Wrong Numbers

~~LineNumbers~~
~~with place values~~ ☹

IconNumbers
BundleNumbers
PerNumbers ☺

Respect & Develop

Kids' own Flexible BundleNumbers with Units

~~T is 48~~ No:

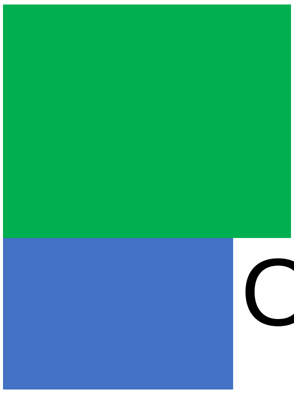
T is **4*B*8 = 3*B*18 = 5*B*-2**

Wrong Operations

~~8/2 is 8 split by 2~~ NO:
8/2 is 8 counted in **2s**

~~5x8 is 40~~ NO:
5x8 is 5 **8s**

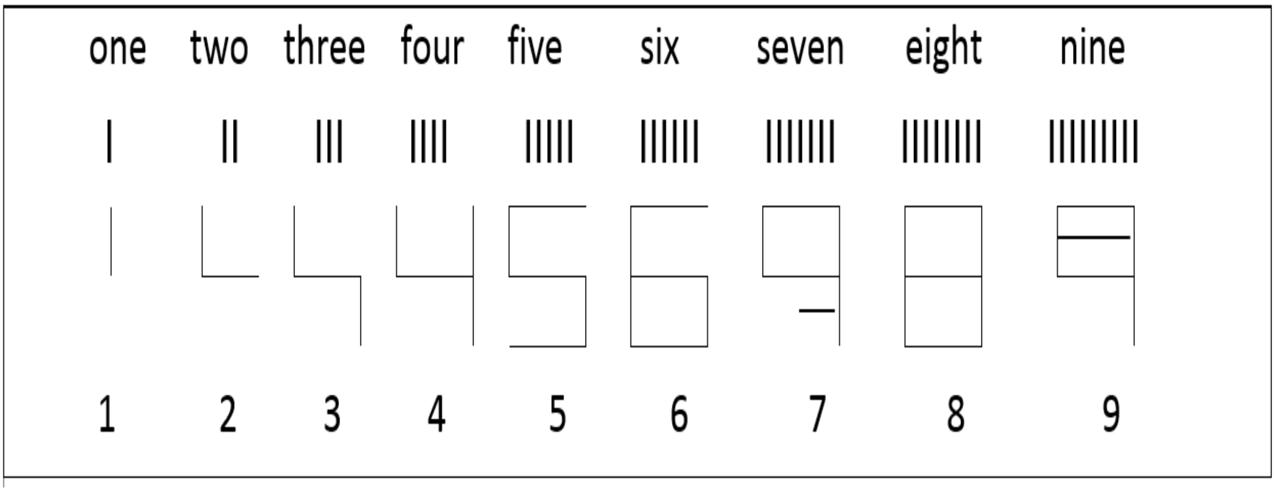
2 **3s** + 4 **5s** = ???


OnTop or NextTo


Wrong Math = **Dislike**

Numbers are Icons

5 sticks in the 5-icon etc.

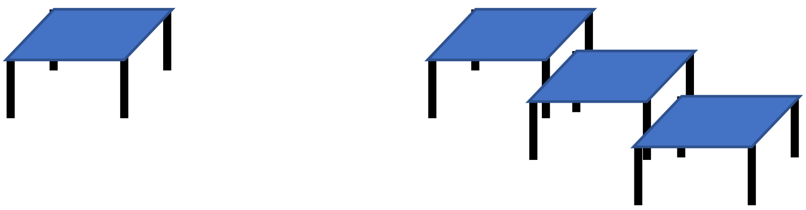


Our two Language Houses have two Floors

**The WORD-language assigns words in sentences with a subject, a verb & a predicate.
The NUMBER-language assigns numbers instead.**

Both languages have a META-language, a grammar, describing the language, that is learned before the grammar in the word-language, but not in the number-language.

