

Constants Lesson Outline

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What is a Constant?

In mathematics, a *constant* is a value that cannot change.

In programming, a *constant* is like a variable,
EXCEPT its value cannot change.



The Difference Between a Variable and a Constant

The difference between a variable and a constant is:

- a variable's value can vary,
but
- a constant's value is constant.

Note that the variable can vary, and the constant's value is constant, at runtime.



Categories of Constants: Literal & Named

There are two categories of constants:

- *literal constants*, whose values are expressed literally;
- *named constants*, which have names.



Literal Constants

A *literal constant* is a constant whose value is expressed literally:

- `int` literal constants

EXAMPLES: `5, 0, -127, +403298, -385092809`

- `float` literal constants

EXAMPLES: `5.2, 0.0, -127.5, +403298.2348,`
`-3.85092809e+08`

- `char` literal constants

EXAMPLES: `'A', '7', '?'`

- character string literal constants

EXAMPLES: `"A", "Henry", "What's it to ya?"`



Literal Constant Example Program #1

```
% cat tax1997_literal.c
#include <stdio.h>
int main ()
{ /* main */
    float income, tax;

    printf("I'm going to calculate the federal income\n");
    printf("  tax on your 1997 income.\n");
    printf("What was your 1997 income in dollars?\n");
    scanf("%f", &income);
    tax = (income - (4150.0 + 2650.0)) * 0.15;
    printf("The 1997 federal income tax on $%2.2f\n", income);
    printf("  was $%2.2f.\n", tax);
} /* main */
```

```
% gcc -o tax1997_literal tax1997_literal.c
```

```
% tax1997_literal
```

```
I'm going to calculate the federal income
  tax on your 1997 income.
```

```
What was your 1997 income in dollars?
```

```
20000
```

```
The 1997 federal income tax on $20000.00
  was $1980.00.
```



Literal Constant Example Program #2

```
% cat tax1997_literal.c
#include <stdio.h>
int main ()
{ /* main */
    float income, tax;

    printf("I'm going to calculate the federal income\n");
    printf("  tax on your 1997 income.\n");
    printf("What was your 1997 income in dollars?\n");
    scanf("%f", &income);
    tax = (income - (4150.0 + 2650.0)) * 0.15;
    printf("The 1997 federal income tax on $%2.2f\n", income);
    printf("  was $%2.2f.\n", tax);
} /* main */

% gcc -o tax1997_literal tax1997_literal.c
% tax1997_literal
I'm going to calculate the federal income
  tax on your 1997 income.
What was your 1997 income in dollars?
20000
The 1997 federal income tax on $20000.00
  was $1980.00.
```

Numeric literal constants



Literal Constant Example Program #3

```
% cat tax1997_literal.c
```

```
#include <stdio.h>
```

```
int main ()
```

```
{ /* main */
```

```
    float income, tax;
```

```
    printf("I'm going to calculate the federal income\n");
```

```
    printf("    tax on your 1997 income.\n");
```

```
    printf("What was your 1997 income in dollars?\n");
```

```
    scanf("%f", &income);
```

```
    tax = (income - (4150.0 + 2650.0)) * 0.15;
```

```
    printf("The 1997 federal income tax on $%2.2f\n", income);
```

```
    printf("    was $%2.2f.\n", tax);
```

```
} /* main */
```

```
% gcc -o tax1997_literal tax1997_literal.c
```

```
% tax1997_literal
```

```
I'm going to calculate the federal income
```

```
    tax on your 1997 income.
```

```
What was your 1997 income in dollars?
```

```
20000
```

```
The 1997 federal income tax on $20000.00
```

```
    was $1980.00.
```

Character string literal constants

Character string literal constants



Literal Constant Example Program #4

```
% cat tax1997_literal.c
```

```
#include <stdio.h>
```

```
int main ()
```

```
{ /* main */
```

```
    float income, tax;
```

```
    printf("I'm going to calculate the federal income\n");
```

```
    printf("    tax on your 1997 income.\n");
```

```
    printf("What was your 1997 income in dollars?\n");
```

```
    scanf("%f", &income);
```

```
    tax = (income - 4150.0 + 2650.0) * 0.15;
```

```
    printf("The 1997 federal income tax on $%2.2f\n", income);
```

```
    printf("    was $%2.2f.\n", tax);
```

```
} /* main */
```

```
% gcc -o tax1997_literal tax1997_literal.c
```

```
% tax1997_literal
```

```
I'm going to calculate the federal income
```

```
    tax on your 1997 income.
```

```
What was your 1997 income in dollars?
```

```
20000
```

```
The 1997 federal income tax on $20000.00
```

```
    was $1980.00.
```

Character string literal constants

Numeric literal constants

Character string literal constants



Named Constants

A **named constant** is a constant that has a name:

```
const float (pi) = 3.1415926;
```

- A named constant is **exactly like a variable, except** its value is set at compile time (by initializing it) and **CANNOT** change at runtime.
- A named constant is **exactly like a literal constant, except** it **HAS A NAME**.

In a named constant declaration,

- we indicate that it's a constant via the `const` **attribute**, and
- we **MUST** initialize the named constant.



