Assignment & Mathematical Expressions

What can you do with a variable?

iClicker Attendance

Please click on A if you are here:

A. I am here today.

Exercise Review: Mass of Atoms

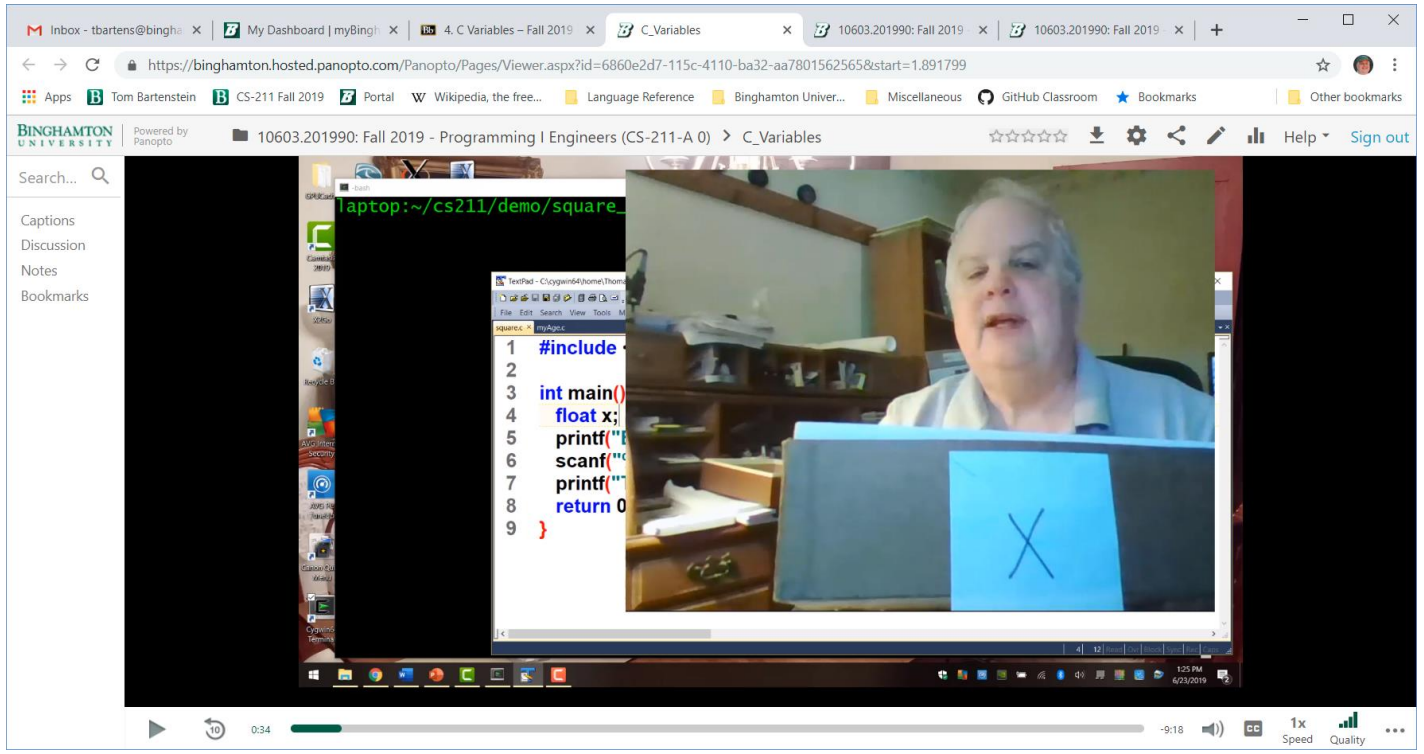
A hydrogen atom consists of one proton and one electron. If the mass of an electron is approximately 9.1×10^{-31} kilograms, and the mass of a proton or a neutron is approximately 1.7×10^{-27} kilograms, what is the mass of a hydrogen atom?

A typical carbon atom contains 6 electrons, 6 protons, and 6 neutrons. What is the mass of a carbon atom?

Write a generalized program that asks for the element name, number of protons, neutrons, and electrons, and prints it's mass.

Video Review: C Variables

- Variable Attributes: name, type, value, location
- Declaring a variable
- Uninitialized Variables
- Declare with Initializations
- Questions???



