http://www.cs.cornell.edu/courses/cs1110/2020sp

Lecture 2:
Variables & Assignments

(Sections 2.1-2.3,2.5)

CS 1110
Introduction to Computing Using Python

Orange text indicates updates made after lecture

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Lab 1 announcement

- Weren’t able to attend lab? Don’t panic. Do it on your own via link on course website.
- To get credit in the online lab system you need this info:
  - Lab 1 instructions state that if Python gives an error message, you just write “ERROR”—don’t paste in whole error message
  - For the short-answer in the boolean activity, the term for Python’s behavior is “short-circuit evaluation”
  - Secret passwords for the 3 activities that ask for them:

    1

    4

    5

More announcements

- Course website: http://www.cs.cornell.edu/courses/cs1110/2020sp/ Make sure it's spring 2020—look for the whale-sushi logo . We do not use Canvas.
- We will use clickers/Reef polling, but not for credit. Therefore no need to register your clicker.
- Cornell IT working on posting lecture recording. Thanks for your patience.
- Before next lecture, read Sections 3.1-3.3
- Install Anaconda Python 3.7 *and Atom editor* according to instructions on course website

Helping you succeed in this class

http://www.cs.cornell.edu/courses/cs1110/2020sp/staff/

Consulting Hours. ACCEL Lab Green Room

- Big block of time, multiple consultants (see staff calendar)
- Good for assignment help

TA Office Hours.

- Staff: 1 TA, 1 or two hours at a time (see staff calendar)
- Good for conceptual help

Prof Office Hours.

- After lecture for an hour in Bailey Hall lower lobby
- Prof. Fan has additional drop-in hours (see staff calendar)
- Prof. Lee has additional hours by appointment (use link on course website, *Staff/OH* → *Office Hours*)

Piazza. Online forum to ask/answer questions

AEW (ENGRG 1010). "Academic Excellence Workshops"

- *Optional* discussion course that runs parallel to this class. See website for more info

From last time: **Types**

Type: set of values & operations on them

Type **float:**

- Values: real numbers
- Ops: +, -, *, /,//,**

Type **int:**

- Values: integers
- Ops: +, -, *,/, //, %, **

Type **bool:**

- Values: `true`, `false`
- Ops: `not`, `and`, `or`

One more type today:

Type **str:**

- Values: string literals
  - Double quotes: **“abc”**
  - Single quotes: **‘abc’**
- Ops: + (concatenation)

Type: `str` (string) for text

Values: any sequence of characters

Operation(s): **+** (catenation, or concatenation)

Notice: meaning of operator **+** changes from type to type

String literal: sequence of characters in quotes

- Double quotes: " abcex3$g<&" or "Hello World!"
- Single quotes: 'Hello World!'

Concatenation applies only to strings

- "ab" + "cd" evaluates to "abcd"
- "ab" + 2 produces an **error**

```
>>> terminal time >>>
```

Converting from one type to another

aka “casting”

<type>(*<value>*)

```
>>> float(2)
2.0

>>>int(2.6)
2



>>>type(2)
<class 'int'>
```

converts value `2` to type **`float`**

converts value `2.6` to type **`int`**

…different from:

type(*<value>*)

which tells you the type

What should Python do?

```
>>> 1/2.6
```

A. turn 2.6 into the integer 2, then calculate 1/2 → 0.5
B. turn 2.6 into the integer 2, then calculate 1//2 → 0
C. turn 1 into the float 1.0, then calculate 1.0/2.6 → 0.3846…
D. Produce a `TypeError` telling you it cannot do this.
E. Exit Python

Widening Conversion (OK!)

From a **narrower** type to a **wider** type
(e.g., `int` → `float`)

Width refers to information capacity. "Wide" → more information capacity

Python does it automatically if needed:

- Example: `1/2.0` evaluates to a `float`: `0.5`
- Example: `True + 1` evaluates to an `int`: `2`
  - `True` converts to `1`
  - `False` converts to `0`

From narrow to wide:
`bool` → **`int`** → **`float`**

Note: does not work for **`str`**

- Example: `2 + "ab"` produces a TypeError

Narrowing Conversion (OK???)

From a **wider** type to a **narrower** type
(e.g., `float` → `int`)

- causes information to be lost
- Python **never** does this automatically

What about:

```
>>> 1/int(2.6)
```

Narrowing Conversion (OK???)

From a **wider** type to a **narrower** type
(e.g., `float` → `int`)

- causes information to be lost
- Python **never** does this automatically

What about:

```
>>> 1/int(2.6)
0.5
```

Python casts the 2.6 to 2 but `/` *is a float division, so Python casts 1 to 1.0 and 2 to 2.0*

Types matter!

You Decide:

- What is the right type for my data?
- When is the right time for conversion (if any)?

- Zip Code as an **`int`**?
- Grades as an **`int`**?
- Lab Grades as a **`bool`**?
- Interest level as **`bool`** or **`float`**?

Operator Precedence

What is the difference between:

2*(1+3) 2*1 + 3

add, then multiply ***multiply, then add***

Operations performed in a set order

- Parentheses make the order explicit

What if there are no parentheses?

→ **Operator Precedence:** fixed order to process operators when no parentheses

Precedence of Python Operators

- **Exponentiation**: **
- **Unary operators**: + –
- **Binary arithmetic**: * / %
- **Binary arithmetic**: + –
- **Comparisons**: < > <= >=
- **Equality relations**: == !=
- **Logical not**
- **Logical and**
- **Logical or**

- Precedence goes downwards
  - Parentheses highest
  - Logical ops lowest
- Same line → same precedence
  - Read “ties” left to right (except for **)
  - Example: 1/2*3 is (1/2)*3

