NCTM 2014 Sesssion 198 ***Building Puzzles:***
Promoting Engagement, Logical Reasoning, and Mathematical Communication

transition to **algebra**
make algebra make sense

Curriculum information and presentation documents: **ttalgebra.edc.org**
Sample materials and ordering information: **transitiontoalgebra.com**

Related EDC Professional Development:

- Transition to Algebra Webinars: transitiontoalgebra.com
- Implementing the Mathematical Practice Standards: mathpractices.edc.org
- Mathematical Practices Institute — professional development opportunities, curriculum support, and technical assistance for schools: mpi.edc.org

Related EDC Projects:

- iPuzzle Math Apps Coming Soon: ipuzzle.edc.org
- ThinkMath! Elementary Curriculum: thinkmath.edc.org
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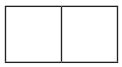
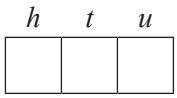
Solving Who Am I? Puzzles

Who Am I?



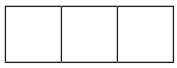
- The product of my digits is 7.
- The sum of my digits is 8.
- My units digit is greater than my tens digit.

Who Am I?



- I am even.
- My tens digit is 1.
- The product of my three digits is 12.
- h is four less than my units digit.

Who Am I?

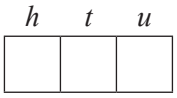


- I am odd.
- $u > t$
- My hundreds digit is prime.
- $t = 2h$
- Two of my digits are square numbers.

Who Am I?

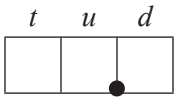
- The product of my digits is 16.
- The sum of my digits is 8.

Who Am I?



- I am a multiple of 10.
- My hundreds digit is one more than my tens digit.
- The sum of my three digits is 7.

Who Am I?



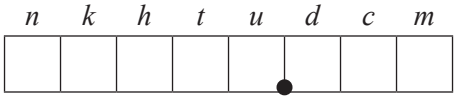
- I am in the thirties.
- $d < t$
- My units digit is twice my tens digit.
- d is four less than u.
- The product of d and t is u.

You can make up problems like these using clues with relevant content.

Building Who Am I? Puzzles

Puzzle Building Steps:

1. **Choose the final answer & construct clue boxes.**
2. **Create clues to help identify the answer.**
3. **Check that the clues lead to a unique solution.**



These variables were selected to match place values and metric system prefixes (n for thousands, k for kilo-, h for hundreds, t for tens, u for units, d for deci-, c for centi-, and m for mili-).

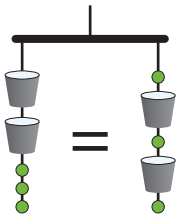
Who Am I?

Who Am I?

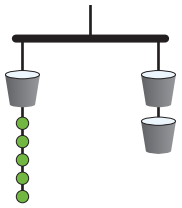
Solving Mobile Puzzles

In each of these problems, a dot (●) equals 1.

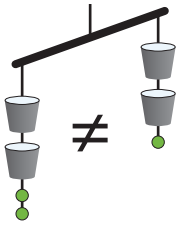
① This mobile *always balances*. Why?



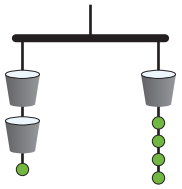
② This mobile *only balances when* the buckets represent a certain number. What number makes it balance?



③ This mobile *never balances* no matter what number the bucket represents. Why?



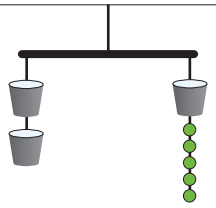
④ Does this mobile balance *always, sometimes,* or *never?*



If sometimes, *when?*

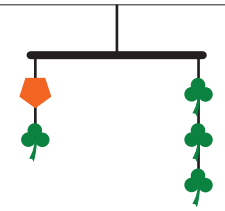
Every beam in the mobiles below is balanced. The strings and the beams weigh nothing. Find the weight of each shape.

