“And so, from Europe, we get things such as ... object-oriented analysis and design (a clever way of breaking up software programming instructions and data into small, reusable objects, based on certain abstraction principles and design hierarchies.)”

-Michael A. Cusumano, 
*The Business Of Software*
public static void cp(Point p) {
    p.translate(2, 3); // add to x, y
    p = new City(4, 7);
}

// client code of cp
Point c1 = new Point(1, 2); // x, y
    cp(c1);
    cp(c1);
    System.out.println(c1);

A. (3, 5)
B. (1, 5)
C. (4, 7)
D. (6, 10)
E. error (syntax error or runtime error)
Encapsulation

- Encapsulation forces *abstraction*.
  - separates external view (behavior) from internal view (state)
  - protects the integrity of an object's data
Private fields

A field that cannot be accessed from outside the class

```java
private type name;
```

- Examples:

```java
private int id;
private String name;
```

- Client code won't compile if it accesses private fields:

  ```java
  PointMain.java:11: x has private access in Point
  System.out.println(p1.x);
  ^
  ```
Accessing private state

// A "read-only" access to the x field ("accessor")
public int getX() {
    return x;
}

// Allows clients to change the x field ("mutator")
public void setX(int newX) {
    x = newX;
}

- Client code will look more like this:

  System.out.println(p1.getX());

  p1.setX(14);
// A Point object represents an (x, y) location.
public class Point {
    private int x;
    private int y;

    public Point(int initialX, int initialY) {
        x = initialX;
        y = initialY;
    }

    public int getX() {
        return x;
    }

    public int getY() {
        return y;
    }

    public double distanceFromOrigin() {
        return Math.sqrt(x * x + y * y);
    }

    public void setLocation(int newX, int newY) {
        x = newX;
        y = newY;
    }

    public void translate(int dx, int dy) {
        setLocation(x + dx, y + dy);
    }
}
Benefits of encapsulation

- Abstraction between object and clients

- Protects object from unwanted access
  - Example: Can't fraudulently increase an Account's balance.

- Can change the class implementation later
  - Example: Point could be rewritten in polar coordinates \((r, \theta)\) with the same methods.

- Can constrain objects' state (invariants)
  - Example: Only allow Accounts with non-negative balance.
  - Example: Only allow Dates with a month from 1-12.
The keyword this

reading: 8.3
The **this** keyword

- **this**: Refers to the implicit parameter inside your class.
  
  *(a variable that stores the object on which a method is called)*

- Refer to a field: `this.field`

- Call a method: `this.method(parameters);`

- One constructor can call another: `this(parameters);`
Variable shadowing

- **shadowing**: 2 variables with same name in same scope.
  - Normally illegal, except when one variable is a field.

```java
public class Point {
    private int x;
    private int y;
    ...

    // this is legal
    public void setLocation(int x, int y) {
        ...
    }
}
```

- In most of the class, `x` and `y` refer to the fields.
- In `setLocation`, `x` and `y` refer to the method's parameters.
Fixing shadowing

```java
public class Point {
    private int x;
    private int y;
    ...
    public void setLocation(int x, int y) {
        this.x = x;
        this.y = y;
    }
}
```

- Inside `setLocation`,
  - To refer to the data field `x`, say `this.x`
  - To refer to the parameter `x`, say `x`
public class Point {
    private int x;
    private int y;

    public Point() {
        this(0, 0); // calls (x, y) constructor
    }

    public Point(int x, int y) {
        this.x = x;
        this.y = y;
    }

    ...
}

• Avoids redundancy between constructors
• Only a constructor (not a method) can call another constructor