



CS-2001

DATA STRUCTURE

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STACKS

Stack

3

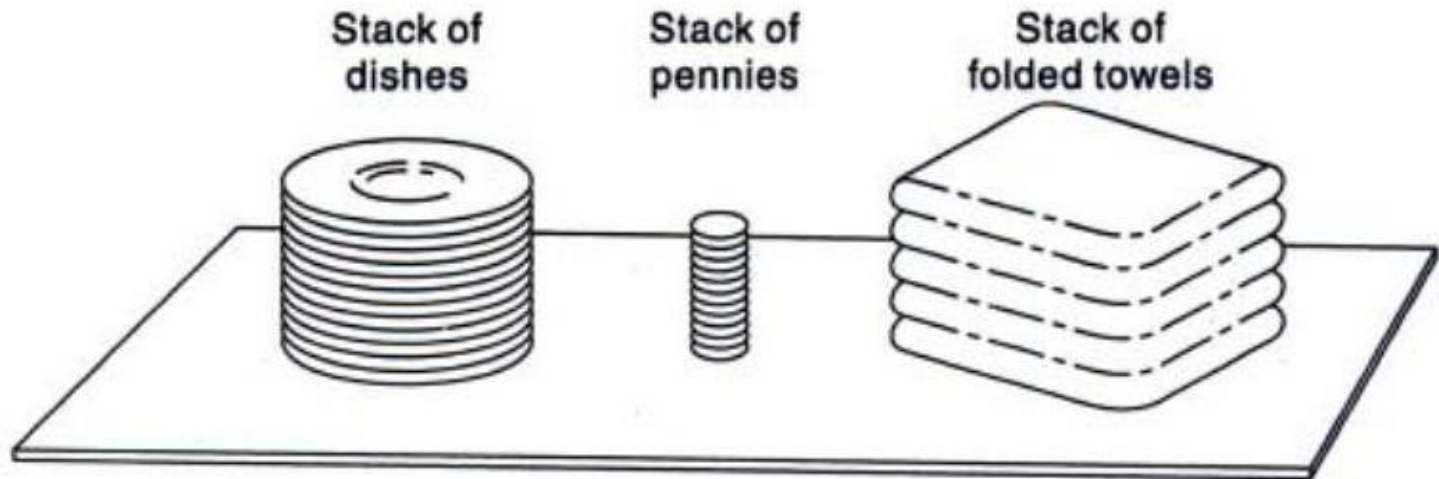
- “A ***Stack*** is a special kind of list in which all insertions and deletions take place at one end, called the ***Top***”
- Other Names
 - Pushdown List
 - Last In First Out (LIFO)

Stack

4

Examples:

- Folded towels on shelf
- Dishes on a shelf
- Pennies on shelf



Common Operations

5

1. **MAKENULL(S)**: Make Stack S be an empty stack.
2. **TOP(S)**: Return the element at the top of stack S .
3. **POP(S)**: Remove the top element of the stack.
4. **PUSH(S)**: Insert the element x at the top of the stack.
5. **ISEMPTY(S)**: Return true if S is an empty stack; return false otherwise.

Static and Dynamic Stacks

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- There are two kinds of stack data structure,
 - a) **Static**, i.e. they have a **fixed size**, and are *implemented as arrays*.
 - b) **Dynamic**, i.e. they **grow in size** as needed, and *implemented as linked lists*

APPLICATION OF STACKS

Application of Stacks

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- Tower of Hanoi
- Expressions
 - ▣ Infix: $A+B-C$
 - ▣ Postfix: $AB+C-$
 - ▣ Prefix: $-+ABC$
- Recursion

Tower of Hanoi

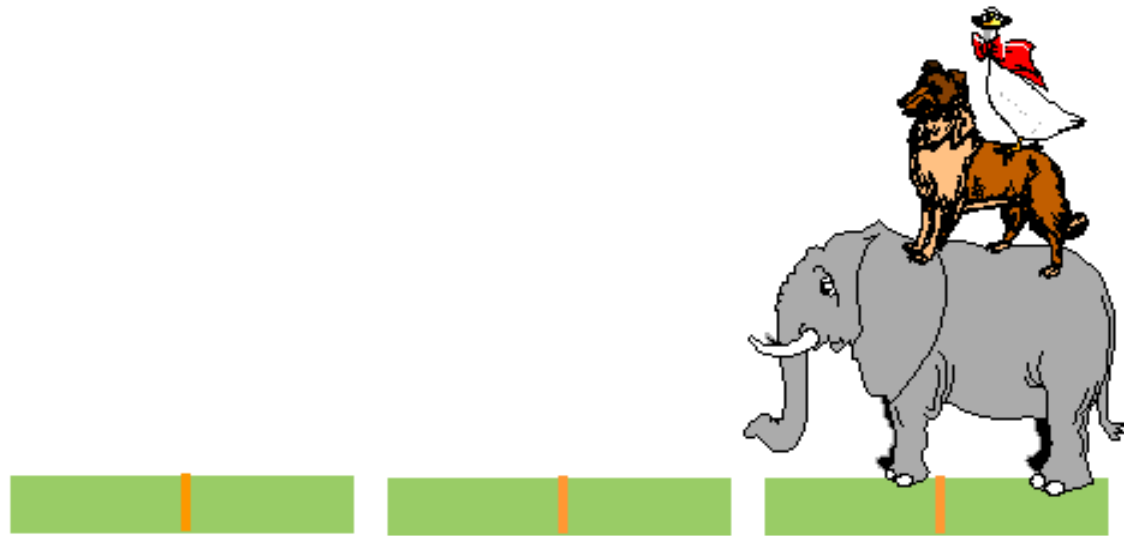
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- GIVEN: Three poles
 - a set of discs on the first pole,
 - discs of different sizes,
 - the smallest discs at the top
- GOAL: move all the discs from the left pole to the right one.
- CONDITIONS: only one disc may be moved at a time.
 - A disc can be placed either on an empty pole or on top of a larger disc.



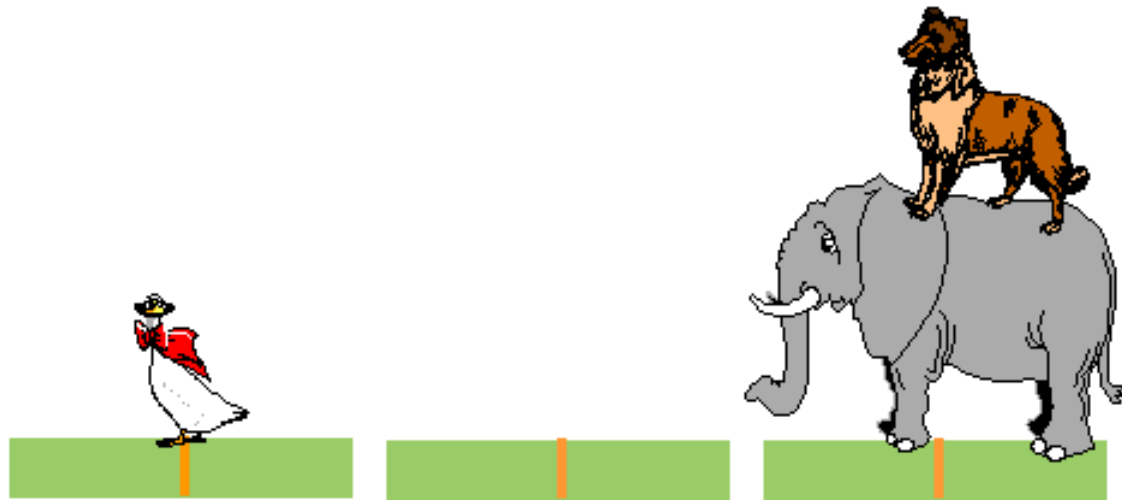
Tower of Hanoi

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Tower of Hanoi

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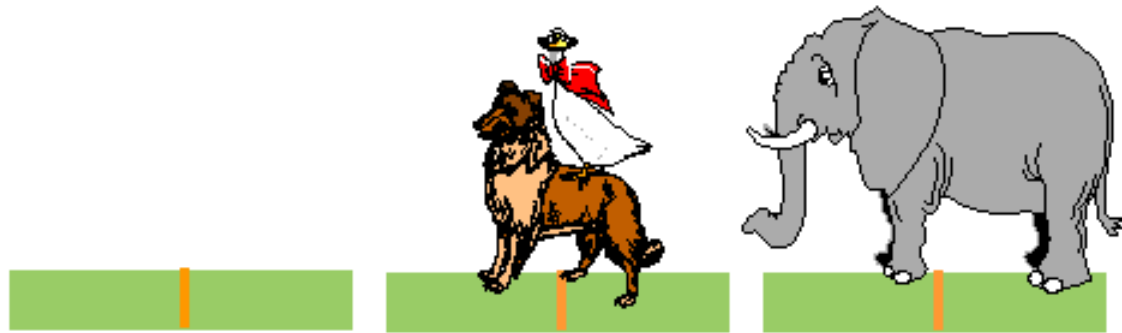
Tower of Hanoi

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Tower of Hanoi

13



Tower of Hanoi

14



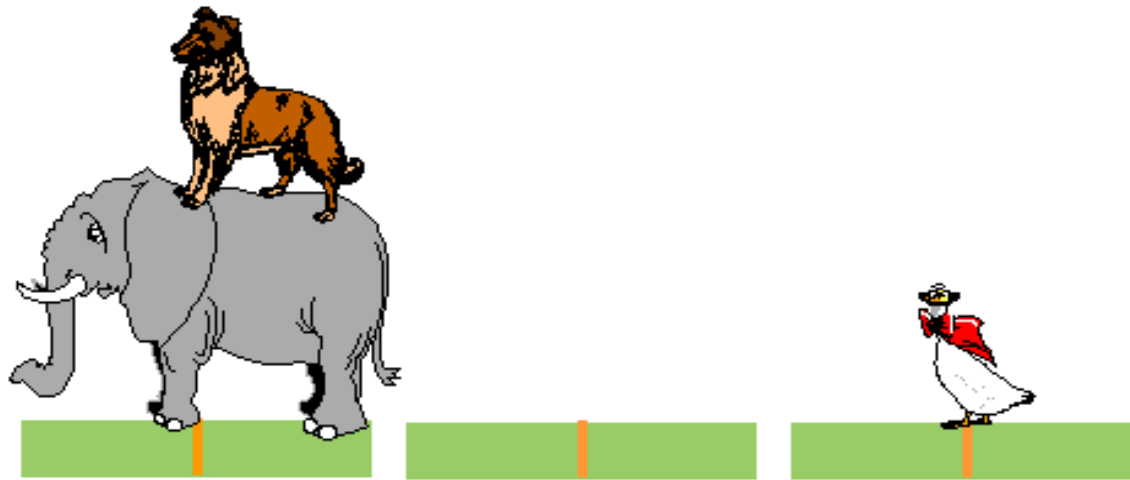
Tower of Hanoi

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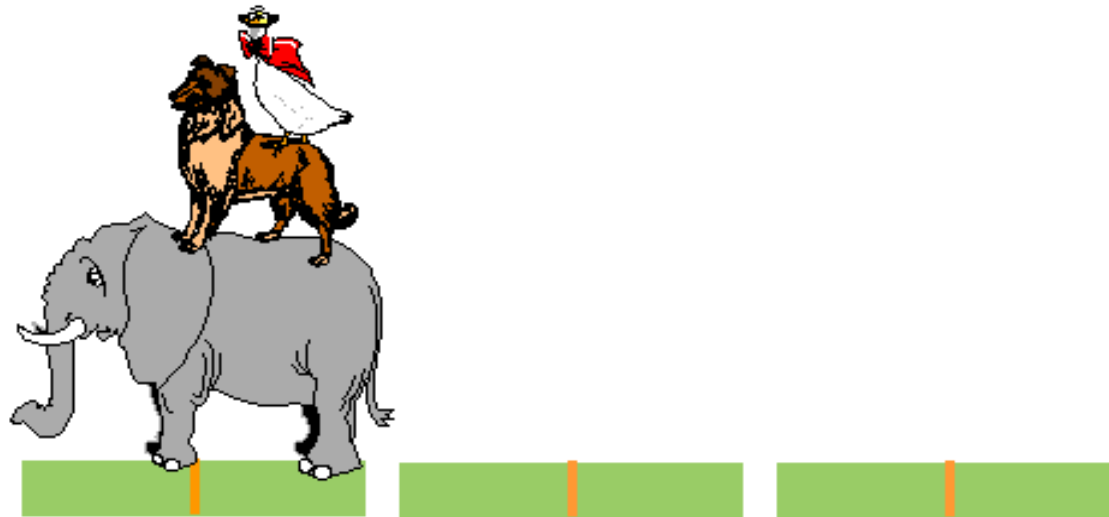
Tower of Hanoi

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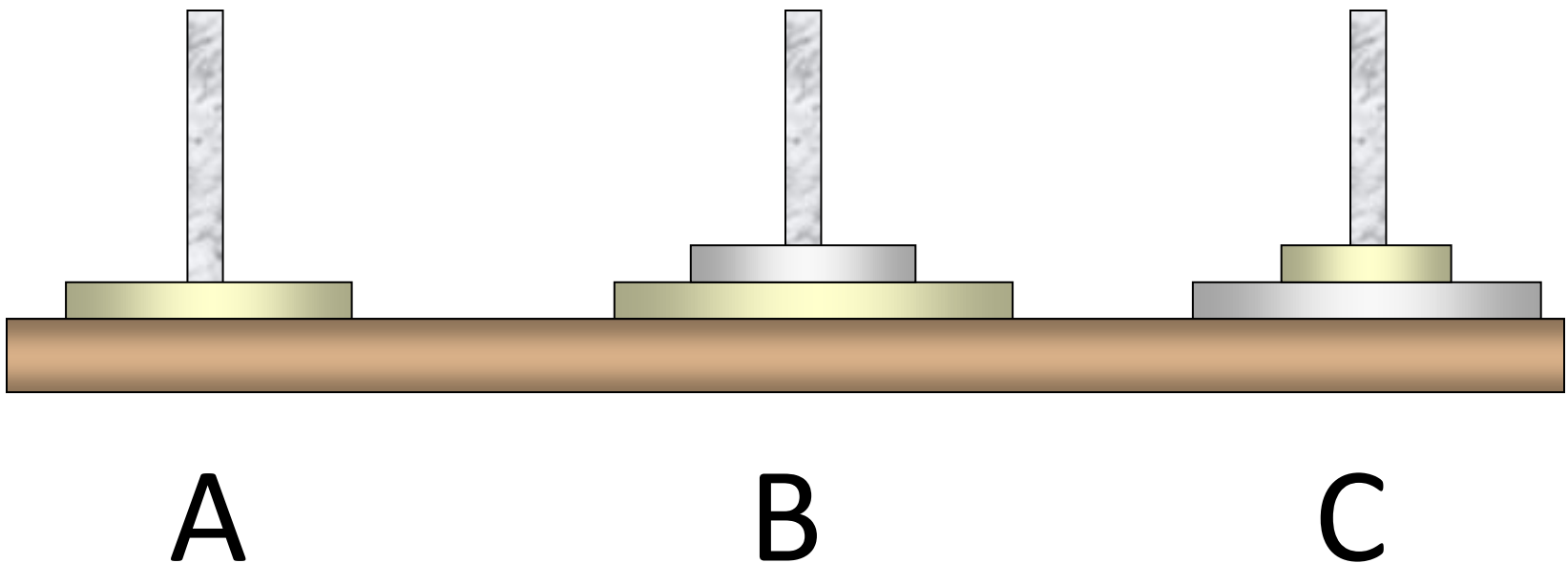
Tower of Hanoi

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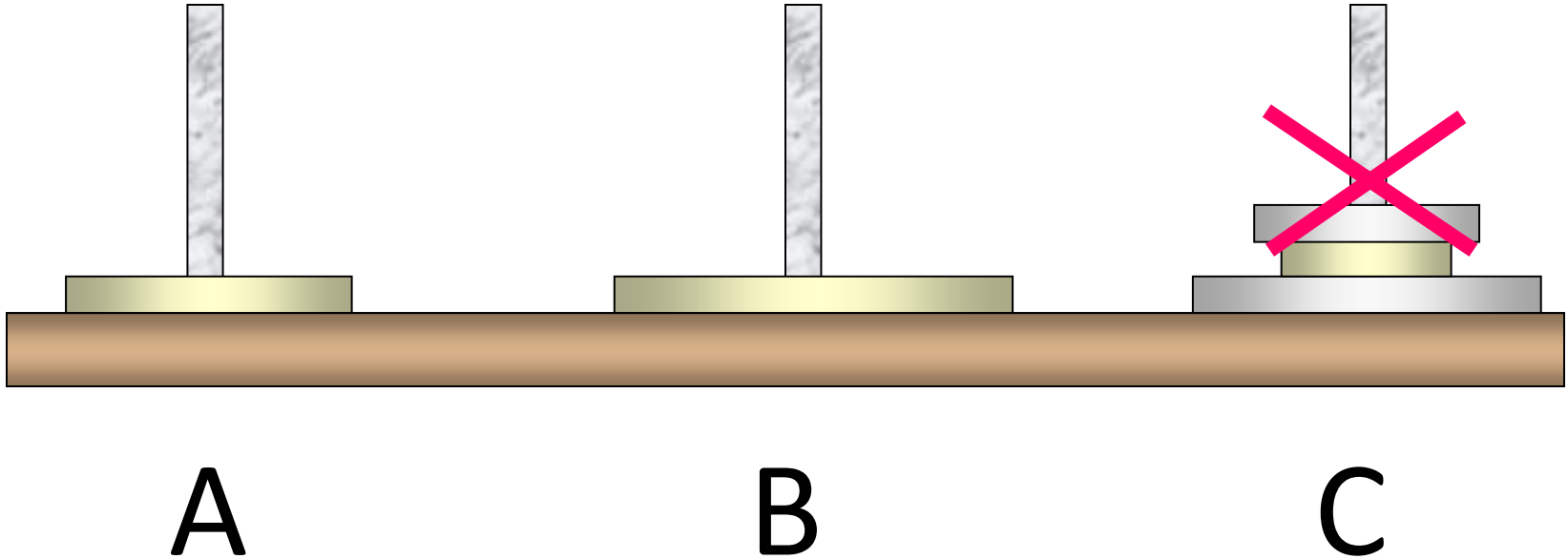
The Tower of Hanoi

5 Tower

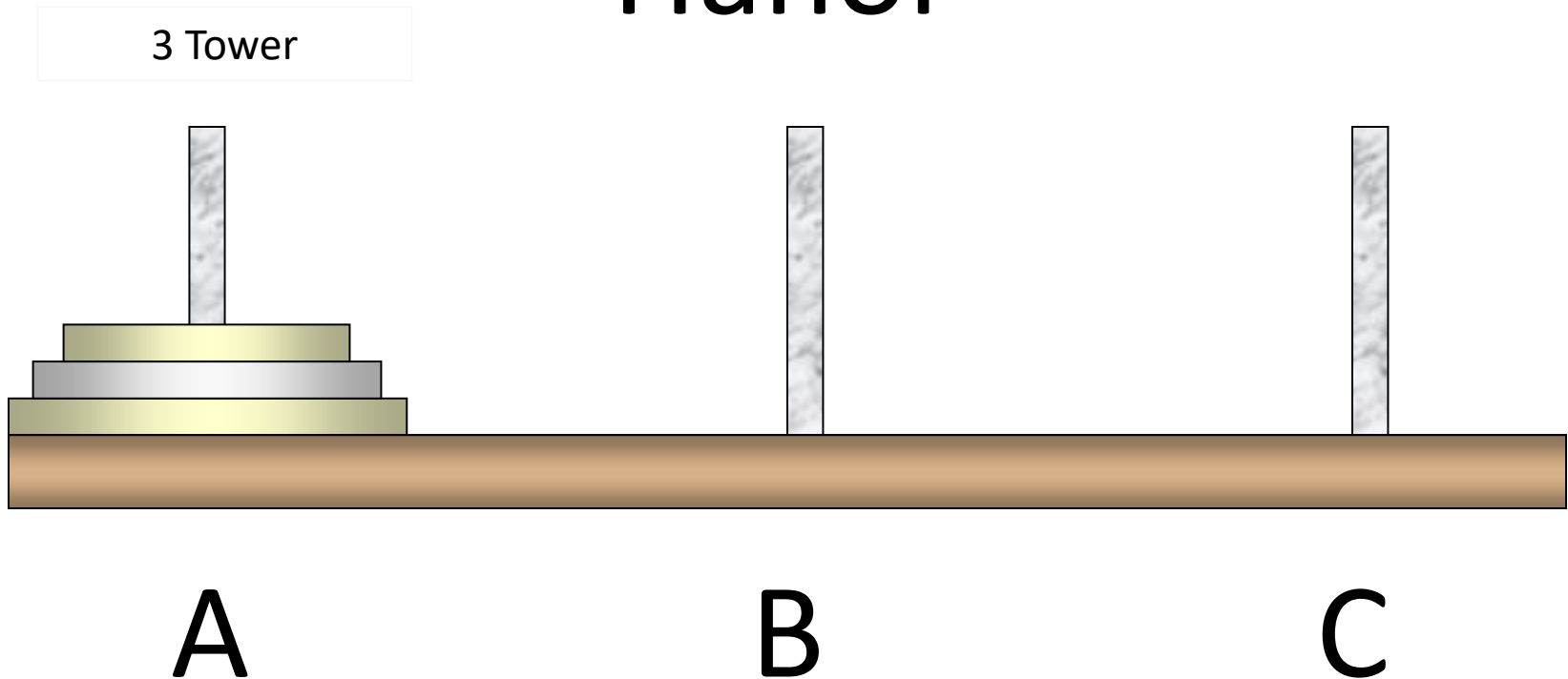


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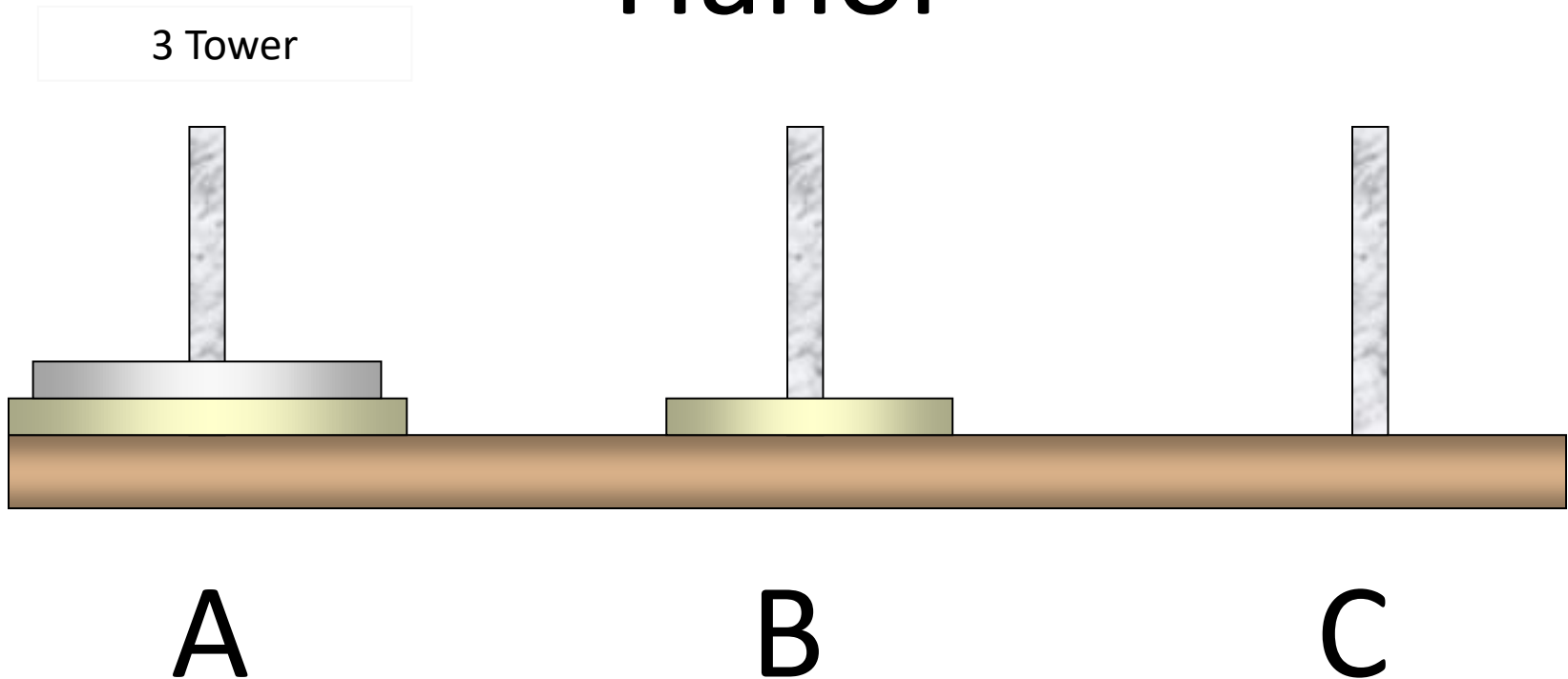
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The Tower of Hanoi