⑤



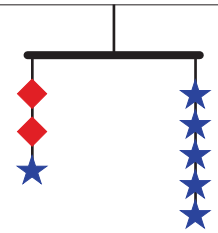
● = 1 ▭ = _____

⑥



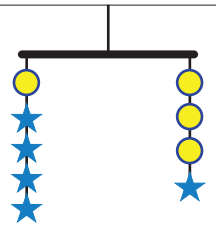
⬟ = _____ ♣ = 2

⑦



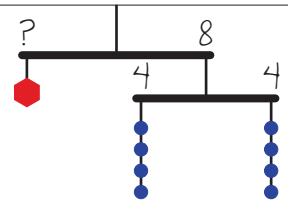
◆ = _____ ★ = 3

⑧



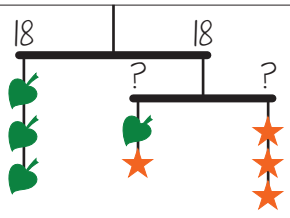
★ = 4 ○ = _____

⑨



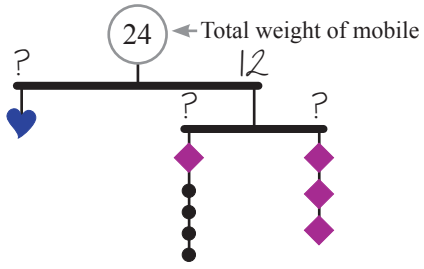
● = 1 ⬢ = _____

⑩



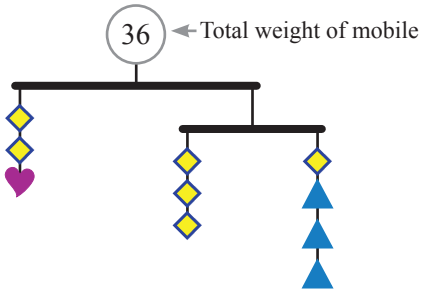
🍃 = 6 ★ = _____

⑪



● = 1 ◆ = _____ ♥ = _____

⑫



♥ = _____ ▲ = 2 ◇ = _____

Building Mobile Puzzles

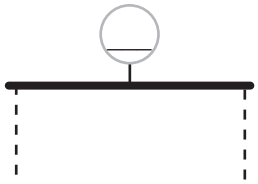
1. Make up a mobile with two shapes and one beam.

   a. Start by picking your own shapes and making up the solutions first:

   = _____

   = _____

   b. Now make up a balanced mobile, and write in the total weight at the top:

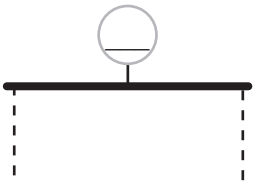


   c. Before you share your mobile, make sure that the solutions you started with are the *only possible solutions*. Cover your solutions and try solving it yourself first. Then trade with someone and solve each other's puzzles.

These two mobiles aren't "wrong," but they're not good puzzles because there is more than one way to make them balance.

Did you make a mobile with more than one possible solution?
If so, it may be possible to fix it by giving more information or using fewer variables. For example, the two mobiles above can be fixed like this:

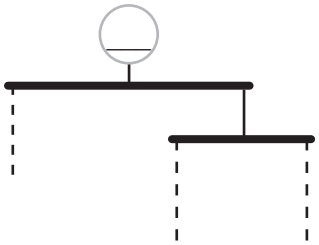
2. Copy your partner's mobile, draw their shapes in below, and solve it.

