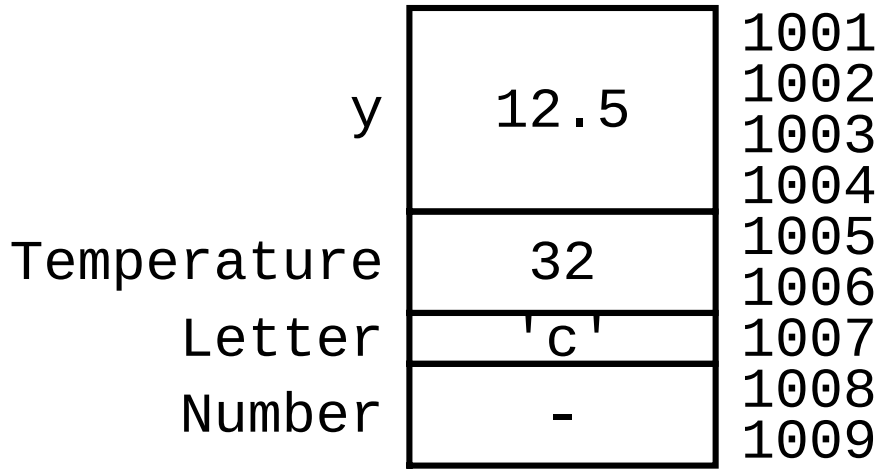
J. P. Cohoon and J. W. Davidson

Modifying objects

Operators and Expressions

Memory Depiction

```
float y = 12.5;
int Temperature = 32;
char Letter = 'c';
int Number;
```



Assignment Statement

- Basic form
  - *object* = *expression* ;


```
Celsius = (Fahrenheit - 32) * 5 / 9;
y = m * x + b;
i = i + 1;
Remember = CurrentValue;
```

- Action
  - Expression is evaluated
  - Expression value stored in object

Assignment Statement

```
int NewStudents = 6;
int OldStudents = 21;
int TotalStudents;
```

NewStudents	6
OldStudents	21
TotalStudents	-

```
TotalStudents = NewStudents + OldStudents;
```

NewStudents	6
OldStudents	21
TotalStudents	27

Assignment Statement

```
TotalStudents = NewStudents + OldStudents;
```

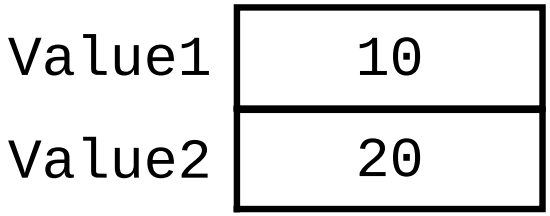
NewStudents	6
OldStudents	21
TotalStudents	27

```
OldStudents = TotalStudents;
```

NewStudents	6
OldStudents	27
TotalStudents	27

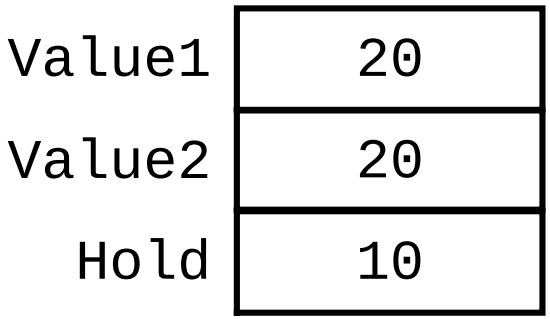
Suppose

```
Value1 = 10;
Value2 = 20;
```