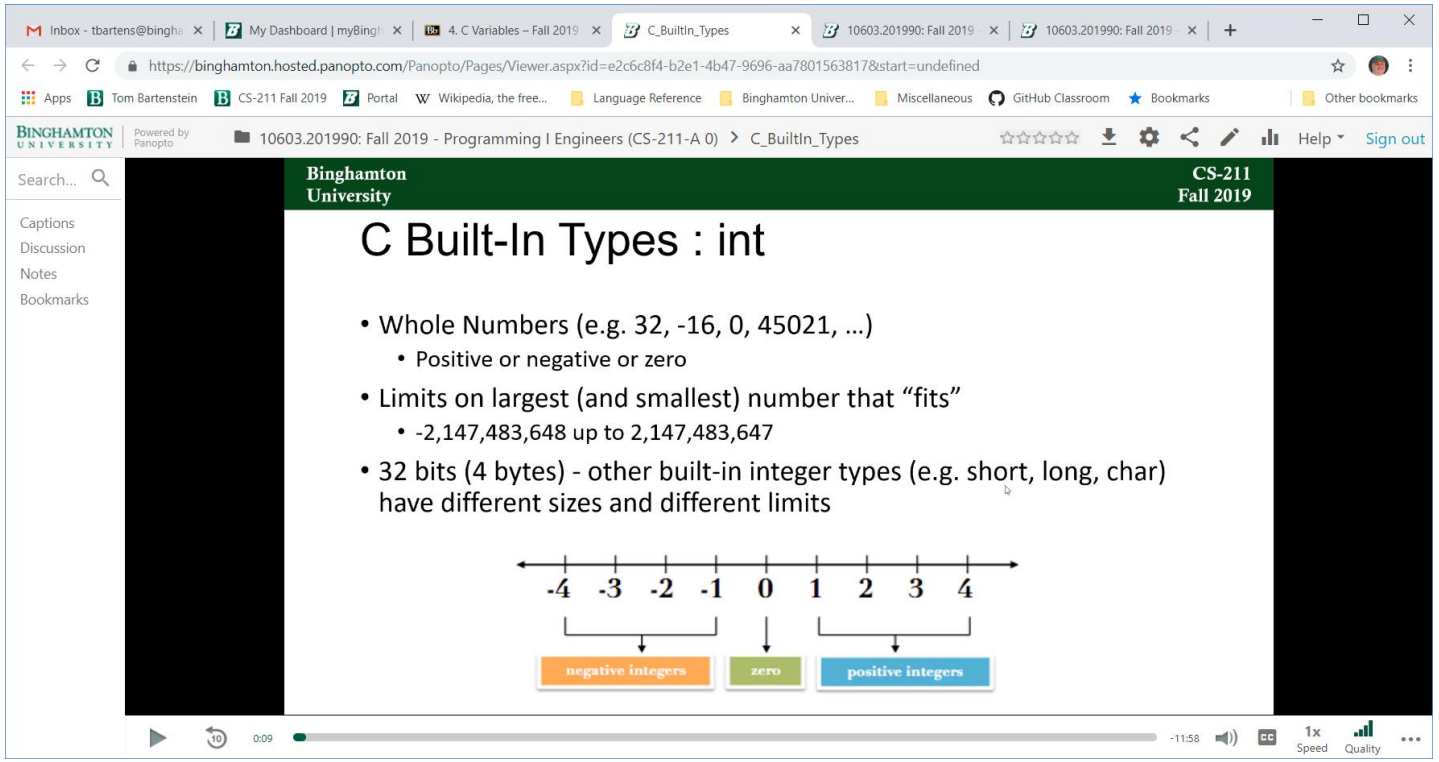
Class Exercise: Declares

- Write a declare statement for a variable to contain the number of electrons in an atom of a specific element.

- In a separate statement, assign the number of electrons in a helium atom to your variable.

Video Review: C Built-In Types

- “int” integer type
- “float” floating point type
- “char” ASCII type
- Questions???



Class Exercise : Integer Literals

- What are the decimal values and internal representations of the following variables:

```
int x=73;
int y=0b11111111111111111111111111111111; // 32 bits of "1".
int z=0x000000AD;
char w=0377;
```

Class Exercise: Float Literals

- How would you declare a float variable in C with the initial value of:
  - The mass of a proton: ~1.7 x 10^{-27} Kg ?
  - The number of sides of a pentagram?
  - Earth's Gravity (metric) : ~9.81 meters/sec^2 ?
  - Avagadro's number : ~6.022 x 10^{23} atoms/mole?

