

Introduction to Computational Thinking and Python Programming

Sarom Leang, Ph.D. (Instructor)

Jesse McClandish (Mentor)

October 29, 2022

Session 1





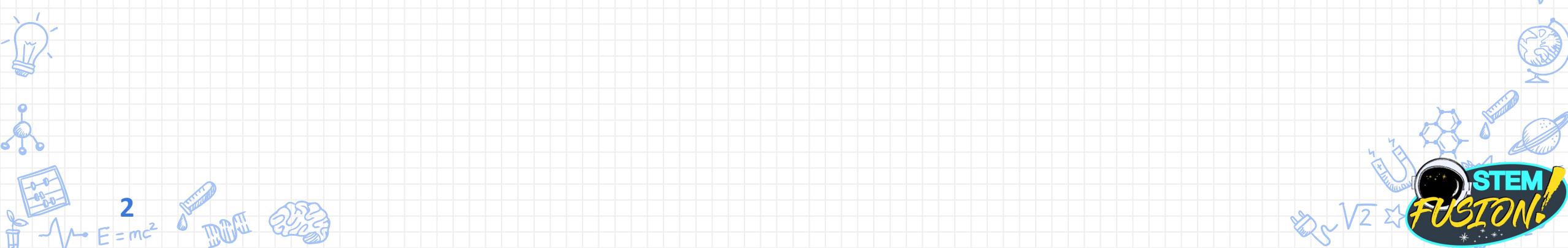
Names and Faces and Pronouns

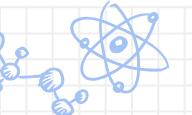
Sarom Leang, Ph.D. (Instructor)

- Professor
- Instructor
- Mr. Leang

Jesse McClandish (Mentor)

- Jesse





H₂O

$\sqrt{2}$



Schedule

10:00 AM – 10:25 AM Homeroom

10:25 AM – 11:45 AM G1 Block

11:45 AM – 12:35 PM Break/Lunch

12:40 PM – 01:55 PM G2 Block

01:55 PM – 02:00 PM Dismissal



$$E=mc^2$$

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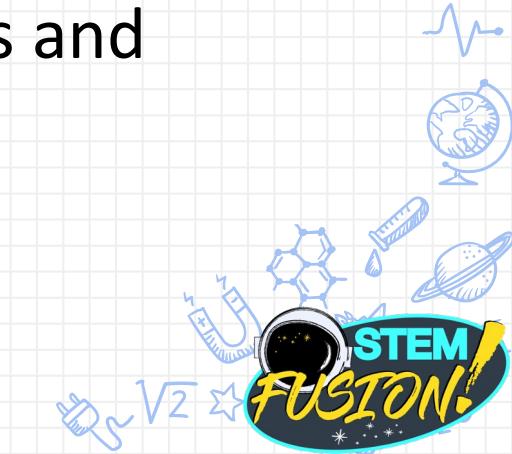


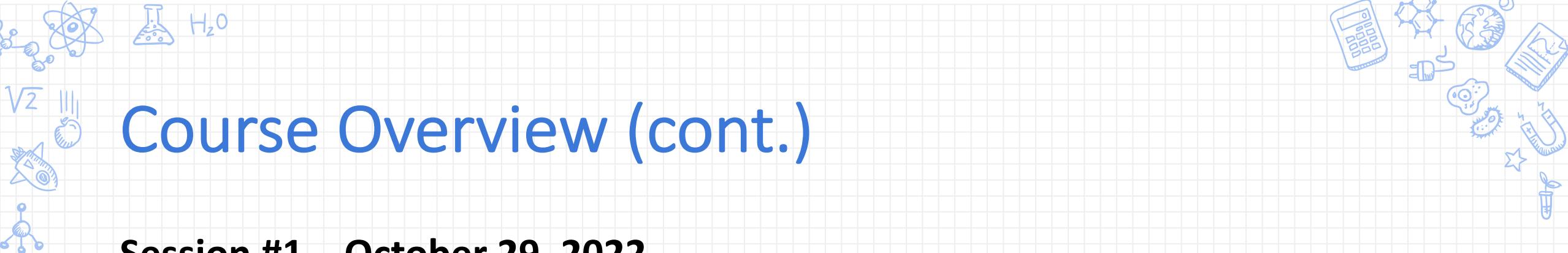
Course Overview

This course introduces the fundamental building blocks of computational thinking and computer programming using the Python language.

Upon successful completion of this course, students will be able to:

- Improve their problem-solving skills
- Write, read, and execute Python code using basic data types and operators





Course Overview (cont.)

Session #1 – October 29, 2022

- Python programming environment, “Hello World”

Session #2 – December 3, 2022

- Python data types, typecasting, conditionals, and Booleans

Session #3 – March 4, 2023

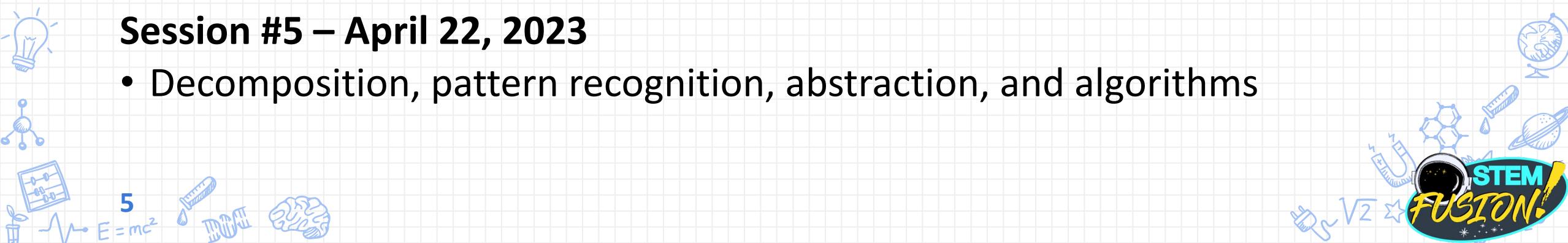
- Loops, {list, dictionary, set} comprehension, and functions