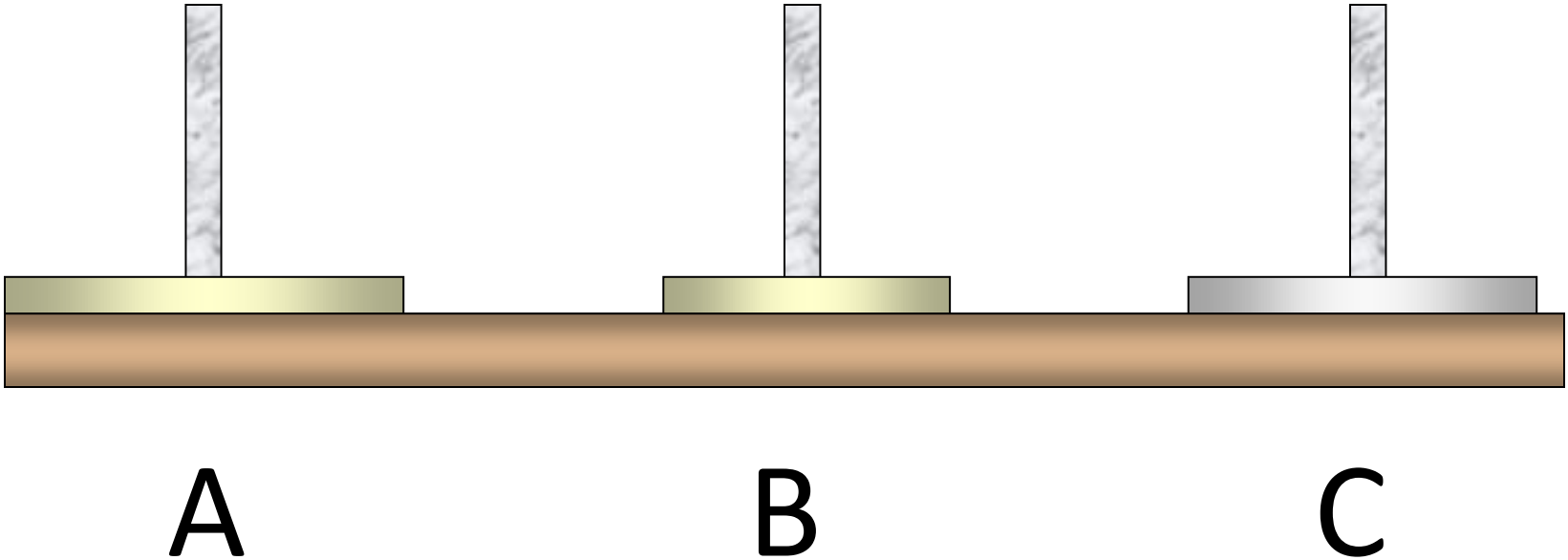


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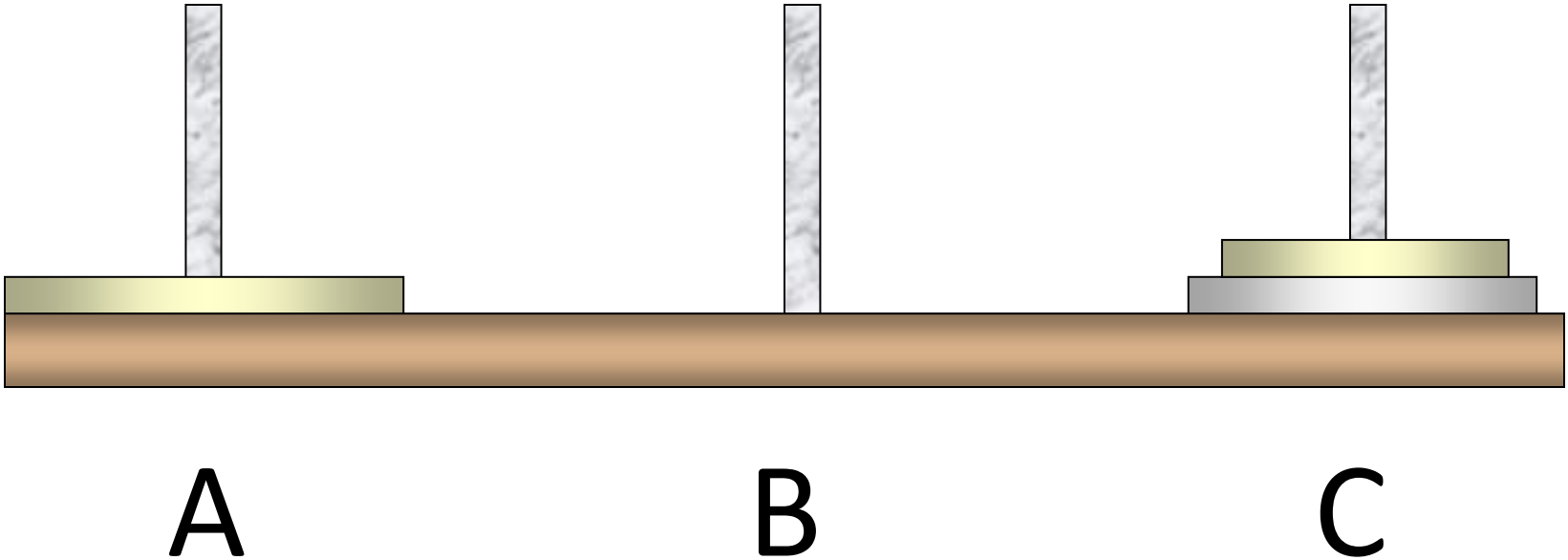
The Tower of Hanoi

3 Tower



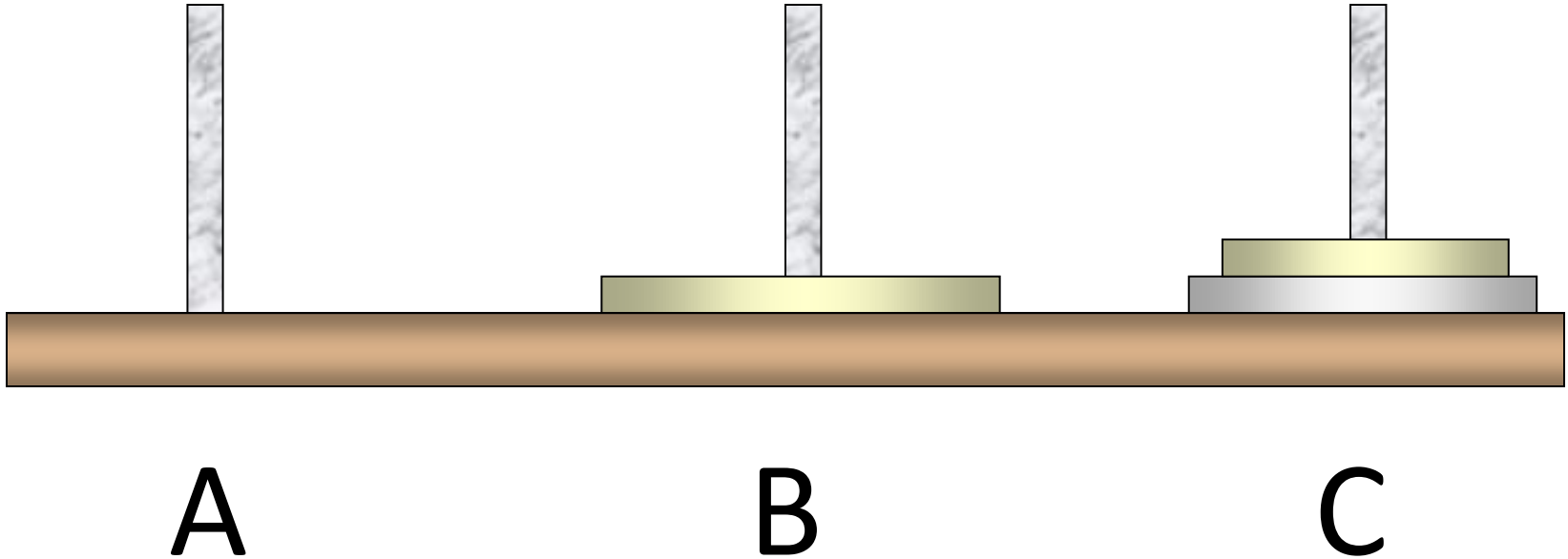
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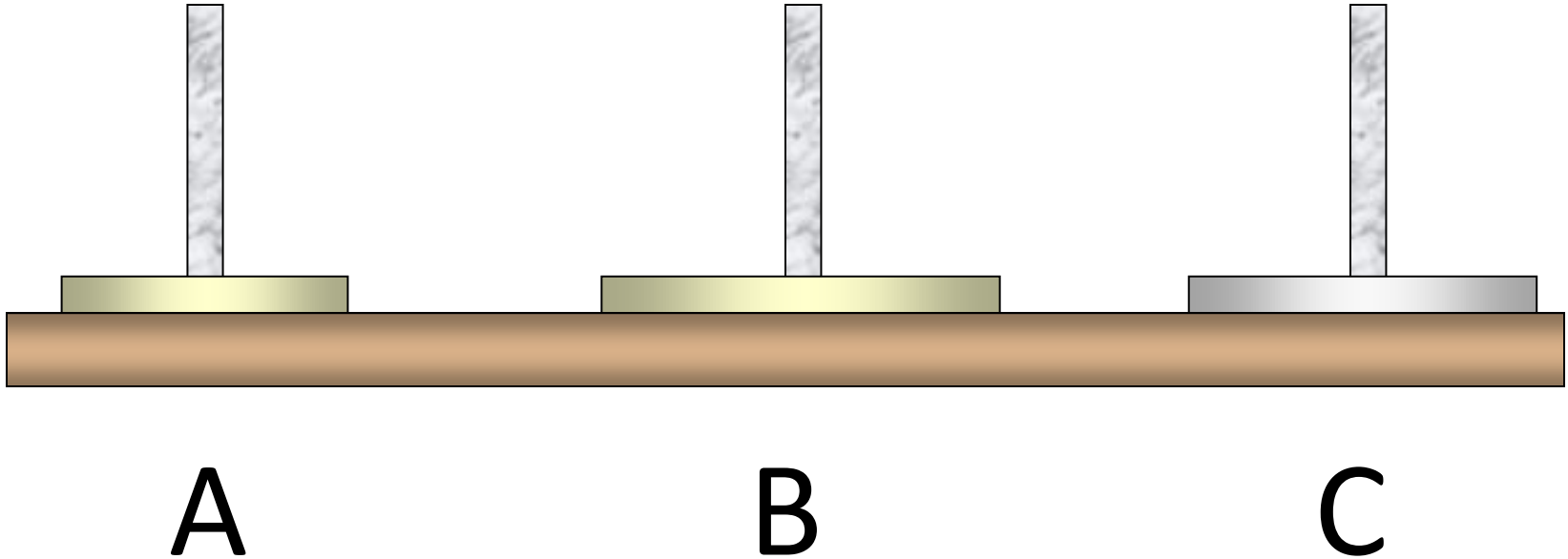
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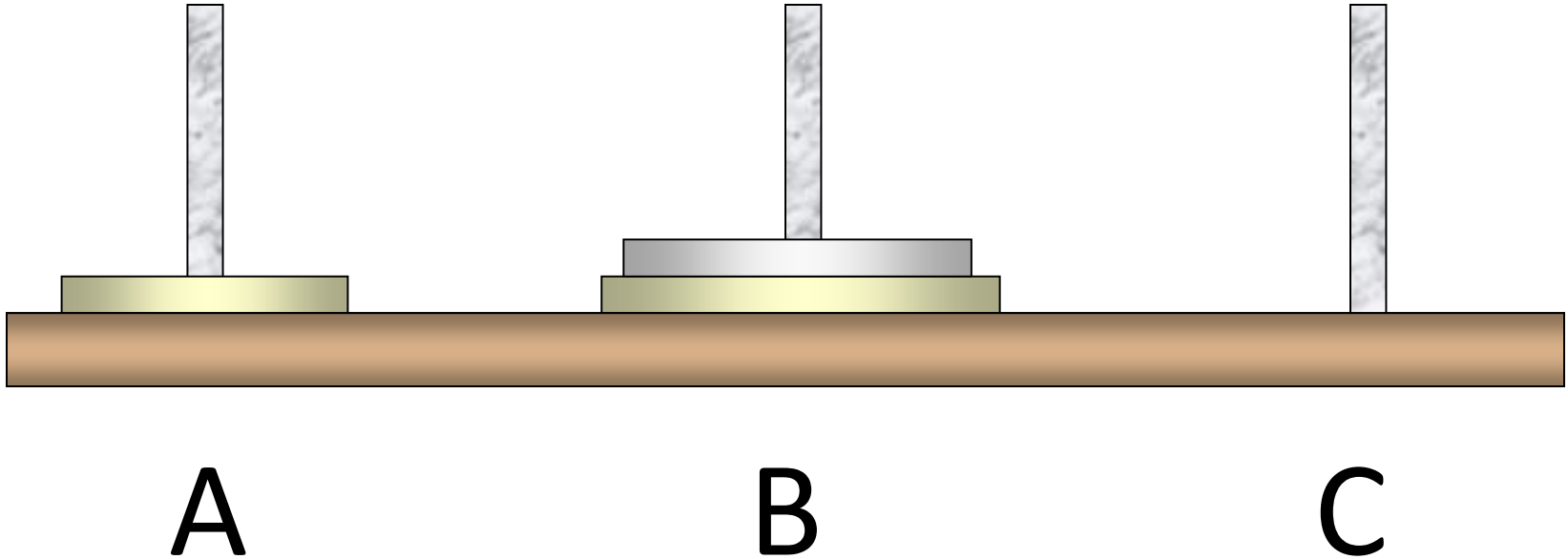
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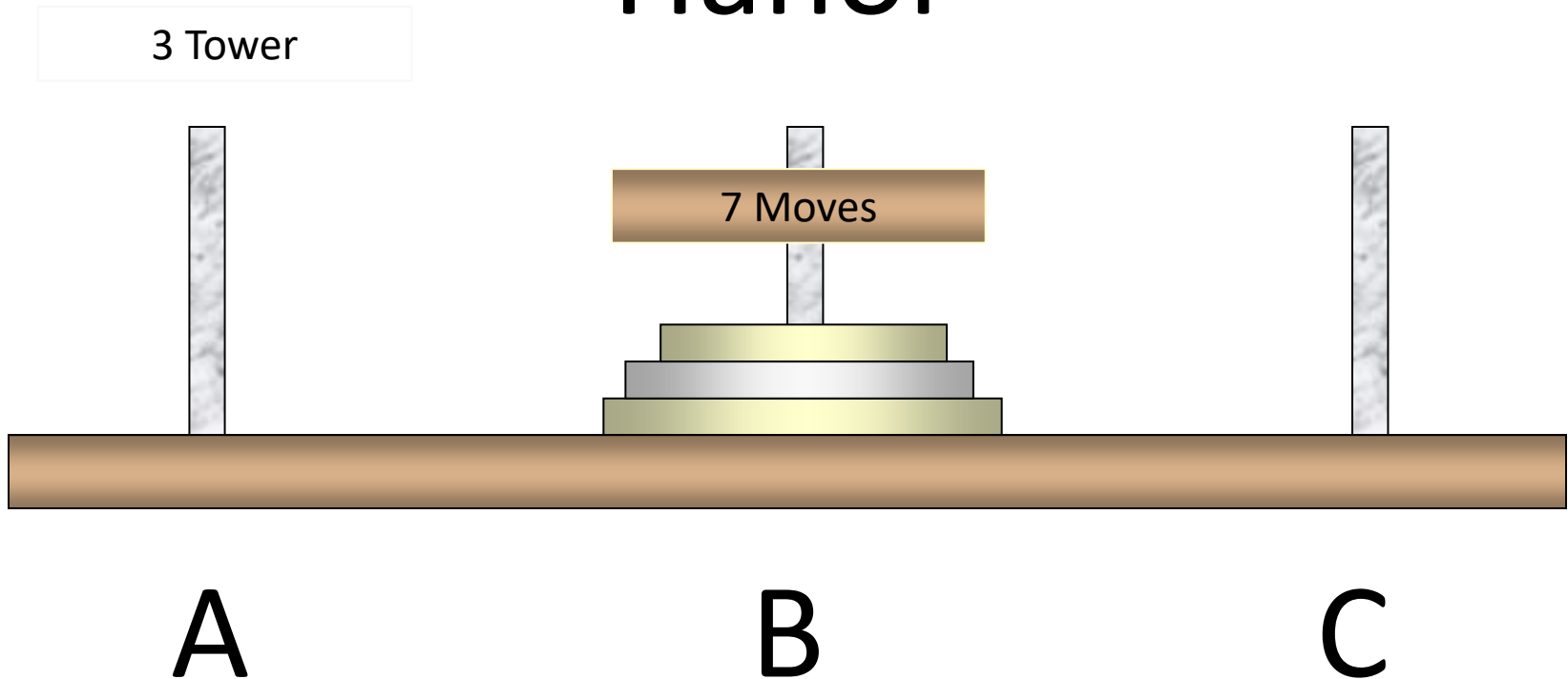


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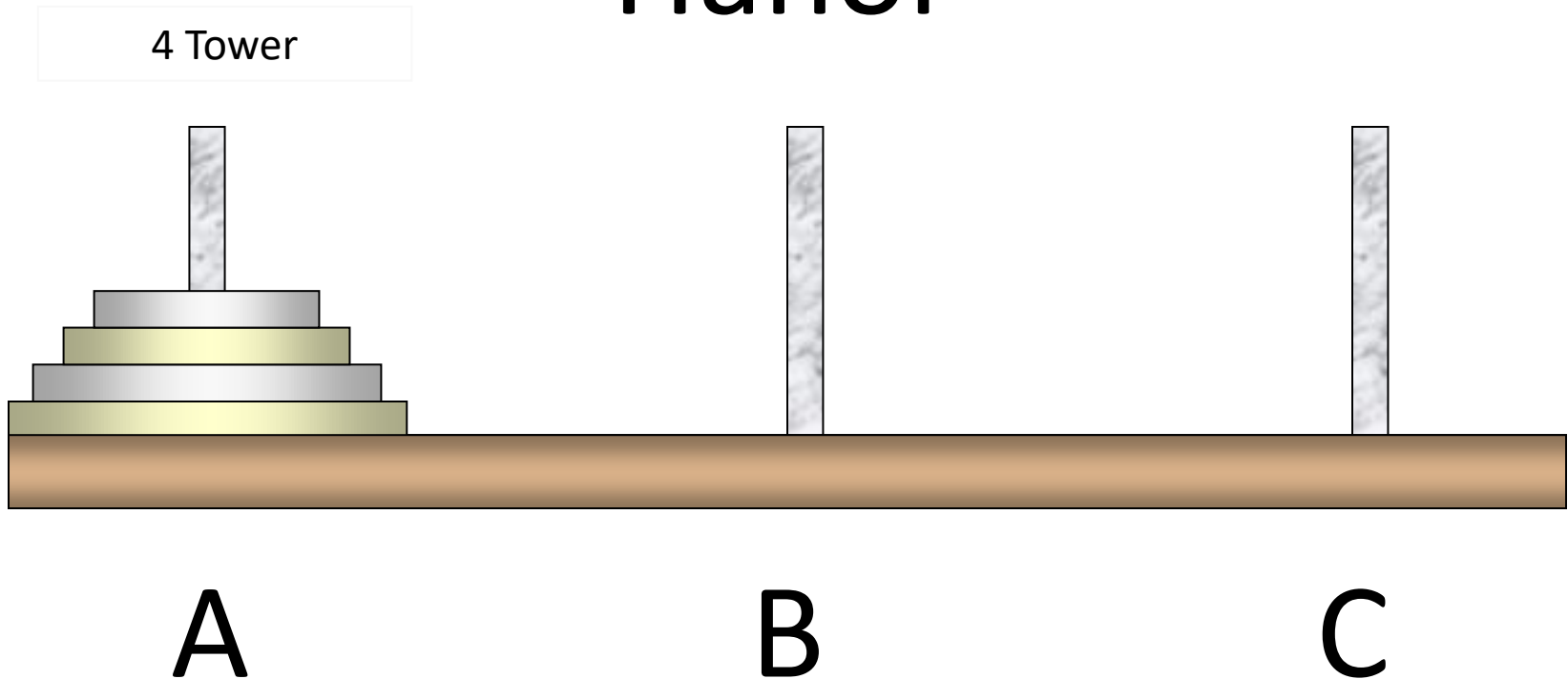
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The Tower of Hanoi