	WORD language	**NUMBER language**
META-language grammar	***'is' is a verb***	***'x' is an operation***
Language	**This is a table**	**T = 3x4**



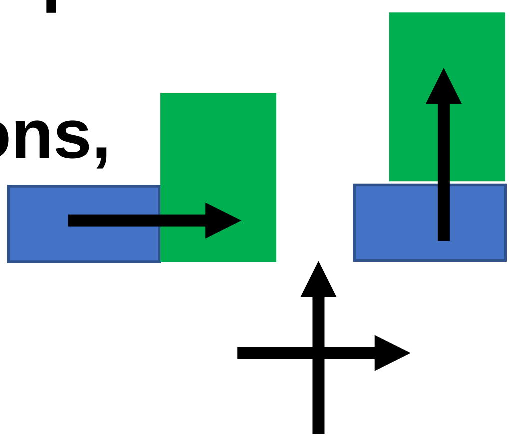
Operations are Icons

From 9 PUSH away 2s we write 9/2 iconized by a broom, called *division*.

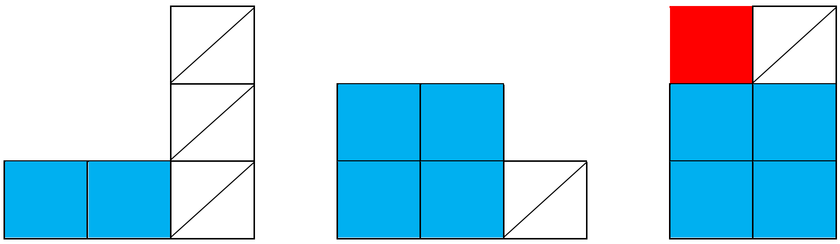
4 times LIFTING 2s to a stack we write 4x2 iconized by a lift called *multiplication*.

From 9 PULL away 4 2s' to find un-bundled we write 9 – 4x2 iconized by a rope, called *subtraction*.

UNITING next-to or on-top we write A+C iconized by two directions, called *addition.*



Flexible Bundle-Numbers



Overload *Standard* *Underload*

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5 = 1*B*3 = 2*B*1 = 3*B*-1 **2s**

5 = 1.3 = 2.1 = 3.-1 **2s**

= 2 ½ **2s**

48 = 4*B*8 = 3*B*18 = 5*B*-2

T = 65 + 27 = ? = 6***B***5 + 2***B***7 = 8***B***12 = 9***B***2 = 92

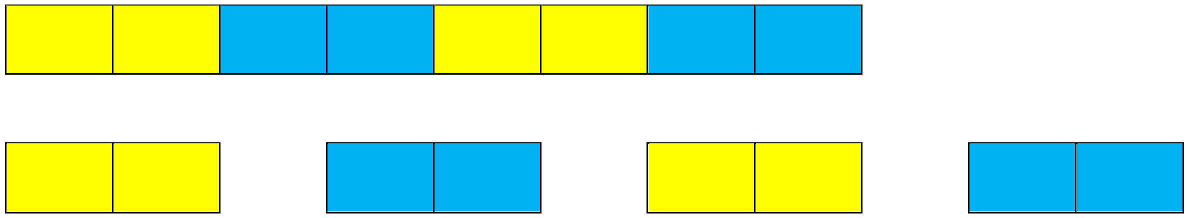
T = 65 – 27 = ? = 6***B***5 – 2***B***7 = 4***B***-2 = 3***B***8 = 38

T = 7* 48 = ? = 7* 4***B***8 = 28***B***56 = 33***B***6 = 336

T = 336 /7 = ? = 33***B***6 /7 = 28***B***56 /7 = 4***B***8 = 48

The RecountFormula

Recounting a total T in B-bundles



8 = (8/2)*2 = 4*2

T = (T/B)*B

From T, T/B times, push B away

Solves equations:

u*2 = 8 *= (8/2)*2*

u = 8/2 (opposite side & sign)

u + 2 = 8	u*2 = 8	u^8 = 2	2^u = 8
u = 8 – 2	u = 8/2	$u = \sqrt[8]{2}$	$u = \log_2(8)$