Session #4 – March 25, 2023

- Exception handling

Session #5 – April 22, 2023

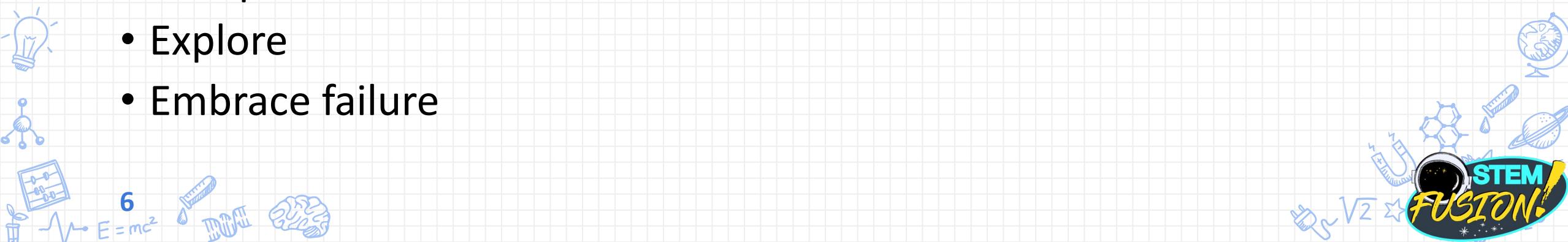
- Decomposition, pattern recognition, abstraction, and algorithms

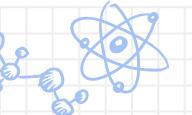




Student Expectations

- **NO FOOD**
- **NO DRINKS** (on the table)
- Be respectful to individuals and property
- Be open to learning
- Be open to not understanding
- Be patient with yourself
- Ask questions
- Explore
- Embrace failure





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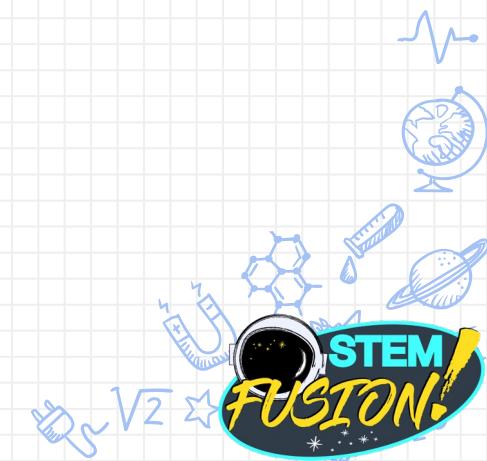


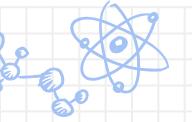
Resources

- Google
 - <https://www.google.com>
 - Refine web searches
 - <https://support.google.com/websearch/answer/2466433>
- Stack Overflow
 - <https://stackoverflow.com>



$$7 \quad E=mc^2$$





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Introductions



Choose one:

- Everyone has a story. What is yours?

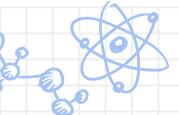
or

- Answer the following questions:
 - Name/Pronouns
 - Grade level and school
 - What did you choose to attend STEM Fusion!?
 - Why did you choose this course for STEM Fusion!?
 - Do you have any experience in computer programming?
 - What do you hope to get out of this course?



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My Story

- 1982 Coming to America!
Khmer Rouge Genocide
- 1998 EIP Class 7 Scholar
Wakefield High School
- 2004 B.S. Chemistry (Honors, High Distinction), Minor CS
George Mason University
- 2011 Ph.D. Physical Chemistry / Postdoctoral Researcher
Iowa State University
- 2014 Assistant Research Scientist
The Ames Laboratory, Department of Energy
- 2018 Senior Computational Scientist/Senior Software Engineer
EP Analytics, Inc.

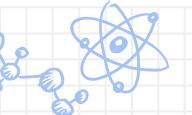


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$$E=mc^2$$



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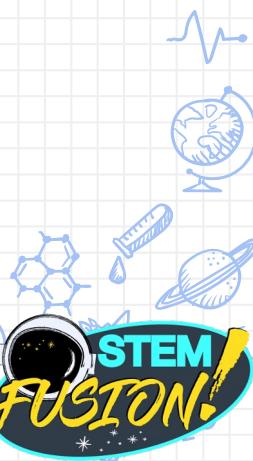


Entrance Survey (10 minutes)

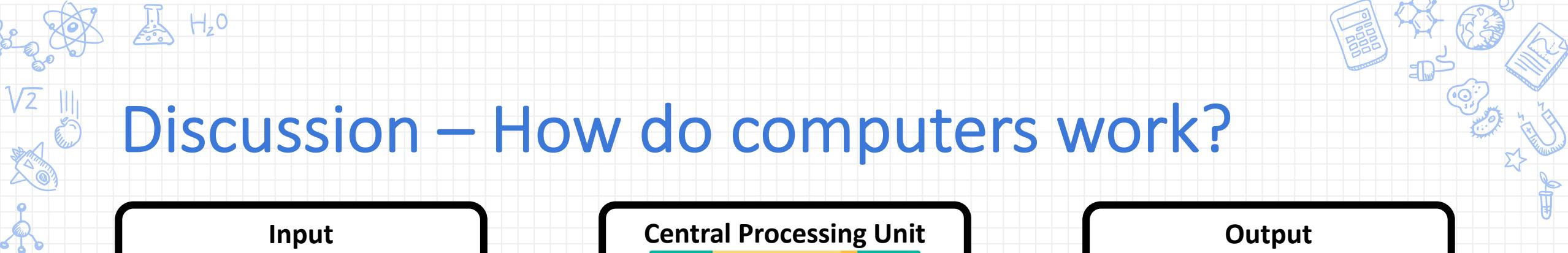
- Visit the following URL and answer the survey as best you can:
 - G1 - <https://bit.ly/Oct22G1>
 - G2 - <https://bit.ly/Oct22G2>