- Section 2.5 in your text
- See website for more info
- Part of Lab 1

Operators and Type Conversions

Operator Precedence

Exponentiation: **

Unary operators: + –

Binary arithmetic: * / %

Binary arithmetic: + –

Comparisons: < > <= >=

Equality relations: == !=

Logical not

Logical and

Logical or

Evaluate this expression:

```
False + 1 + 3.0 / 3
```

A. 3

B. 3.0

C. 1.3333

D. 2

E. 2.0

Operators and Type Conversions

Operator Precedence

Exponentiation: **

Unary operators: + –

Binary arithmetic: * / %

Binary arithmetic: + –

Comparisons: < > <= >=

Equality relations: == !=

Logical not

Logical and

Logical or

Evaluate this expression:

$$\texttt{False + 1 + }\underline{\texttt{3.0 / 3}}$$

$$\underline{\texttt{False + 1}}\texttt{ + 1.0}$$

$$\underline{\texttt{1 + 1.0}}$$

$$\texttt{2.0}$$

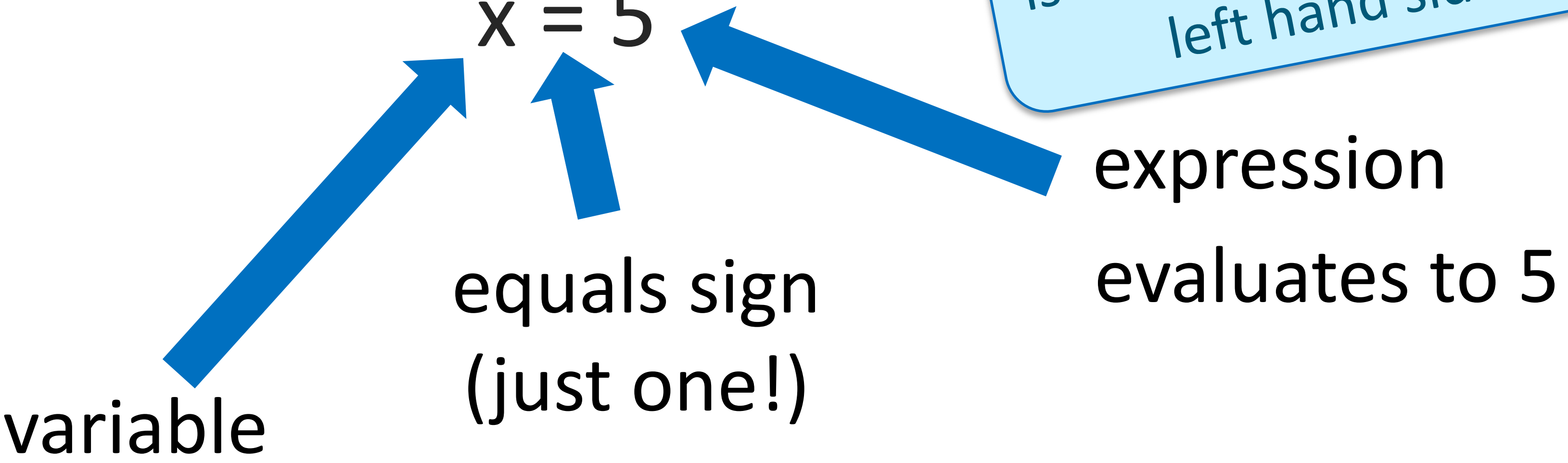
New Tool: Variable Assignment

An *assignment statement:*

- takes an *expression*
- evaluates it, and
- stores the *value* in a *variable*

Example:

Value on right hand side (RHS) is stored in variable named on left hand side (LHS)



x = 5

variable

equals sign (just one!)

expression evaluates to 5

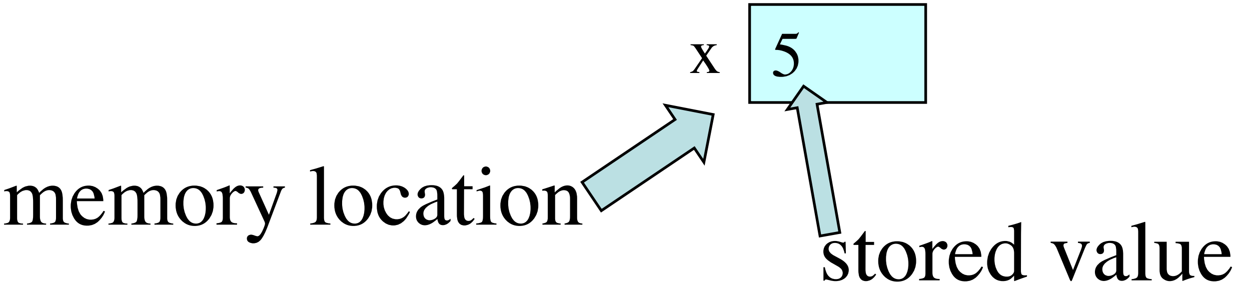
Executing Assignment Statements

```
>>> x = 5
>>>
```

Press ENTER and…

Hmm, looks like nothing happened…

- But something did happen!
- Python *assigned* the *value* 5 to the *variable* x
- Internally (and invisible to you):



x

5

memory location

stored value

```
>>> terminal time >>>
```

Retrieving Variables

```
>>> x = 5
>>> x
5
>>>
```

Press ENTER and…

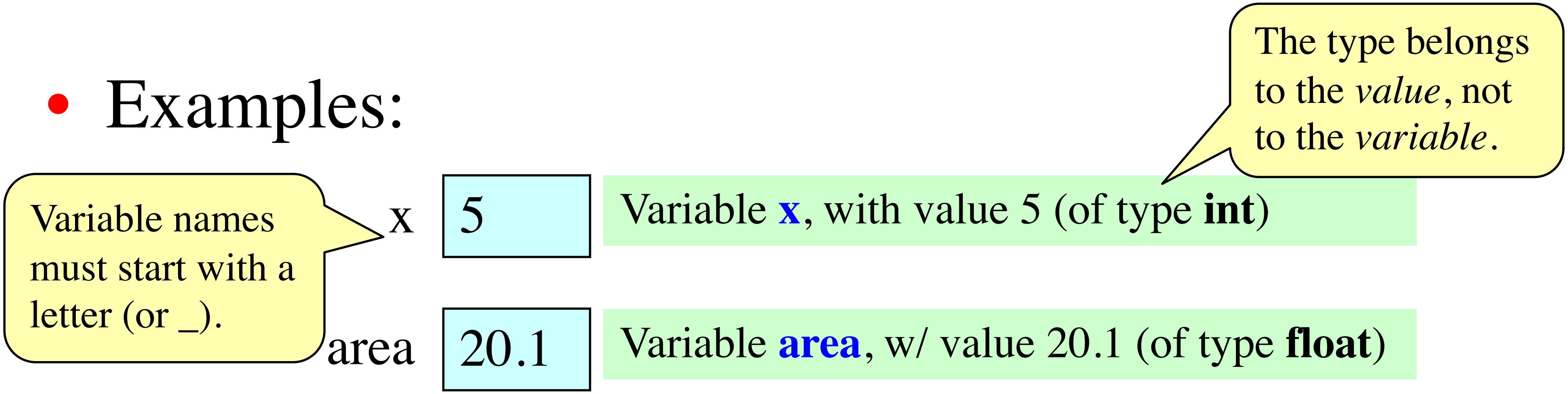
Interactive mode tells me the value of x

`>>> terminal time >>>`

In More Detail: Variables (Section 2.1)

- A **variable**
  - is a **named** memory location (**box**)
  - contains a **value** (in the box)

- Examples:



The type belongs to the *value*, not to the *variable*.