Root: factor-finder & log: factor-counter

Used in STEM-formulas

m = (m/s)*s = speed*sec

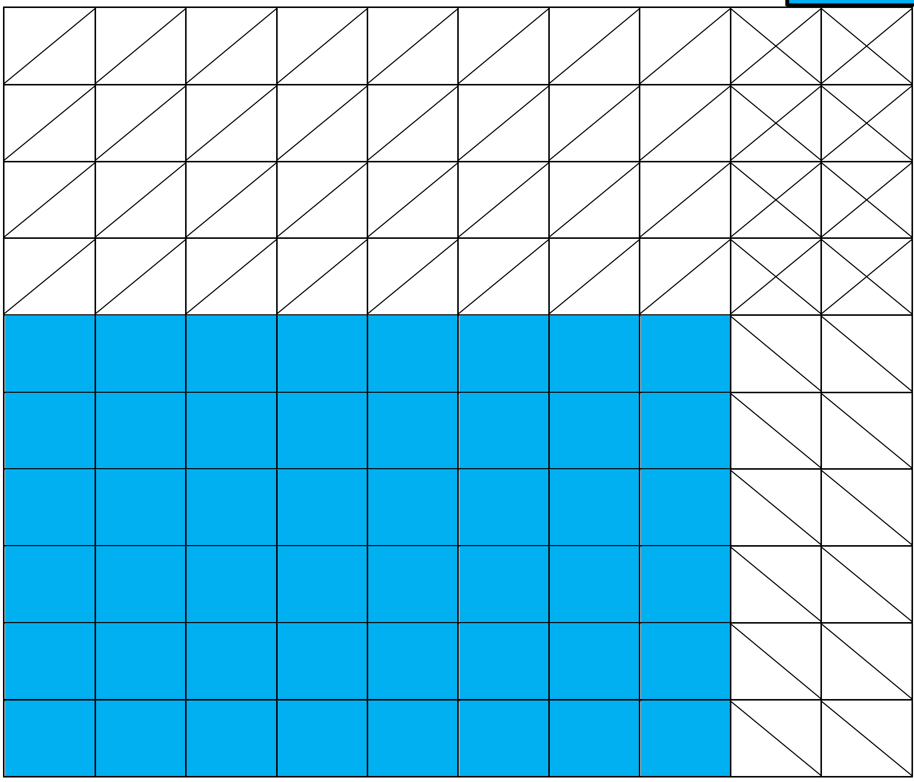
$ = ($/h)*h = rate*hour

Ten-numbers

Tables: recount to tens

6 **8s** = ? **tens**

longer base - shorter height:



T = 6 **8s** = 6*8

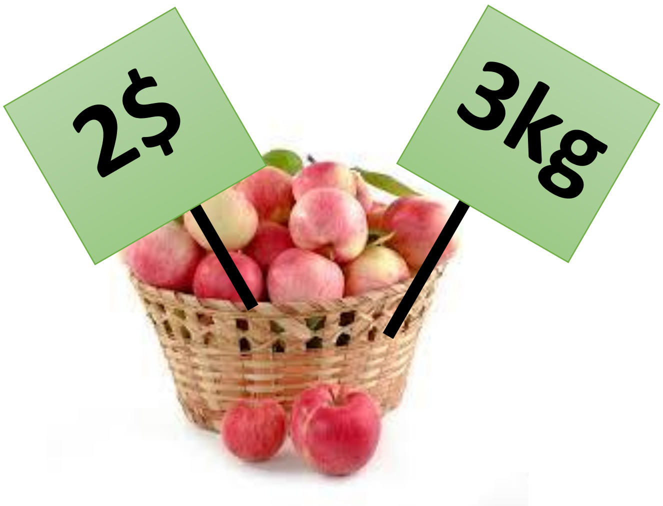
= (***B***-4)*(***B***-2)