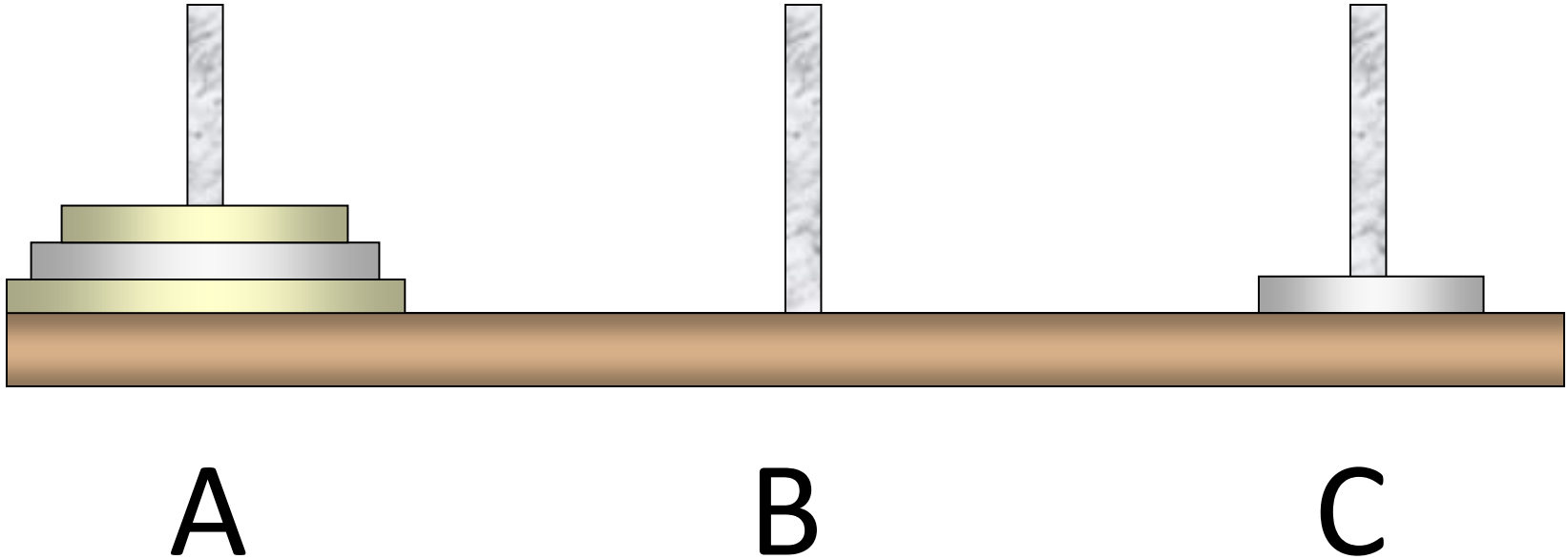


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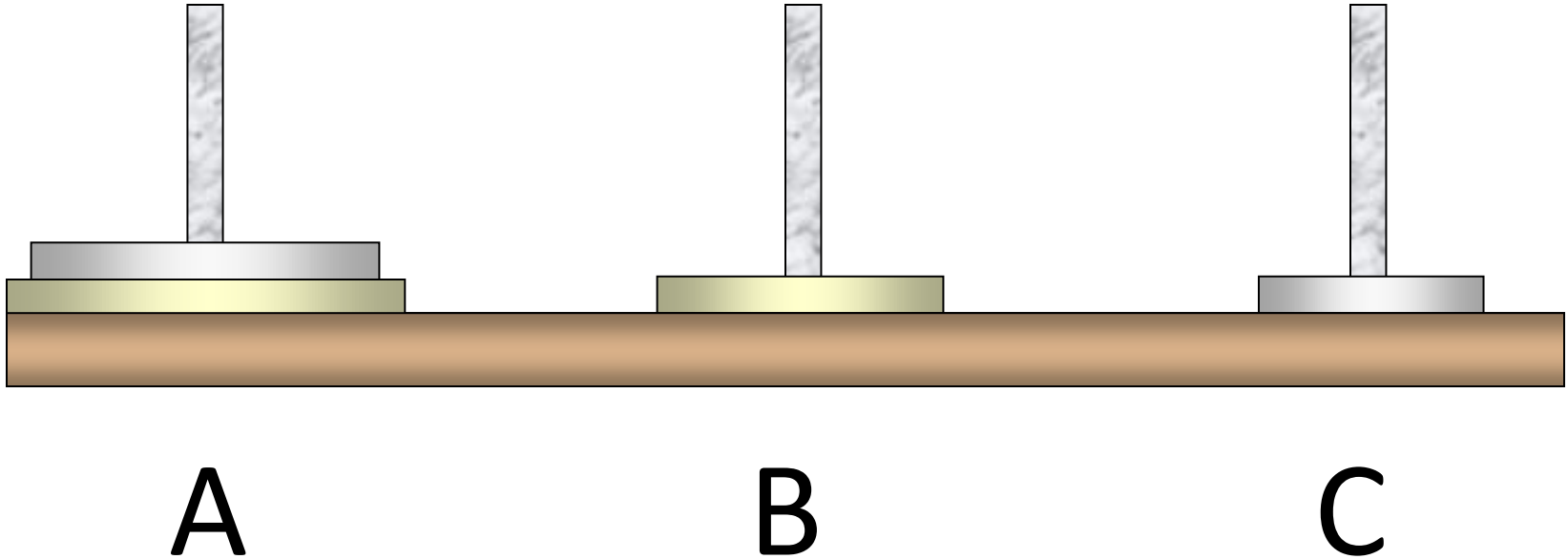
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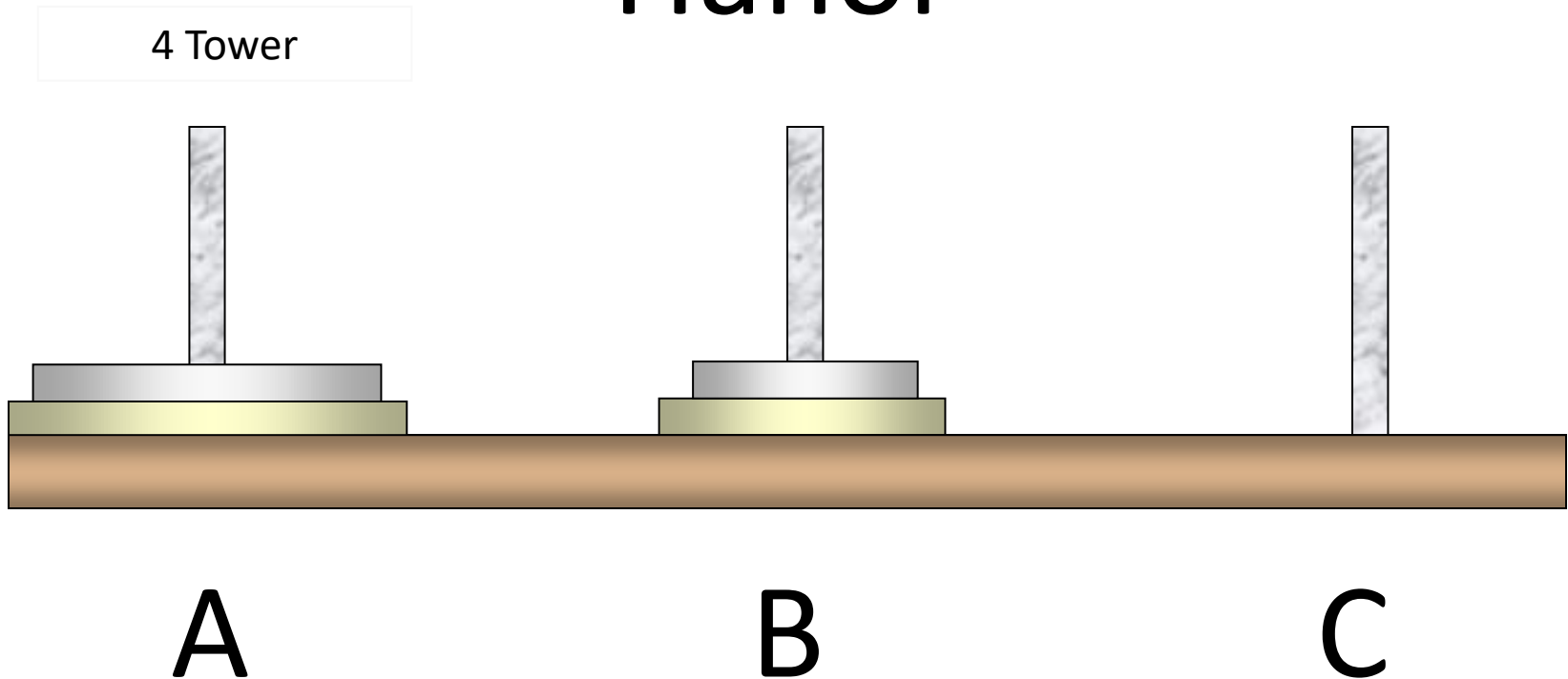


The Tower of Hanoi

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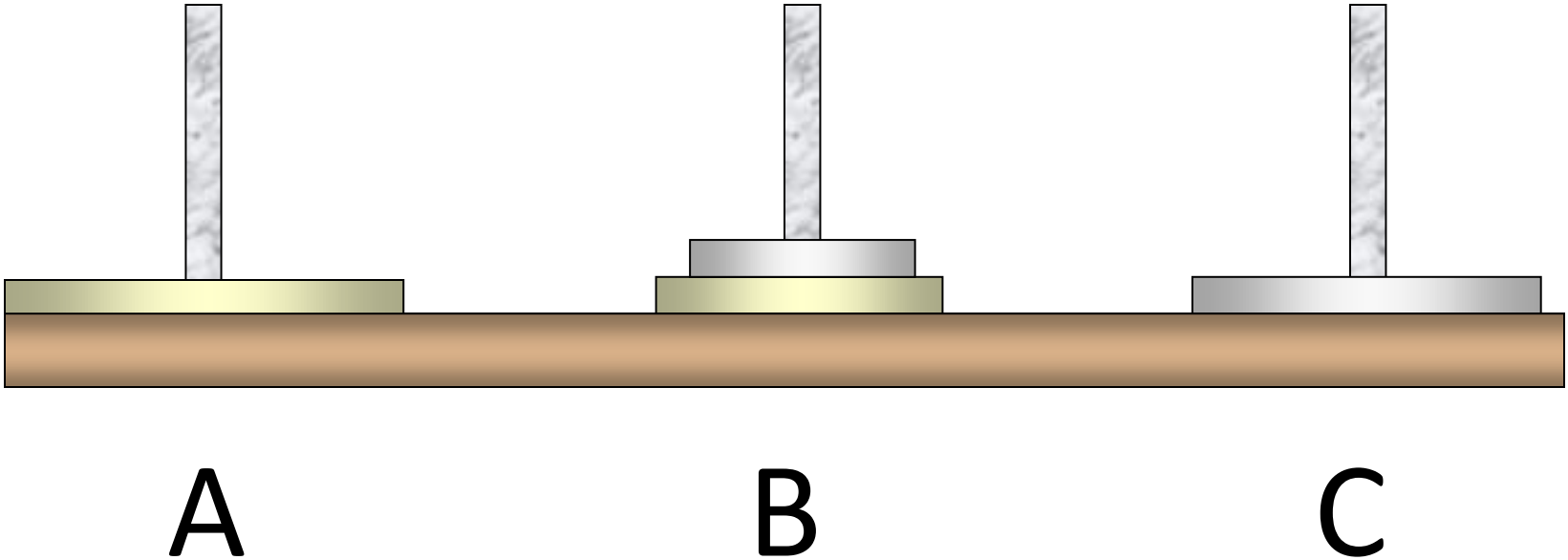


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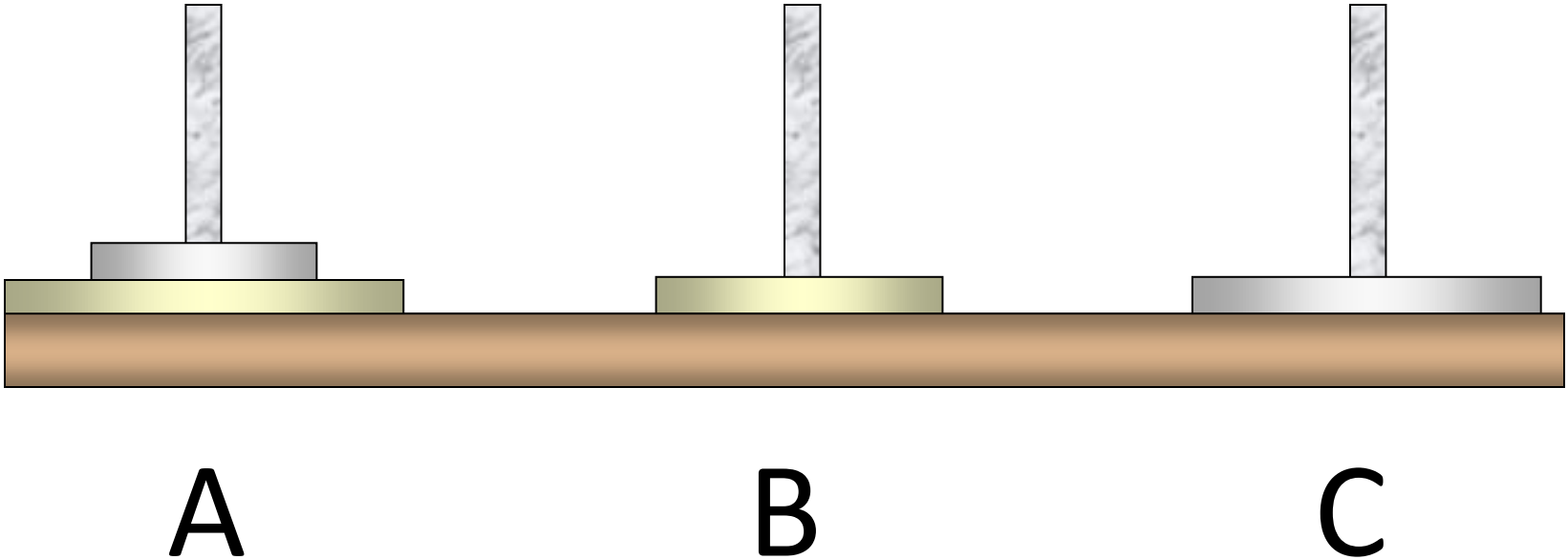
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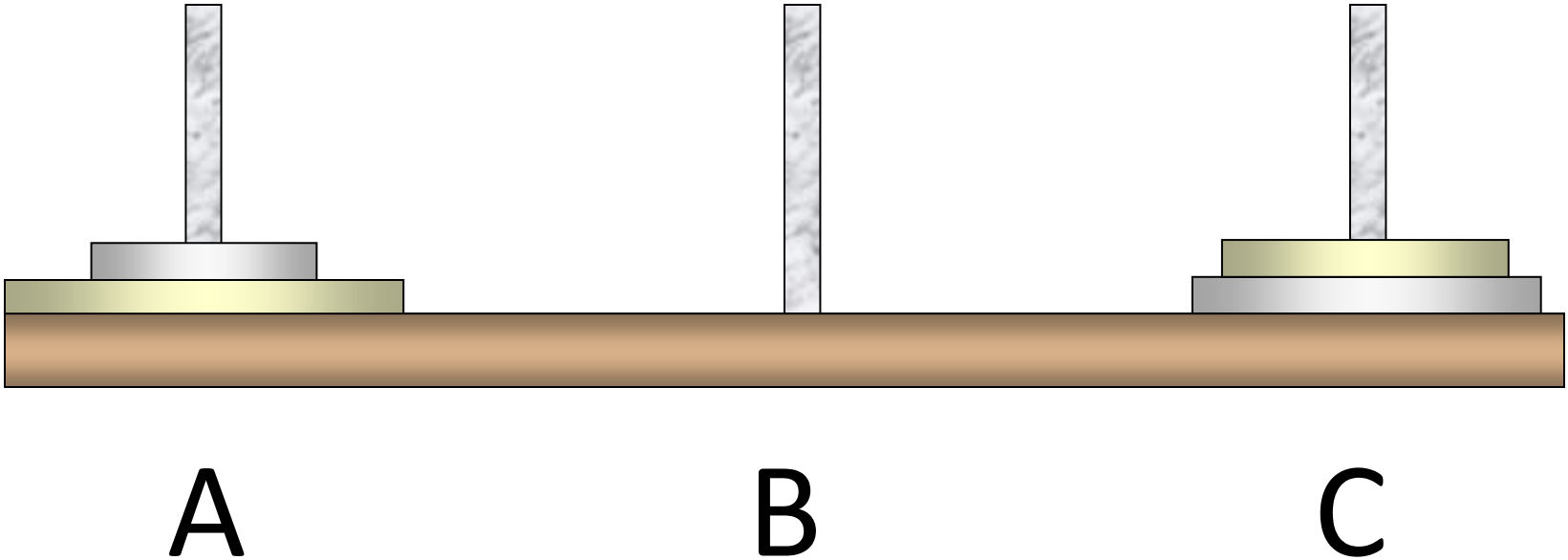
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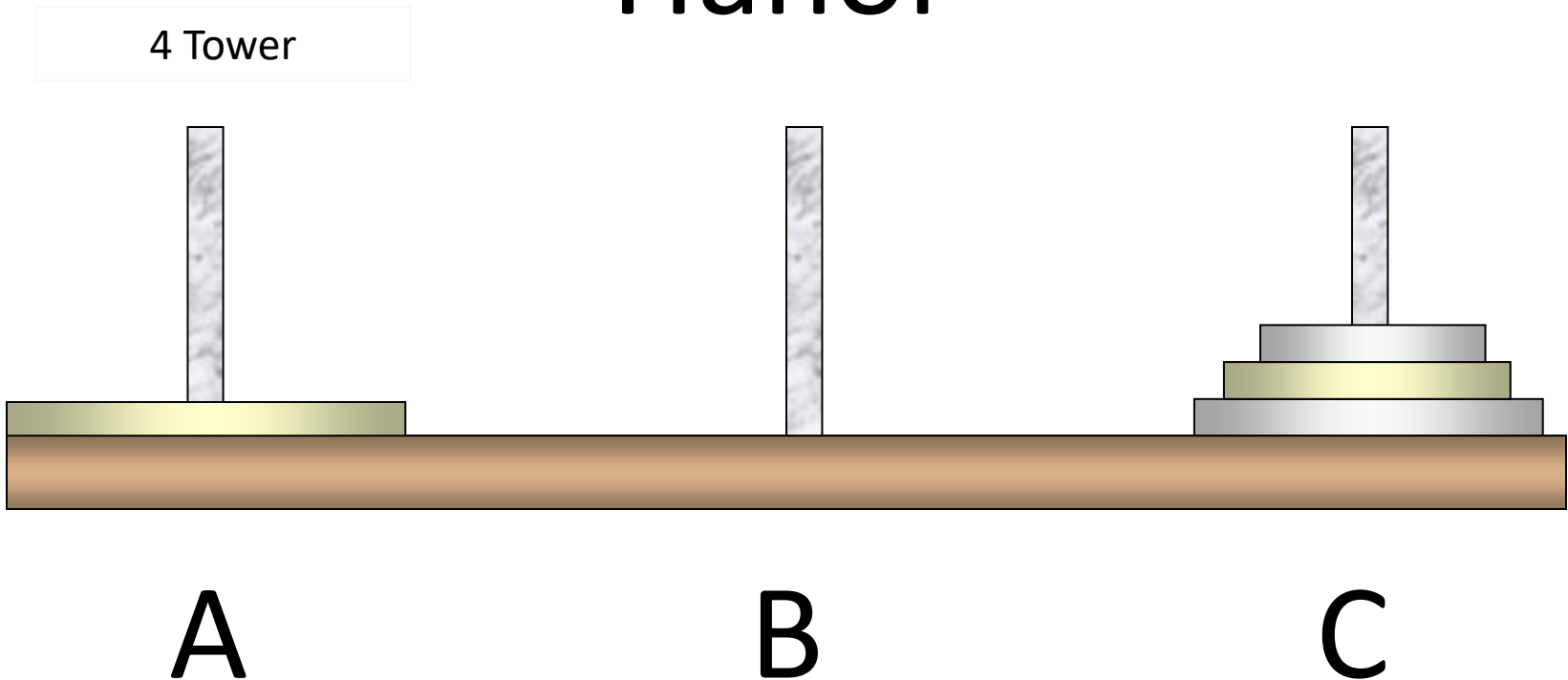


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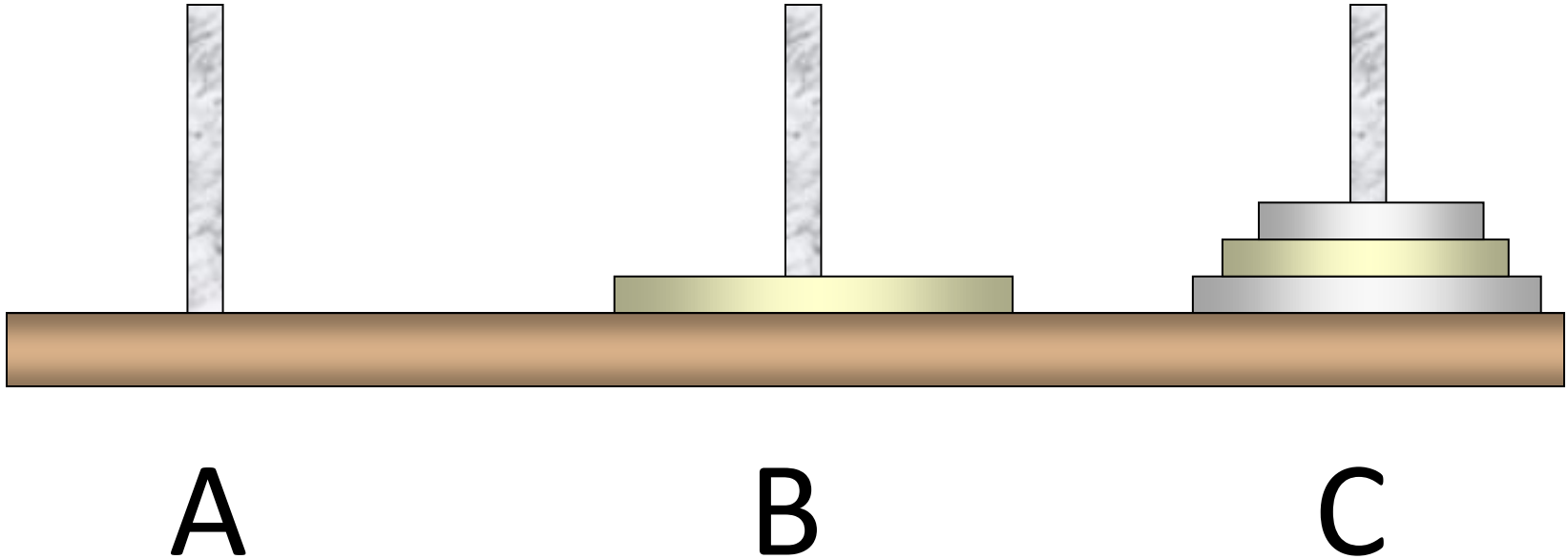