Class Exercise : Integer Representation

- What is the internal representation of the following variable:

```
int x=73;
```

Class Exercise: Float Representation

- What is the internal representation of the following variable:

```
float fx=19.75;
```

Class Exercise: Char Representation

- What is the internal representation of the following variable:

```
char letter='q';
```

iClicker Question

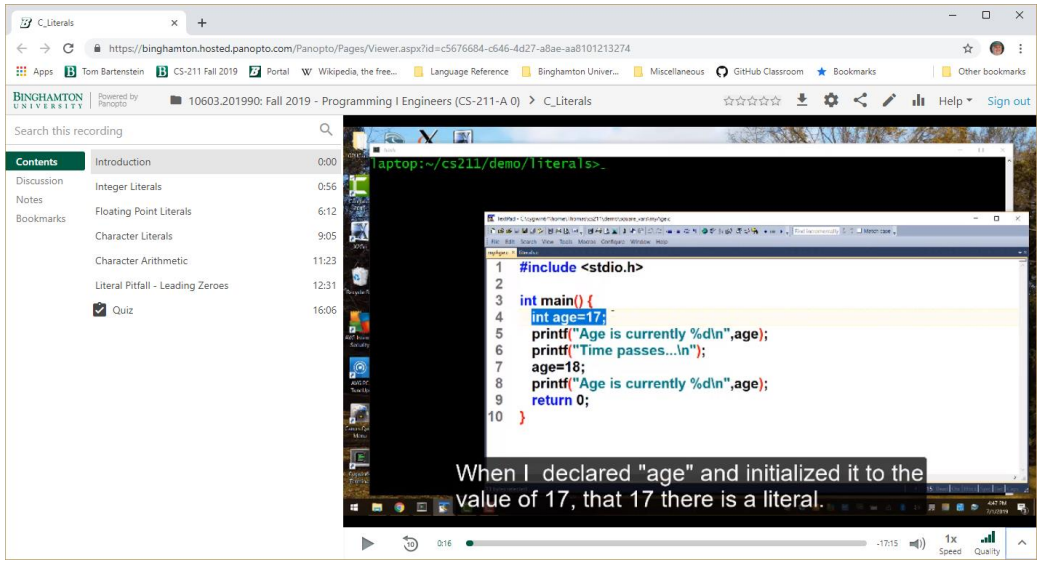
- What is the decimal value of num?

```
char num='G' - 'A';
```