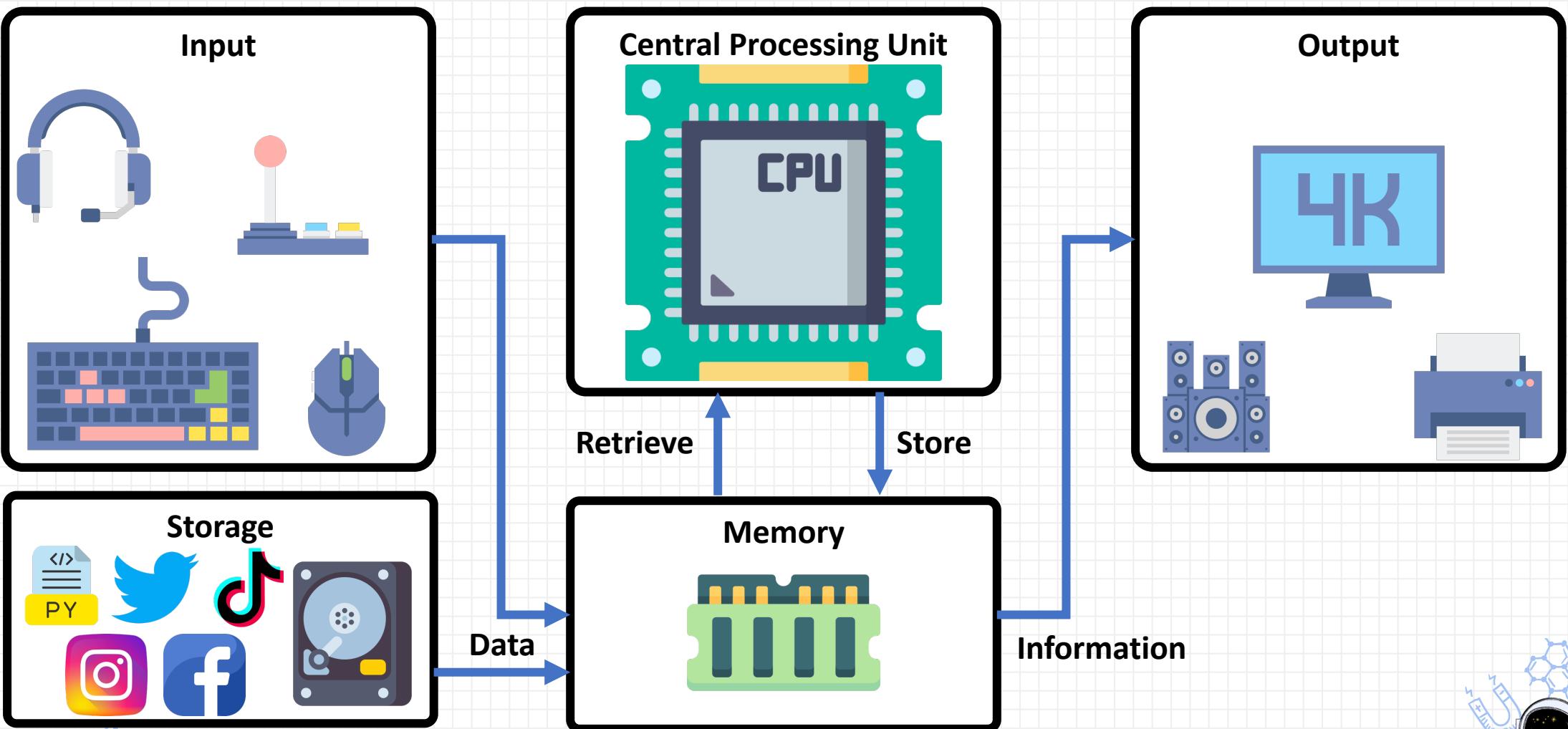
$$10 \quad E = mc^2$$

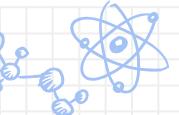


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Discussion – How do computers work?





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Discussion – What is a computer?



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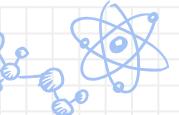
$$E=mc^2$$

100

100

100





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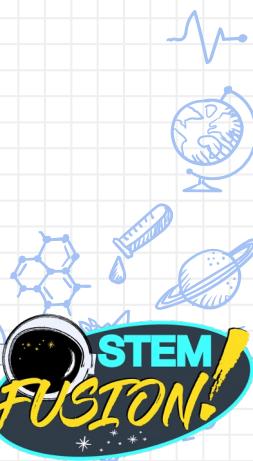
Discussion – What is a computer?

- An electronic device that **stores, retrieves, and processes** data.



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$$E=mc^2$$





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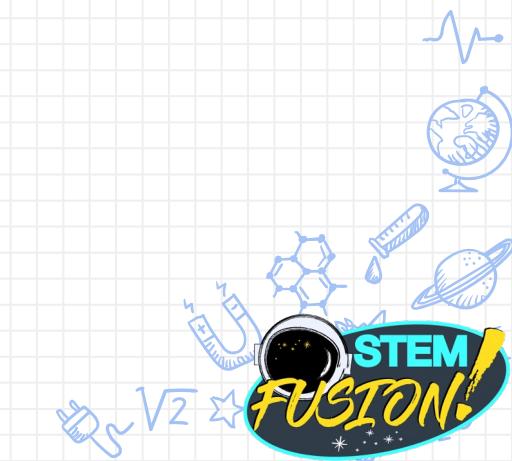


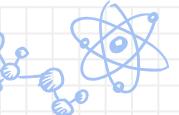
Discussion – What is a computer?

- An electronic device that **stores, retrieves, and processes** data.
- A **programmable** electronic device that **stores, retrieves, and processes** data.



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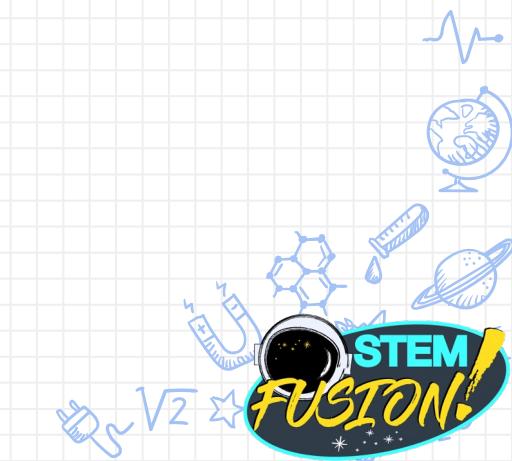
Discussion – What is a computer?

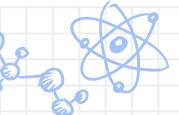
- An electronic device that **stores, retrieves, and processes** data.
- A **programmable** electronic device that **stores, retrieves, and processes** data following a **set of instructions**.



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$$E=mc^2$$





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Discussion – What is a computer?