= ***BB*** - 4***B*** - 2***B*** - - 8

= 10***B*** - 6***B*** + 8

= 4***B***8 = 4.8 **tens** = 48

Per-numbers



DoubleCounting in kg & $ gives a **Per-number 2$/3kg**

<u>8$ = ?kg</u>

8$ = (8/2) x 2$

= (8/2) x 3kg = 12kg

<u>9kg = ?$</u>

9kg = (9/3) x 3kg

= (9/3) x 2$ = 6$

With like units, per-numbers are fractions: **2$/3$ = 2/3**

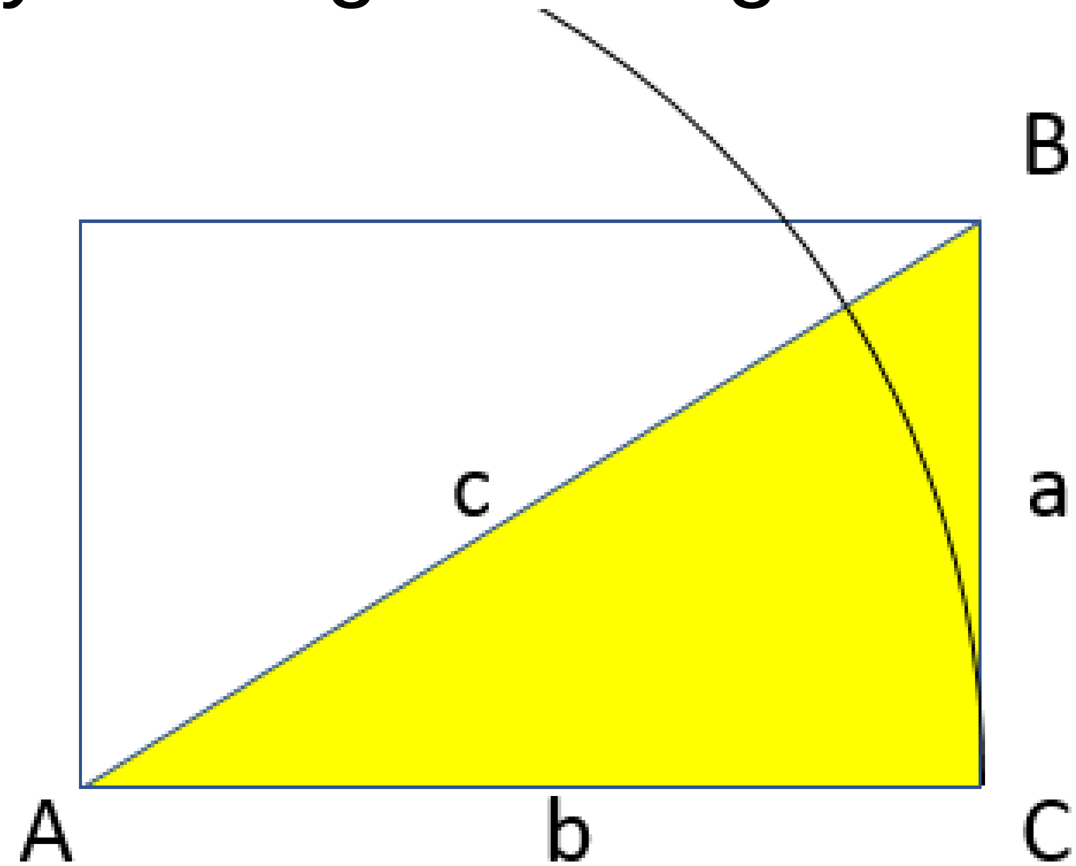
STEM-formulas contain per-numbers coming from double-counting:

m = (m/sec) * sec = speed * sec

kg = (kg/m^3) * m^3 = density * m^3

Side-numbers

Recount sides in a box halved by its diagonal: Trigonometry



T = (T/B)*B

a = (a/c)*c = **sinA***c

a = (a/b)*b = **tanA***b

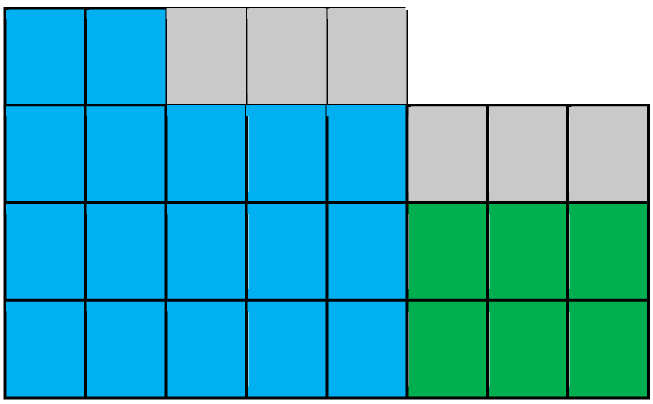
π = n*sin(180/n) for n large

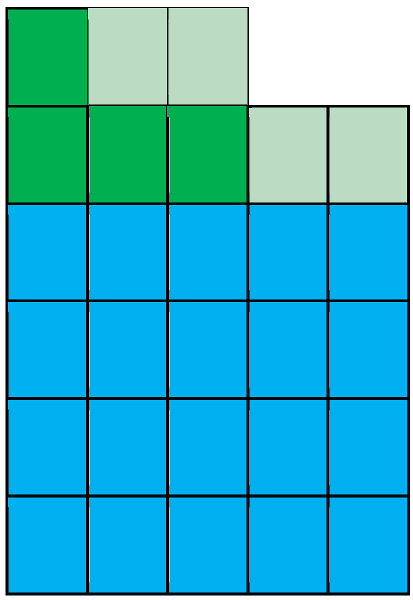
c*c = a*a + b*b

Addition is not Well Defined

Counted & Recounted, Totals may Add

BUT: NextTo	or OnTop
4 **5s** + 2 **3s** = 3**B**2 **8s**	4 **5s** + 2 **3s** = 5**B**1 **5s**
The areas are integrated *Adding areas = Integration*	Units changed to the same *Change unit = Proportionality*



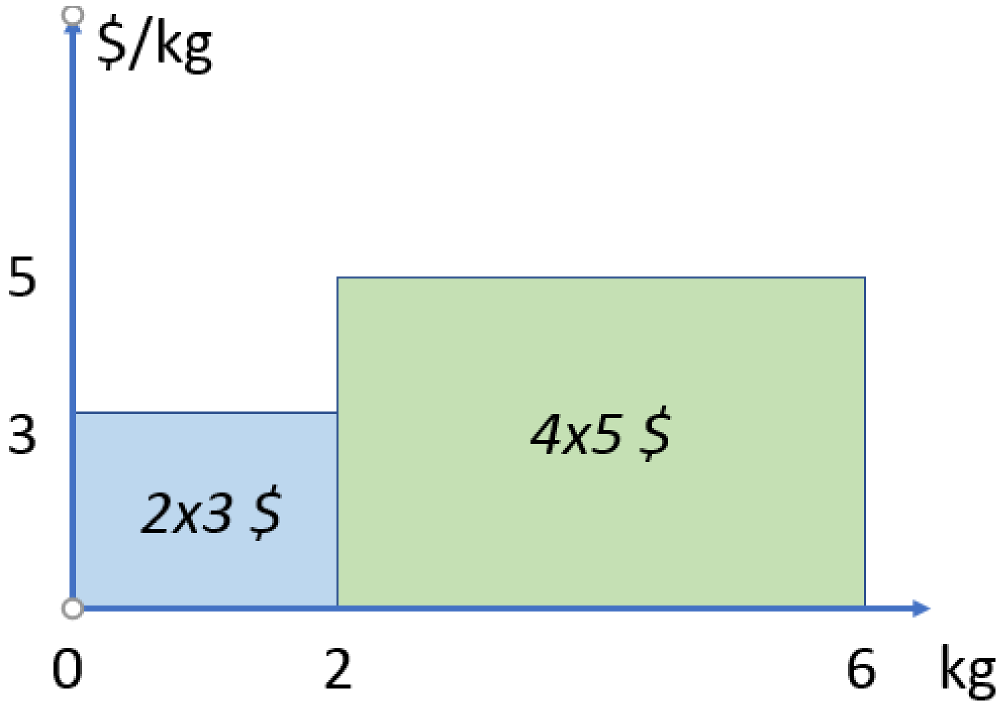


Adding fractions and per-numbers: Calculus

2 kg at 3 $/kg
+ 4 kg at 5 $/kg

(2+4) kg at ? $/kg

Unit-numbers add on-top.
Per-numbers add next-to as areas under the per-number graph:



4 Ways to Unite & Split

A number-formula T = 345 = 3**BB**4**B**5 = 3***B**^2+4***B**+5 (a polynomial) shows the four ways to add:

+, *, ^, next-to block-addition (integration)

<u>Add</u> & <u>multiply</u> add changing and constant unit-numbers.