Variable names must start with a letter (or _).

x | 5 | Variable **x**, with value 5 (of type **int**)

area | 20.1 | Variable **area**, w/ value 20.1 (of type **float**)

In More Detail: Statements

```
>>> x = 5
>>>
```

Press ENTER and…

Hm, looks like nothing happened…

- This is a **statement**, not an **expression**
  - Tells the computer to DO something (not give a value)
  - Typing it into >>> gets no response (but it is working)

Expressions vs. Statements

Expression

- **Represents** something
  - Python *evaluates it*
  - End result is a value
- Examples:
  - `2.3`
  - `(3+5)/4`
  - `x == 5`

Value

Complex Expression

Statement

- **Does** something
  - Python *executes it*
  - Need not result in a value
- Examples:
  - `x = 2 + 1`
  - `x = 5`

Look so similar

but they are not!

You can assign more than literals

```
>>> x = 5
>>> x = 3.0 ** 2 + 4 – 1
>>> x = 2 + x
```

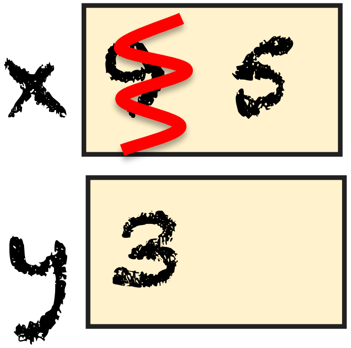
“x gets 5”

“x gets the value of this expression”

“x gets 2 plus the current value of x”

The RHS is an expression. An expression includes *literals*, *operators*, and *variables*.

Keeping Track of Variables



- Draw boxes on paper:

```
>>> x = 9
```

- New variable declared?

```
>>> y = 3
```

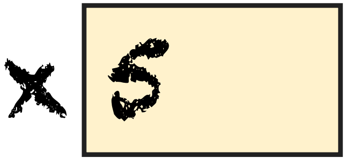
Write a new box.

- Variable updated?

```
>>> x = 5
```

Cross out old value. Insert new value.

Start with variable x having value 5. Draw it on paper:



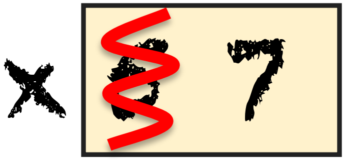
Task: Execute the statement x = x + 2

1. Evaluate the RHS expression, x + 2
   - For x, use the value in variable x
   - Write the expression somewhere on your paper
2. Store the value of the RHS expression in variable named on LHS, x
   - Cross off the old value in the box
   - Write the new value in the box for x

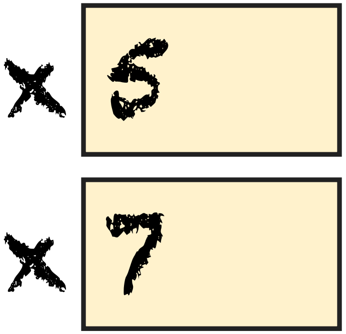
Did you do the same thing as your neighbor ?
If not, *discuss*.

Which one is closest to your answer?

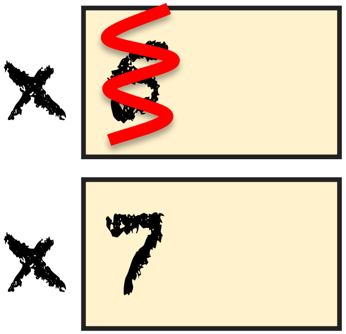
A.



B.



C.



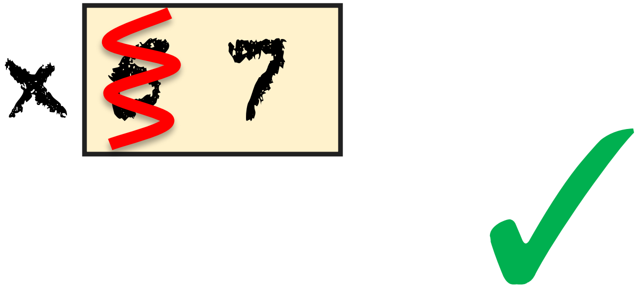
D.

¯_(ツ)_/¯

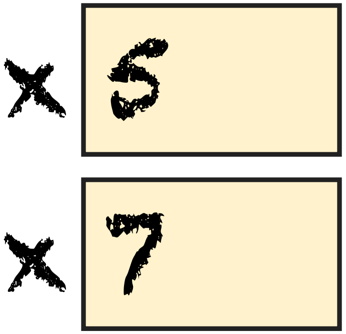
x = x + 2

And The Correct Answer Is...

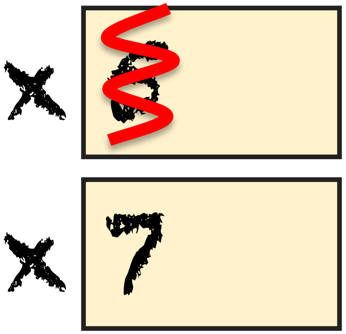
A.



B.



C.



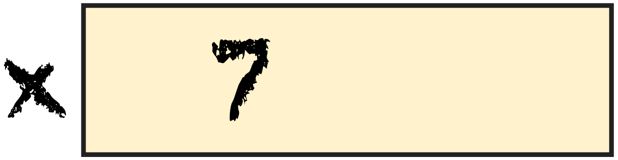
D.

¯_(ツ)_/¯

x = x + 2

Execute the Statement: `x = 3.0*x+1.0`

Begin with this:



1. **Evaluate** the expression `3.0*x+1.0`

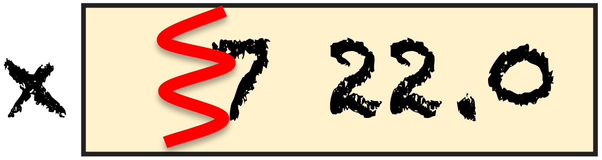
2. **Store** its value in `x`

Did you do the same thing as your neighbor?

