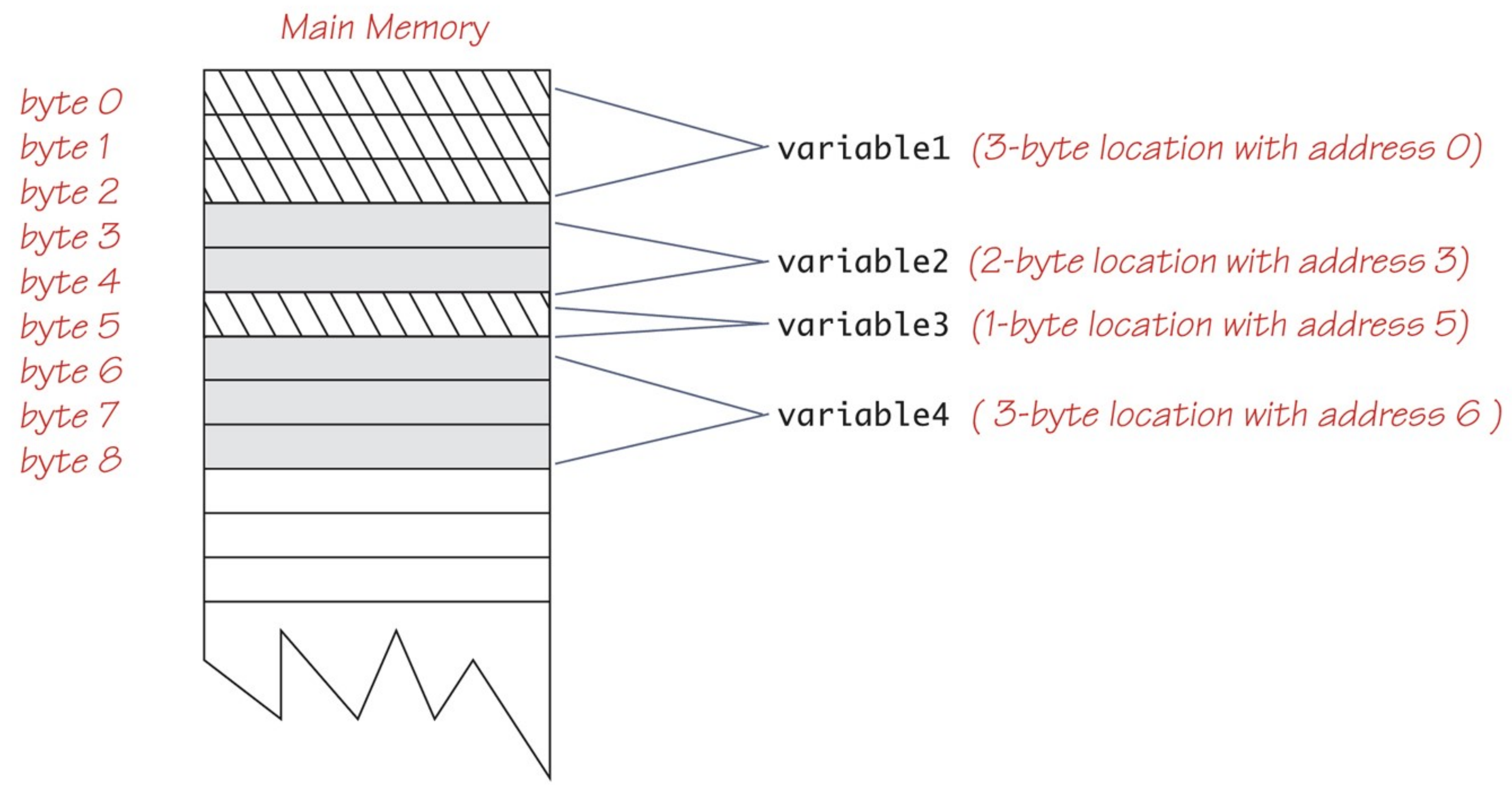
# Object storage in memory

## Variables and Memory

- Values of most data types require more than one byte of storage
  - Several adjacent bytes are then used to hold the data item
  - The entire chunk of memory that holds the data is called its *memory location*
  - The address of the first byte of this memory location is used as the address for the data item
- A computer's main memory can be thought of as a long list of memory locations of *varying sizes*