A. No value – compiler error.
B. '@'
C. 6
D. 71

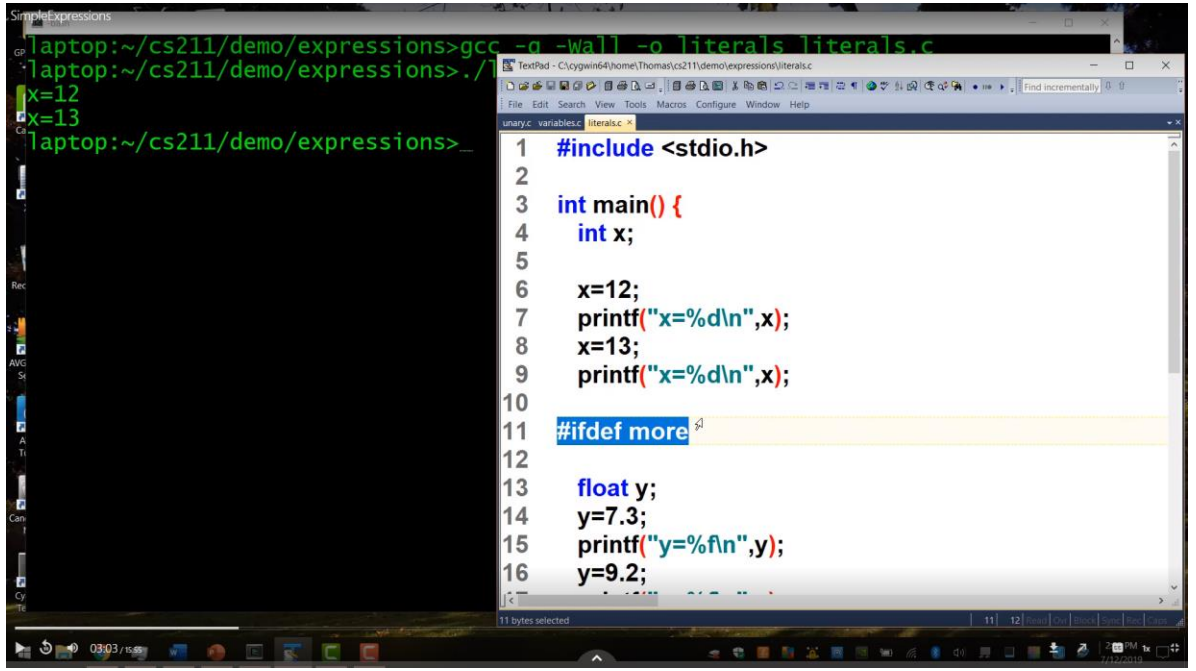
Video Review: C Literals

- Integer Literals
  - Decimal, Hexadecimal, Octal, and Binary specification
- Floating Point Literals
  - Decimal and Scientific Notation representation
- Character Literals
  - Numeric and Character representation



Simple Expressions

- Watch the video, available on myCourses
  - Content
    - Videos
      - 5. Mathematical (Numeric) Expressions



Math Expressions

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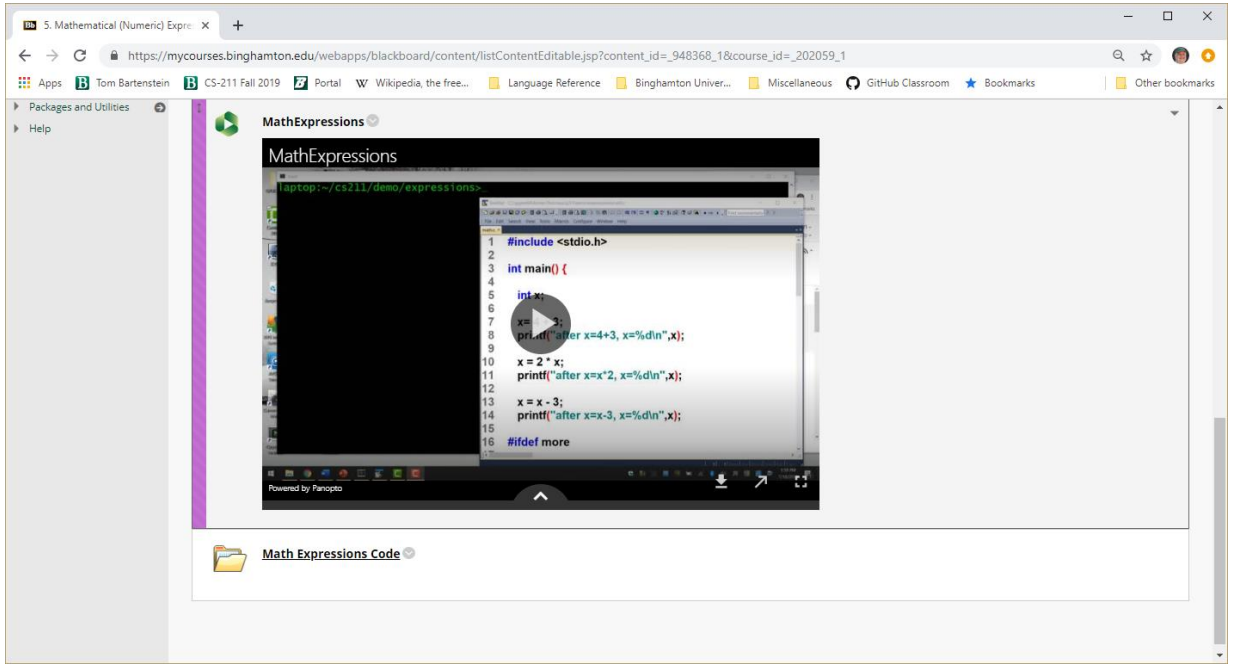
      - 5. Mathematical (Numeric) Expressions



Exercise: Ball Motion

Assume you throw a (frictionless) ball straight up in the air at some initial velocity. With gravity acting at 9.81 m/s^2, after time t, what is the height and velocity of the ball?