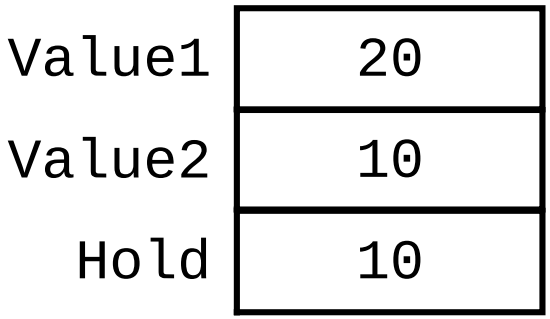


Consider

```
int Hold = Value1;
Value1 = Value2;
```

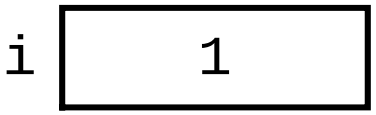


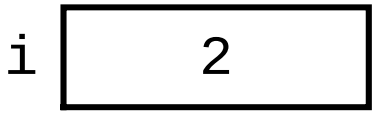

```
Value2 = Hold;
```



Incrementing

```
int i = 1;
```






```
i = i + 1;
```

Assign the value of expression `i + 1` to `i`

Evaluates to 2

Const Definitions

- Modifier `const` indicates that an object cannot be changed
  - Object is read-only
- Useful when defining objects representing physical and mathematical constants

```
const float Pi = 3.1415;
```