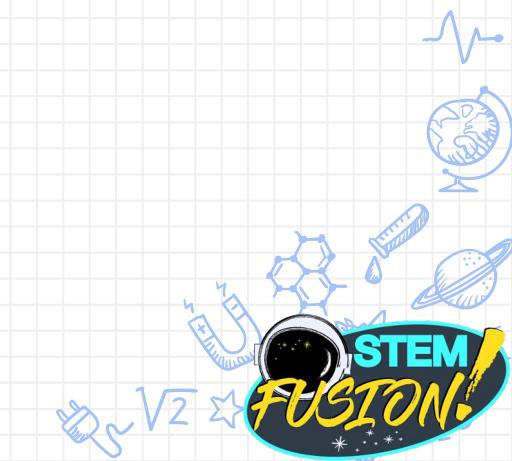
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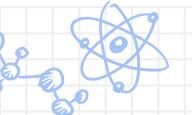
program



$$E = mc^2$$

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Discussion – What is computer programming?



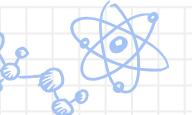
$$E=mc^2$$

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Discussion – What is computer programming?

- The **mental process** of developing a **set of instructions** for a computer.
 - Design and planning



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Discussion – What is computer programming?

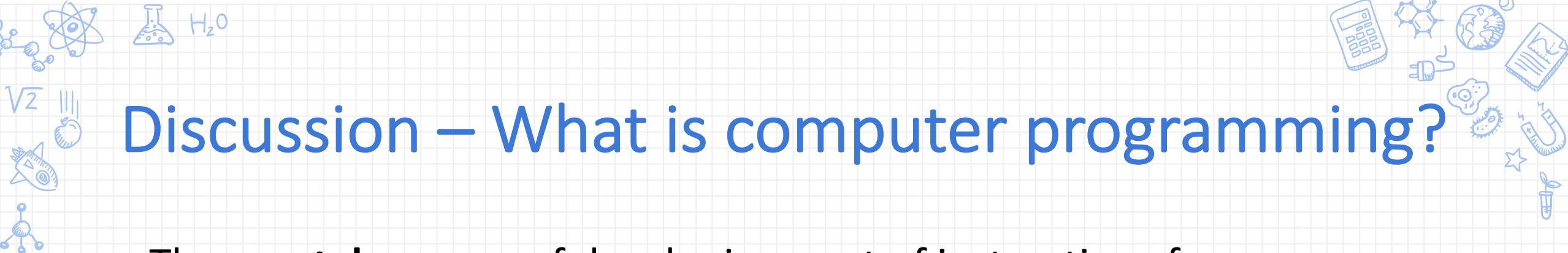
- The **mental process** of developing a set of instructions for a computer.
 - Design and planning
 - **What is the physical process called?**



$$E = mc^2$$

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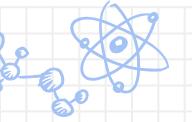




Discussion – What is computer programming?

- The **mental process** of developing a set of instructions for a computer.
 - Design and planning
- **What is the physical process called?**
 - Coding





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Example – Set of Instructions (For Humans)

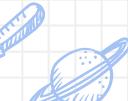
- Left hand out and up
- Right hand out and up
- Flip left hand
- Flip right hand
- Left hand to right shoulder
- Right hand to left shoulder
- Left hand to back of head
- Right hand to back of head
- Left hand to right hip
- Right hand to left hip
- Left hand on left bottom
- Right hand on right bottom
- Wiggle
- Wiggle
- Jump

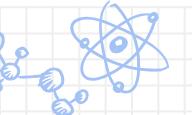


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Example – Set of Instructions (For Computers)

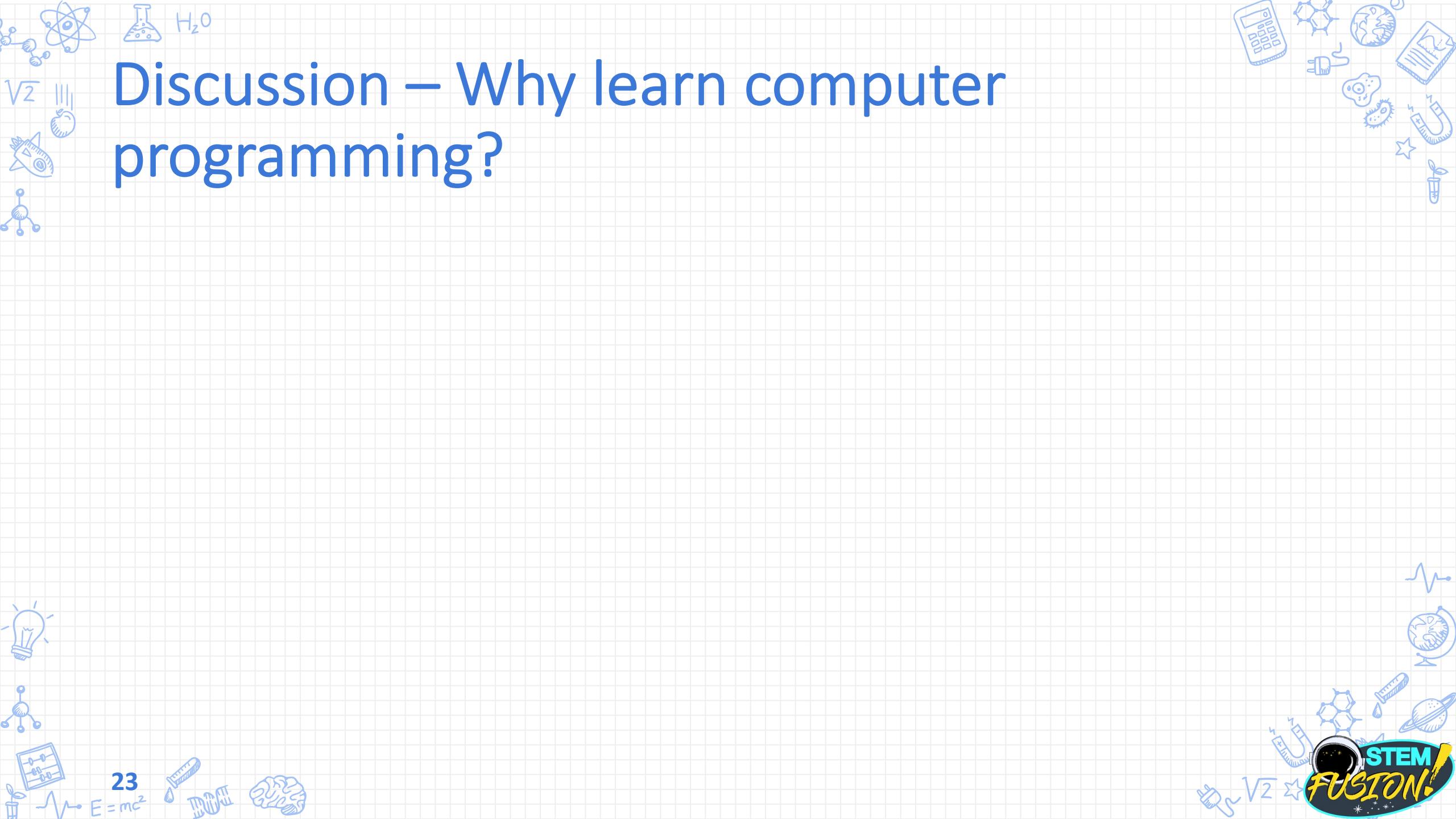
```
r=int(input("Enter upper limit: "))
for a in range(2,r+1):
    k=0
    for i in range(2,a//2+1):
        if(a%i==0):
            k=k+1
    if(k<=0):
        print(a)
```