Physics: $v(t) = v_0 - gt$ and $h(t) = v_0 t - \frac{gt^2}{2}$

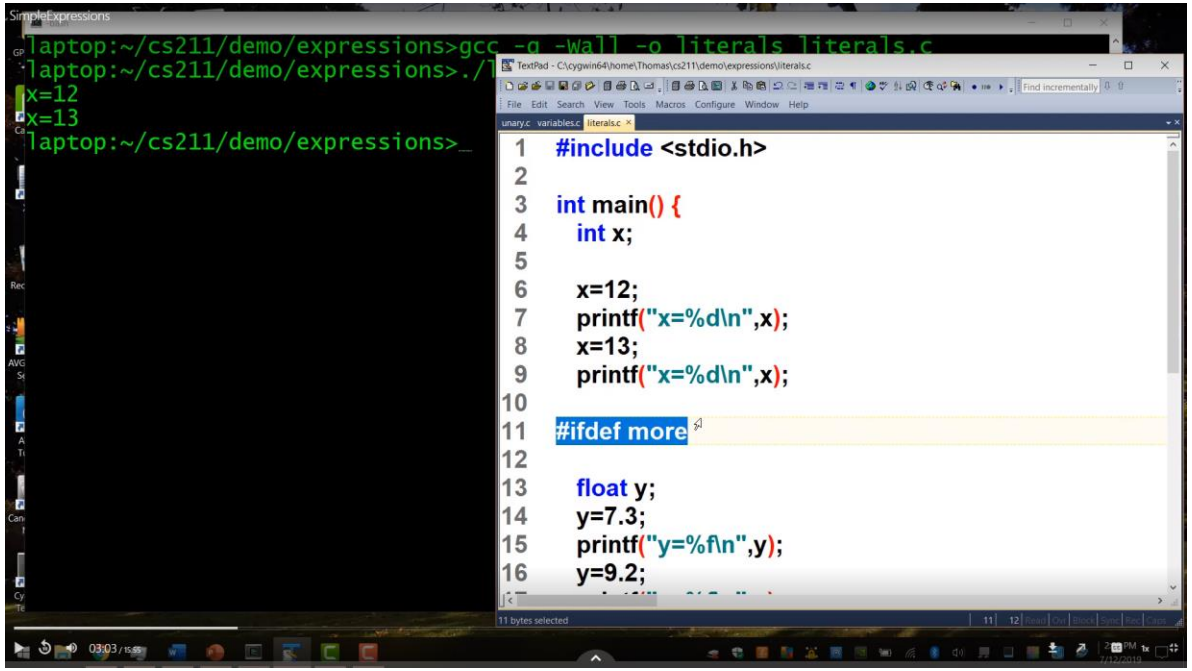
Q: What do you need to know? v_0 and t

Exercise assumptions

- Express velocity in meters per second, with + being up, and – being down.
- Express location (height) in meters, where the ball starts at zero meters.

Resources

- Programming in C, Chapter 3
- WikiPedia: Operators in C and C++ (https://en.wikipedia.org/wiki/Operators_in_C_and_C%2B%2B)
- GNU C Tutorial, Expressions and Operators (http://www.crasseux.com/books/ctutorial/Expressions-and-operators.html#Expressions%20and%20operators)