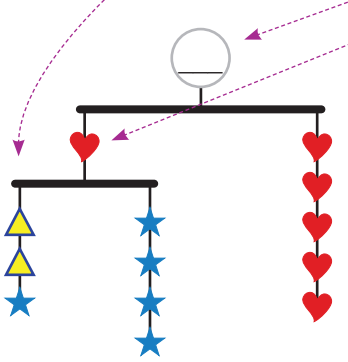


= _____

= _____

3. Build a complicated mobile of your own.





= 8 = _____ = _____

To complicate a mobile, try:

- Strings with more than one kind of shape
- More shapes
- More beams
- Not giving the top weight
- Middle weights

But beware! It can be hard to make complex mobiles that have just one possible solution.

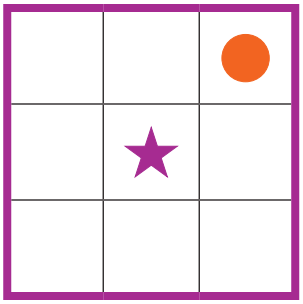
Solving MysteryGrid Puzzles

Use the clues to fill in each grid so that every row and every column contains all of the numbers in the title.

5, 7, 9 Latin Square

	5	
7	9	
		9

●, ▲, ★ Latin Square



MysteryGrid **3, 4, 5**

2,–		7,+
20,•	4	
	8,+	

r*, *s*, *t Latin Square

	s	
		r

MysteryGrid **1, 2, 3, 4**

8,•		6,•	4,•
4,+			
3,–	5,+	7,+	
		3,+	

MysteryGrid $\frac{1}{3}$, $\frac{1}{2}$, **1**

$1\frac{1}{2}$, +	$\frac{1}{6}$, •	
	$\frac{1}{2}$, –	$\frac{1}{3}$, •
$\frac{1}{3}$		

MysteryGrid **6, 7, 8, 9**

30, +	72, •	63, •	
		30, +	
		48, •	
42, •			

MysteryGrid ***a*, *a*², *a*³**

a^4, •	a^2+a, +	
	a^6, •	a^5, •

MysteryGrid **0, 1, *x*, *x*²**

2, +		$2x^2+x$, +	
	$2x$, +		
0, •			1, +
x	x^2+1, +		

MysteryGrid **0.1, 0.2, 0.3, 0.4**

.6,+		.08,×	
	.016,×	3,÷	
.12,×			.5,+
	.02,×		

MysteryGrid **(*a* – 1), *a*, (*a* + 1)**

$2a-1$, +		a^2+a, •
$2a+1$, +	$a-1$	
	a^2-1, •	

MysteryGrid a^{-1}, ***a*, *a*², *a*³**

a^3, •	a, •	a^6, •	
a^4, •		a^5, •	1, •
a, •			

Building MysteryGrid Puzzles

① Choose a grid size and pick a combination of three or four numbers or expressions with variables. Fill in the grid like a Latin Square puzzle with exactly one of each number or expression in each row and column.

Latin Square ___, ___, ___

Latin Square ___, ___, ___, ___

You can start by writing your numbers in the first row, then filling in the second row so that it's different from the first row, and so on.

② Start making your cages. Block off a group of numbers. Then use an operation (+, –, •, or ÷) to make your clue. These example grids have been started. Complete these grids, or add cages and clues to the Latin Square you made above.

MysteryGrid **2, 3, 4, 7**

2	7	9, + 4	3
3	4	7	2
7	2	3	4
4	3	5, – 2	7

You can make cages with just one number, too.

For subtraction and division, use cages with only two numbers.

MysteryGrid **2x, (x + 2), x^2**

$2x^3$, • $2x$	x^2	$x+2$
x^2	$x+2$	$2x$
$x+2$	$2x$	x^2

③ Make sure there is *only one solution*.

Puzzles with more than one solution aren't "wrong," but they aren't satisfying because the player will get stuck at the point where there is no unique answer.

Copy only your clues and try solving your puzzle yourself before sharing it with someone else.

Adjust the cages as needed to make the puzzle have only one solution.

Then share and solve your puzzle with someone else.

MysteryGrid ___, ___, ___

MysteryGrid ___, ___, ___, ___