- Value has a name that can be used throughout the program

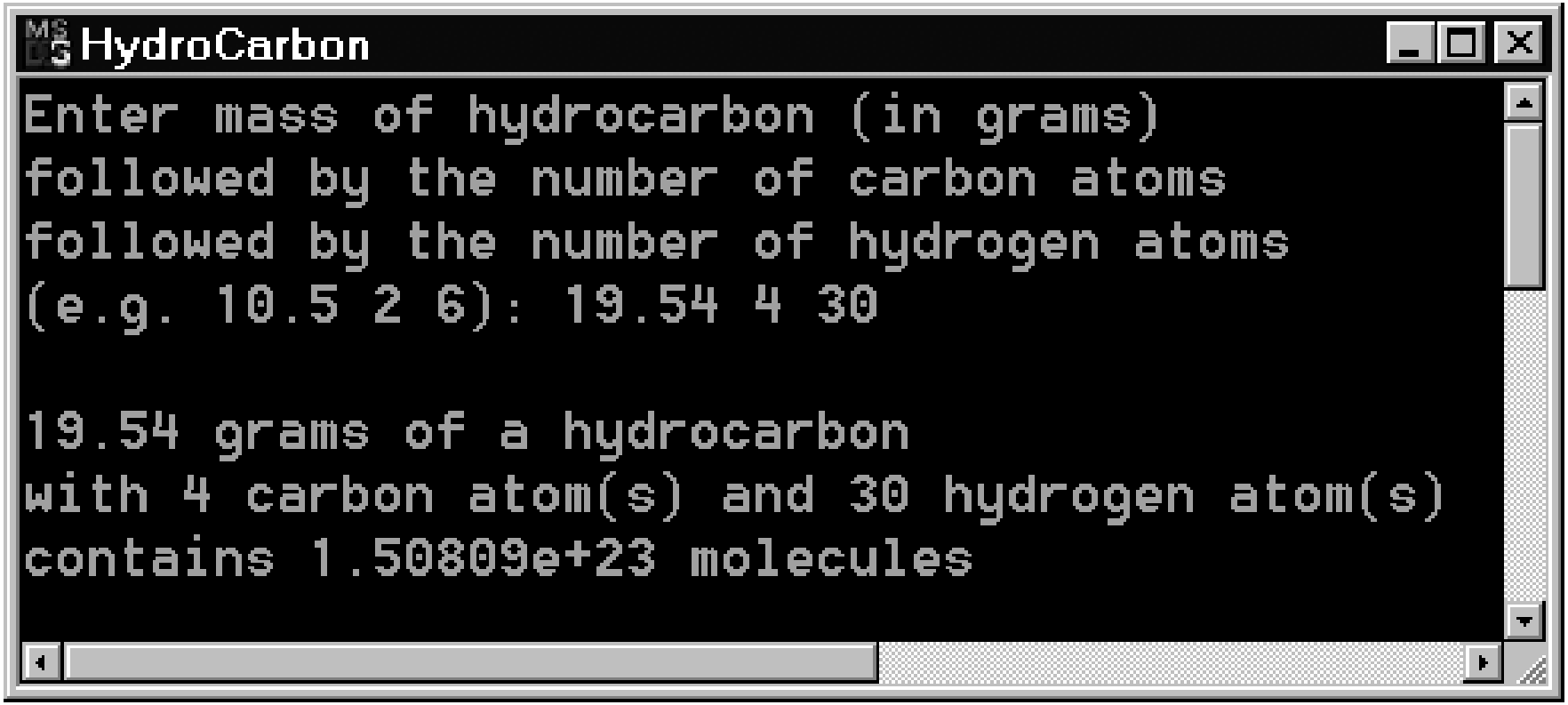
```
const int SampleSize = 100;
```

- Makes changing the constant easy
  - Only need to change the definition and recompile

```
// Program 3.2

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

int main() {
   cout << "Enter mass of hydrocarbon (in grams)\n"
   "followed by the number of carbon atoms\n"
   "followed by the number of hydrogen atoms\n"
    "(e.g. 10.5 2 6): " ;

   float Mass;
   int CarbonAtoms;
   int HydrogenAtoms;
   cin >> Mass >> CarbonAtoms >> HydrogenAtoms;
```

```
// Program 3.2 (continued)

   const int CarbonAMU = 12;
   const int HydrogenAMU = 1;

   long int FormulaWght = (CarbonAtoms * CarbonAMU)
    + (HydrogenAtoms * HydrogenAMU);

   const double AvogadroNbr = 6.02e23;
   double Molecules = (Mass / FormulaWght) *
    AvogadroNbr;
   cout << Mass << " grams of a hydrocarbon\nwith "
    << CarbonAtoms << " carbon atom(s) and "
    << HydrogenAtoms << " hydrogen atom(s)\ncontains "
    << Molecules << " molecules" << endl;

   return 0;
}
```

Sample I/O Behavior



Assignment Conversions

- A floating-point expression assigned to an integer object is truncated
- An integer expression assigned to a floating-point object is converted to a floating-point value
- Consider

```
float y = 2.7;
int i = 15;
int j = 10;
i = y;                    // i is now 2
cout << i << endl;
y = j;                    // y is now 10.0
cout << y << endl;
```

Compound Assignment

- C++ has a large set of operators for applying an operation to an object and then storing the result back into the object
- Examples

```
int i = 3;
i += 4;                          // i is now 7
cout << i << endl;

float a = 3.2;
a *= 2.0;                        // a is now 6.4
cout << a << endl;
```

Increment and Decrement

- C++ has special operators for incrementing or decrementing an object by one
- Examples

```
int k = 4;
++k;                                    // k is 5
k++;                                    // k is 6
cout << k << endl;
int i = k++;                            // i is 6, k is 7
cout << i << " " << k << endl;
int j = ++k;                            // j is 8, k is 8
cout << j << " " << k << endl;
```

Nonfundamental Types

- Nonfundamental as they are additions
- C++ permits definition of new types and *classes*
  - A class is a special kind of type
- Class objects typically have
  - *Data members* that represent attributes and values
  - *Member functions* for object inspection and manipulation
  - Members are accessed using the selection operator (.)

```
j = s.size();
```

  - *Auxiliary* functions for other behaviors
- Libraries often provide special-purpose types and classes
- Programmers can also define their own types and classes

Nonfundamental Types

- Examples
  - Standard Template Library (STL) provides class `string`
  - EzWindows library provides some graphical types and classes
    - `SimpleWindow` is a class for creating and manipulating window objects
    - `RectangleShape` is a class for creating and manipulating rectangle objects

Nonfundamental Types

- To access a library use a preprocessor directive to add its definitions to your program file

```
#include <string>
```

- Using statement makes syntax less clumsy
  - Without it

```
std::string s = "Wahoo";
std::string t = "Spiffy";
```

  - With it

```
using namespace std; // std contains string
string s = "Wahoo";
string t = "Spiffy";
```

Class string

- Class string
  - Used to represent a sequence of characters as a single object
- Some definitions

```
string Name = "Joanne";
string DecimalPoint = ".";
string Question = '?';        // illegal
```

Class string

- Some string member functions
  - size() determines number of characters in the string

```
string Saying = "Rust never sleeps.";
cout << Saying.size() << endl;        // 18
```

  - substr() determines a substring (Note first position has index 0)

```
string Word = Saying.substr(11, 16); // sleeps
```

  - find() computes the position of a subsequence

```
int j = Word.find("ee");              // 2
int k = Rust.find("steel");           // ?
```