# Variables in Memory

**Display 5.10 Variables in Memory**



Main Memory
byte 0
byte 1
byte 2
byte 3
byte 4
byte 5
byte 6
byte 7
byte 8
variable1 (3-byte location with address 0)
variable2 (2-byte location with address 3)
variable3 (1-byte location with address 5)
variable4 ( 3-byte location with address 6 )

## References

- Every variable is implemented as a location in computer memory
- When the variable is a primitive type, the value of the variable is stored in the memory location assigned to the variable
  - Each primitive type always require the same amount of memory to store its values

## REFERENCES

- When the variable is a class type, only the memory address (or *reference*) where its object is located is stored in the memory location assigned to the variable
  - The object named by the variable is stored in some other location in memory
  - Like primitives, the value of a class variable is a fixed size
  - Unlike primitives, the value of a class variable is a memory address or reference
  - The object, whose address is stored in the variable, can be of any size

# Class Type Variables Store a Reference (Part 1 of 2)

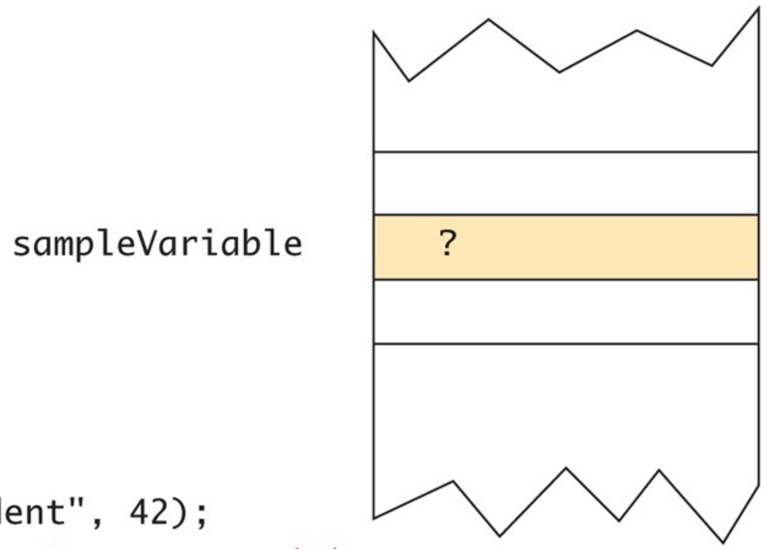
**Display 5.12 Class Type Variables Store a Reference**

```
public class ToyClass
{
     private String name;
     private int number;
```

*The complete definition of the class* `ToyClass` *is given in Display 5.11.*

```
ToyClass sampleVariable;
```