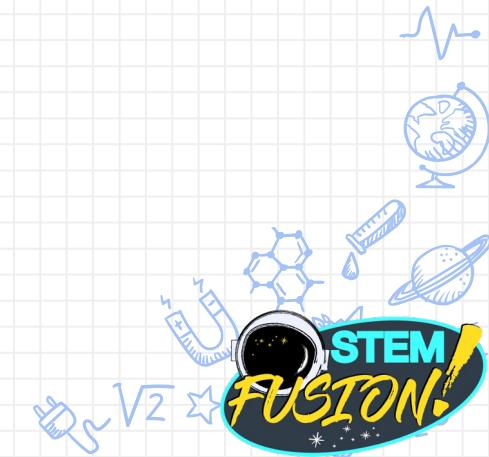
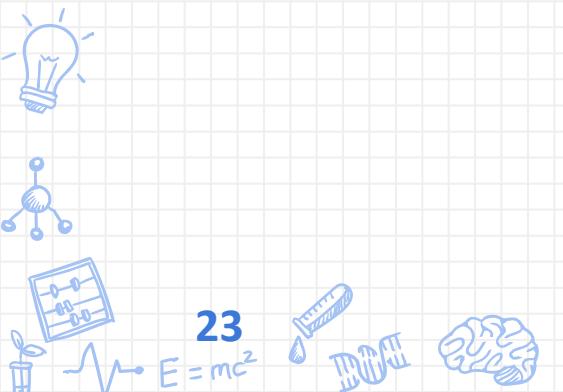
$$E=mc^2$$

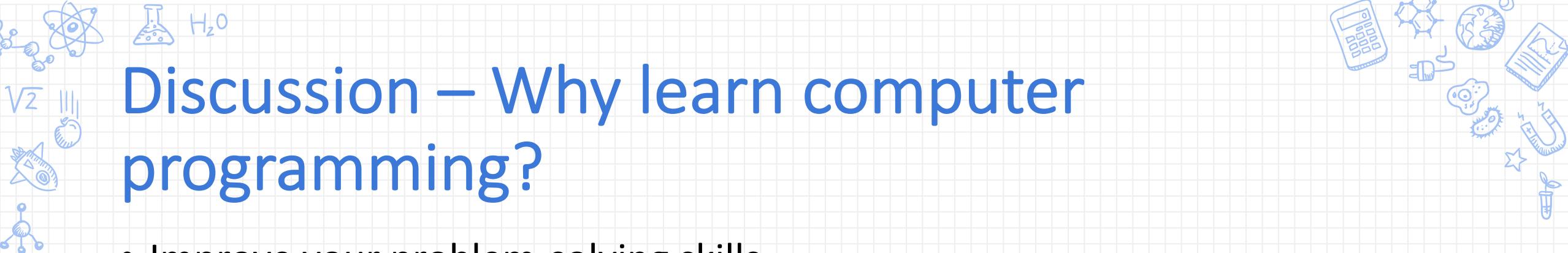
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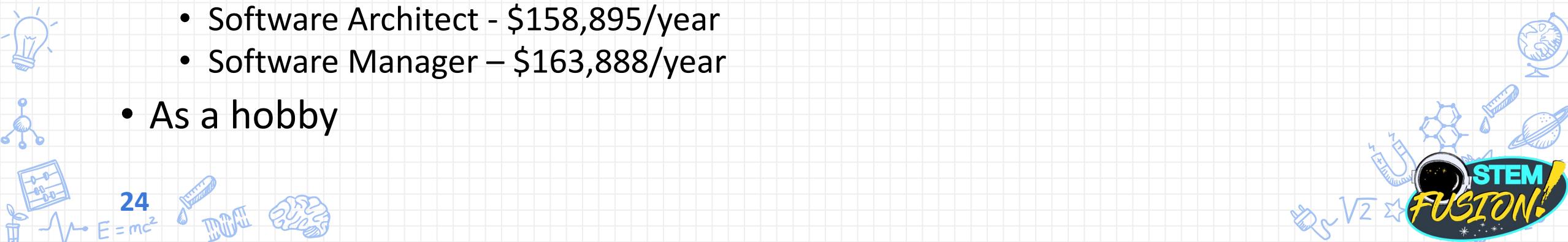
Discussion – Why learn computer programming?





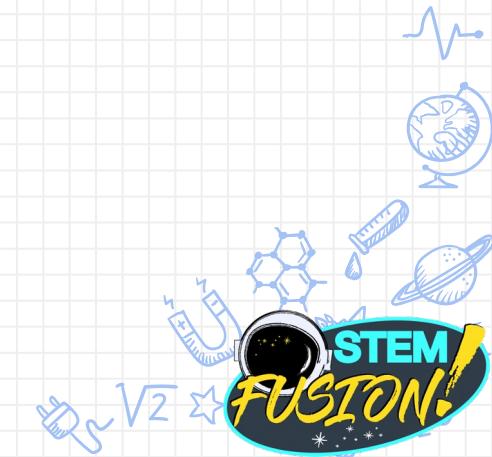
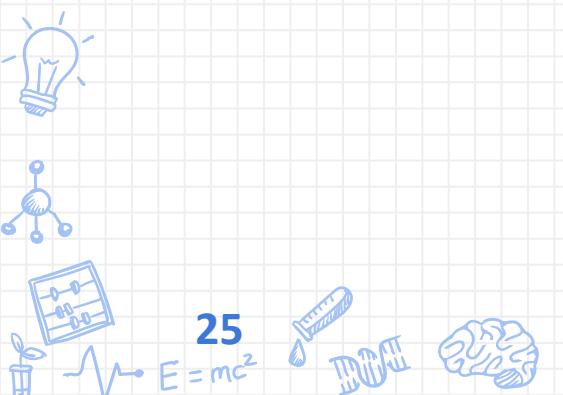
Discussion – Why learn computer programming?