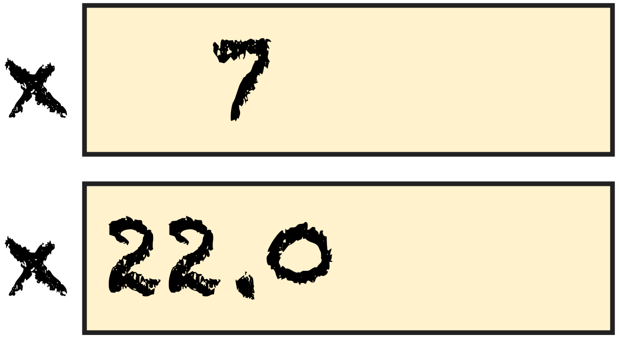
If not, *discuss*.

Which one is closest to your answer?

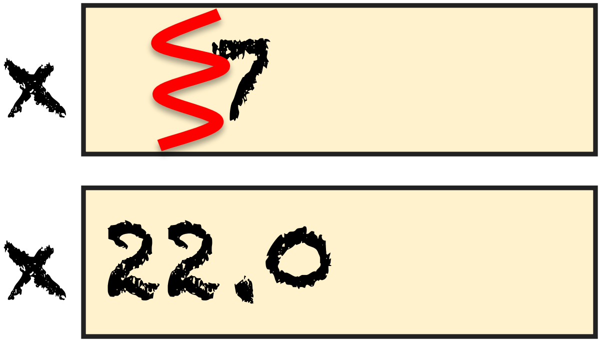
A.



B.



C.



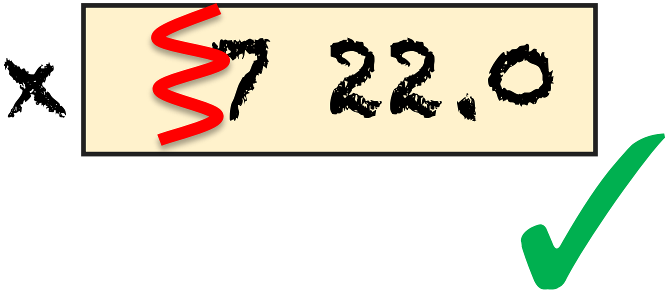
D.

¯_(ツ)_/¯

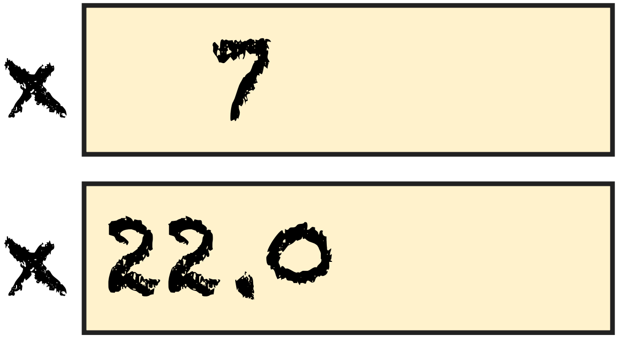
```
x = 3.0*x+1.0
```

And The Correct Answer Is...

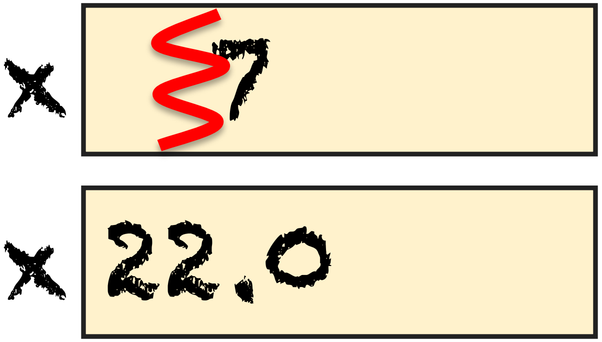
A.



B.



C.



D.

¯_(ツ)_/¯

```
x = 3.0*x+1.0
```

Executing an Assignment Statement

The command: `x = 3.0*x+1.0`

"Executing the command":

1. Evaluate right hand side `3.0*x+1.0`

2. Store the value in the variable `x`'s box

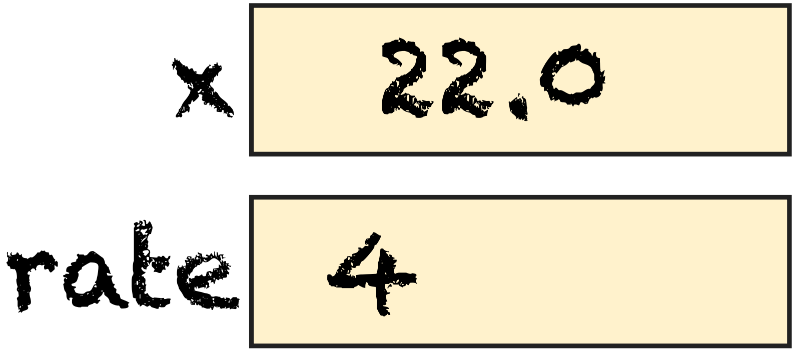
- Requires both evaluate AND store steps
- Critical mental model for learning Python

Exercise 1: Understanding Assignment

Have variable **x** already from previous

Declare a new variable:

```
>>> rate = 4
```



Execute this assignment:

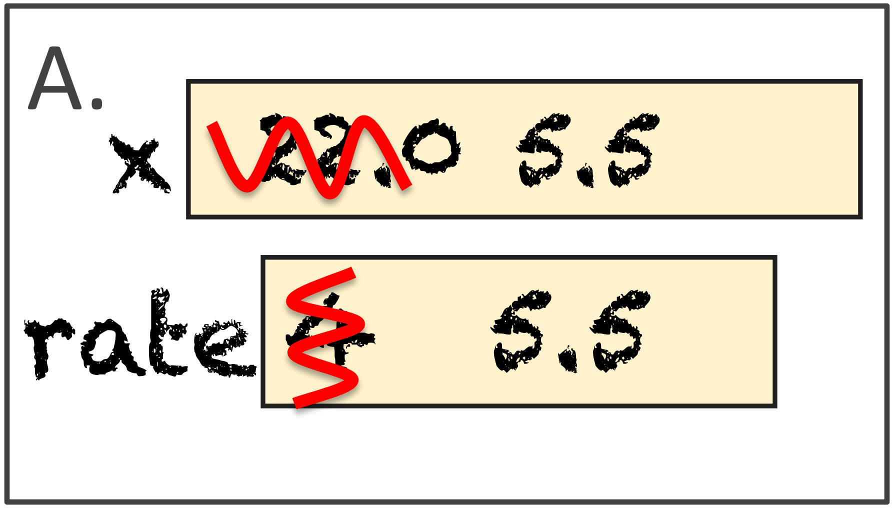
```
>>> rate = x / rate
```

Did you do the same thing as your neighbor?