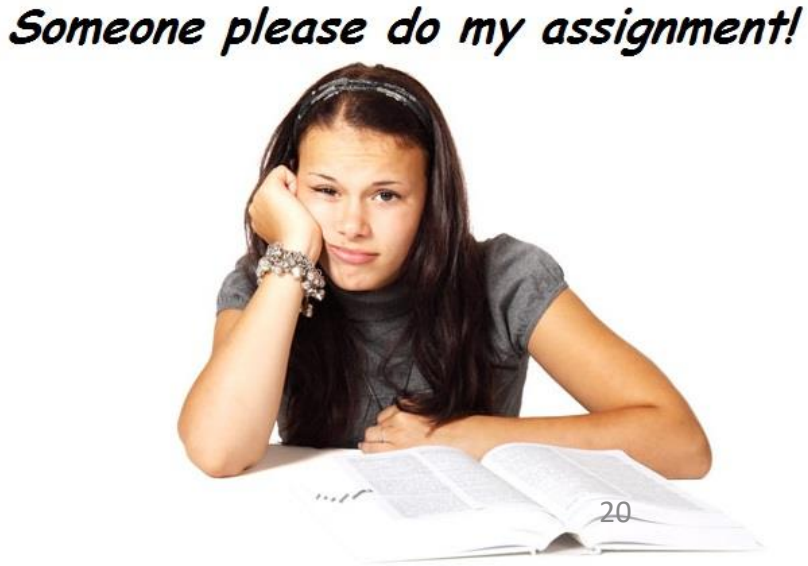


Simple Expressions

Summary Notes

Assignment Statement

Changing a Variable Value



Anatomy of an Assignment Statement

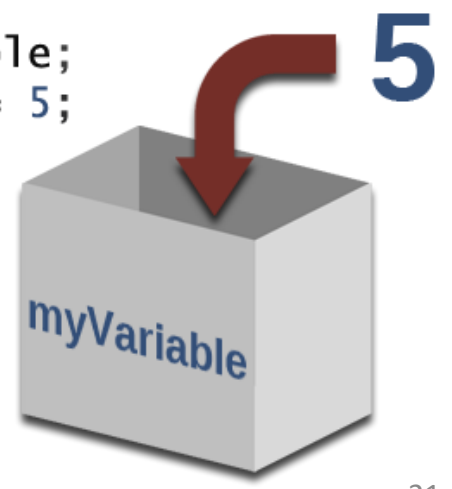
$$lhs = rhs;$$

lhs : Left-Hand-Side – reference to memory, e.g. variable name

(we will learn other ways to reference memory)

rhs : C Expression

```
int myVariable;
myVariable = 5;
```



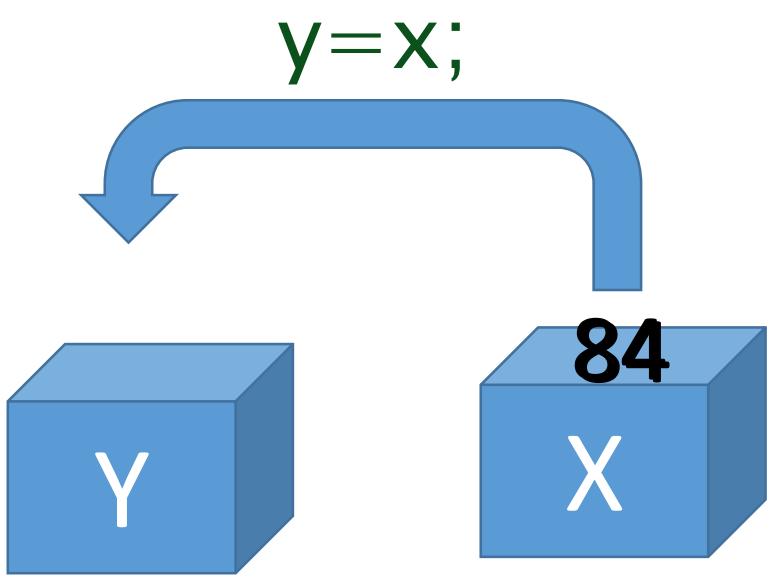
Expression is evaluated to a value, and the memory (variable) at *lhs* is updated with that value.

Literal Expressions

```
int x;
float y;
char first_init;

x=13;
y=7.3;
first_init='T';
```

Variable Expressions

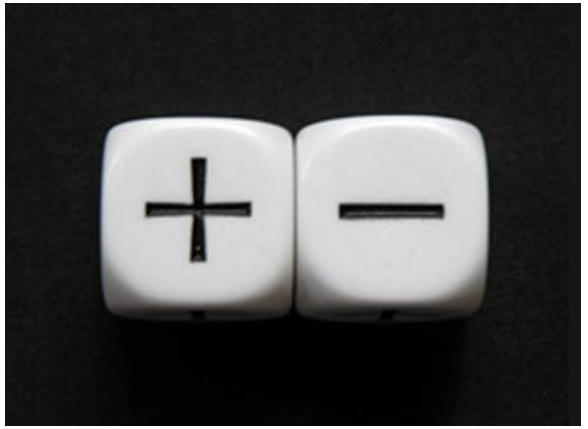
```
int x=84; int y=17;
float fx=7.3; float fy=9.2;
char first_init='W';

y=x;
fy=fx;
first_init=y;
```



What is y? fy? first_init?

Unary Operator Expressions

```
int x=5; int y;

y=-x;
x=+30;
```



What is x? y?