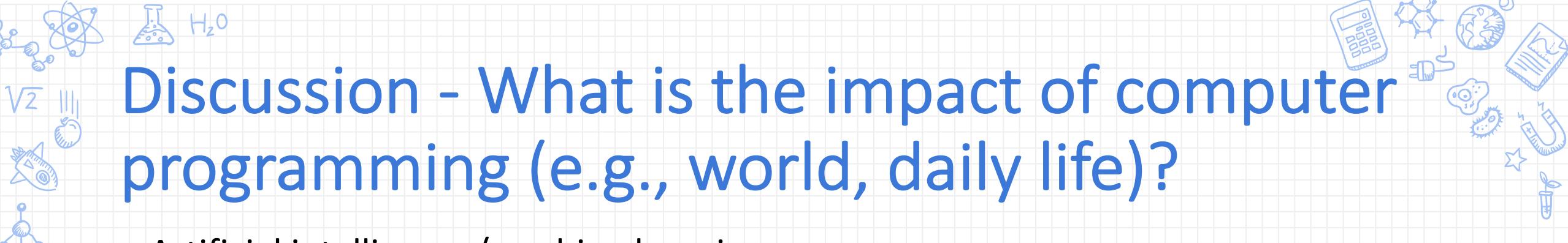
- Improve your problem-solving skills
- Process large amounts of data (finance, manufacturing, healthcare, science)
- Create/design a web site/application/game
- To better understand computer programs/technology
- As a career (Glassdoor salary search for Washington D.C. area)
 - Software Developer - \$109,099/year
 - Data Scientist - \$118,542/year
 - Software Architect - \$158,895/year
 - Software Manager – \$163,888/year
- As a hobby





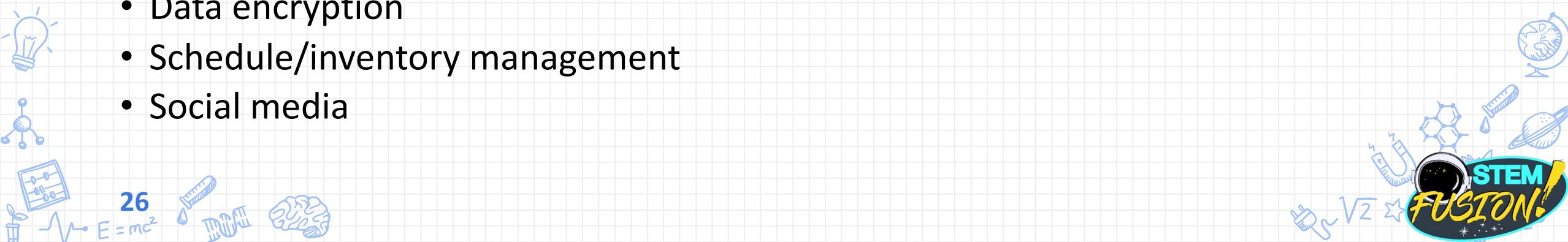
Discussion - What is the impact of computer programming (e.g., world, daily life)?

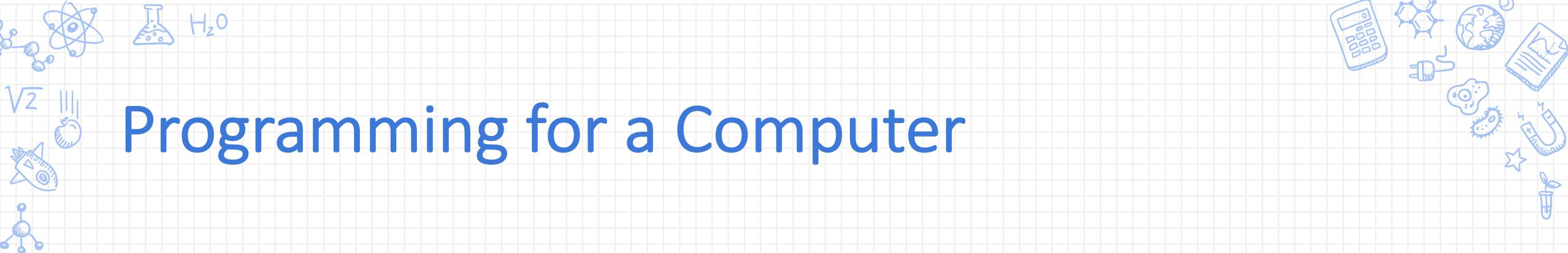




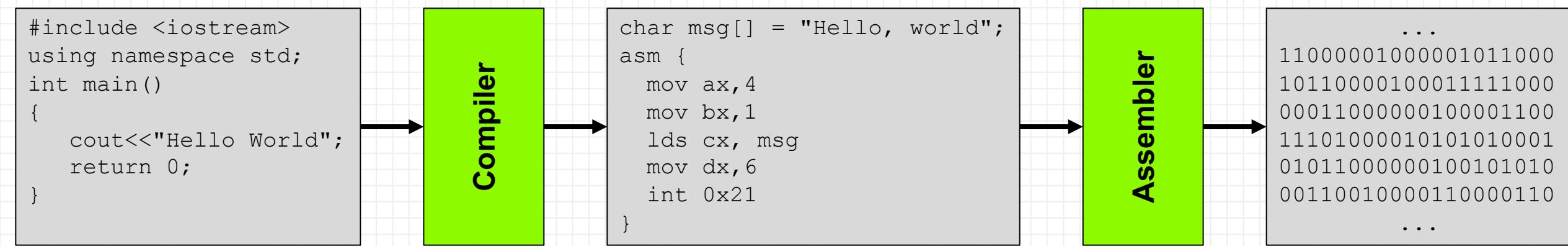
Discussion - What is the impact of computer programming (e.g., world, daily life)?