Class string

- Auxiliary functions and operators
  - getline() extracts the next input line

```
string Response;
cout << "Enter text: ";
getline(cin, Response, '\n');
cout << "Response is \"" << Response
 << "\"” << endl;
```

  - Example run

```
Enter text: Want what you do
Response is "Want what you do"
```

Class string

- Auxiliary operators
  - + string concatenation

```
string Part1 = "Me";
string Part2 = " and ";
string Part3 = "You";
string All = Part1 + Part2 + Part3;
```

  - += compound concatenation assignment

```
string ThePlace = "Brooklyn";
ThePlace += ", NY";
```

```
#include <iostream>                    // Program 3.4
#include <string>
using namespace std;
int main() {
   cout << "Enter the date in American format: "
    << "(e.g., December 29, 1953) : ";
   string Date;
   getline(cin, Date, '\n');
   int i = Date.find(" ");
   string Month = Date.substr(0, i);
   int k = Date.find(",");
   string Day = Date.substr(i + 1, k - i - 1);
   string Year = Date.substr(k + 2, Date.size() - 1);
   string NewDate = Day + " " + Month + " " + Year;
   cout << "Original date: " << Date << endl;
   cout << "Converted date: " << NewDate << endl;
   return 0;
}
```

EzWindows Library Objects

- Definitions are the same form as other objects
- Example

```
SimpleWindow W;
```

- Most non-fundamental classes have been created so that an object is automatically initialized to a sensible value
- `SimpleWindow` objects have member functions to process messages to manipulate the objects
- Most important member function is `Open()` which causes the object to be displayed on the screen
- Example

```
W.Open();
```

Initialization

- Non-fundamental objects may have several attributes to initialize
- Syntax for initializing an object with multiple attributes

  `Type Identifier(Exp`$_1$`, Exp`$_2$`, ..., Exp`$_n$`);`

- SimpleWindow definitions can optionally specify attributes

  ```
  SimpleWindow W("Window Fun", 8, 4);
  ```

  - First attribute
    - Window banner
  - Second attribute
    - Width of window in centimeters
  - Third attribute
    - Height of window in centimeters

An EzWindows Program

```
#include <iostream>
#include <string>
using namespace std;
#include "ezwin.h"
int ApiMain() {
   SimpleWindow W("A Window", 12, 12);
   W.Open();

   cout << "Enter a character to exit" << endl;
   char a;
   cin >> a;

   return 0;
}
```

Sample Display Behavior

RectangleShape Objects

- EzWindows library also provides `RectangleShape` class for manipulating rectangles
- `RectangleShape` objects can specify the following attributes
  - A `SimpleWindow` object that contains the rectangle (mandatory)
  - Offset from left edge of the `SimpleWindow`
  - Offset from top edge of the `SimpleWindow`
    - Offsets are measured in centimeters from rectangle center
  - Width in centimeters
  - Height in centimeters
  - Color
    - `color` is an EzWindows type

RectangleShape Objects

- Examples

```
SimpleWindow W1("My Window", 20, 20);
SimpleWindow W2("My Other Window", 15, 10);

RectangleShape R(W1, 4, 2, Blue, 3, 2);
RectangleShape S(W2, 5, 2, Red, 1, 1);
RectangleShape T(W1, 3, 1, Black, 4, 5);
RectangleShape U(W1, 4, 9);
```

RectangleShape Objects

- Major `RectangleShape` member functions for processing messages
  - `Draw()`
    - Causes rectangle to be displayed in its associated window
  - `GetWidth()`
    - Returns width of object in centimeters
  - `GetHeight()`
    - Returns height of object in centimeters
  - `SetSize()`
    - Takes two attributes -- a width and height -- that are used to reset dimensions of the rectangle

Another EzWindows Program

```
#include <iostream>
#include <string>
using namespace std;
#include "rect.h"
int ApiMain()  {
   SimpleWindow W("Rectangular Fun", 12, 12);
   W.Open();
   RectangleShape R(W, 5.0, 2.5, Blue);
   R.Draw();
   cout << "Enter a character to exit" << endl;
   char Response;
   cin >> Response;
   return 0;
}
```

Sample Display Behavior