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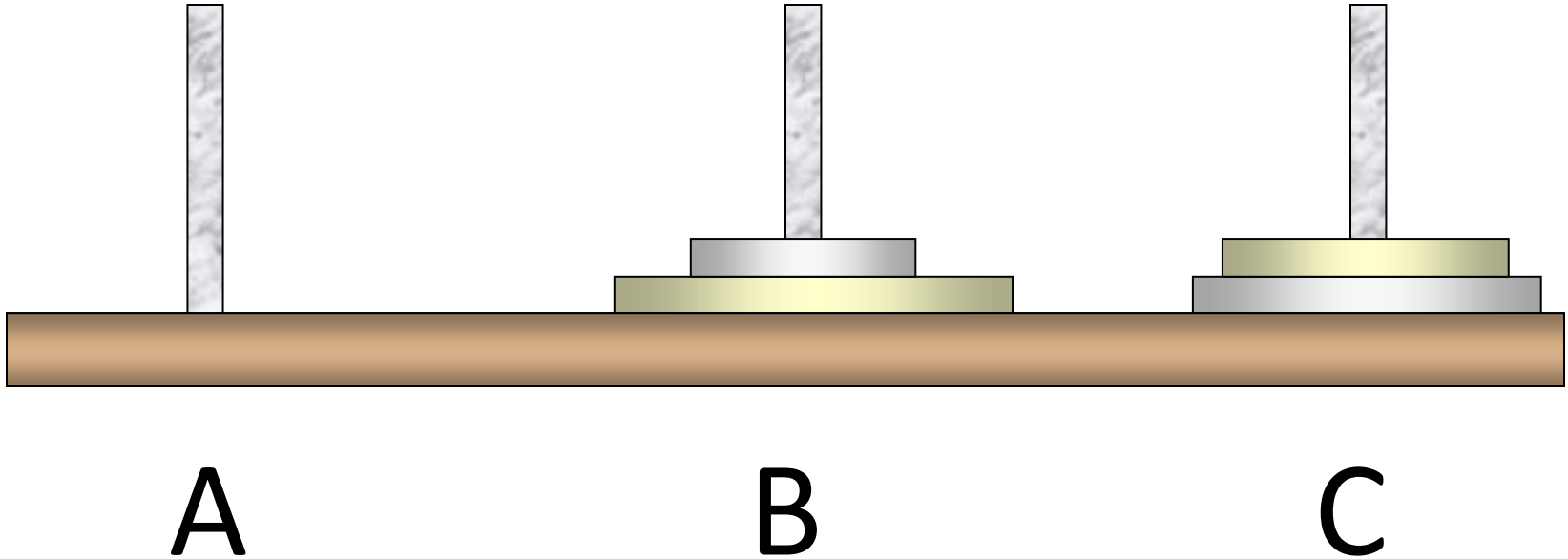
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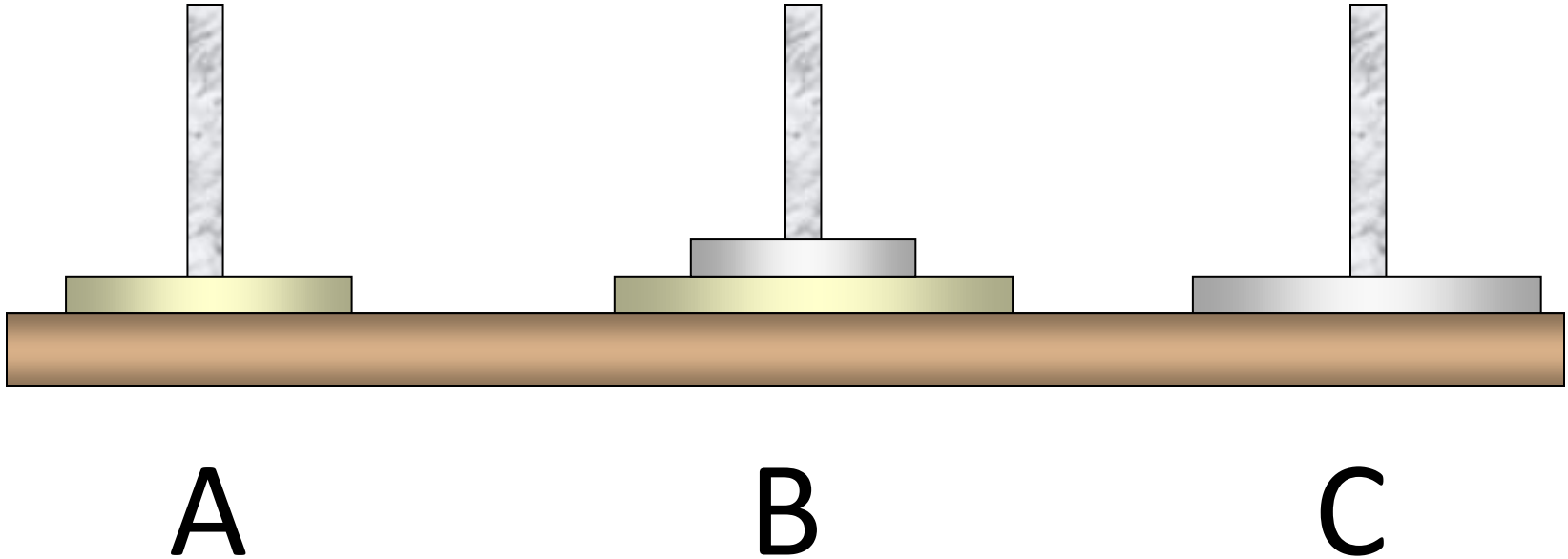
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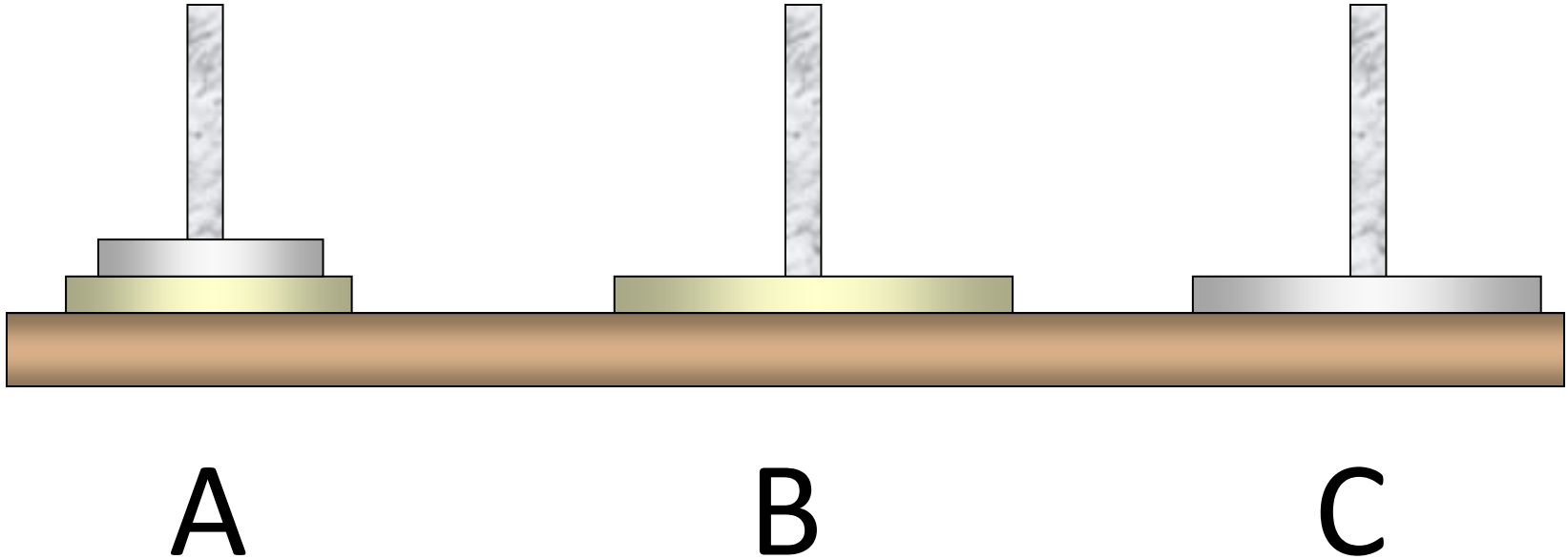
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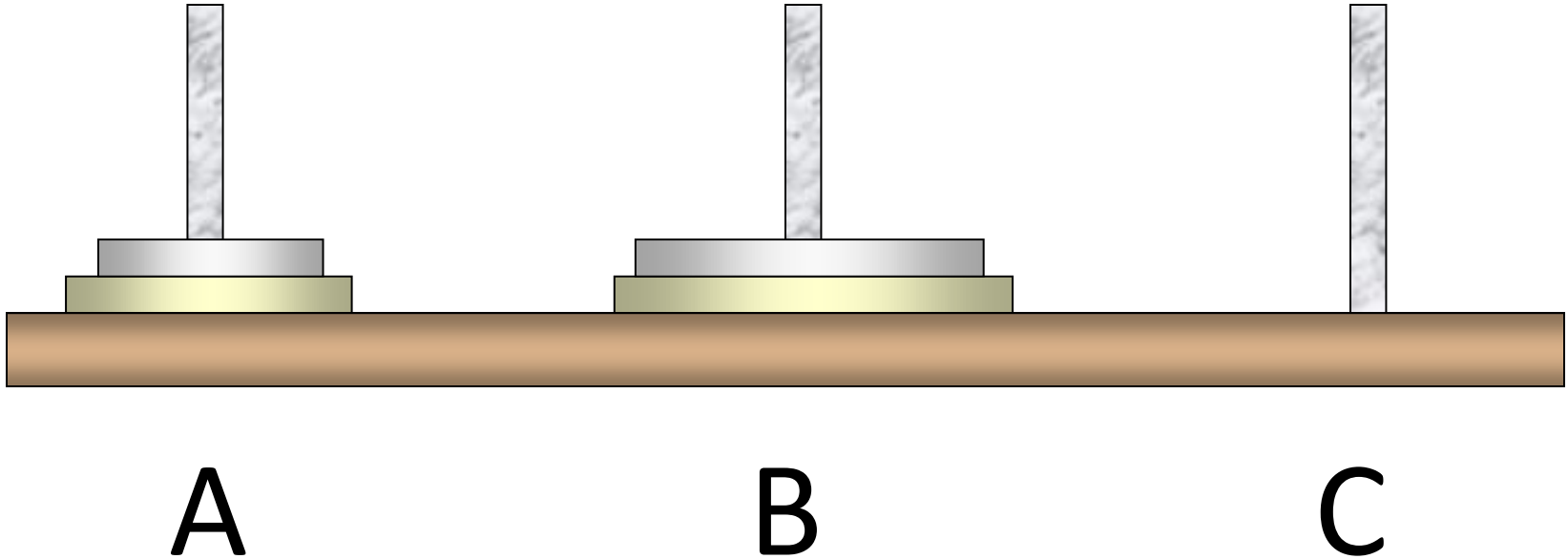
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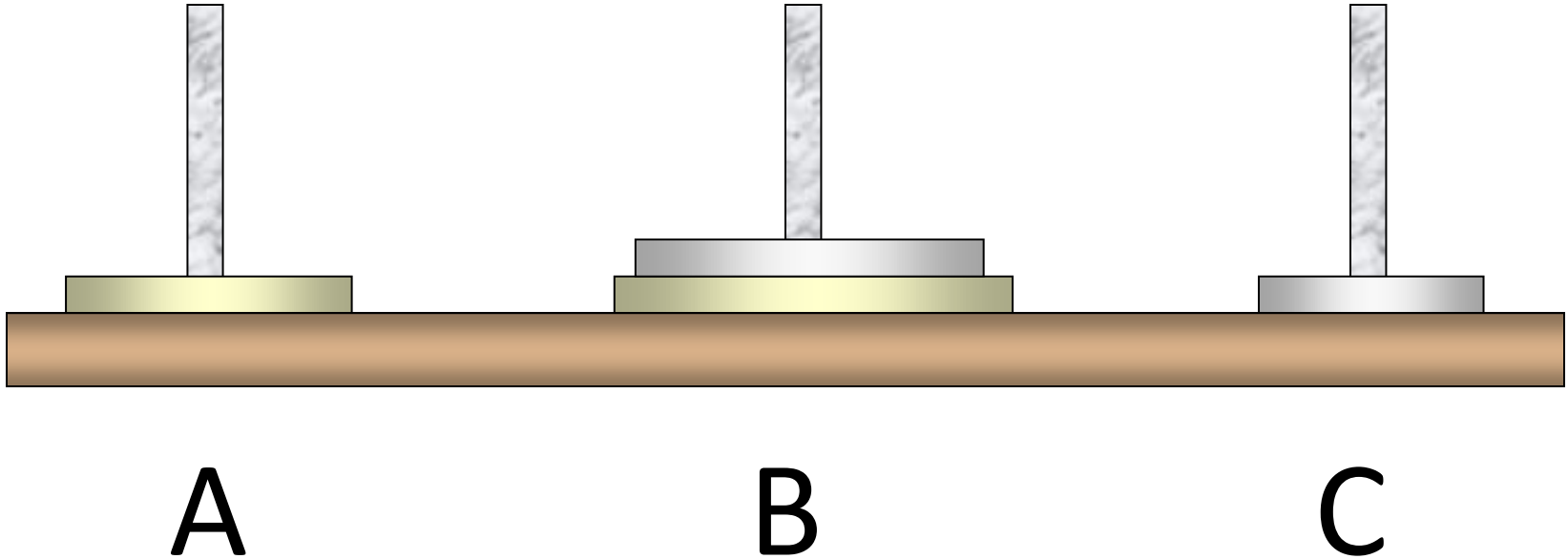
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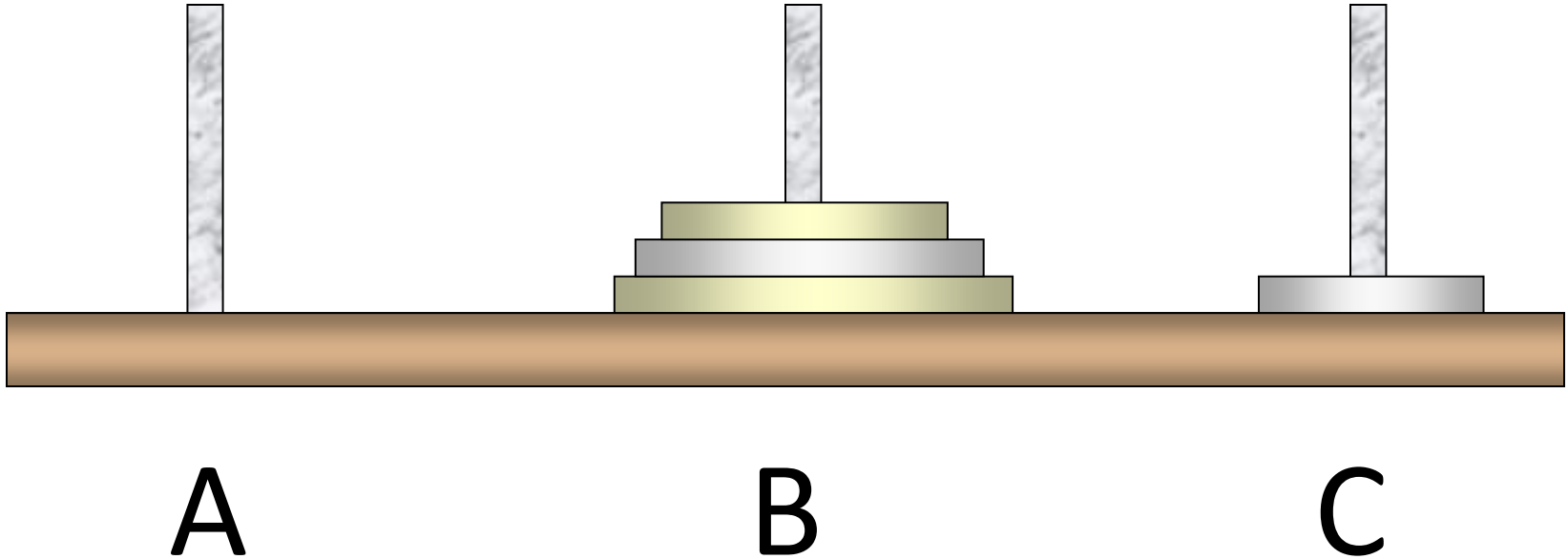
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The Tower of Hanoi

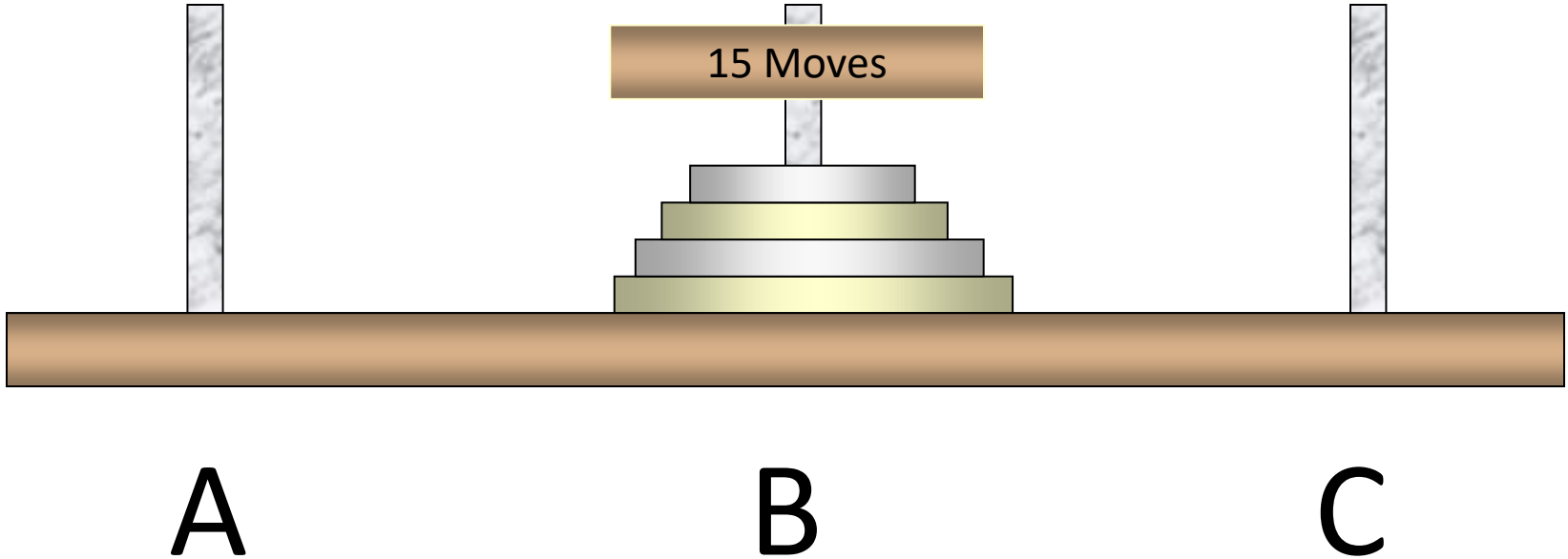
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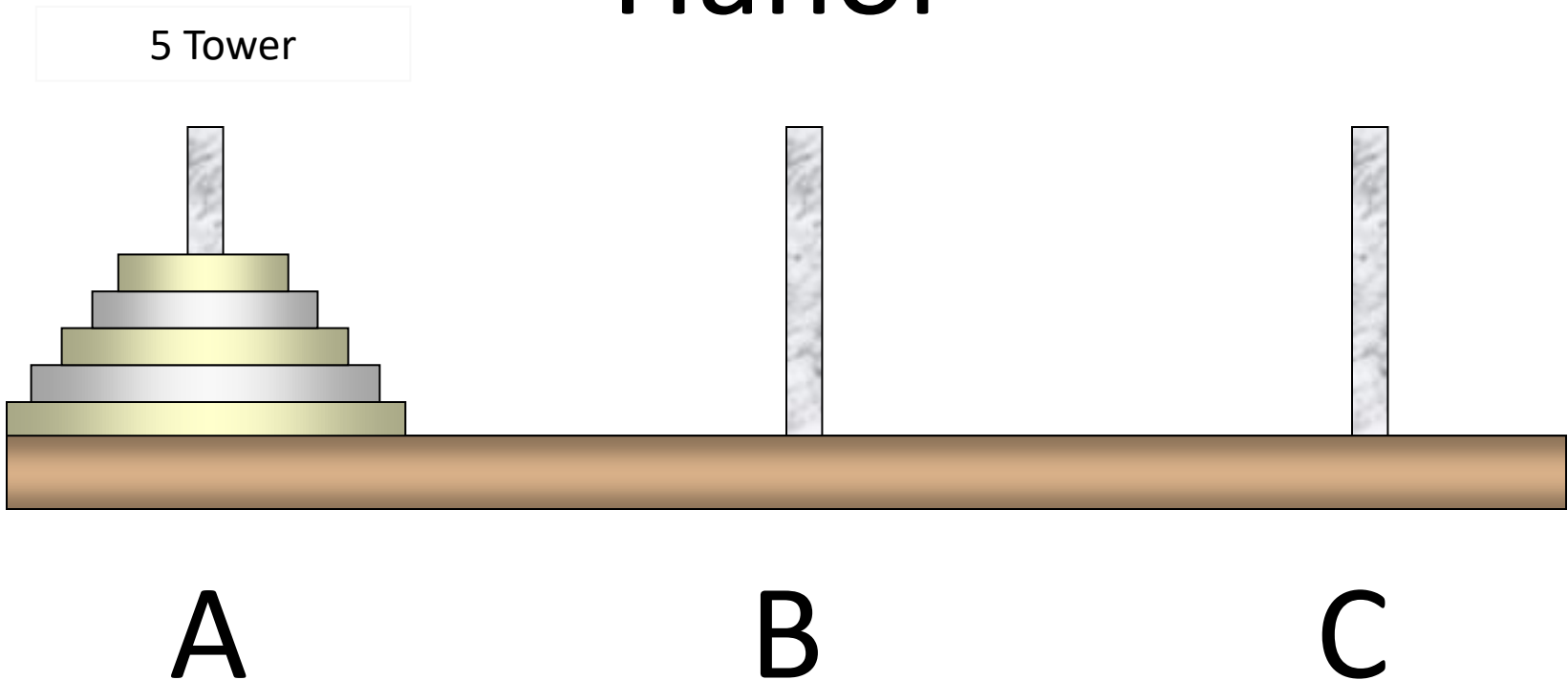
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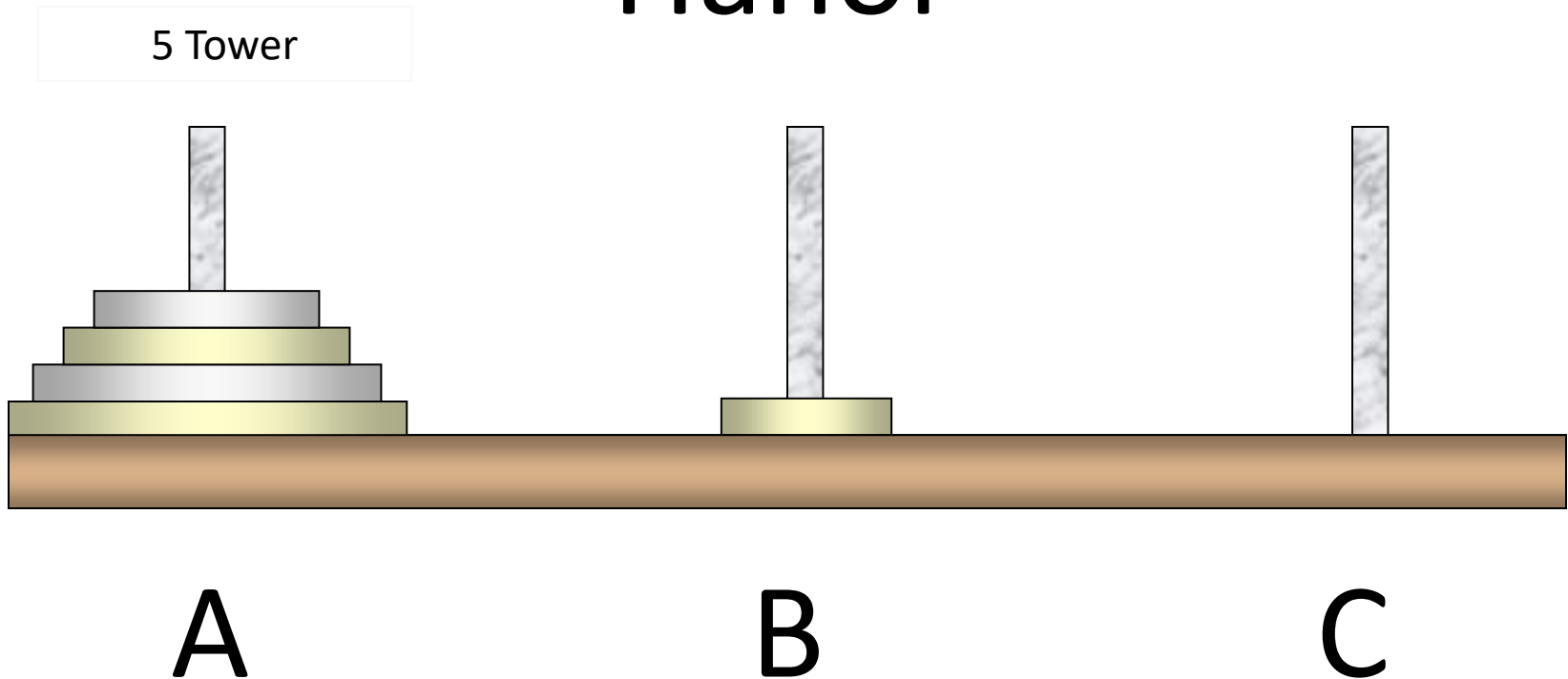
15 Moves