- Artificial intelligence/machine learning
- Robotics/automation
- Cybersecurity/threats
- Websites/E-commerce
- Payment processing/transactions
- Mobile Apps
- Weather modeling
- Global positioning system (GPS)
- Data encryption
- Schedule/inventory management
- Social media





Programming for a Computer

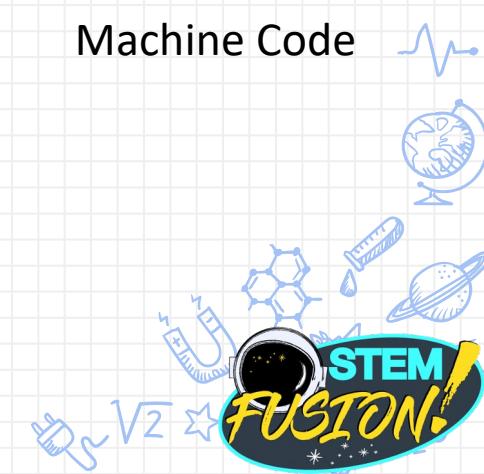
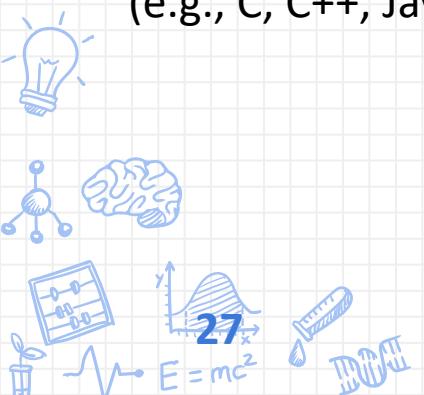


High level language
(e.g., C, C++, Java)

Assembly Language
(e.g., x86, ARM)

Machine Code

Note: Python uses an interpreter to convert Python code to Python bytecode (line-by-line).



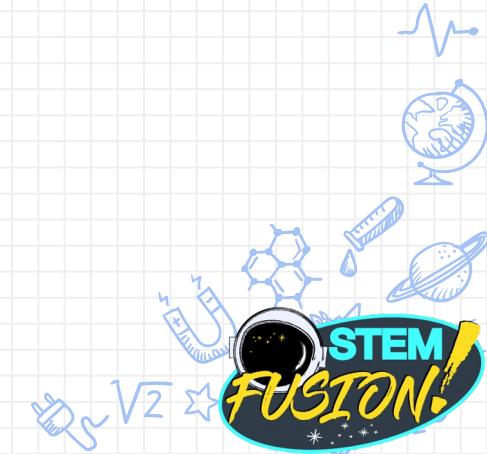


Python

- An interpreted high-level programming language released in 1991.
- Can be used for web development, software development, mathematics, and system scripting.
- Works on different platforms (Windows, Mac, Linux, etc.).
- Simple syntax similar to the English language.
 - Syntax – arrangement of words/phrases to create something understandable



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H₂O

V²



Programming Environment

- A text editor
 - Sublime <https://www.sublimetext.com>
- A Python interpreter
 - Python 3.11.0 <https://www.python.org>



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ECG

E=mc²



R²



V²



U



M



S



W



E



F



G

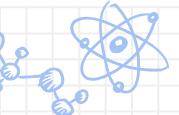


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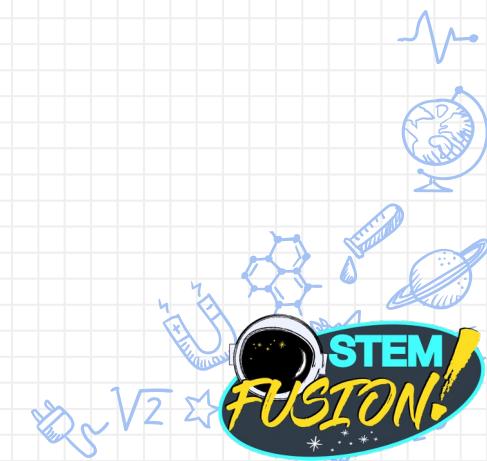
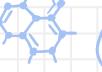
H₂O

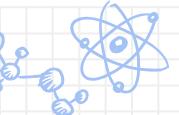
$\sqrt{2}$



hello.py

```
print("Hello World!")
```





H₂O

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hello.py

```
print("Hello World!")
```

function

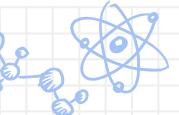


$$E=mc^2$$

31



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✓²



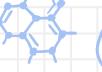
hello.py

```
print("Hello World!")
```

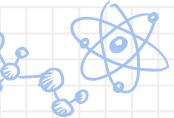
function input



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hello.py

```
print("Hello World!")
```

function input

What/Where is the output?



$$E = mc^2$$

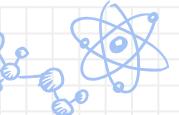
33



BOE



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V²



First Programming Exercise: Hello World

- Open up a blank document in the ATOM editor
- Type: **print("Hello World!")**
- Save the file as **hello.py** into your Documents folder
- Open up the command prompt
 - 1. Test if python is working: type **python** and hit enter
 - 2. If you get an error then: type
set PATH=%PATH%;C:\Python311
and hit enter
 - 3. Repeat step 1
- Execute your script:
 - Switch into the directory containing **hello.py**
 - **cd Documents**
 - Call the python program to interpret and execute your code
 - **python hello.py**

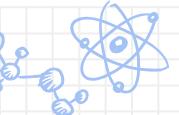


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$$E=mc^2$$





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Discussion – What are computers good at?



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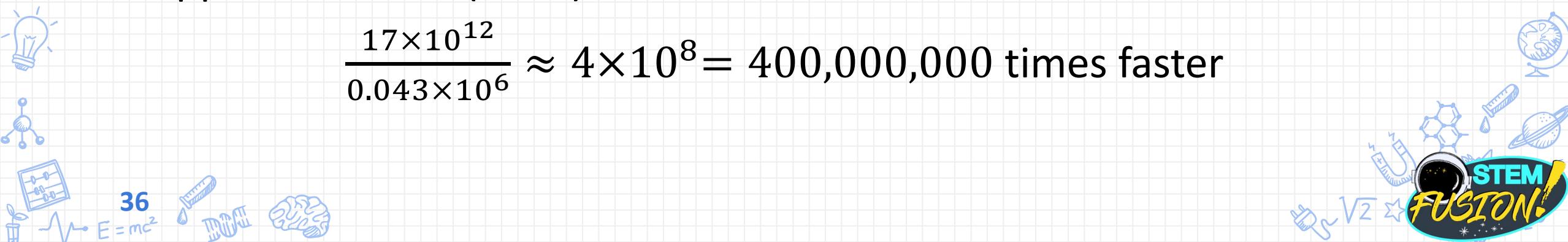


