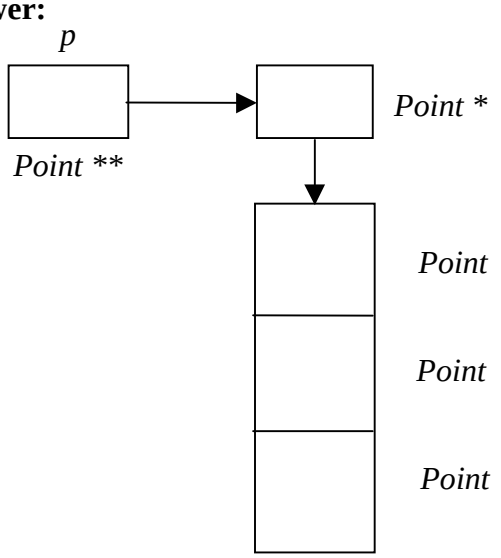
Question 6. Examine the following code carefully and draw a diagram to illustrate the data structures that it creates. Be sure to indicate all data types on your diagram.

```
class Point {
   private:
  int x, y;

   public:
  Point() { x = y = 0; }
  Point(int ix, int iy) { x = ix; y = iy; }
};

int main() {
  Point **p;
  p  = new Point *;
 *p = new Point[3];
  for (int i = 0; i < 3; i++) {
    (*p)[i] = Point(i, 0);
  }
  return 0;
}
```

Answer:



Question 7. In the following code, circle the statements that will produce compilation errors. Explain your reasoning.

```
class Point {
   private:
  int x, y;
  static int i;

   public:
  Point() {}
  static void set_data(int a, int b, int c) {
    x = a;  y = b;  i = c;
  }
};

int Point::i = 0;

int main() {
  Point::i++;
  Point *p = new Point;
  p->set_data(2,3,1);
  delete p;
  return 0;
}
```

Answer:

There are two errors.

(1) Static member functions cannot access non-static members. Static member functions can be invoked even if no objects exist, whereas non-static members belong to objects.
(2) Private data is not accessible outside the class definition.

Question 8. Identify and explain the errors, if any, in the following code.

```
#include <iostream.h>

class Point {
   private:
  const int x, y;

   public:
  Point(int ix = 0, int iy = 0) : x(ix), y(iy) { }
  void print() const { cout << "(" << x << ", " << y << ")" << endl; }
};

int main() {
  const int i = 0;
  const Point a;
  Point * const p = new Point(2,3);
  const Point& b = a;

  b.print();
  p->print();

  delete p;
  return 0;
}
```

Answer:

There are no errors.

Part II

In the code below answer the following questions:

```
#include <iostream.h>

class Point {                        // Line 1
 private:
   int x, y;
 public:
   Point(){x=0;y=0;}
   Point(int a, int b){x=a;y=b;}
   ~Point(){};
   ??? operator+(Point&);
   ??? operator<<(???);
   ??? operator[](???);
};
```

Question 9. Give the body of the code i.e. the definition, for *operator+* including the return type so that the code adds together two Point objects so that the following code will work.

```
main(){
  Point a(2,3),b(3,3);
  Point c = a + b;
}
```

```
Point Point::operator +(const Point& p)const{
        return Point(x+p.x,y+p.y);
}
```

Question 10 What changes would you make to make the following code work. Make any assumptions you need to about how the code should interpret the meaning of the statements below.

```
main(){
  Point a(2,3),b(3,3);
  Point c =  b + 7;
}
```

```
Point(int a, int b=0):x(a),y(b){};
```

Question 11 Give the body of the code to overload operator[] which should allow the following code to work

```
main(){
  Point a(2,3);
  a[0] = 4;
  a[1] = 2*a[0];
}
```

```
int& Point::operator [](int i){
        if(i == 0) return x;
        else if(i == 1) return y;
        else {
cout << "error in index for Point object"<< endl;
        }
}
```

Question 12 Give the body of the code to overload the output operator<< for the Point object so that the following code will work.

```
#include <iostream.h>
main(){
  Point a(2,3), b(3,3);
  cout << a << b;
}
```

Answer:

```
ostream& operator<<(ostream& o, Point& p){
 o << "x = "<< p[0] <<", y = "<< p[1] << endl;
return o;
}
```

For the code below answer the following questions:

```
class Shape{
   private:
  Point center;
   public:
  Shape(const Point&);
  virtual ~Shape();
  void set_center(const Point&);
  Point get_center(){return center;}
  virtual void print(){cout << "Center at  "<<center[0]<<","<<center[1]<< endl;};
};

class Circle:public Shape
{
   private:
         int radius;
   public:
         Circle();
     Circle(int,int, int)?????
     Circle(Point&,int)?????
    Circle(Circle&) ????
     ~Circle();
     void print(){};
};
```

Question 13 How many bytes of data are needed for the variables in a Circle object?