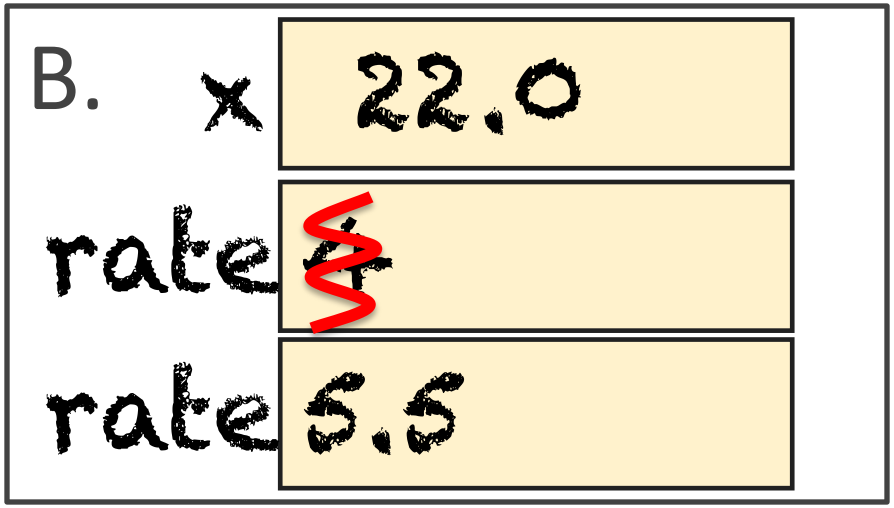
If not, *discuss*.

Which one is closest to your answer?

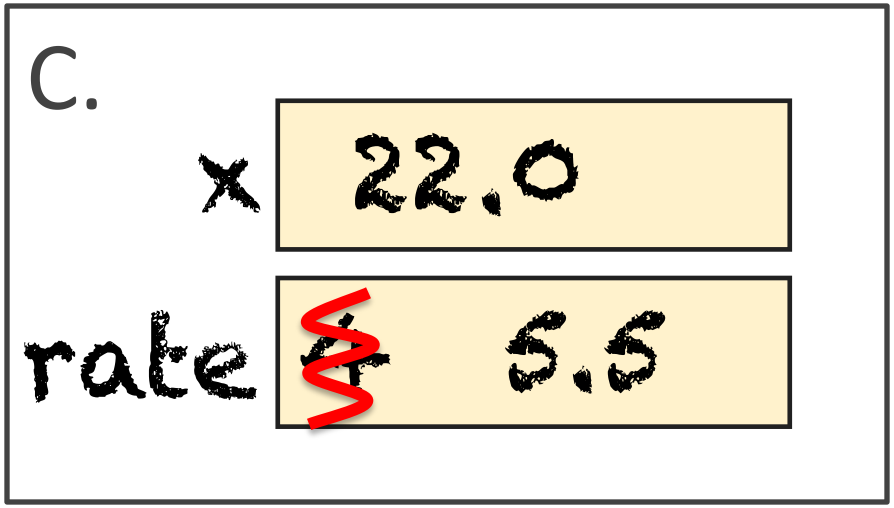
A.



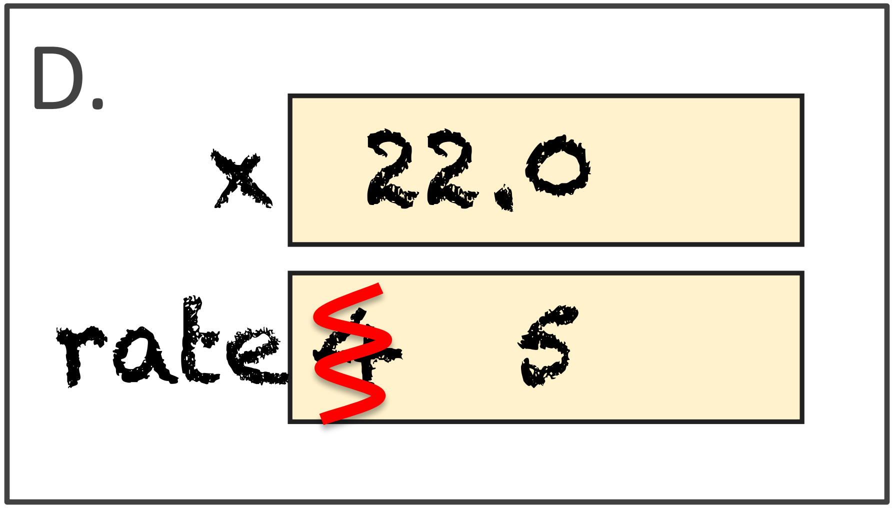
B.



C.



D.