*Creates the variable* `sampleVariable` *in memory but assigns it no value.*



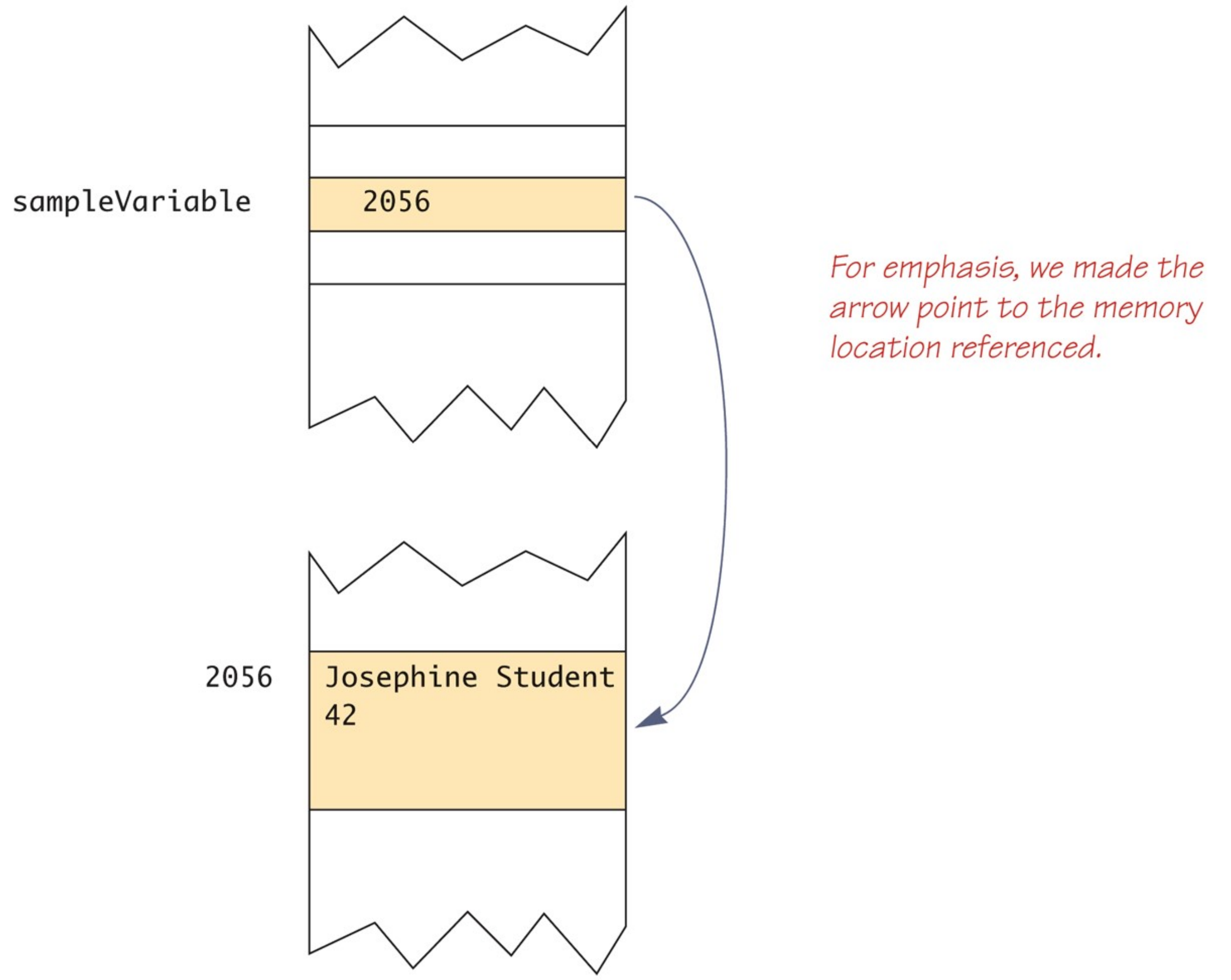
```
sampleVariable =
new ToyClass("Josephine Student", 42);
```

*Creates an object, places the object someplace in memory, and then places the address of the object in the variable* `sampleVariable`*. We do not know what the address of the object is, but let's assume it is* `2056`*. The exact number does not matter.*

(continued)

## Class Type Variables Store a Reference (Part 2 of 2)

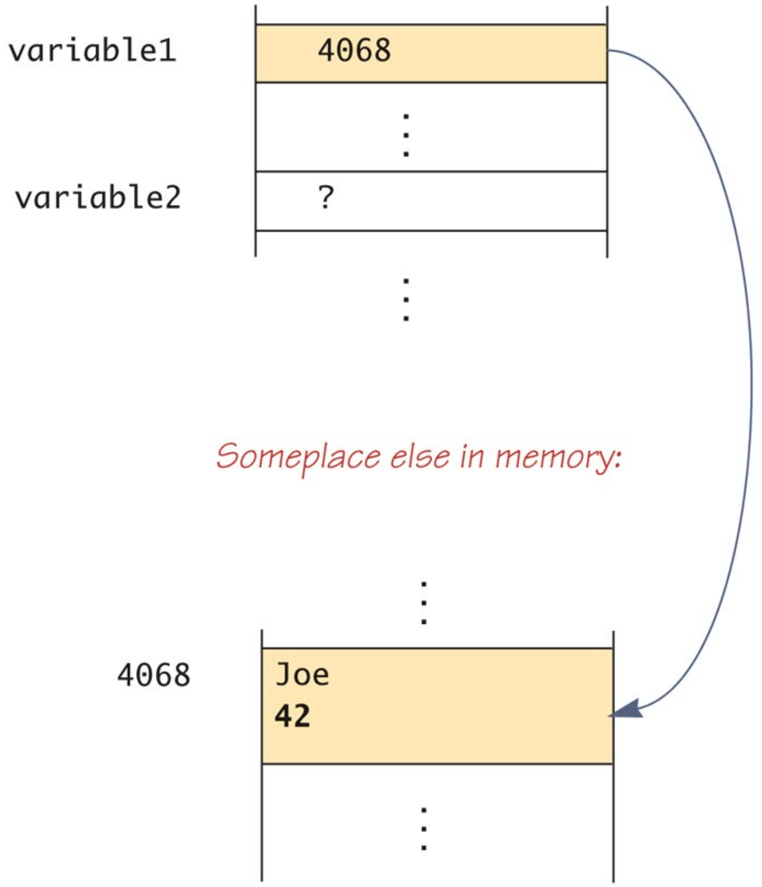
**Display 5.12** **Class Type Variables Store a Reference**