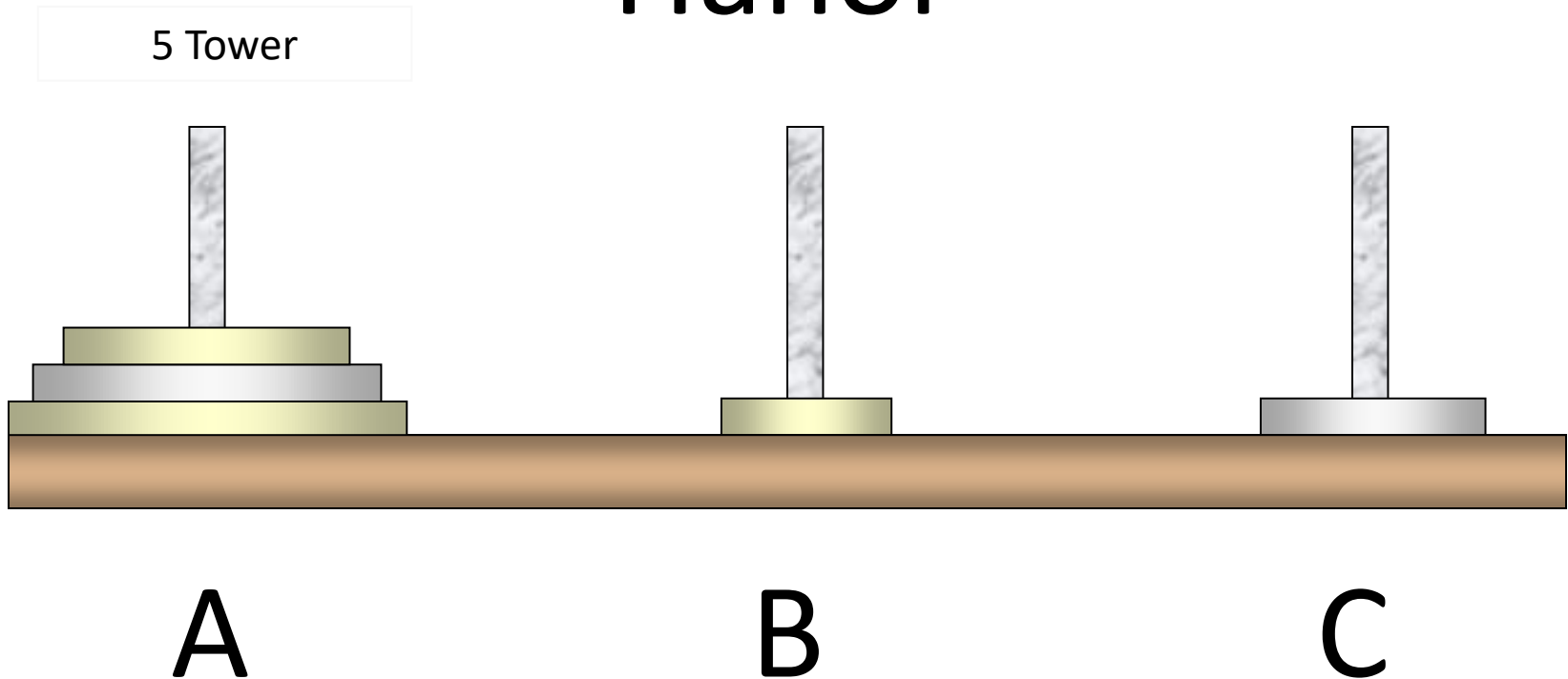
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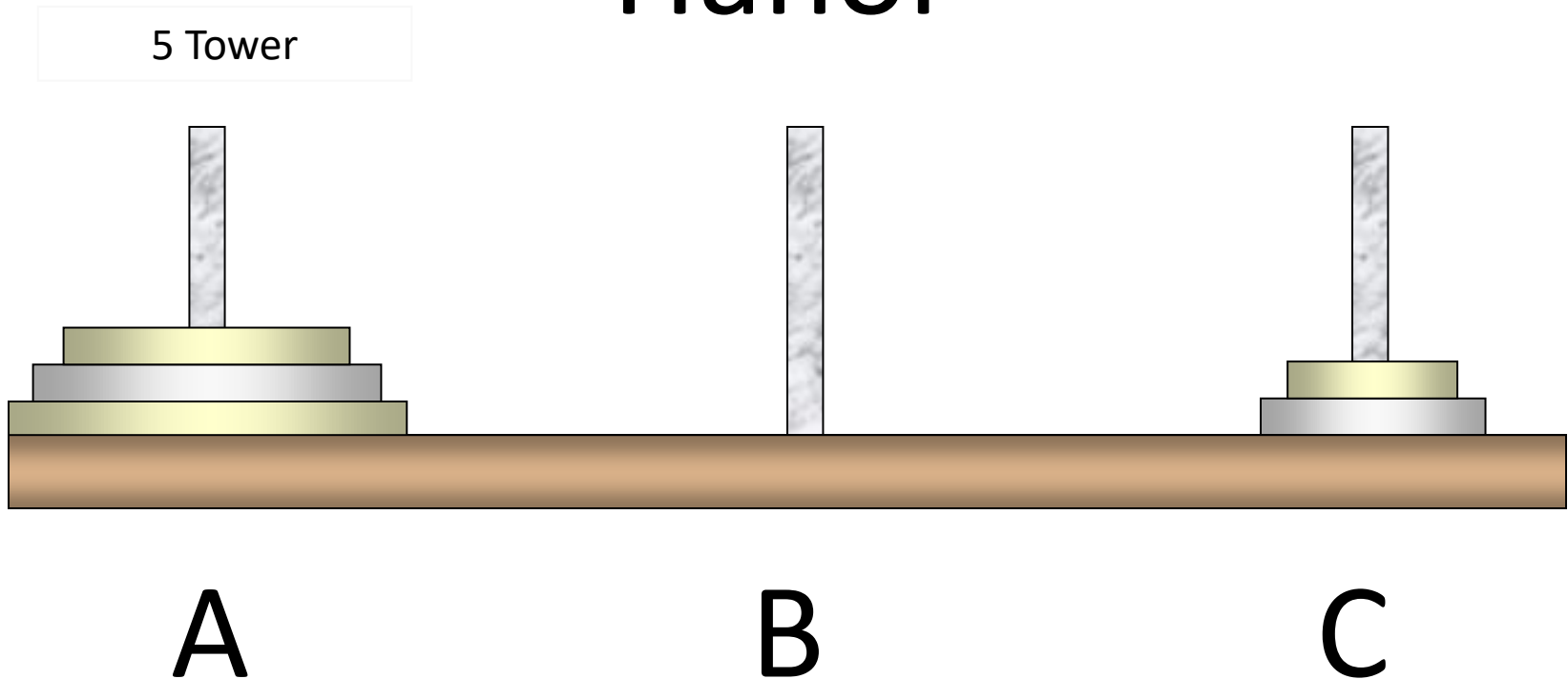
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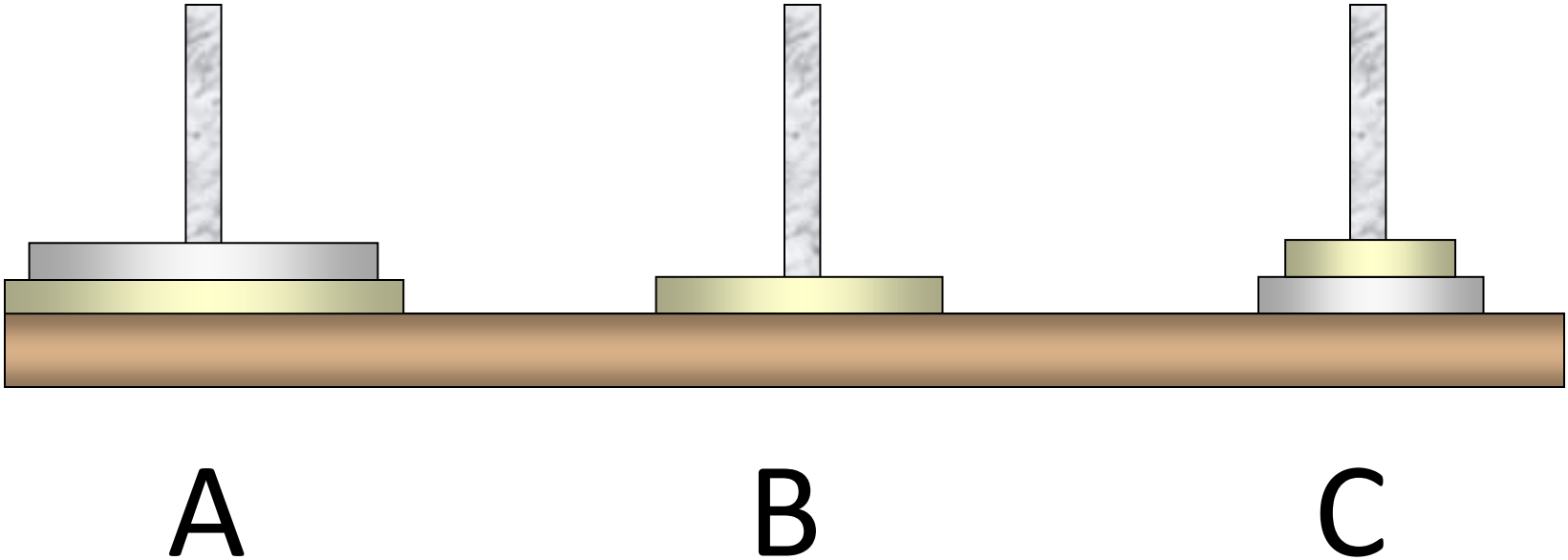


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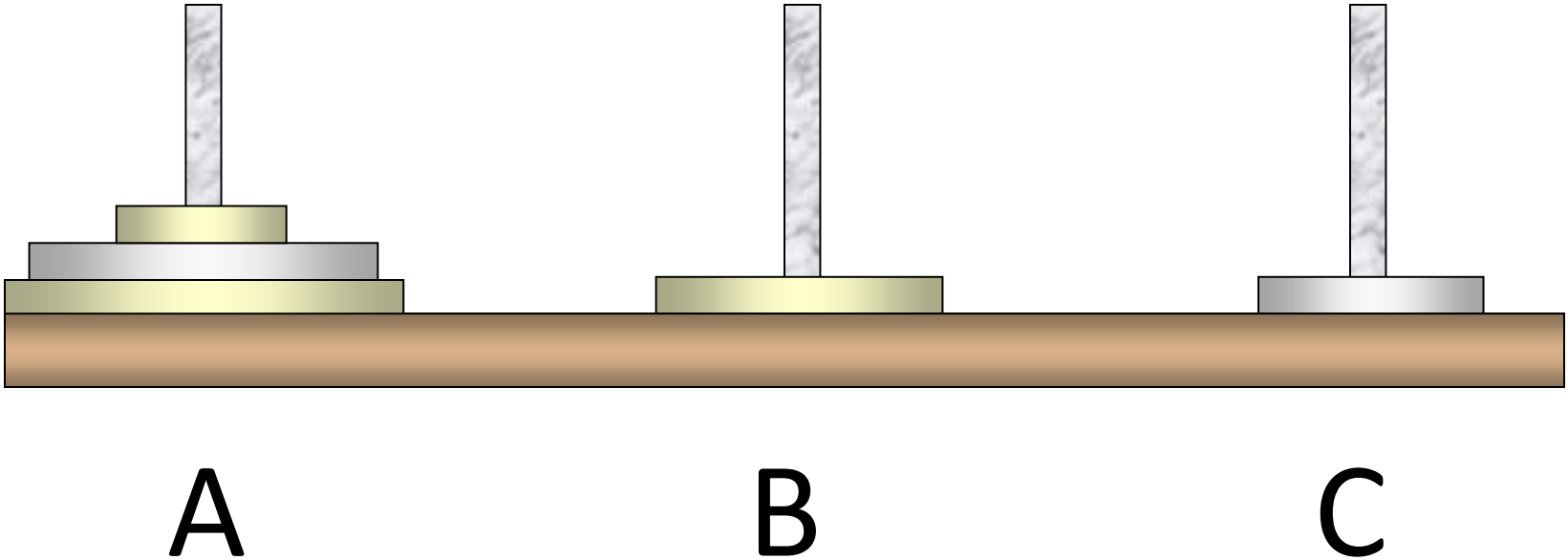
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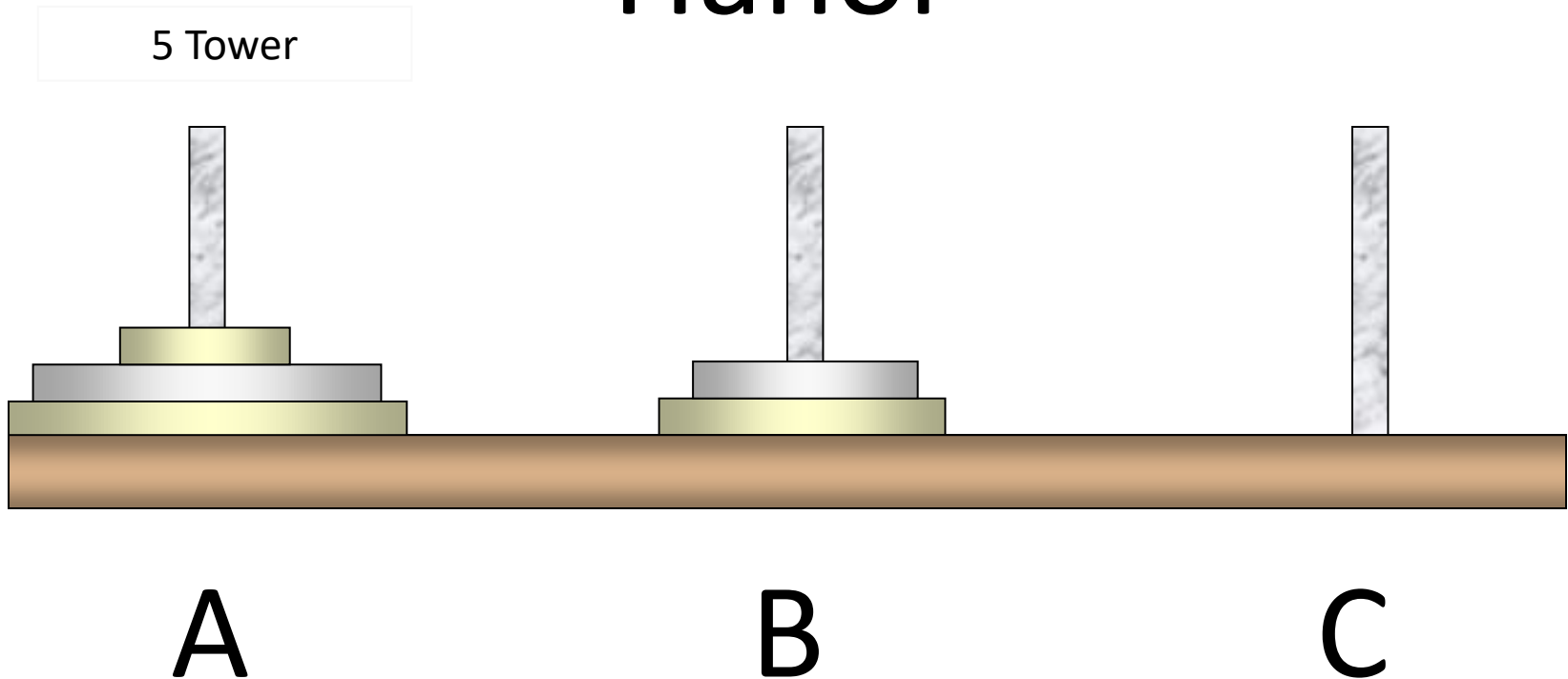


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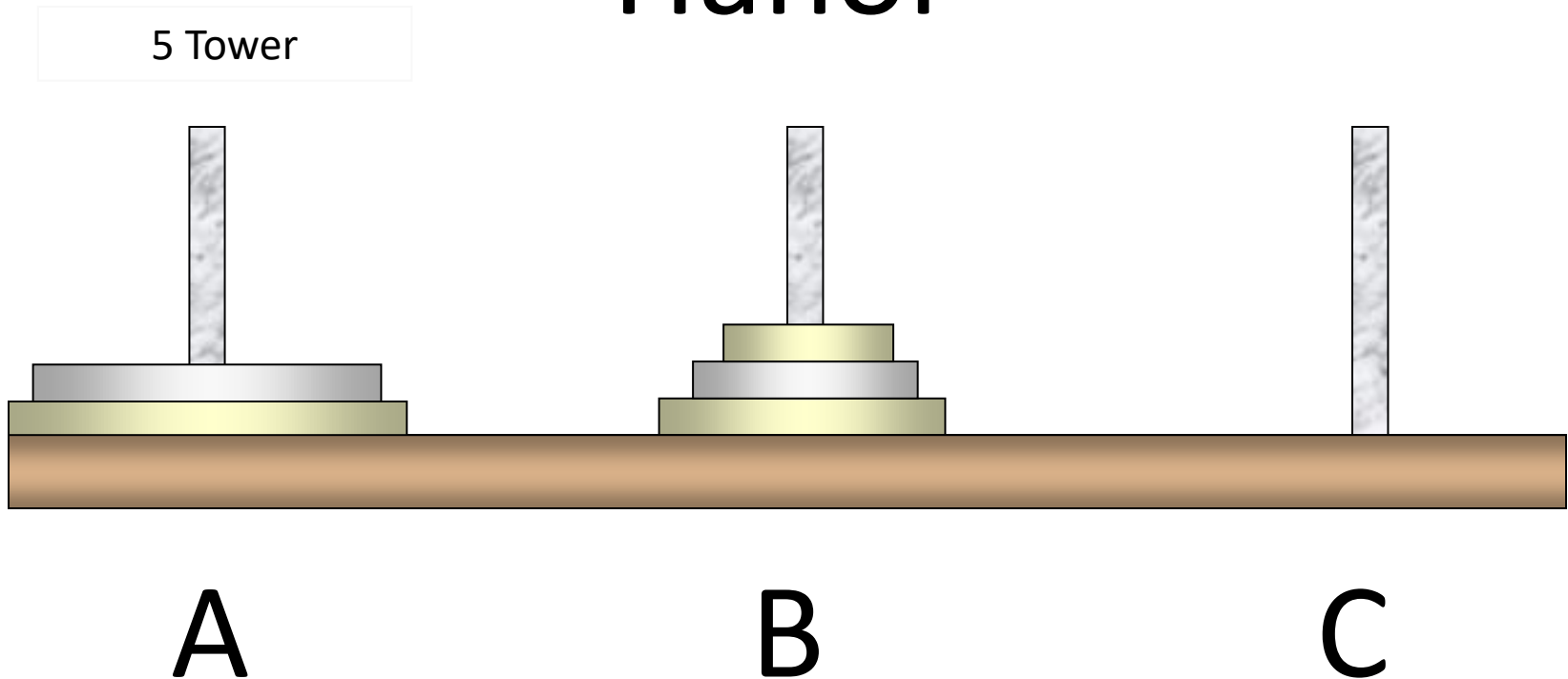
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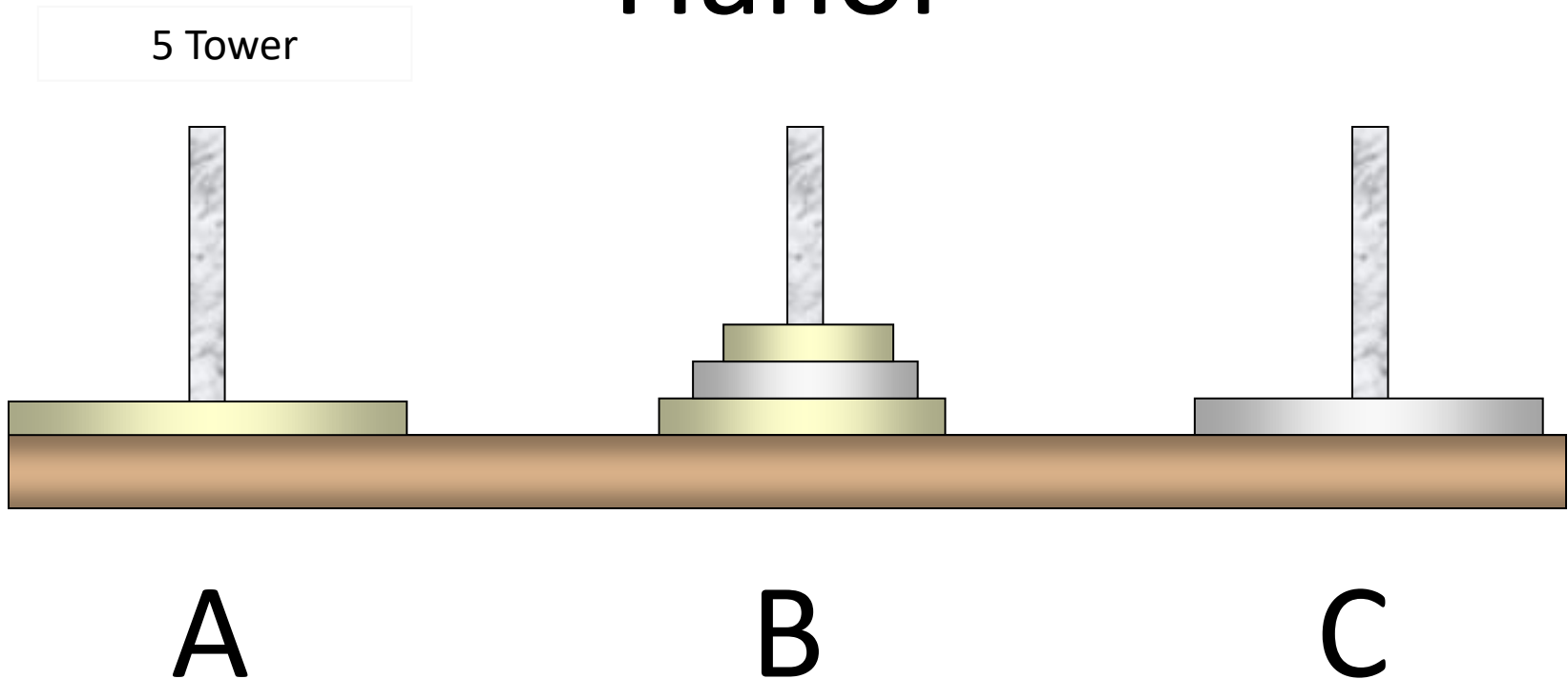
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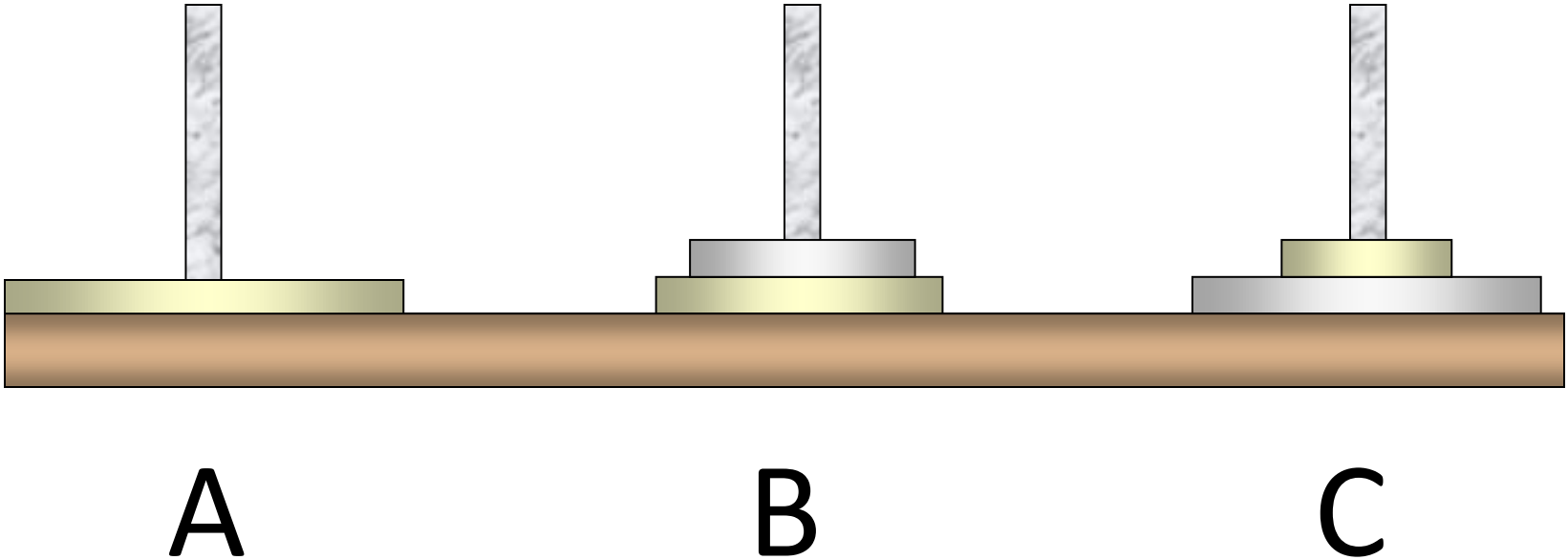


