Simple Program Format

```
/************************************
 *
 *   Header comments
 *
 *  Written by: Bob Rinker
 *  Date: 14 - June - 2004
 *
 ************************************/
#include <iostream>
// other includes go here
using namespace std;

int main()
  {      // start of the body of the program

   // variable declarations

   // executable statements

  }  // End main
```


General C Program Rules

C statements are "free-form":

- Statements can begin and end in any line or column
- Statements can span multiple lines
- Multiple statements can be placed on a single line
- Blank lines are ignored

Comments are ignored by the compiler

- Multiple line comments are enclosed within /* --- */
- Single line comments start with // and continue to end of line

C statements are terminated with ; (semicolon)

White space can be placed around tokens

- White space: blanks, tabs, newlines
- Token: constants, variables, keywords, special characters

C is case sensitive!

- Abc, ABC, abc are all different

A Simple First Program

```
/*************************************
 *
 *  This program does some simple calculations
 *
 *  Written by: Bob Rinker
 *
 *************************************/
#include <iostream>
using namespace std;

int main()  {      // Alternate format
   int a, b, c, d;

   cout << "Input values for a and b: ";
   cin >> a >> b;

   c = a + b;
   d = a - b;
   cout << "You input " << a << " for a and " << b <<
           " for b" << endl << " The sum is " << c <<
           " and the difference is " << d << endl;
  } // END main
```


First Program Output

```
Input values for a and b: 2 4
You input 2 for a and 4 for b
The sum is 6 and the difference is -2
```

Keywords in C

Keywords are composed of lower case letters

Keywords are reserved – they cannot be used as variable or function names

C and C++

auto	do	goto	signed	unsigned
break	double	if	sizeof	void
case	else	int	static	volatile
char	enum	long	struct	while
continue	extern	register	switch	
const	float	return	typedef	
default	for	short	union	

C++ Only

asm	delete	new	public	throw
catch	friend	operator	template	try
class	inline	private	this	virtual
		protected		

C Data Types

int – integer (whole numbers).

```
123
-27
938271 (might be too big for some systems)
0x123  (Hexadecimal = base 16)
```

float – fractional values. Sometimes called "real"

```
123.0
-27.
18.75
938271.0 (representable on all systems)
0.00000000000000000013
1.3e-20  ("exponential notation")
```

char – a single char, different from a string

```
'x'
'T'
```

Some Other Types

C has some additional types that are different in size from the basic types:

long – (or long int) – usually longer (uses more bits) than a standard int, can store larger numbers than int

short – (or short int) – usually smaller than standard int, saves some memory space but can't store large numbers

double – a larger version of float, can usually store larger numbers, more accuracy than float, but uses more space

The C standard doesn't specify sizes of types – it varies with computer/compiler type.

Variable Declarations in C

All variables must be *declared* before being used in a program.

The declaration can also be used to *define* (initialize) the variable.

```
int lower, upper, step;
float fahr, celsius;
int i = 0;
char ast = '*', ans;
```

Style point – declarations of all variables usually done at the beginning of the body of a program.

Variable Names

Variable names have the following rules:

- must start with a letter (some systems also allow $)
- other characters can be upper/lower alpha, numbers, and a few other characters (_, $)
- explicitly cannot contain operators or white space
- some systems impose a maximum length, others only use a certain number of chars and ignore the rest.

LEGAL	NOT LEGAL
abc	1bc
Abc	.com
abc123	a*b
sum_of_items	sum of items
SumOfItems	

Constants in C

It is sometimes useful to declare constant values in our programs:

```
const int MAX = 10;
const float PI=3.1416;
const char YES = 'y';
```

Style point – it is conventional to use capital letters for constants declared in a program.