sampleVariable
2056
2056
Josephine Student
42
For emphasis, we made the arrow point to the memory location referenced.

## Assignment Operator with Class Type Variables (Part 1 of 3)

**Display 5.13 Assignment Operator with Class Type Variables**

```
ToyClass variable1 = new ToyClass("Joe", 42);
ToyClass variable2;
```



*We do not know what memory address (reference) is stored in the variable* `variable1`*. Let's say it is* `4068`*. The exact number does not matter.*

*Note that you can think of*

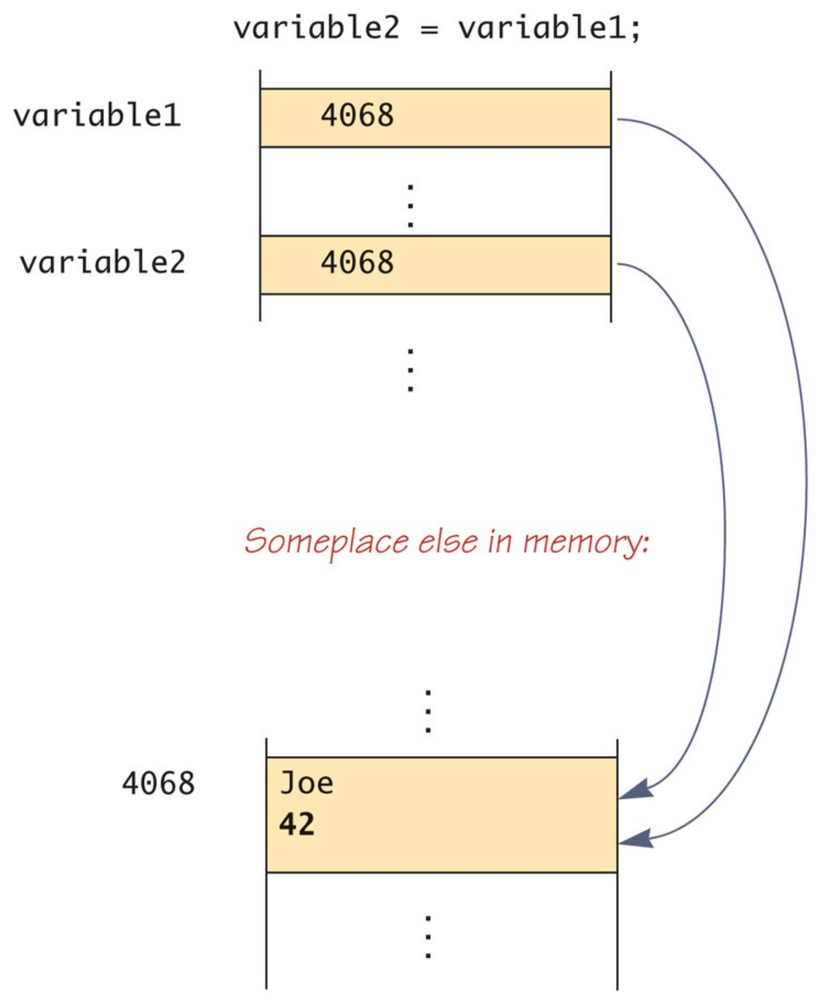
```
new ToyClass("Joe", 42)
```

*as returning a reference.*

(continued)