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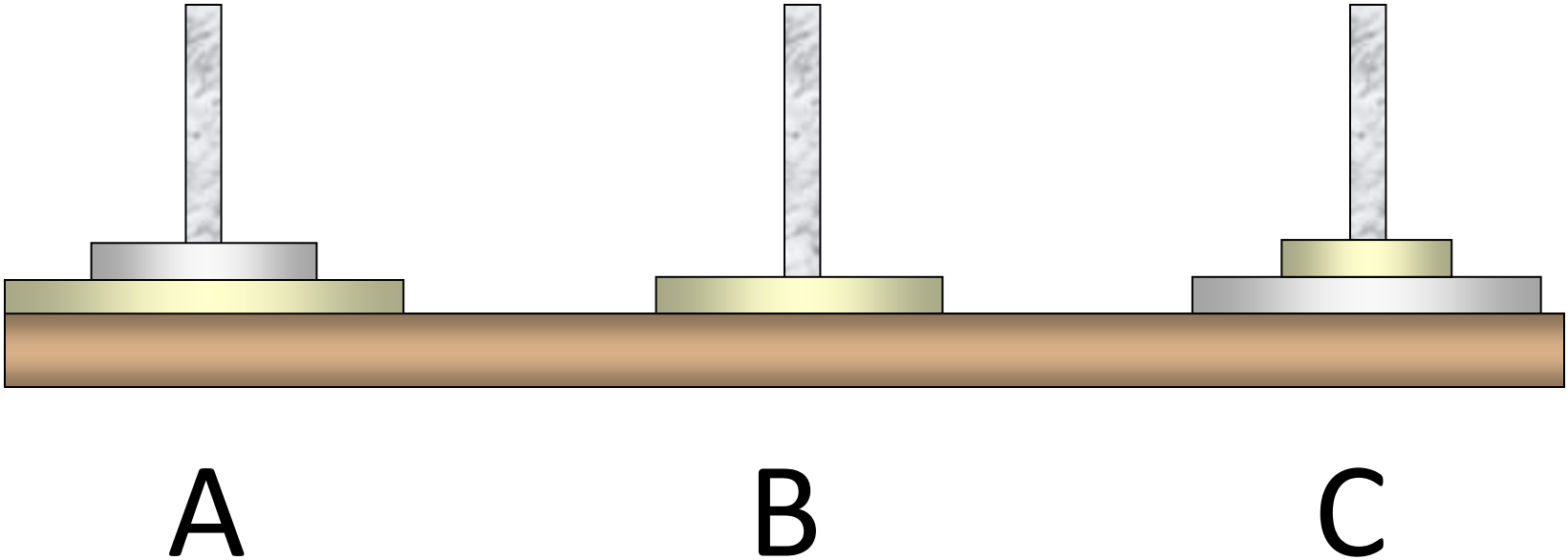
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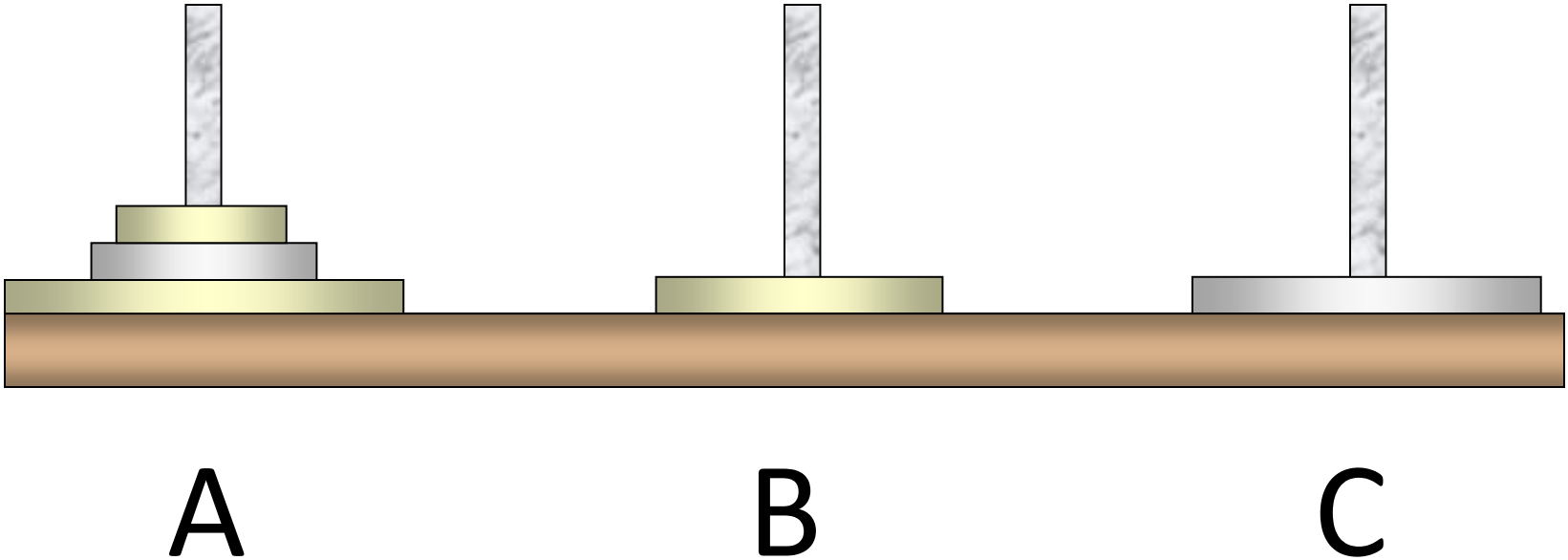
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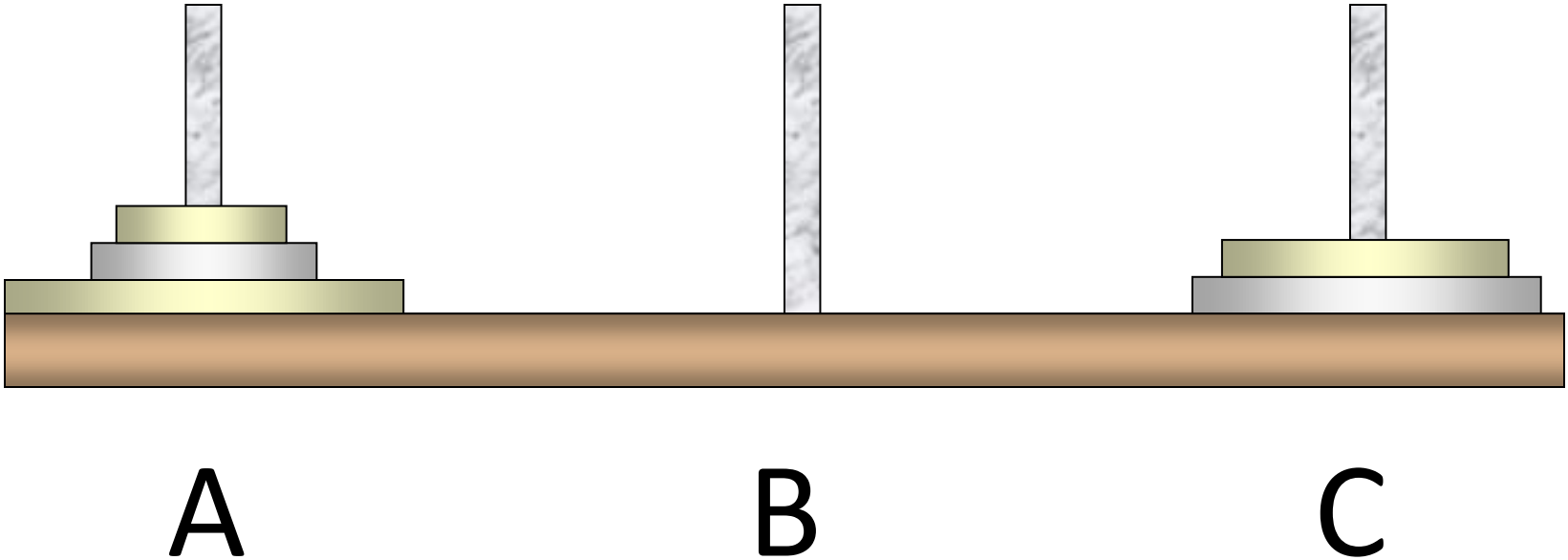
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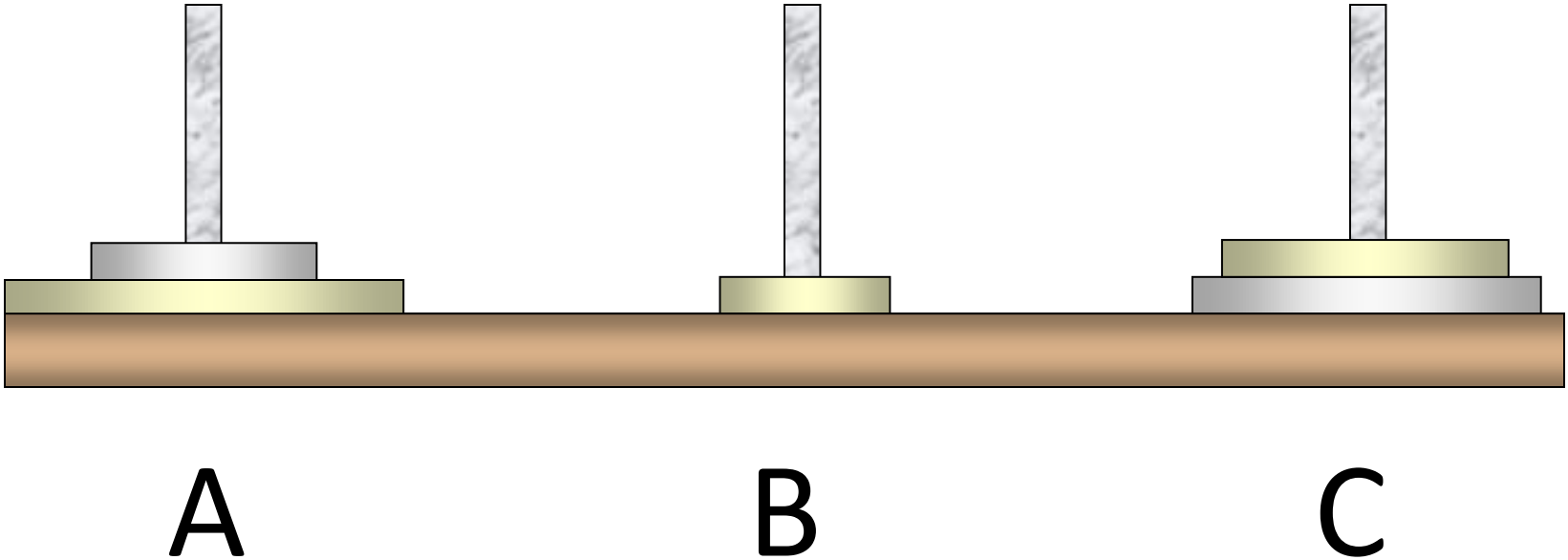
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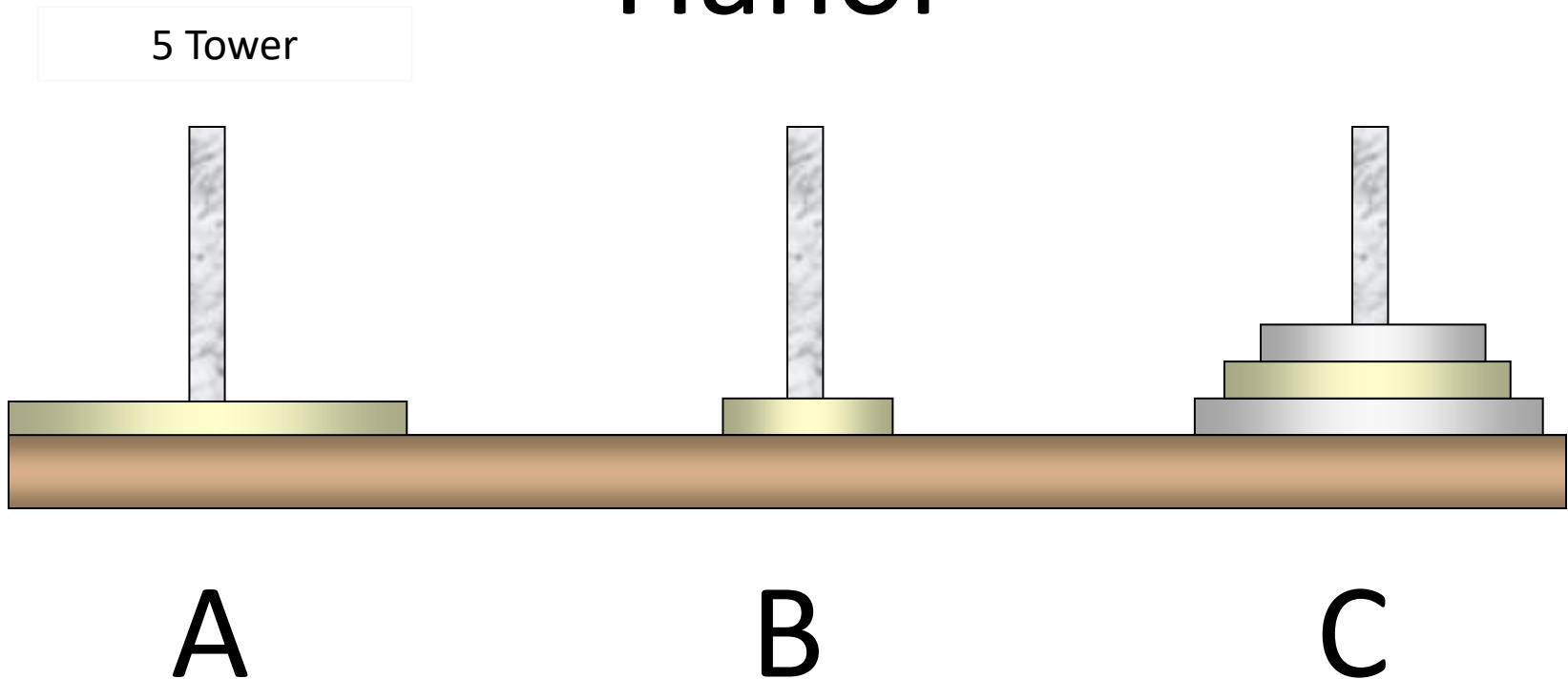


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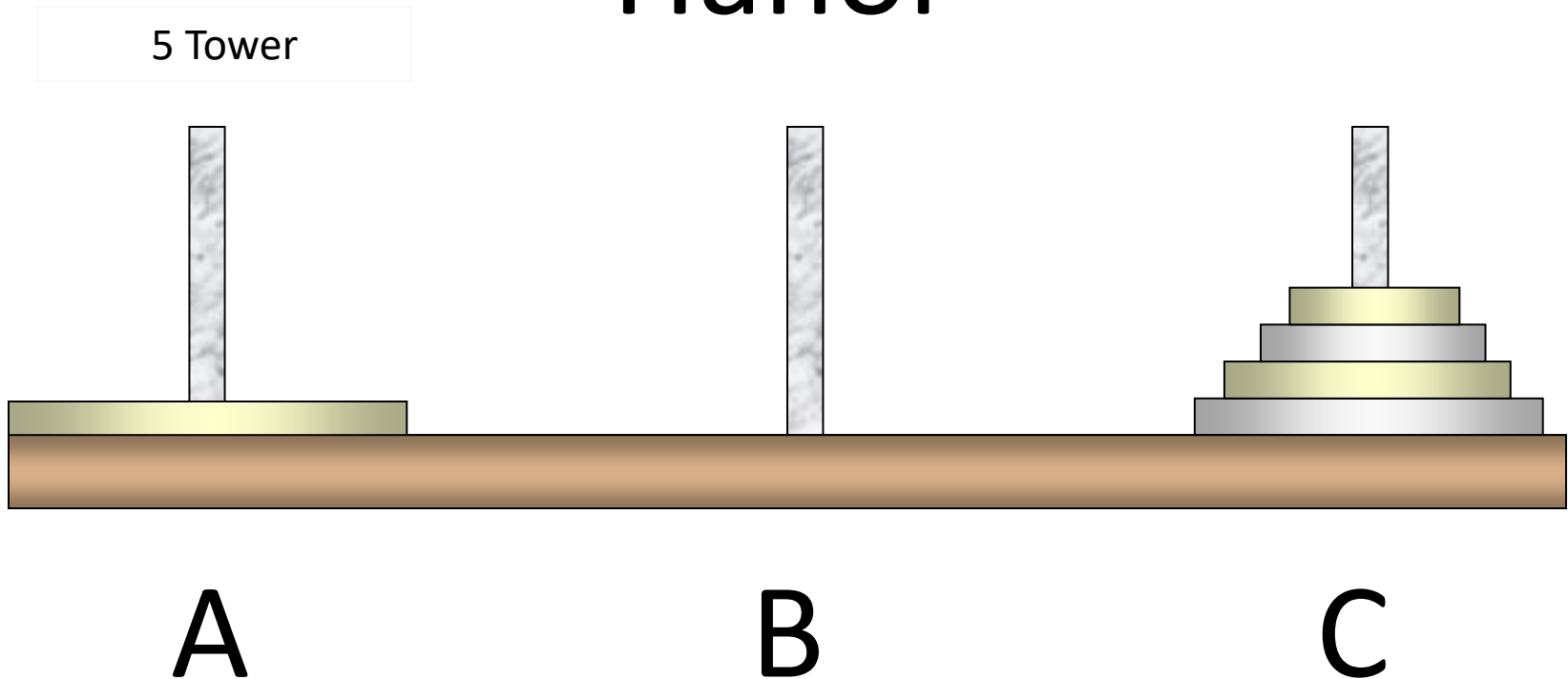
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The Tower of Hanoi