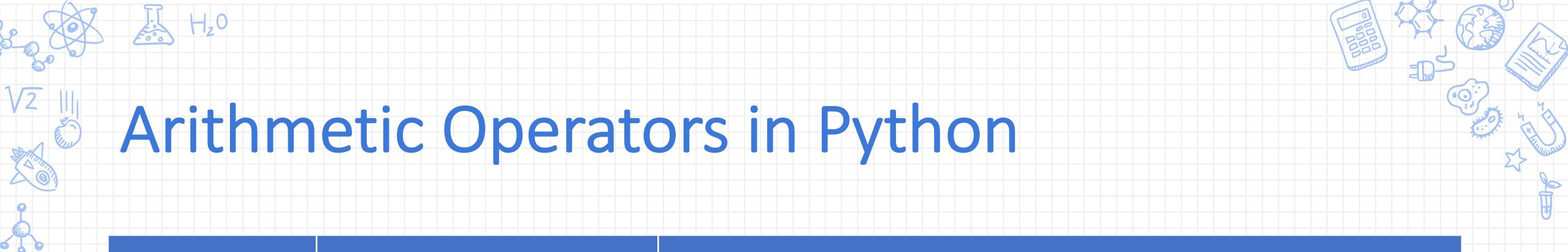


Discussion – What are computers good at?

- Math (computations)
- Processing power is measured in Hertz (Hz)
 - 1 Hz = 1 clock cycle per second = 1 CPU fetch and execution of an instruction
 - A 1 Hz CPU can do 1 instruction per second
 - 2 GHz = 2 billion clock cycles per second = 2 billion instructions per second! 😱
- NASA Apollo Guidance Computer (1960s) : 0.043 MHz = 0.043×10^6 Hz
- Apple iPhone 14 (2022) : 17 THz = 17×10^{12} Hz

$$\frac{17 \times 10^{12}}{0.043 \times 10^6} \approx 4 \times 10^8 = 400,000,000 \text{ times faster}$$

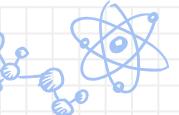




Arithmetic Operators in Python

Operator	Usage	Operation
+	<code>x + y</code>	Addition
-	<code>x - y</code>	Subtraction
*	<code>x * y</code>	Multiplication
/	<code>x / y</code>	Division
%	<code>x % y</code>	Remainder (the remainder after division)
**	<code>x ** y</code>	Exponentiation
//	<code>x // y</code>	Floor division





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Second Programming Exercise: Maths!!

Operation	Result
Let x = 8 and y = 2	
print(x + y)	
print(x - y)	
print(-x)	
print(x*y)	
print(x/y)	
print(x//y)	
print(x%y)	
print(x**y)	



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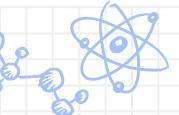
$$E=mc^2$$

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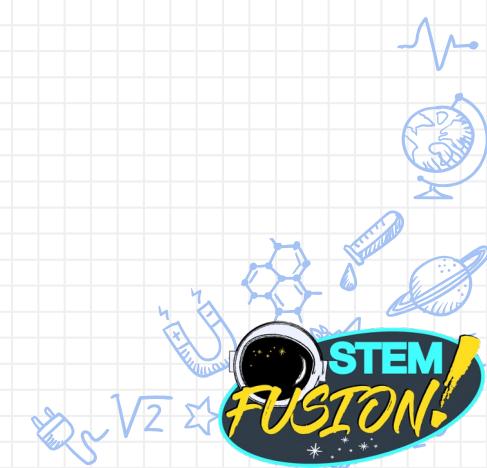
Second Programming Exercise: Maths!!

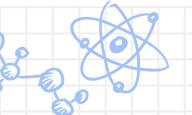
Operation	Result
Let x = 9 and y = 4	
print(x + y)	
print(x - y)	
print(-x)	
print(x*y)	
print(x/y)	
print(x//y)	
print(x%y)	
print(x**y)	



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$E=mc^2$





H₂O

$\sqrt{2}$



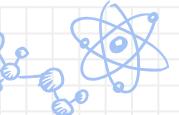
Operator Precedence

- In Python, operators will be evaluated in order of precedence.
- Order of operations – **PEMDAS**
 1. Parentheses ()
 2. Exponentiation **
 3. Multiplication * and Division /, //, %
 4. Addition + and Subtraction –
- After **PEMDAS**, order goes left to right.
- Use parentheses to override order.



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H₂O

$\sqrt{2}$



Class Exercise: PEMDAS

Try to determine the solution by hand and then verify with Python

$$1 + 2 * 4 = ?$$

$$(1 + 2) * 4 = ?$$

$$5 + (4 - 2) * 2 + 4 \% 2 - 4 // 3 - (5 - 3) / 1 = ?$$



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$$E = mc^2$$

$\sqrt{2}$



BOE



STEM
FUSION!





H₂O

$\sqrt{2}$



Class Exercise: PEMDAS

$$1 + 2 * 4 = ?$$

$$1 + 2 * 4 = ?$$

$$1 + 8 = 9$$

$$(1 + 2) * 4 = ?$$

$$(1 + 2) * 4 = ?$$

$$3 * 4 = 12$$

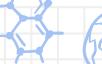
$$5 + (4 - 2) * 2 + 4 \% 2 - 4 // 3 - (5 - 3) / 1 = ?$$

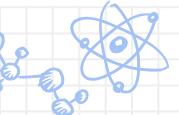


42

$$E = mc^2$$

$\sqrt{2}$





H₂O

$\sqrt{2}$



Class Exercise: PEMDAS

$$5 + (4 - 2) * 2 + 4 \% 2 - 4 // 3 - (5 - 3) / 1 = ?$$

$$5 + (\textcolor{red}{4 - 2}) * 2 + 4 \% 2 - 4 // 3 - (\textcolor{red}{5 - 3}) / 1 = ?$$

$$5 + \textcolor{red}{2} * 2 + 4 \% 2 - 4 // 3 - \textcolor{red}{2} / 1 = ?$$

$$5 + \textcolor{blue}{2} * \textcolor{blue}{2} + \textcolor{green}{4 \% 2} - \textcolor{purple}{4} // 3 - \textcolor{orange}{2} / \textcolor{yellow}{1} = ?$$

$$5 + \textcolor{blue}{4} + \textcolor{green}{0} - \textcolor{purple}{1} - \textcolor{orange}{2} = 6$$



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$$E = mc^2$$