Unary expressions with side effects

Expression	Interpretation	Example

++x	x=x+1, value is x+1	x=12;
		y=++x;
		// x is 13, y is 13

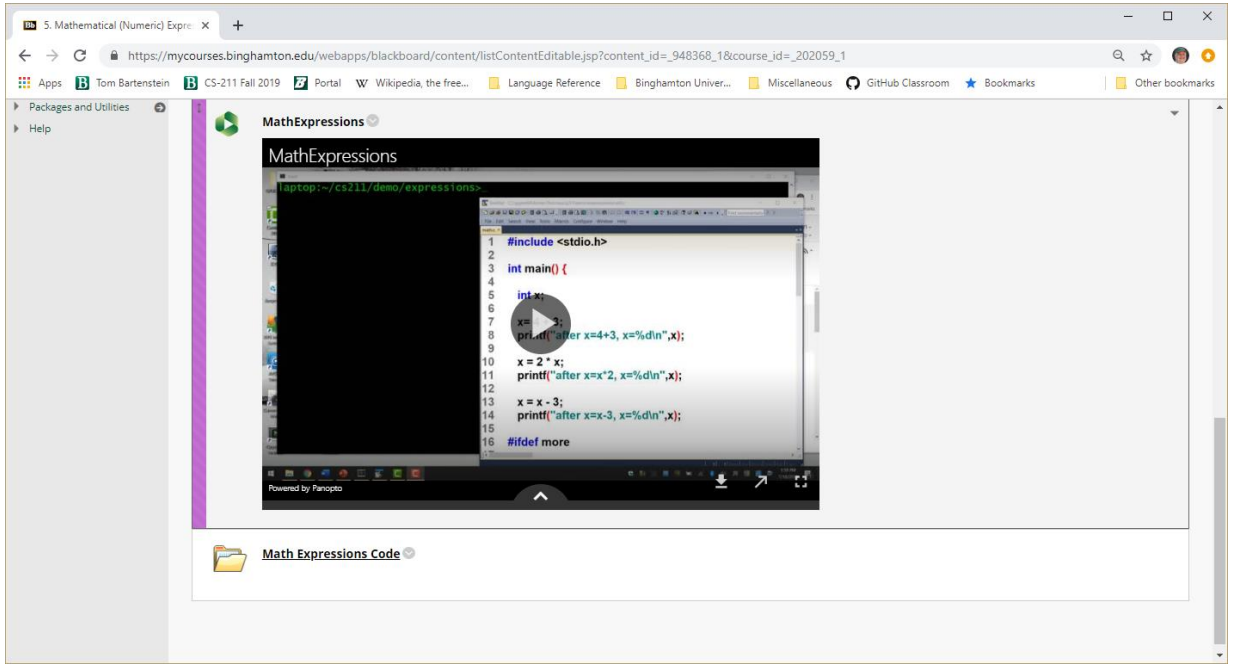
x++	value is x, x=x+1	x=12;
		y=x++;
		// x is 13, y is 12

--x	x=x-1, value is x-1	x=12;
		y=--x;
		// x is 11, y is 11

x--	value is x, x=x-1	x=12;
		y=x--;
		// x is 11, y is 12

Pitfall : Don't mix assign and increment

- x=x++; is redundant and ambiguous!
  - Which assignment happens first – x= or the side effect of x++?
  - On some machines, if x starts out at 12, it ends up 13
  - On other machines, if x starts out at 12, it ends up as 12!
- Typically, we increment or decrement without an assignment:
  - ++x;
- Sometimes, we get more complex:
  - array[i++]=next();
  - But even this can cause a compiler warning or bug