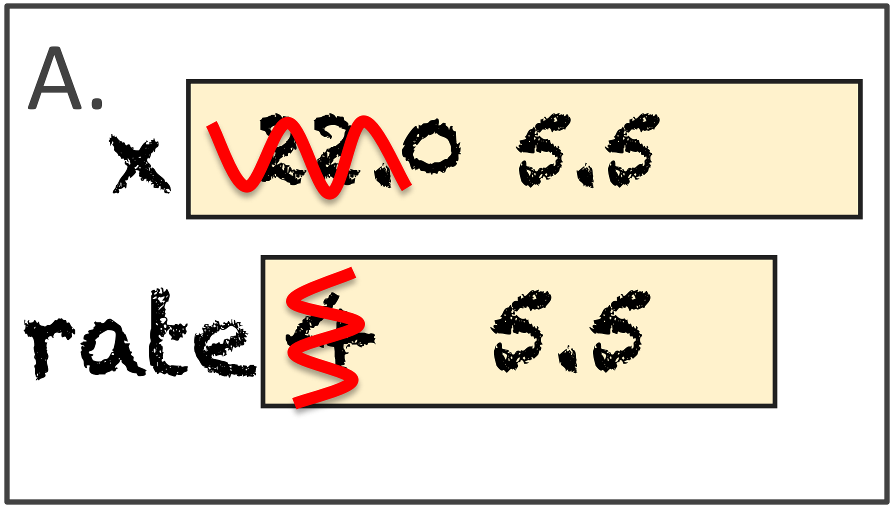


E. ¯_(ツ)_/¯

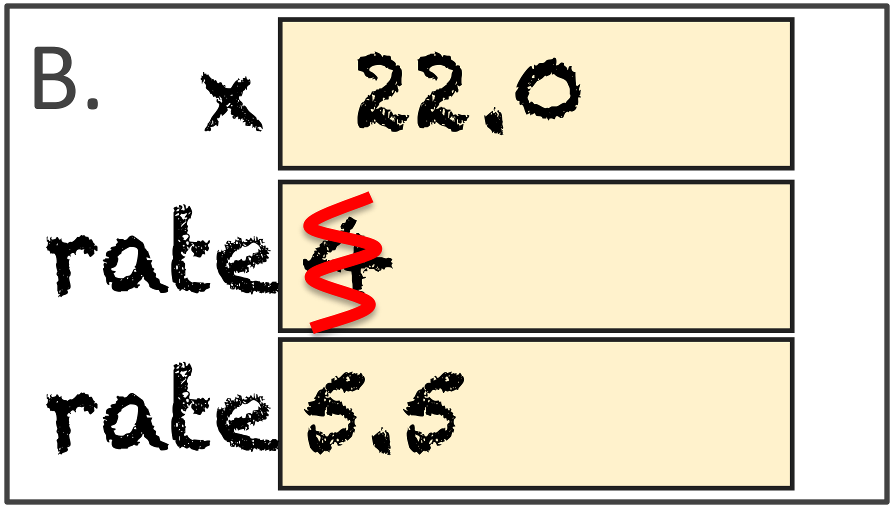
```
rate = x / rate
```

And The Correct Answer Is…

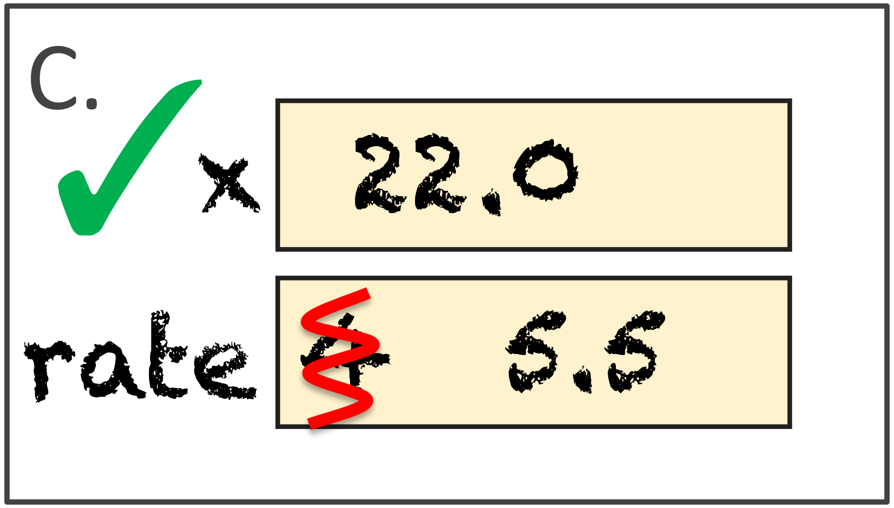
A.



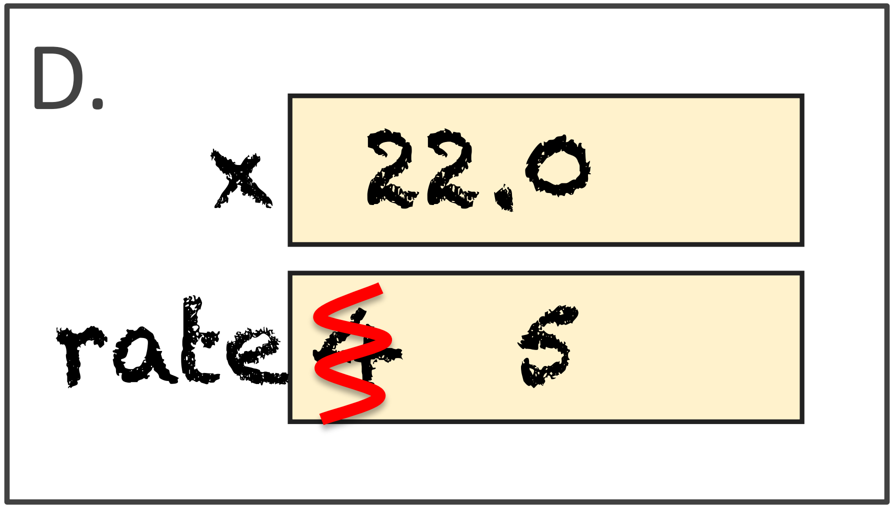
B.



C.



D.



```
rate = x / rate
```

Dynamic Typing

Python is a **dynamically typed** language

- Variables can hold values of any type
- Variables can hold different types at different times

The following is acceptable in Python:

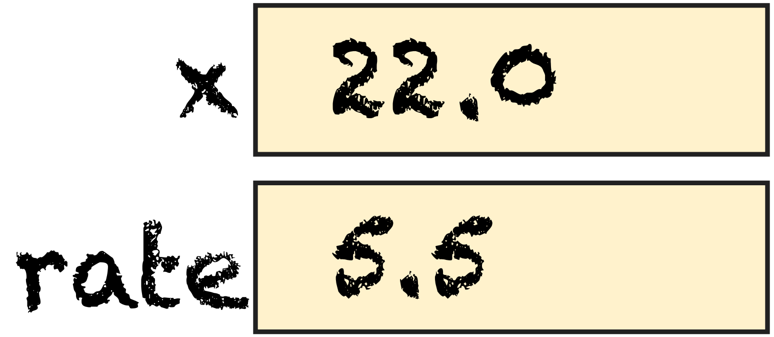
```
>>> x = 1          ← x contains an int value
>>> x = x / 2.0    ← x now contains a float value
```

Alternative: a **statically typed** language

- Examples: Java, C
- Each variable restricted to values of just one type

Exercise 2: Understanding Assignment

Begin with:



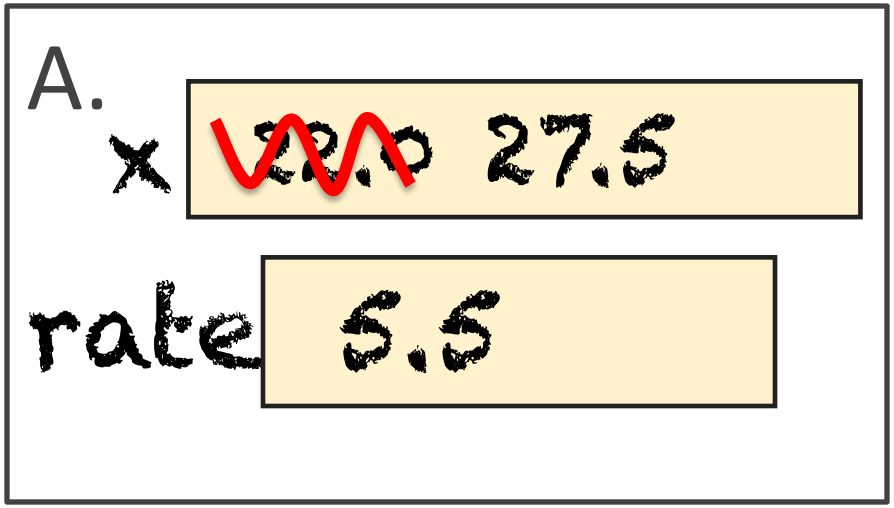
Execute this assignment:

```
>>> rat = x + rate
```

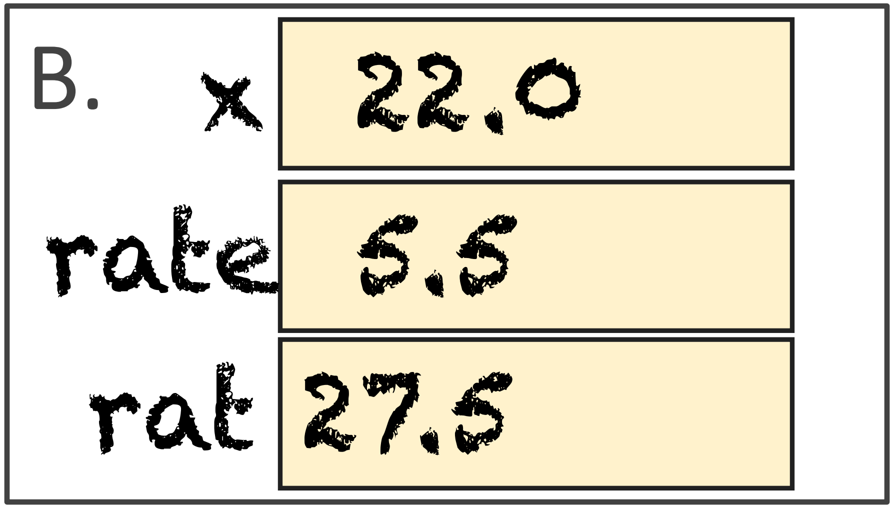
Did you do the same thing as your neighbor?
If not, *discuss*.

Which one is closest to your answer?

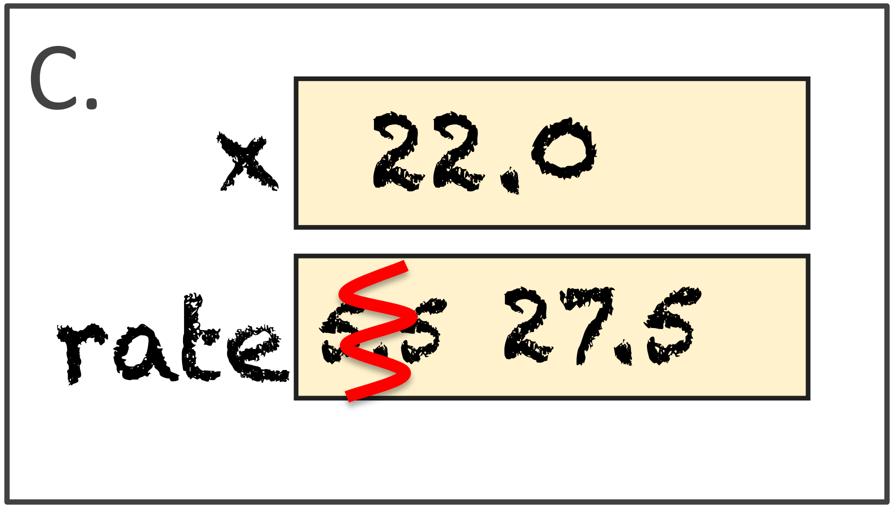
A.



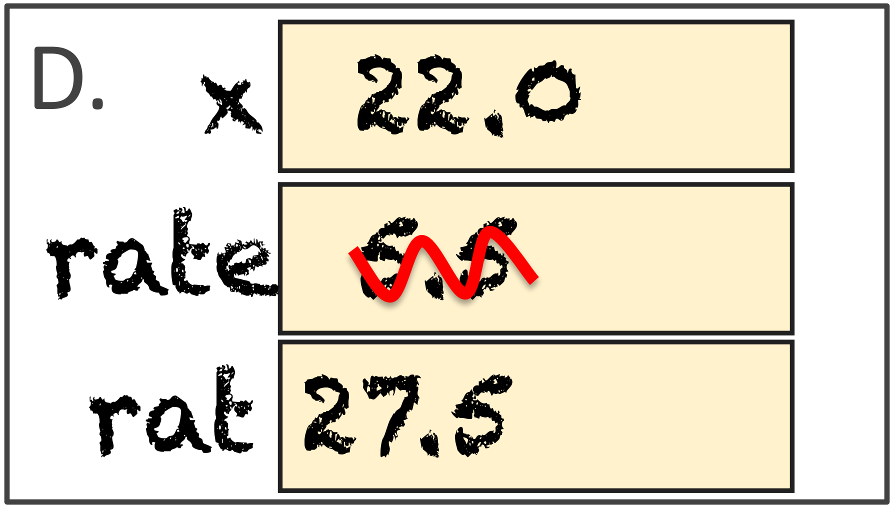
B.



C.