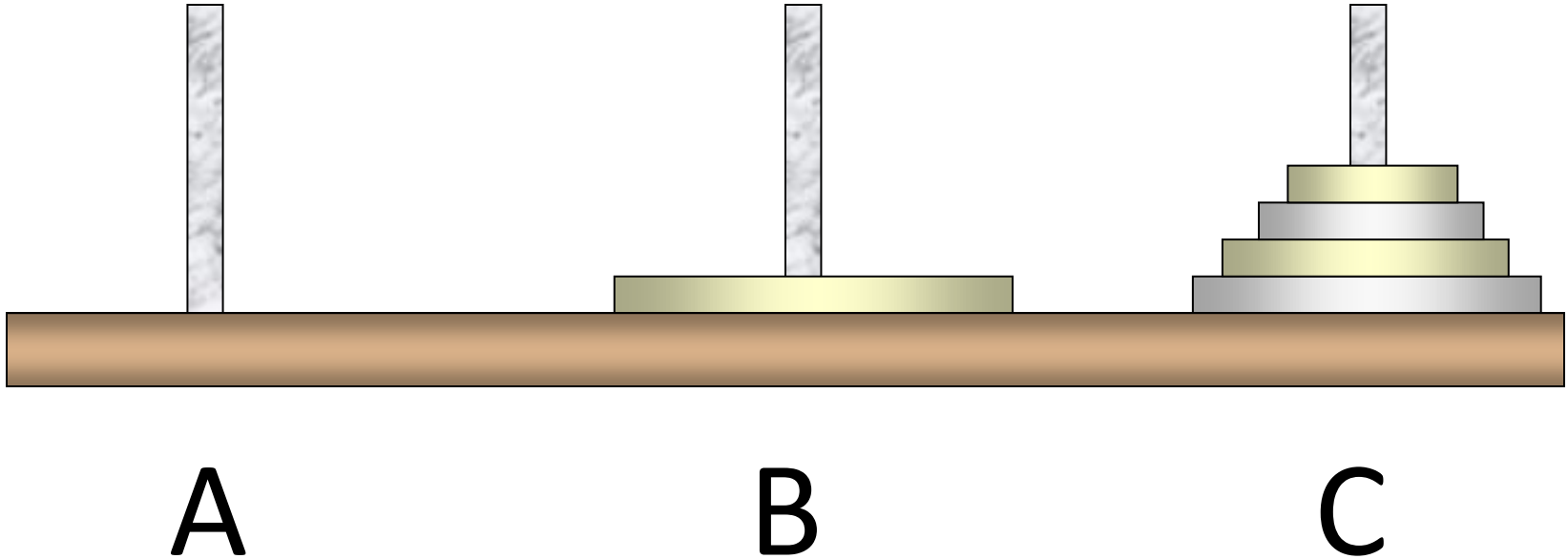


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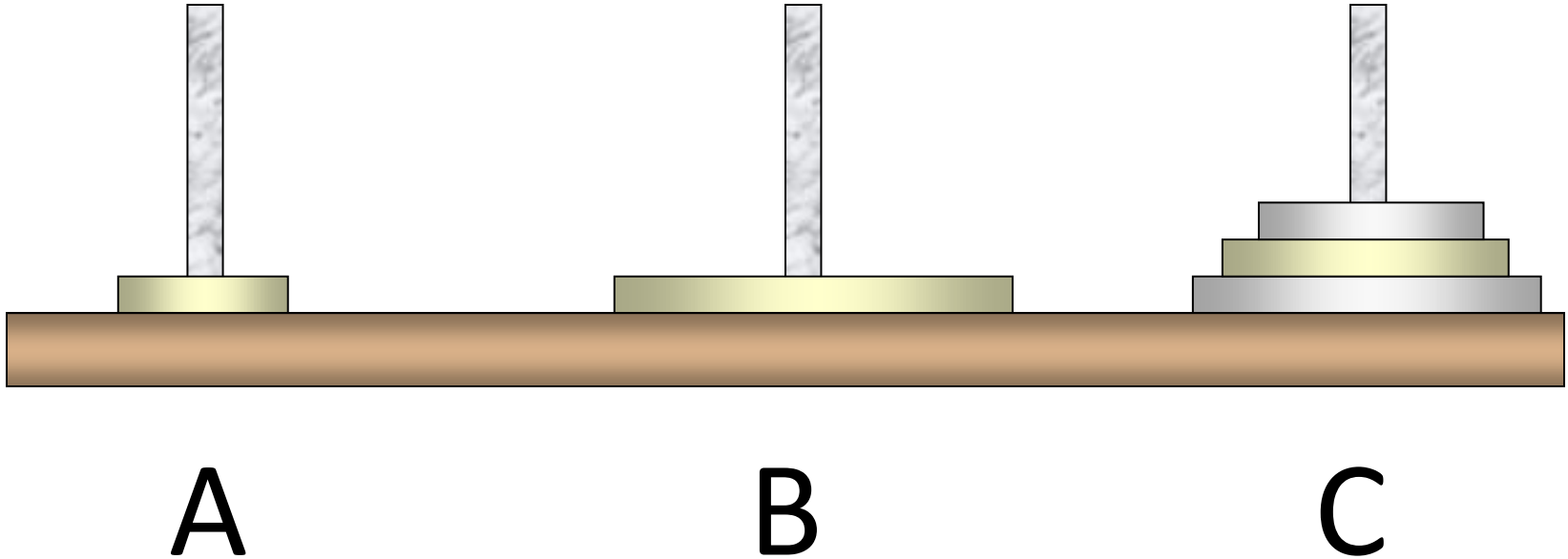
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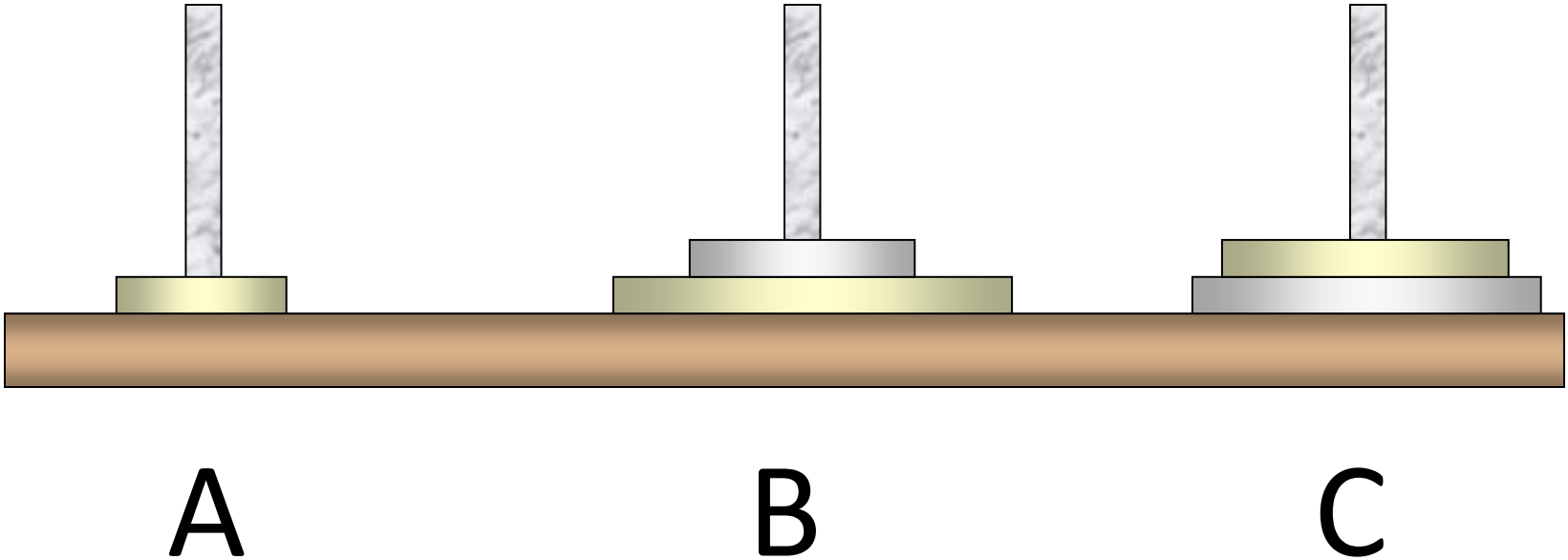
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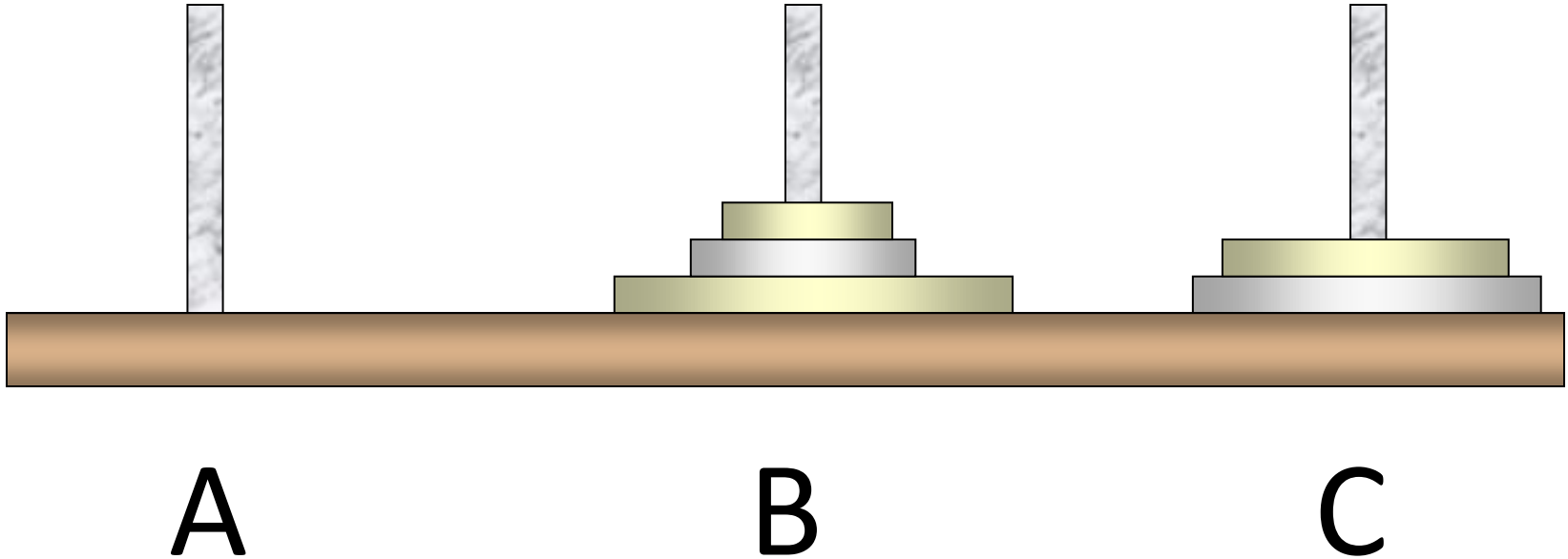
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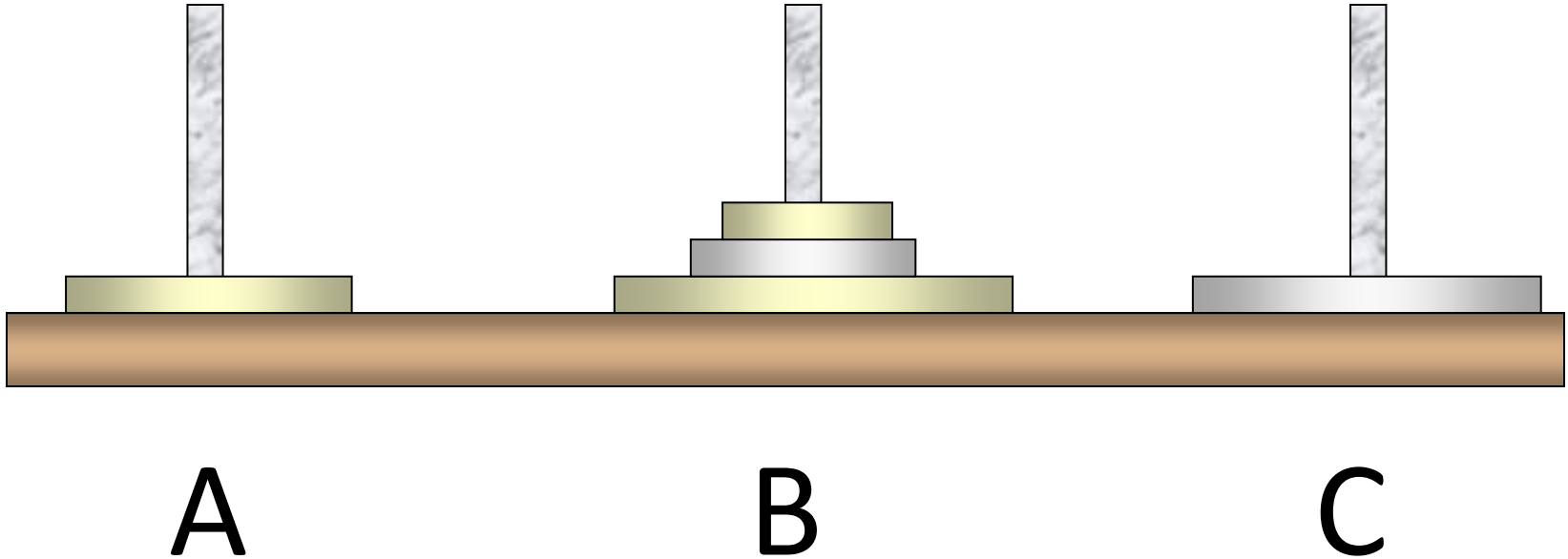
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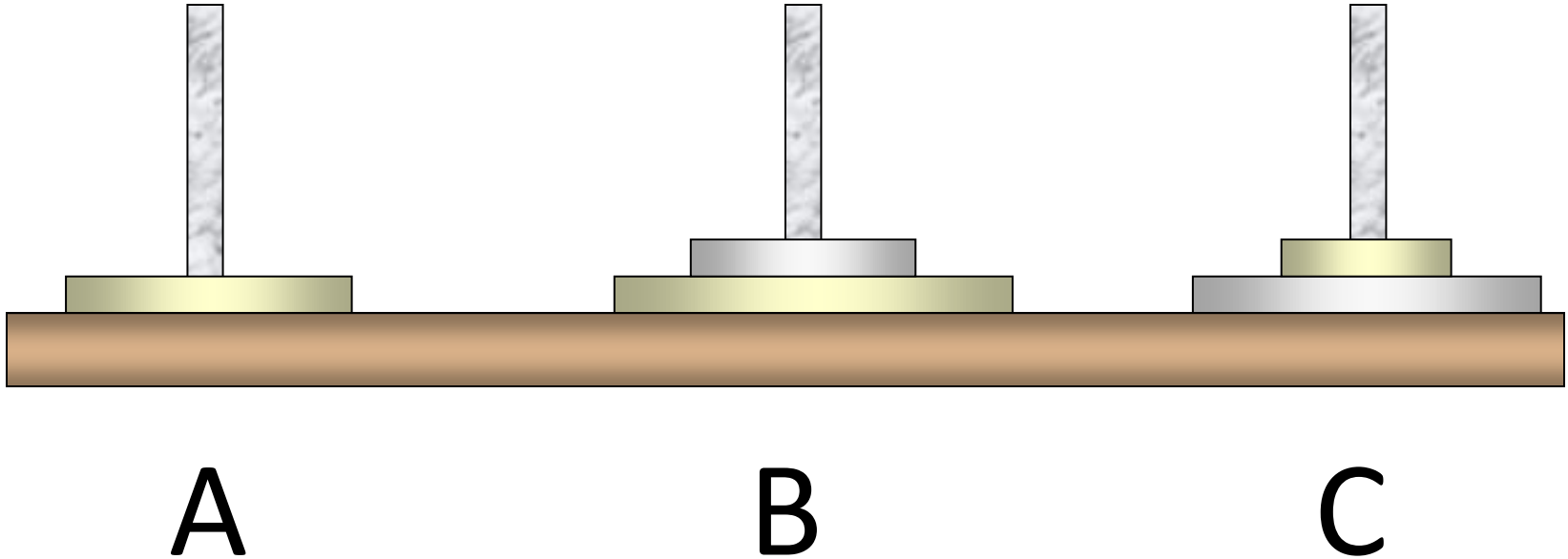
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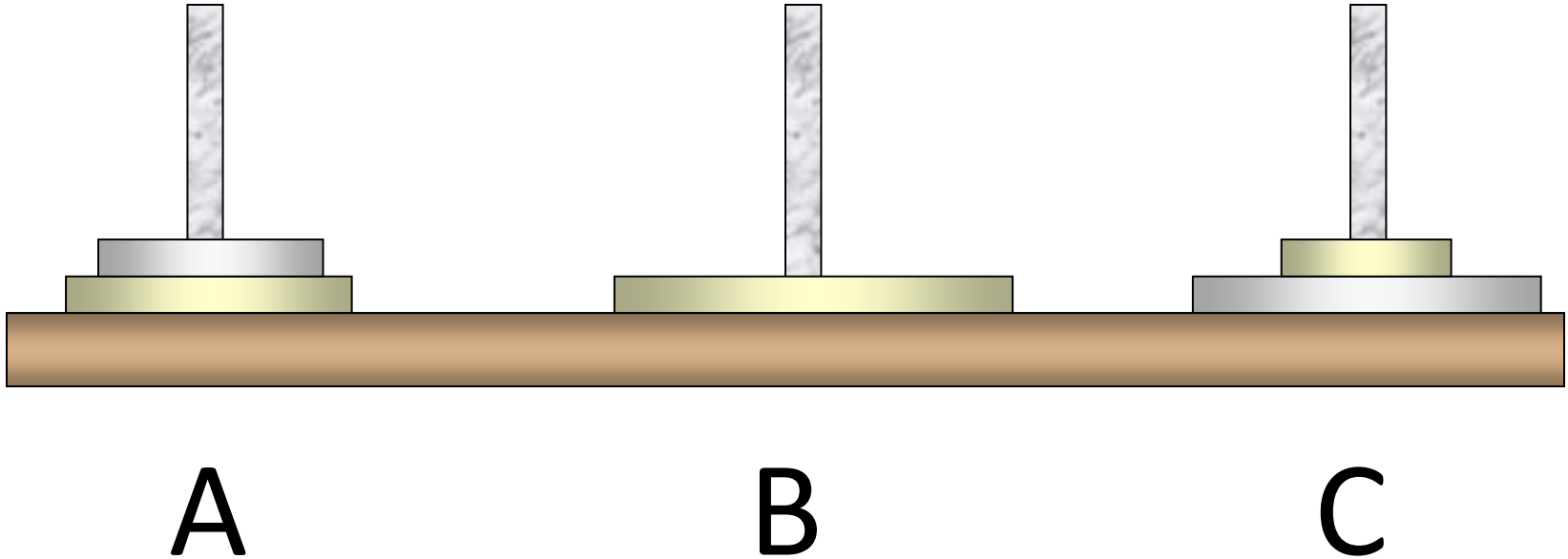
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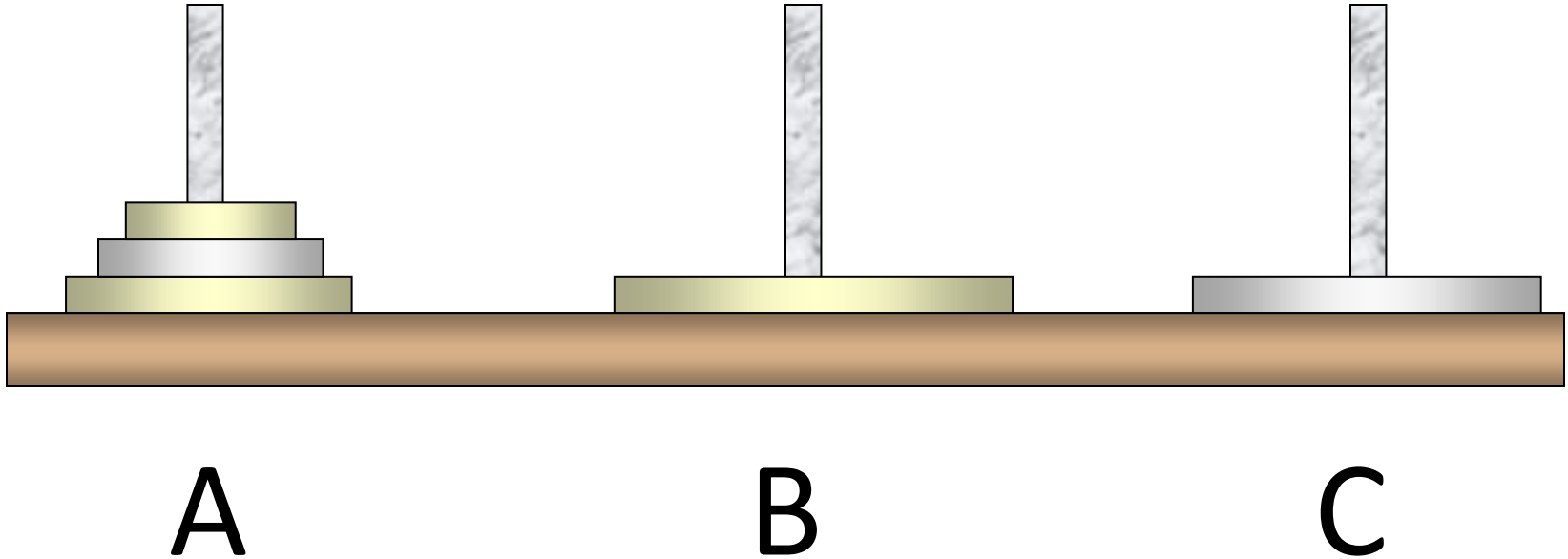
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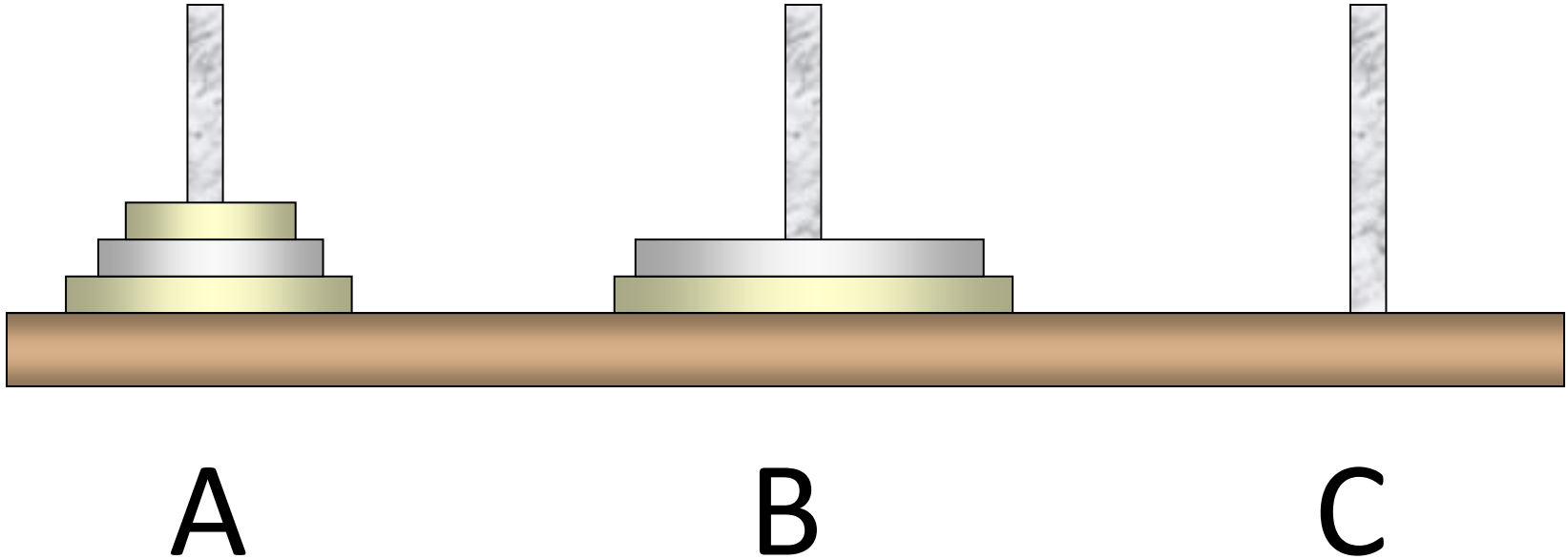
The Tower of Hanoi