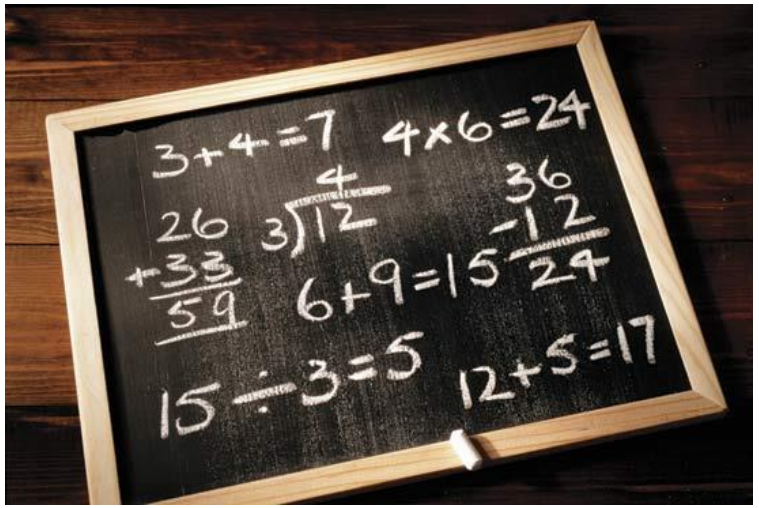


Math Expressions

Summary Notes

Binary Math Expressions: +,-,*,/,%

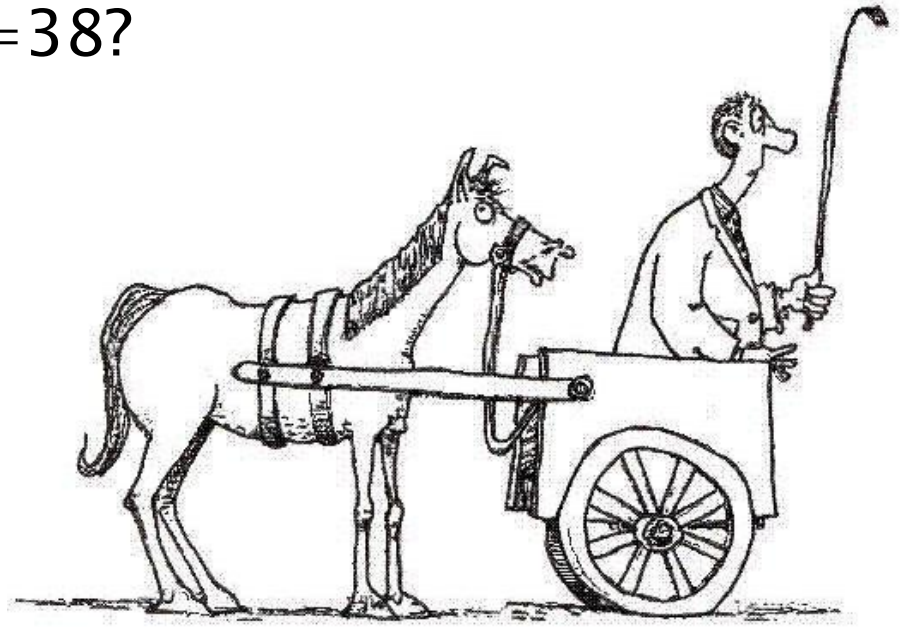
```
int x,d,r; float fx;

x = 13 * 3;  /* x=39 */
d = x / 4; /* d = 9 */
r = x % 4; /* r = 3 */
fx = x / 4.0; /* fx = 9.750 */
```



What is x? y? fx?

Operator Precedence

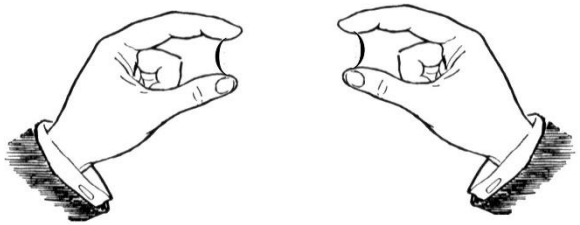
- Binary expressions are in the form *expr op expr*
- So, for instance, `3+5*7` is a valid expression
  - Should this be evaluated as `3+5=8, 8*7=56`?
  - Should this be evaluated as `5*7=35, 3+35=38`?



- Rules in C: Operator Precedence
  - Always do multiplication/division/modulo first
  - Then do addition/subtraction

Parenthesis in Expressions

- Evaluate sub-expression in parenthesis first
  - e.g. `(3+5)*7` is evaluated `3+5=8`, `8*7=56`
- Parenthesis can be nested
  - e.g. `((3+5)*(2+2))` is evaluated `3+5=8`, `2+2=4`, `8*4=32`
- If you're not sure, use parenthesis
  - Extra parenthesis don't change the answer, `3+(5*7) = 36`
  - Missing parenthesis may result in the "wrong" answer, `3+5*7 = 36`



Assignment Expressions

- The value of an assignment is the value of the Left Hand Side

```
int x; int y; int z;
x=y=z=3;
```

What is x? y? z?

```
x=1+(y=1+(z=2));
```

What is x? y? z?

Assignment Operators

- Assignment of the form: *LHS op*= *RHS*;
  - *LHS* : Memory Reference (variable) as in assignment
  - *op* : Binary operator such as +, -, /, *, %, …
  - *RHS* : Expression
- Shorthand for *LHS* = *LHS op RHS*;

```
int x=6;
x +=2; /*x=8*/
x /=3; /*x=2*/
x*=5; /*x=10*/
```

```
int x=6;
x = x+2; /*x=8*/
x = x / 3; /*x=2*/
x = x*5; /*x=10*/
```

What is x?