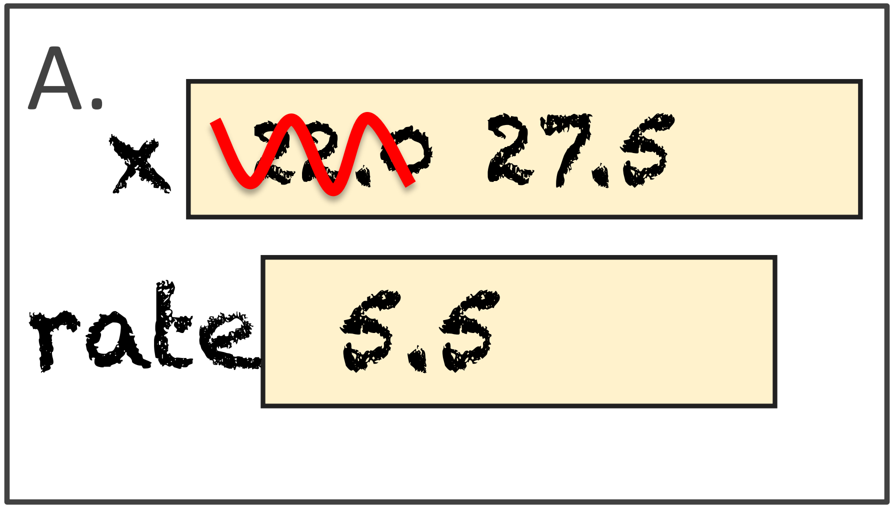
D.



E. ¯\_(ツ)_/¯

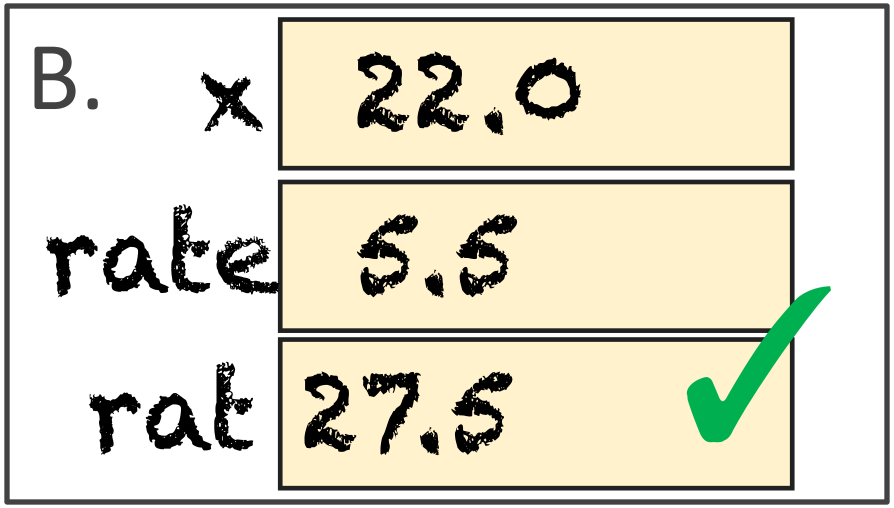
```
rat = x + rate
```

And The Correct Answer Is...


A.

x ~~22.0~~ 27.5

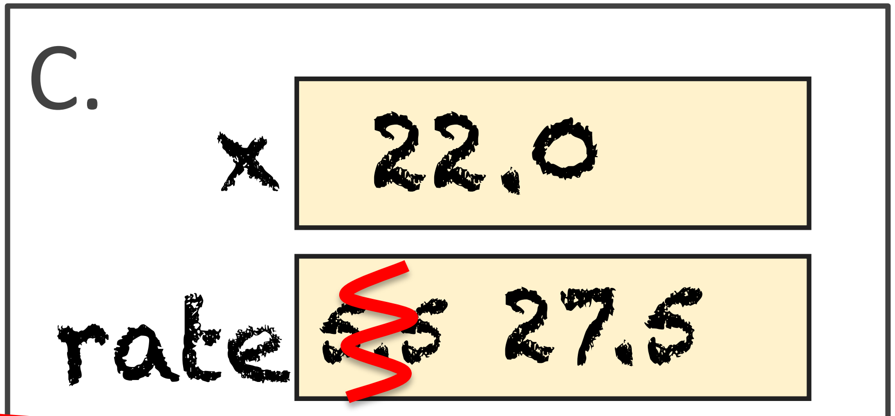
rate 5.5


B.

x 22.0

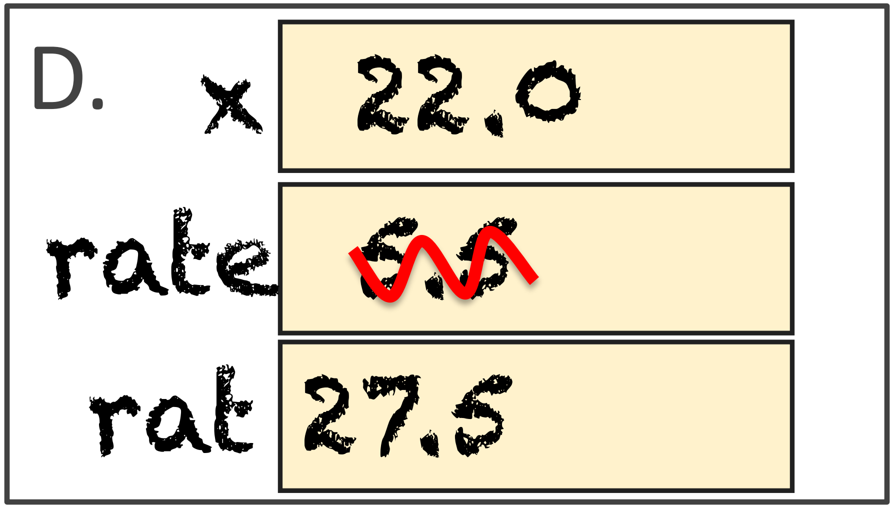
rate 5.5

rat 27.5 ✓


C.

x 22.0

rate ~~5.5~~ 27.5


D.

x 22.0

rate ~~5.5~~

rat 27.5

Spelling Matters!

rat = x + rate

More Detail: Testing Types

May want to track the type in a variable

Command: **type(***<expression>***)**

Can get the type of a variable:

```
>>> x = 5
>>> type(x)
<class 'int'>
```

Can test a type with a Boolean expression:

```
>>> type(2) == int
True
```