Arithmetic Operators

There are many operators in C. These are the ones called arithmetic operators

+ Addition
- Subtraction
** Multiplication*
/ Division
% Modulus (remainder - integer only)

Arithmetic Expressions

Expressions are composed of contants, variables and operators. C *evaluates* expressions

```
int a = 10, b = 20;
float x = 2.0, y = 0.5;
```

```
a + b
x + 3.0
a+b*3
x / y
a / b
```

Operator Hierarchy (Simplified)

The compiler performs arithmetic operations in a specific order:

- (negation) is done first

* (multiplication), / (division), % (mod) are done next, left to right

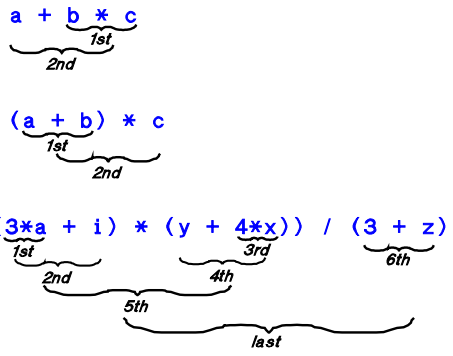
Then + (addition), - (subtraction) are done next, left to right

Then = (assignment) is done, right to left

All operators we will learn will be added to this hierarchy.

Changing the Hierarchy

Parentheses can be used to change the order of operations. Expressions in ( ) are evaluated first



"When in doubt, use parentheses"

int Arithmetic

ints can only store whole numbers. When performing calculations with ints, any fractional results are truncated!

```
4 / 3 * 5
  1
      5

1 / 2 * 28
  0
      0
```

Compare the last result with this:

Note float numbers!

```
1. / 2. * 28.
  0.5
      14.0
```

Be careful!!! Choose your types carefully!

Mixed Type Expressions

C determines the result type from the types of the operands. It uses int arithmetic if the operands are ints, float arithmetic if the operands are floats.

For mixed expressions, it uses the following rules:

- If either operand is double, convert the other to double
- Otherwise, if either operand is float, convert the other to float
- Otherwise, convert char and short to int.
- Then, if either operand is long, convert the other to long

Assignment

Assignment is designated by the = sign
(i.e., = is an operator)

The variable on the left is assigned the value
of the expression on the right.

```
int a = 10, b = 20;
float x = 2.0, y = 0.5;
int c, d;
float z, v, w;

c = a + b;
z = x +      3.0;
d = (a+b)*3;
v = x / y;
w = a / b;
a = a + 1;
```


Library Functions

Some operations are impossible or very difficult to calculate using just operators. Some of these operations can be performed using library functions.

$$roots = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

```
r1 = (-b + sqrt(pow(b,2) - 4.0 * a * c)) / (2.0 * a);
r2 = (-b - sqrt(pow(b,2) - 4.0 * a * c)) / (2.0 * a);
```

You must #include the correct library header file.
For the above example, you need to #include <cmath>

Character Values

Computers store characters as small numbers (bytes).
The most common encoding for chars is called ASCII

Some "control" (non printing) chars have special designations (can also be used in strings):

```
'\t'   - tab character
'\n'   - newline
'\''   - the ' character
'\"'   - the " character
'\\'   - the backslash

'\x41' - the char whose ASCII value is 41 hex ('A')

"\x7 Wake \x7 up!!! \x7" - print this string!
```


Some More Operators

Some operators in C are provided as a sort-of shorthand notation for common operations:

Post Increment

```
i++;      // i = i+1;
a = i++; // a = i; i = i+1;
```

Post Decrement

```
k--;      // k = k-1;
c = k--; // c = k; k = k-1;
```

Pre Increment

```
++j;      // j = j+1;
b = ++j; // j = j+1; b = j;
```

Pre Decrement

```
--m;      // m = m-1;
d = --m; // m = m-1; d = m;
```

Assignment Operators

Shortcuts for writing assignments:

```
a += 10;   // Same as a = a + 10;

b -= 3;    // Same as b = b - 3;

x *= y;    // Same as x = x * y;

r /= 5;    // Same as r = r / 5;
```


C++ Input/Output

C++ uses the "iostream class" to do I/O

Strictly speaking, I/O is not a part of the C++ language, but rather is implemented as functions and operators that allow us to do I/O.

Original C used some different functions (printf and scanf) to do I/O.

"Standard Input/Output"

The cin and cout functions are connected to "standard input" and "standard output." Normally, this means the keyboard and screen, but is actually operating system dependent.

UNIX (and DOS) allows "redirection" of the standard input and output:

```
a.out < infile

a.out > outfile
```


The iostream class

- cin, cout, and endl are functions ("methods") of the iostream class.
- >> (for cin) and << (for cout) are operators defined by the iostream class.
- Classes exist to do many useful things.
- Eventually, we will learn how to write our own classes.