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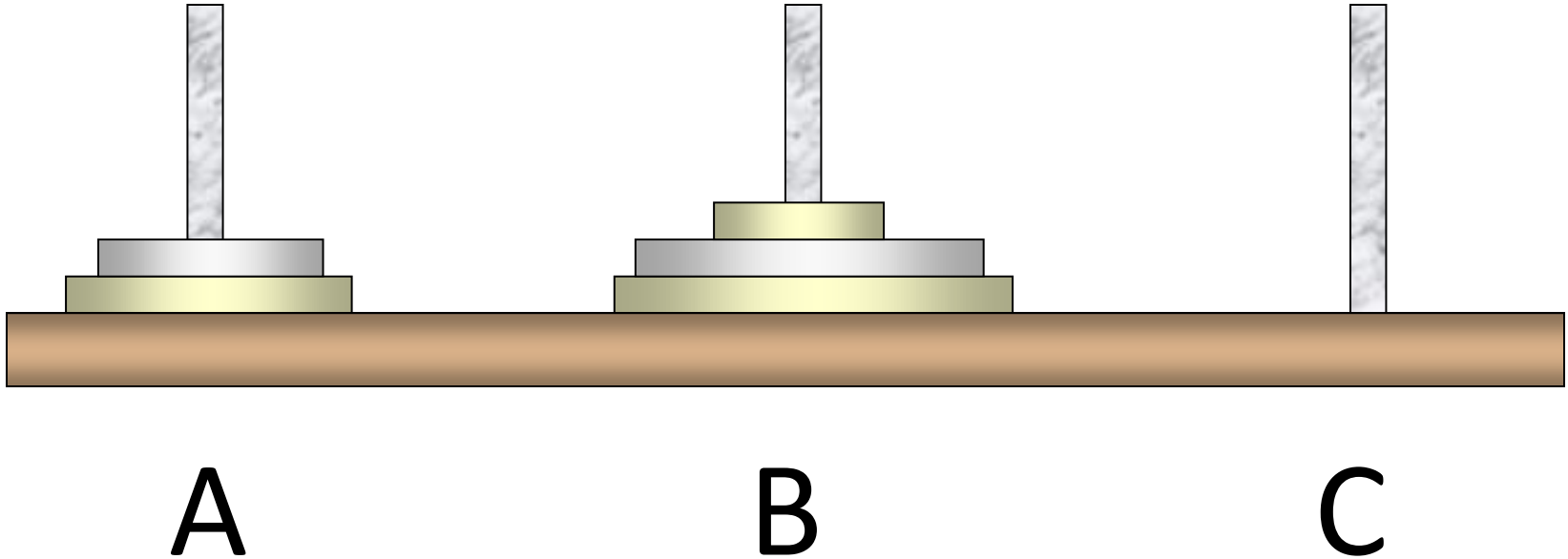
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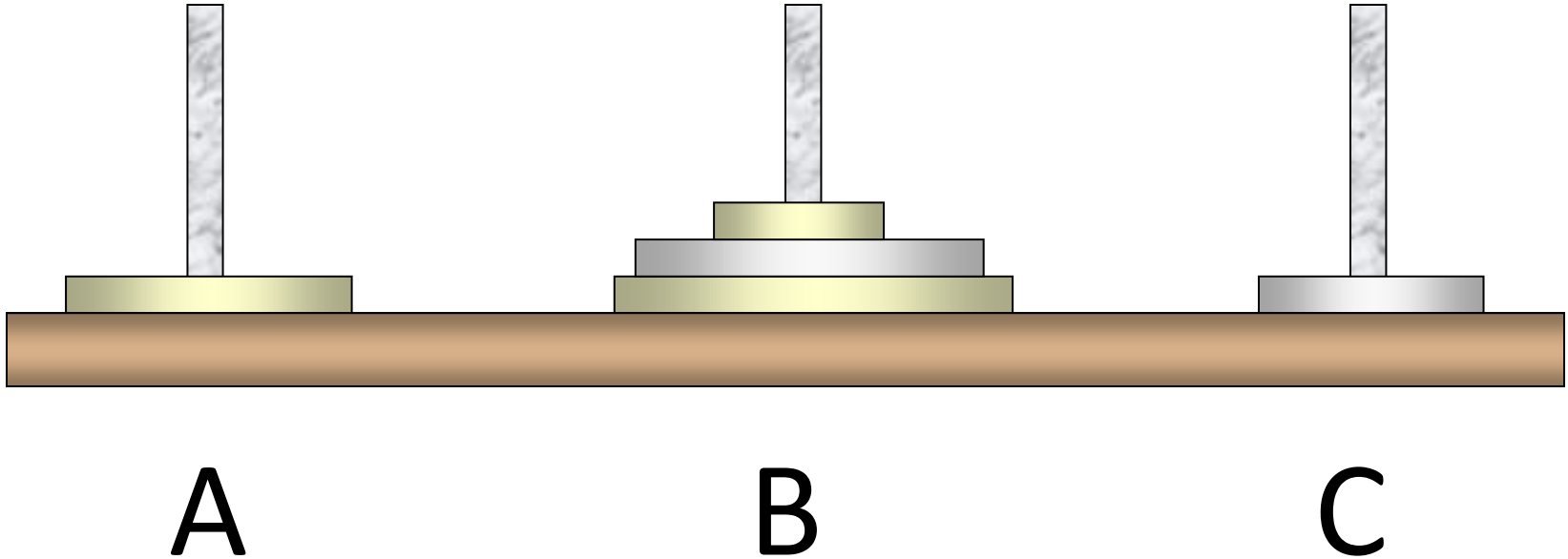
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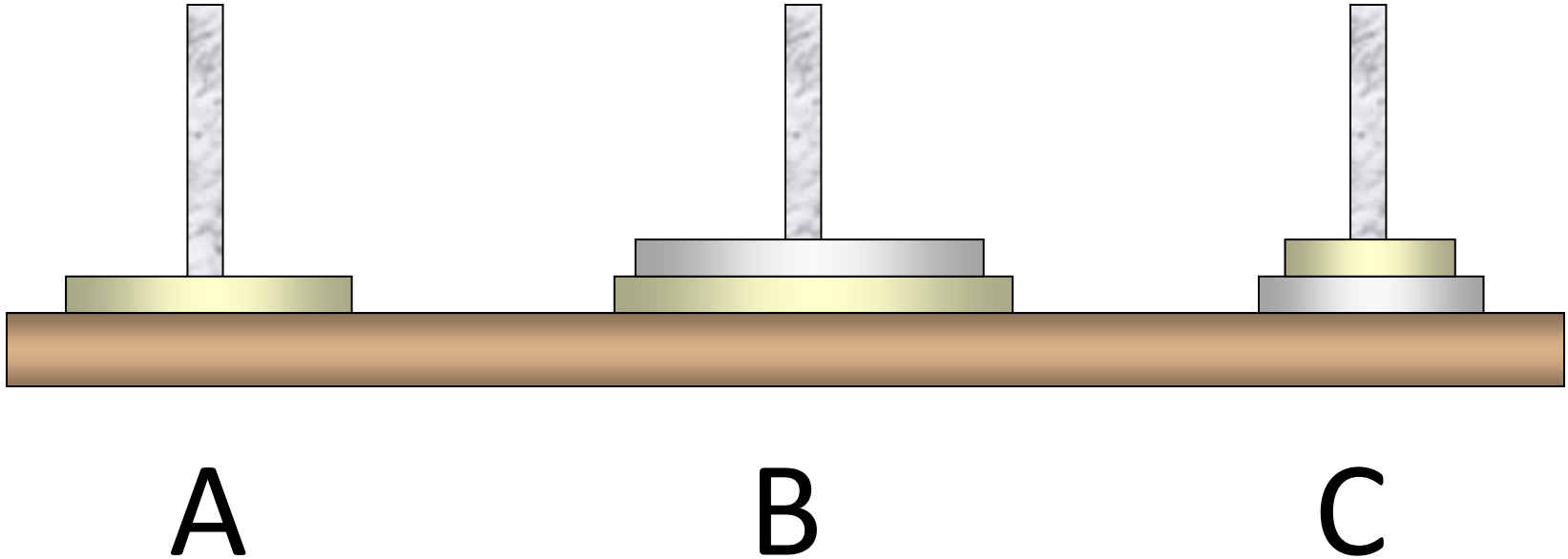
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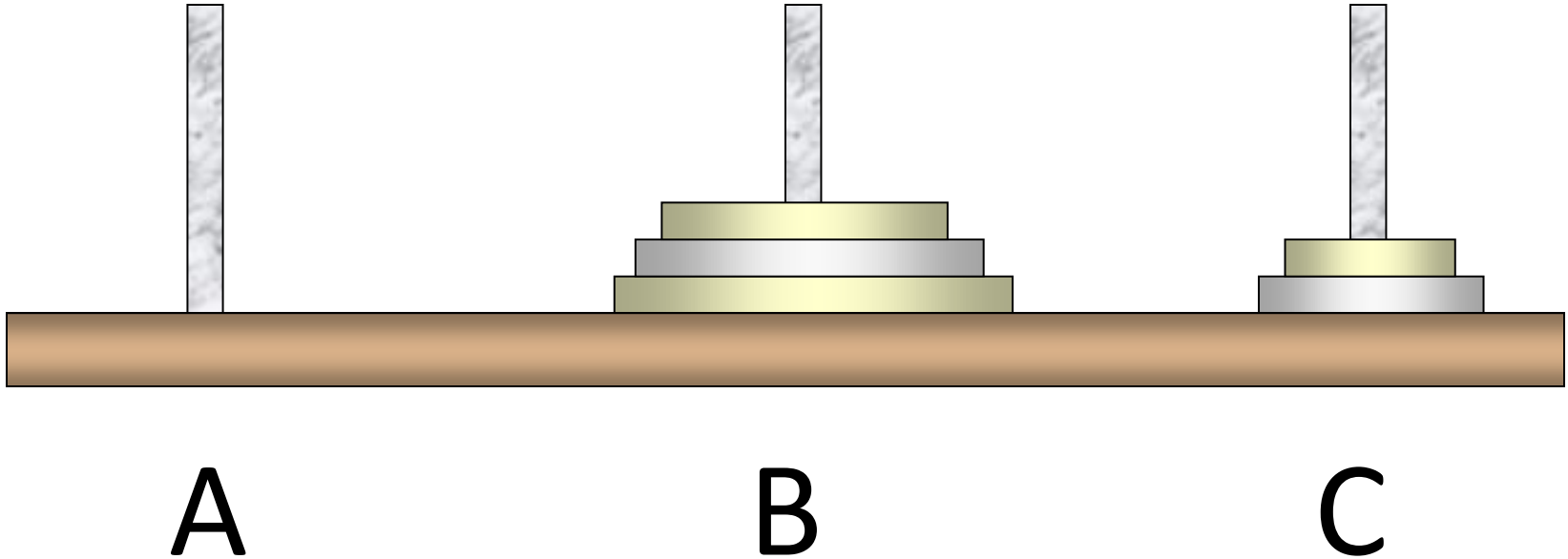
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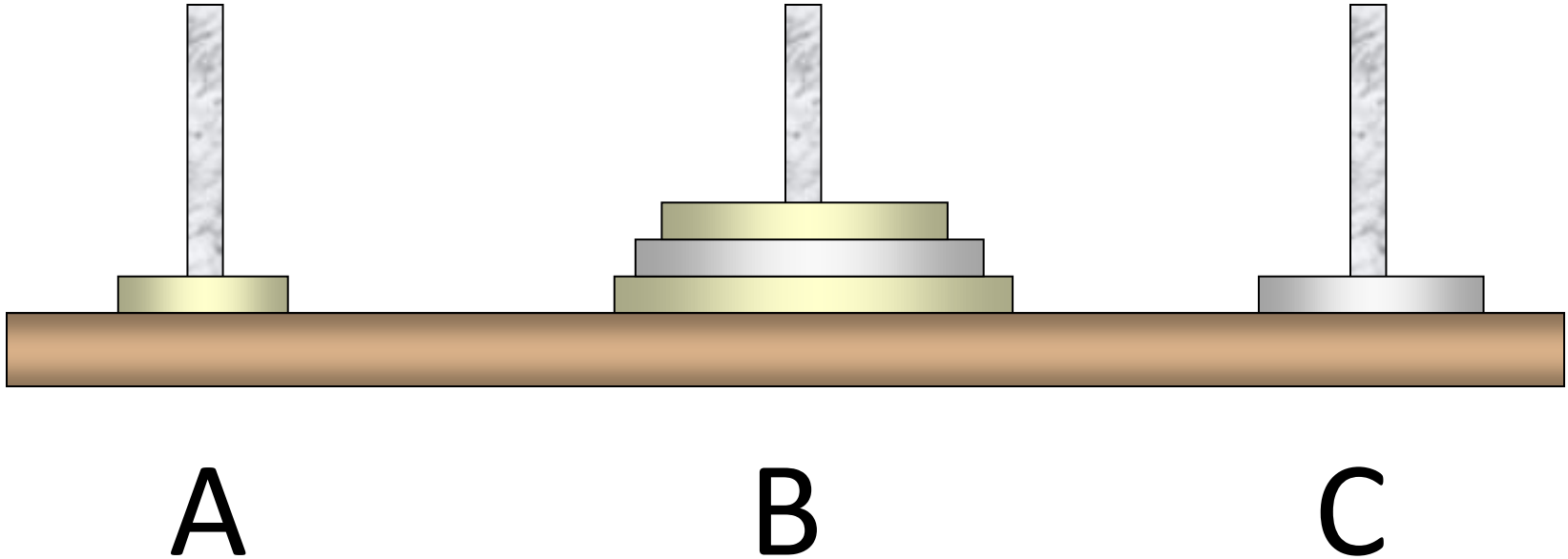
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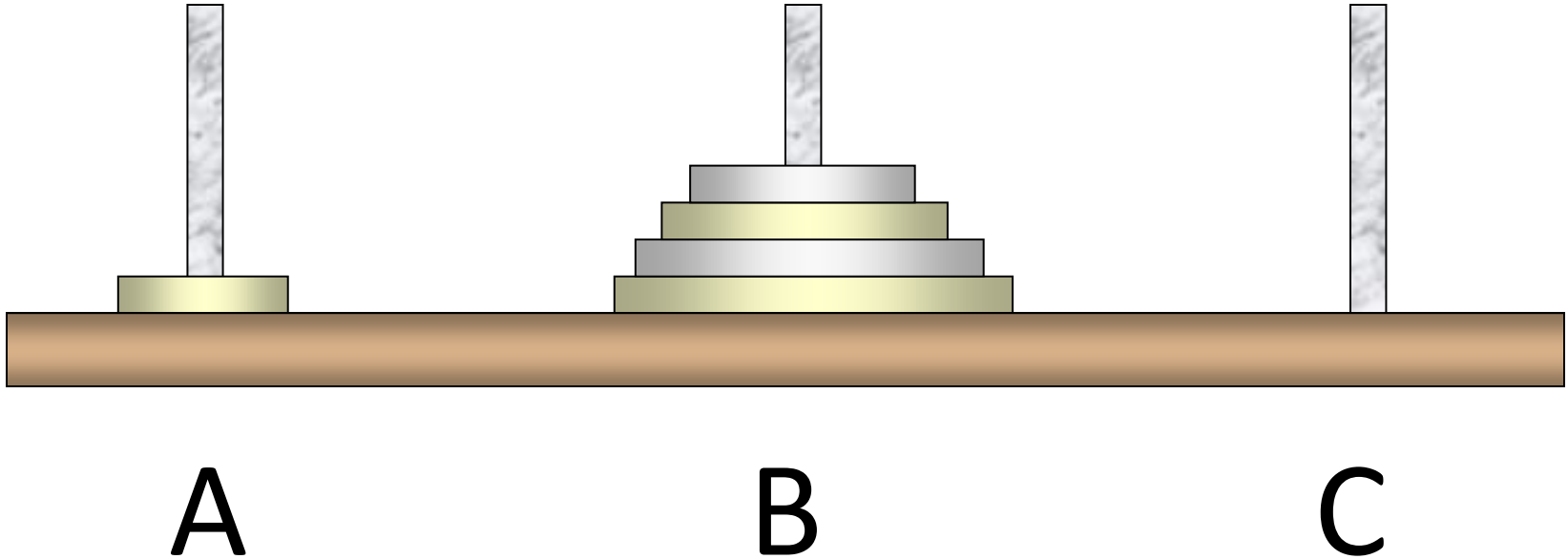
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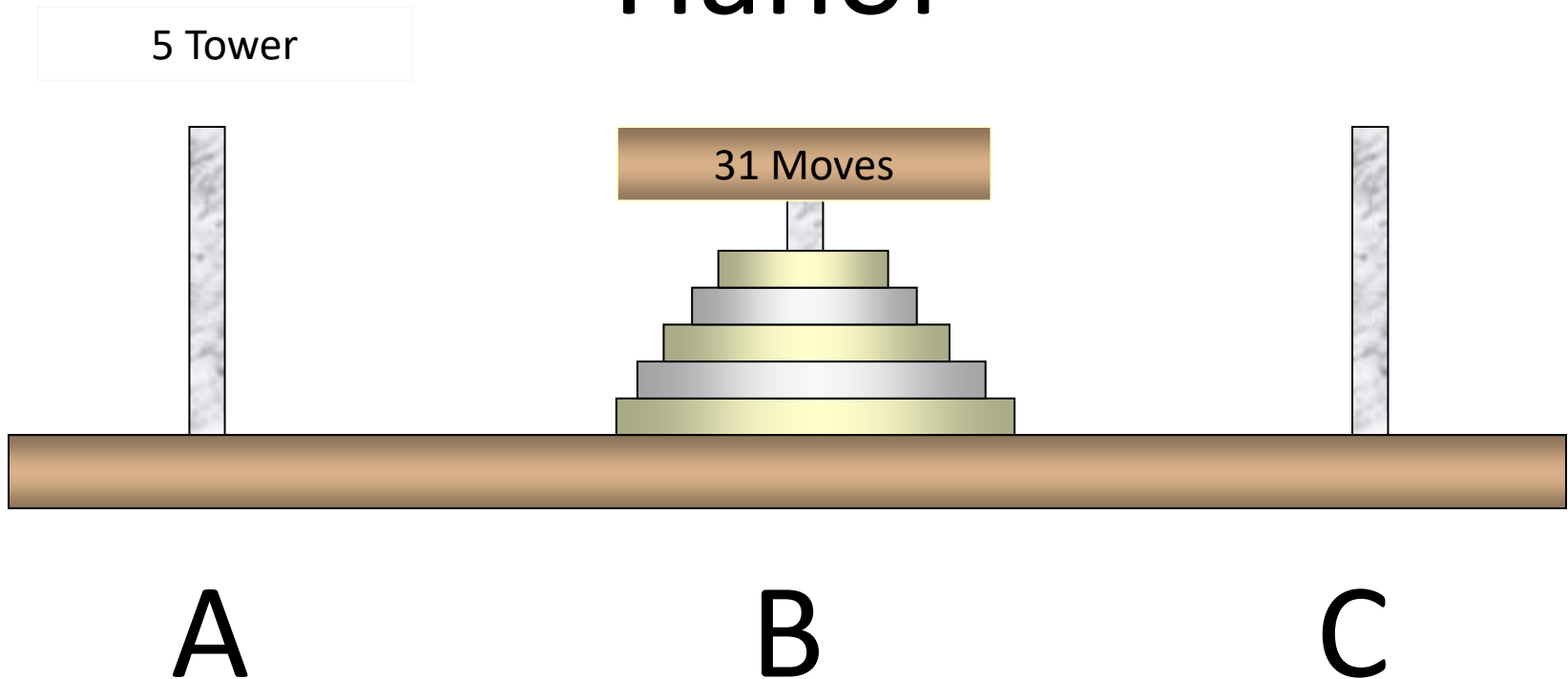


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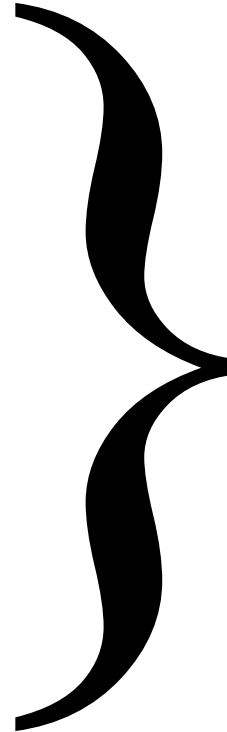


The Tower of Hanoi



The Tower of Hanoi

Discs	Moves
1	1
2	3
3	7
4	15
5	31
6	63
7	127
8	255



This is called a recursive function.

64	$2^{64} - 1$
----	--------------

n	$2^n - 1$
-----	-----------

EXPRESSIONS

Expressions

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- An **algebraic expression** is a legal combination of operands and the operators.
- **Operand** is the *quantity* on which a mathematical operation is performed.
- **Operator** is a *symbol* which signifies a mathematical or logical operation.

Expressions

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- **INFIX:** expressions in which operands surround the operator.
- **POSTFIX:** operator comes after the operands, also known as *Reverse Polish Notation (RPN)*.
- **PREFIX:** operator comes before the operands, also known as *Polish Notation*.

Example

- Infix: $A+B$
- Postfix: $AB+$
- Prefix: $+AB$

Infix Expression

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- Appearance may be misleading, INFIX notations are not as simple as they seem

- To evaluate an infix expression, we need to consider
 - ▣ Operators' Priority
 - ▣ Associative property
 - ▣ Delimiters

Infix Expression

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- Infix Expression is hard to parse and difficult to evaluate.
- Postfix and prefix do not rely on operator priority and are easier to parse.

An expression in infix form is thus converted into prefix or postfix form and then evaluated without considering the operators priority and delimiters.

Example

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Infix

$A+B$

$(A+B) * (C + D)$

$A-B/(C*D^E)$

PostFix

$AB+$

$AB+CD+*$

$ABCDE^{*}/-$

Prefix

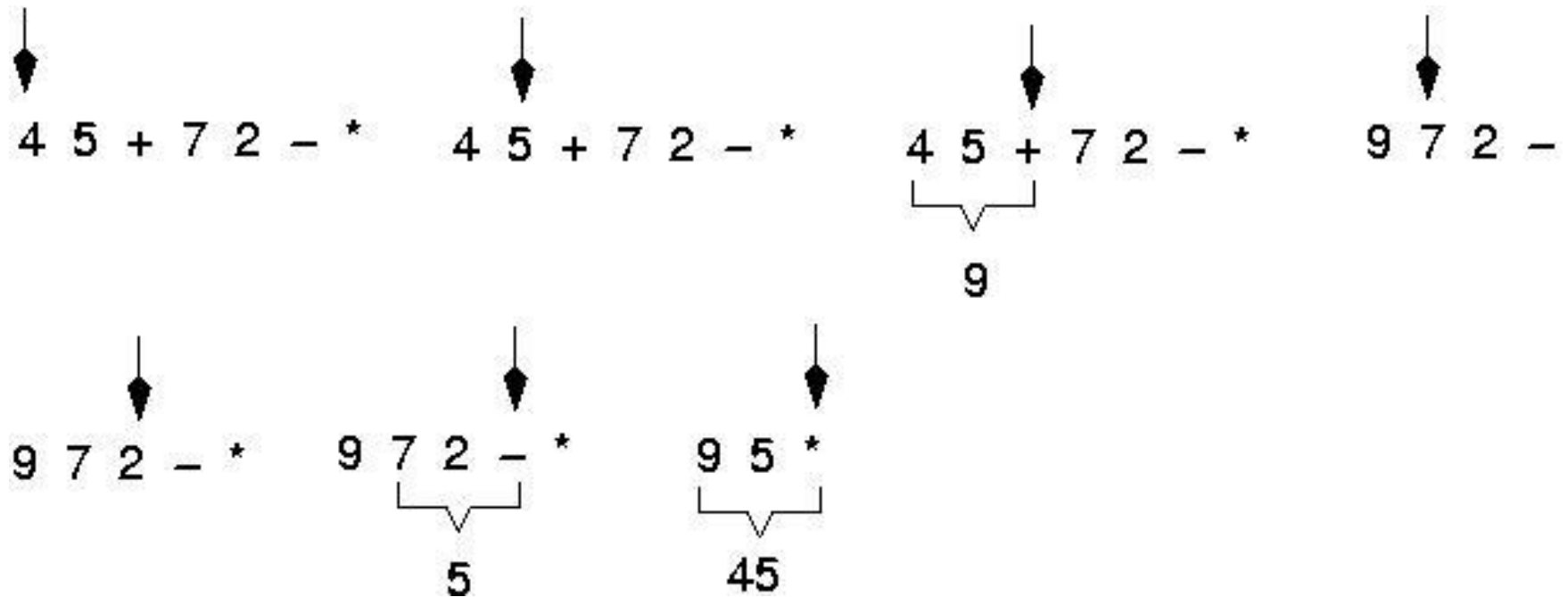
$+AB$

$*+AB+CD$

$-A/B*C^DE$

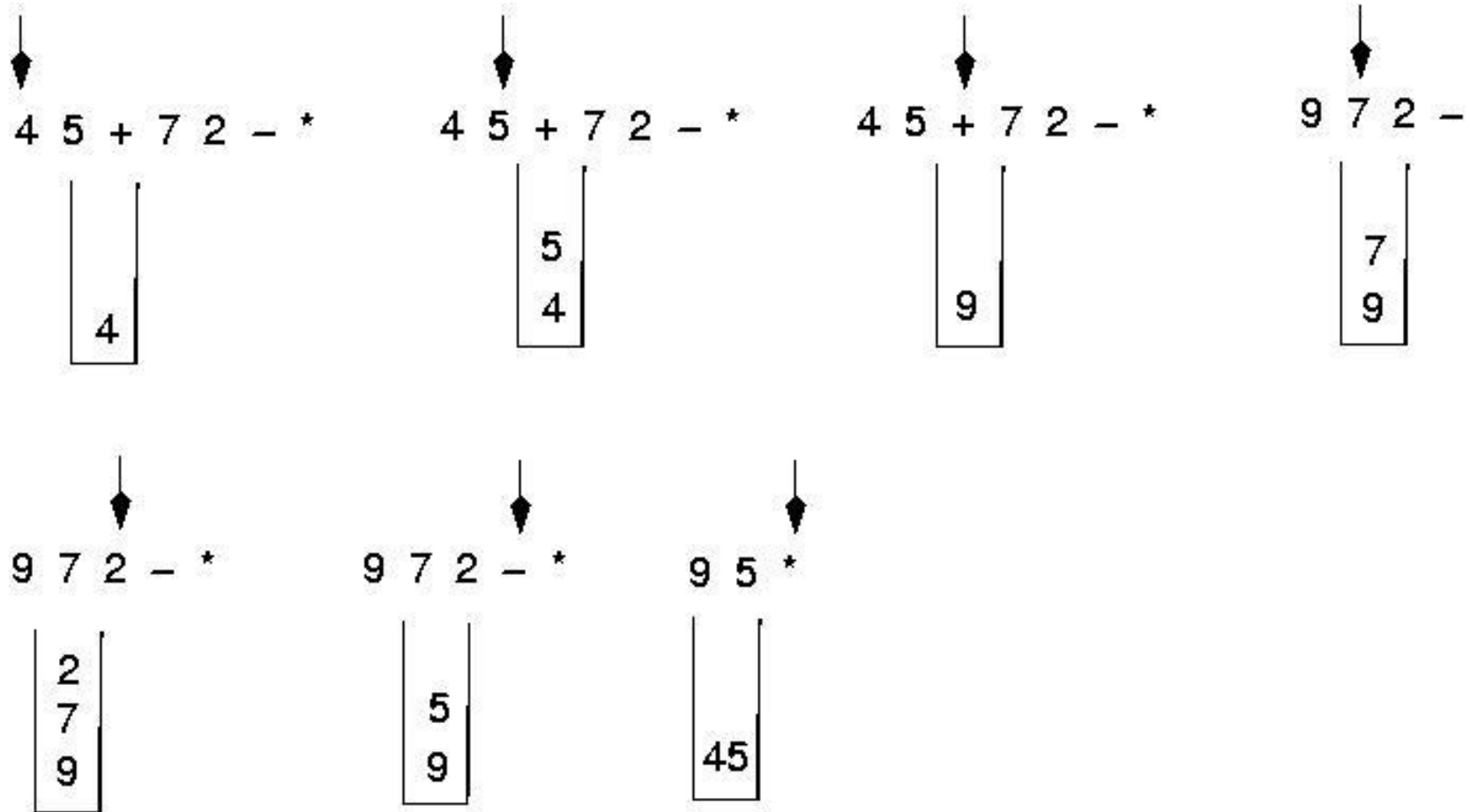
Example

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Example

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Reading Materials

85

- Nell Dale – Chapter#4
- Schaum's Outlines – Chapter#6
- D. S. Malik – Chapter#7
- <http://www.cs.man.ac.uk/~pjj/cs2121/fix.html>