## Assignment Operator with Class Type Variables (Part 2 of 3)

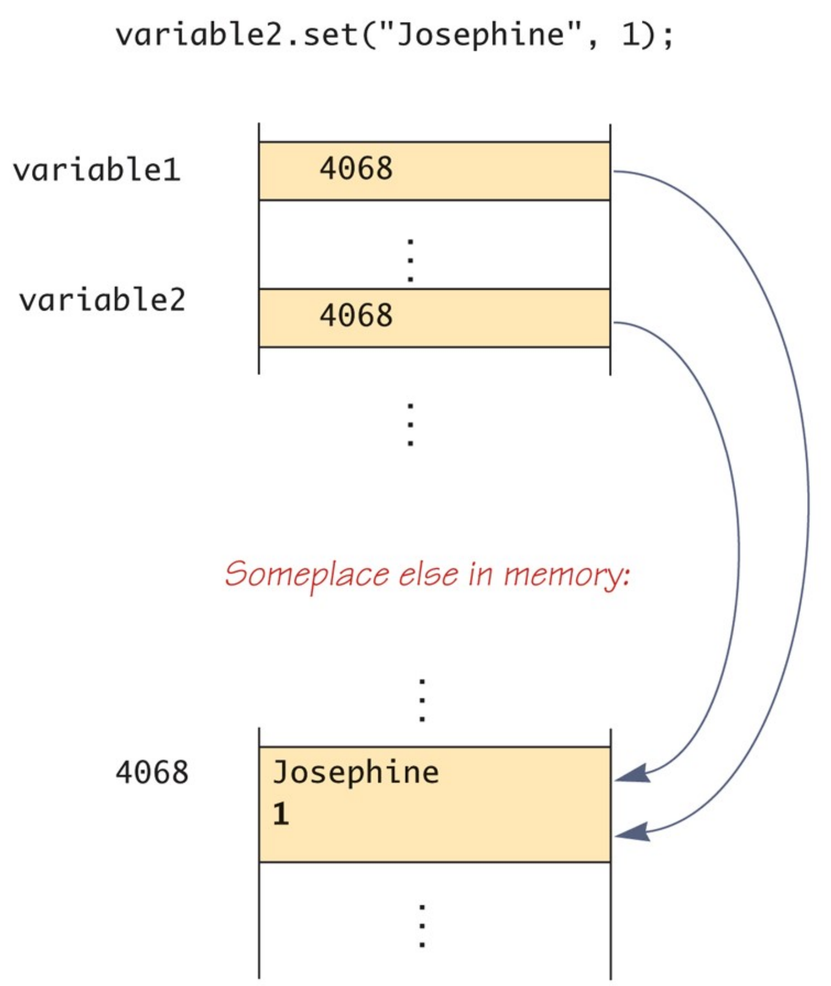
**Display 5.13 Assignment Operator with Class Type Variables**



(continued)

# Assignment Operator with Class Type Variables (Part 3 of 3)

**Display 5.13 Assignment Operator with Class Type Variables**



## References

- Two reference variables can contain the same reference, and therefore name the same object
  - The assignment operator sets the reference (memory address) of one class type variable equal to that of another
  - Any change to the object named by one of theses variables will produce a change to the object named by the other variable, since they are the same object

```
variable2 = variable1;
```

## The equals Method

- When the == operator is used with reference variables, the memory address of the objects are compared.
- The contents of the objects are not compared.

- If we try the following:

```
Stock stock1 = new Stock("GMX", 55.3);
Stock stock2 = new Stock("GMX", 55.3);
if (stock1 == stock2) // This is a mistake.
  System.out.println("The objects are the same.");
else
  System.out.println("The objects are not the same.");
```

only the addresses of the objects are compared.

## Methods That Copy Objects

- There are two ways to copy an object.
  - You cannot use the assignment operator to copy reference types
  - Reference only copy (shallow Copy)
    - This is simply copying the address of an object into another reference variable.

```
Stock stock1 = new Stock("GMX", 55.3);
Stock stock2 = stock1;
```

  - Deep copy (correct)
    - This involves creating a new instance of the class and copying the values from one object into the new object.

## Copy Constructors

- A copy constructor accepts an existing object of the same class and clones it

```
public Stock(Stock object2)
{
 if (object2 == null) //Not a real stock.
   {
     System.out.println("Fatal Error.");
     System.exit(0);
   }
      this.symbol = object2.symbol;
      this.sharePrice = object2.sharePrice;
}

// Create a Stock object
Stock company1 = new Stock("XYZ", 9.62);

//Create company2, a copy of company1
Stock company2 = new Stock(company1);
```

## END