There are 3 int objects which take 12 bytes.

Question 14 Are there any inline functions in class Shape? If so name them.

get_center() is an inline function
print() is NOT because its virtual.

Question 15 Write down all the functions in class Circle that can access **center** in the
private part of Shape.

There are no functions that can access the private part of Shape.

Question 16 Write the definition of the copy constructor for class Circle.

```
Circle(Circle& c){radius =
c.radius;set_center(c.get_center());}
```

Question 17 How would we make the class Shape an abstract class? What does an abstract class mean?

Set any function = 0 eg
func() = 0;

Question 18 Will the following code compile without errors?

```
main(){
  int  x=5.0,y=6.0;
  int radius = 2;
  Shape* a;
  a = new Circle(x, y, radius);
  Circle b(*a);
  a = &b;
  a->print();
  delete a;
};
```

It will compile without errors.

Question 19 What would the code above print out if print() was **NOT** a virtual function in class Shape?

Center at 5,6
If it were a virtual function it would print
Center at 5,6 with radius 2

Question 20 How many bytes of memory would be released on line 10 if the destructors were NOT virtual.

```
main(){
  int  x=5.0,y=6.0;
  int radius = 2;
  Shape* a;
  a = new Circle(x, y, radius);
  Circle b(*a);
 // a=&b;  this line taken out
  a->print();
  delete a;
};
```

8 Bytes since it would just destroy the Shape part of the object

File point.h

```
#include <iostream.h>
class Point {                    // Line 1
 private:
   int x, y;
 public:
   Point(){x=0;y=0;}
   Point(int a, int b=0):x(a),y(b){};
   Point(const Point&);
   Point operator+(const Point&)const;
   int& operator[](int);
   ~Point(){};
   friend ostream& operator<<(ostream&, Point&);
};
```

file shape.h

```
#include "point.h"
#include <iostream.h>
class Shape{
    private:
  Point center;
    public:
                    Shape(){center[0]=0;center[1]=0;}
  Shape(const Point&);
  virtual ~Shape(){};
  void set_center(const Point&);
  Point get_center(){return center;}
  virtual void print(){cout <<"center at "<<center[0] <<","<< center[1];};
};
```

file circle.h

```
#include "shape.h"
class Circle:public Shape
{
    private:
          int radius;
    public:
          Circle():Shape(),radius(0){};
    Circle(int a,int b, int r):radius(r){set_center(Point(a,b));}
    Circle(Point& p,int r):Shape(p),radius(r){}
    Circle(Circle& c){radius = c.radius;set_center(c.get_center());}
    virtual ~Circle();
          void print(){Shape::print(); cout<<" with radius "<< radius<<endl;};
```

```
};
```

file point.C

```
Point::Point(const Point& p)
{
        x = p.x;
        y = p.y;

}
Point Point::operator +(const Point& p)const{
        return Point(x+p.x,y+p.y);
}

int& Point::operator [](int i){
        if(i == 0) return x;
        else if(i == 1) return y;
        else {
                cout << "error in index for Point object"<< endl;
        }
}

ostream& operator<<(ostream& o, Point& p){
                o << "x = "<< p[0] <<", y = "<< p[1] << endl;
                return o;
}
```

File shape.C

```
#include "shape.h"

void Shape::set_center(const Point& p){
        center = p;
}
```

File circle.C

```
#include "circle.h"

Circle::~Circle(){}
```

File shape_test.C

```
#include "point.h"
#include "shape.h"
#include "circle.h"
int main(int argc, char* argv[])
{
  Point a(2,3), b(3,3);
  Point c =  b + 7;
  c = a + b;

  cout << a << b;
  Circle d(4,5,6);
  d.print();
  Circle e(d);
  e.print();
  Shape* sp;
  sp = &e;
  sp->print();
          return 0;
}
```