Name Constant Example Program

```
% cat circlecalc.c
#include <stdio.h>

int main ()
{ /* main */
    const float pi          = 3.1415926;
    const float diameter_factor = 2.0;
    float radius, circumference, area;

    printf("I'm going to calculate a circle's\n");
    printf(" circumference and area.\n");
    printf("What's the radius of the circle?\n");
    scanf("%f", &radius);
    circumference = pi * radius * diameter_factor;
    area = pi * radius * radius;
    printf("The circumference is %f\n", circumference);
    printf(" and the area is %f.\n", area);
} /* main */

% gcc -o circlecalc circlecalc.c
% circlecalc
I'm going to calculate a circle's
 circumference and area.
What's the radius of the circle?
5
The circumference is 31.415924
and the area is 78.539810.
```



The Value of a Named Constant Can't Be Changed

```
% cat constassign.c
```

```
#include <stdio.h>
```

```
int main ()
```

```
{ /* main */
```

```
    const float pi = 3.1415926;
```

```
    pi = 3.0; ←
```

```
} /* main */
```

This WON'T WORK!

```
% gcc -o constassign constassign.c
```

```
constassign.c: In function 'main':
```

```
constassign.c:7: error: assignment of read-only variable 'pi'
```

You can't change the value of a named constant at runtime!

This shows why you have to initialize every named constant:
if you didn't initialize it, then its value would be garbage,
forever.

(By contrast, you **DON'T** have to initialize every variable.)



Why Numeric Literal Constants Are BAD BAD BAD

When you embed numeric literal constants in the body of your program, you make it much harder to *maintain* and *upgrade* your program.



1997 Tax Program with Numeric Literal Constants

```
% cat tax1997_literal.c
#include <stdio.h>

int main ()
{ /* main */
    float income, tax;

    printf("I'm going to calculate the federal income\n");
    printf("    tax on your 1997 income.\n");
    printf("What was your 1997 income in dollars?\n");
    scanf("%f", &income);
    tax = (income - (4150.0 + 2650.0)) * 0.15;
    printf("The 1997 federal income tax on $%2.2f\n", income);
    printf("    was $%2.2f.\n", tax);
} /* main */

% gcc -o tax1997_literal tax1997_literal.c
% tax1997_literal
I'm going to calculate the federal income
    tax on your 1997 income.
What was your 1997 income in dollars?
20000
The 1997 federal income tax on $20000.00
    was $1980.00.
```



1999 Tax Program with Numeric Literal Constants

```
% cat tax1999_literal.c
#include <stdio.h>

int main ()
{ /* main */
    float income, tax;

    printf("I'm going to calculate the federal income\n");
    printf("    tax on your 1999 income.\n");
    printf("What was your 1999 income in dollars?\n");
    scanf("%f", &income);
    tax = (income - (4300.0 + 2750.0)) * 0.15;
    printf("The 1999 federal income tax on $%2.2f\n", income);
    printf("    was $%2.2f.\n", tax);
} /* main */

% gcc -o tax1999_literal tax1999_literal.c
% tax1999_literal
I'm going to calculate the federal income
    tax on your 1999 income.
What was your 1999 income in dollars?
20000
The 1999 federal income tax on $20000.00
    was $1942.50.
```



Why Named Constants Are Good

When you use named constants in the body of your program instead of literal constants, you **isolate** the constant values in the declaration section, making them **trivial** to find and to change.



1997 Tax Program with Named Constants

```
% cat tax1997_named.c
#include <stdio.h>

int main ()
{ /* main */
    const float standard_deduction = 4150.0;
    const float single_exemption = 2650.0;
    const float tax_rate = 0.15;
    const int tax_year = 1997;
    float income, tax;

    printf("I'm going to calculate the federal income tax\n");
    printf("  on your %d income.\n", tax_year);
    printf("What was your %d income in dollars?\n", tax_year);
    scanf("%f", &income);
    tax = (income - (standard_deduction + single_exemption)) * tax_rate;
    printf("The %d federal income tax on $%2.2f\n", tax_year, income);
    printf("  was $%2.2f.\n", tax);
} /* main */

% gcc -o tax1997_named tax1997_named.c
% tax1997_named
I'm going to calculate the federal income tax
  on your 1997 income.
What was your 1997 income in dollars?
20000
The 1997 federal income tax on $20000.00
  was $1980.00.
```



1999 Tax Program with Named Constants

```
% cat tax1999_named.c
#include <stdio.h>

int main ()
{ /* main */
    const float standard_deduction = 4300.0;
    const float single_exemption = 2750.0;
    const float tax_rate = 0.15;
    const int tax_year = 1999;
    float income, tax;

    printf("I'm going to calculate the federal income tax\n");
    printf("  on your %d income.\n", tax_year);
    printf("What was your %d income in dollars?\n", tax_year);
    scanf("%f", &income);
    tax = (income - (standard_deduction + single_exemption)) * tax_rate;
    printf("The %d federal income tax on $%2.2f\n", tax_year, income);
    printf("  was $%2.2f.\n", tax);
} /* main */

% gcc -o tax1999_named tax1999_named.c
% tax1999_named
I'm going to calculate the federal income tax
  on your 1999 income.
What was your 1999 income in dollars?
20000
The 1999 federal income tax on $20000.00
  was $1942.50.
```