<u>Integrate</u> & <u>power</u> add changing and constant per-numbers.

The 4 uniting operations have a reverse splitting operation:

Add has <u>subtract</u> (–), and multiply has <u>divide</u> (/).

Power has factor-find (<u>root</u>, √) and factor-count (<u>logarithm</u>, log).

Integrate has per-number find (<u>differentiate</u> dT/dn = T‘).

Reversing operations solve equations by moving to **opposite side** with **opposite sign**.

Operations unite/ *split into*	**changing**	**constant**
Unit-numbers *m, s, \$, kg*	$\mathbf{T = a + n}$ $T - a = n$	$\mathbf{T = a * n}$ $T/n = a$
Per-numbers *m/s, \$/kg, m/(100m) = %*	$\mathbf{T = \int a\, dn}$ $dT/dn = a$	$\mathbf{T = a\text{^}n}$ $\log_a T = n,\ \sqrt[n]{T} = a$

We call this beautiful simplicity the ‘**Algebra Square**’ since in Arabic, algebra means to reunite.

Solving Equations

ManyMath: Recount

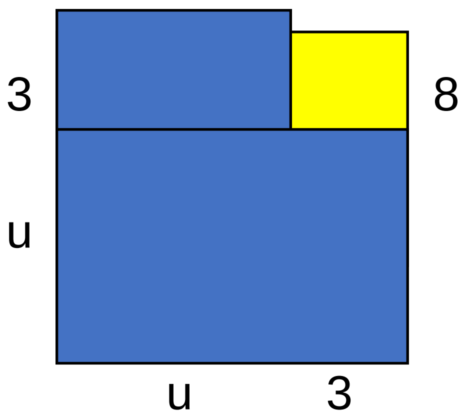
2 x u = 6 = (6/2) x 2	Solved by recounting 6
u = 6/2 **= 3**	Test: 2 x 3 = 6 OK

MatheMatics: Neutralize with Abstract Algebra

2 x u = 6	Multiply has 1 as neutral element, and 2 has ½ as inverse element
(2 x u)x½ = 6x½	Multiply 2's inverse element to both number-names
(u x 2)x½ = 3	Apply the commutative law to ux2, 3 is the short number-name for 6x½
u x (2x½) = 3	Apply the associative law
u x 1 = 3	Apply the definition of an inverse element
u = 3	Apply definition of a neutral element *With arrows, a test is not needed*

Quadratic Equations
with 3 Cards

Solve the quadratic equation



$$\mathbf{u^2 + 6u + 8 = 0}$$

$$(u+3)^2 = u^2 + 6u + 8 + 1$$

$$(u+3)^2 = \quad 0 \quad + 1$$

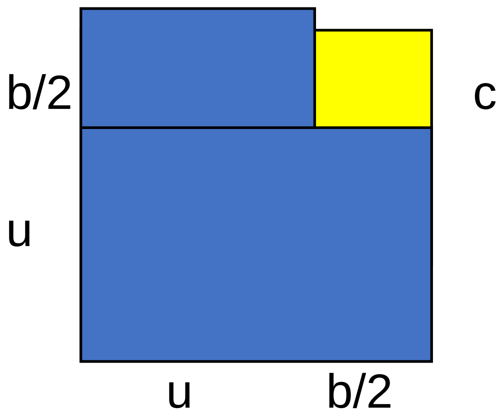
$$u+3 = \pm 1$$

$$u = -3 \pm 1$$

Solution: **$u = -4$, $u = -2$**

With unspecified numbers:

Solve the quadratic equation



$$\mathbf{u^2 + b*u + c = 0}$$

$$(u+b/2)^2 = u^2 + b*u + c + (b/2)^2 - c$$

$$(u+b/2)^2 = \quad 0 \quad + D/4$$

$$u+b/2 = \pm \sqrt{D}/2 \text{ , } D = b^2-4c$$

$$u = -b/2 \pm \sqrt{D}/2$$

Solution: **$u = (-b \pm \sqrt{D})/2$**

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- Teaches Teachers to Teach MatheMatics as **Many**Math, a natural science about **Many**
- Cures **Math Dislike** when counting fingers in flexible bundle-numbers
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IconNumbers • ReCounting 7 in **5s** & **3s** & **2s**