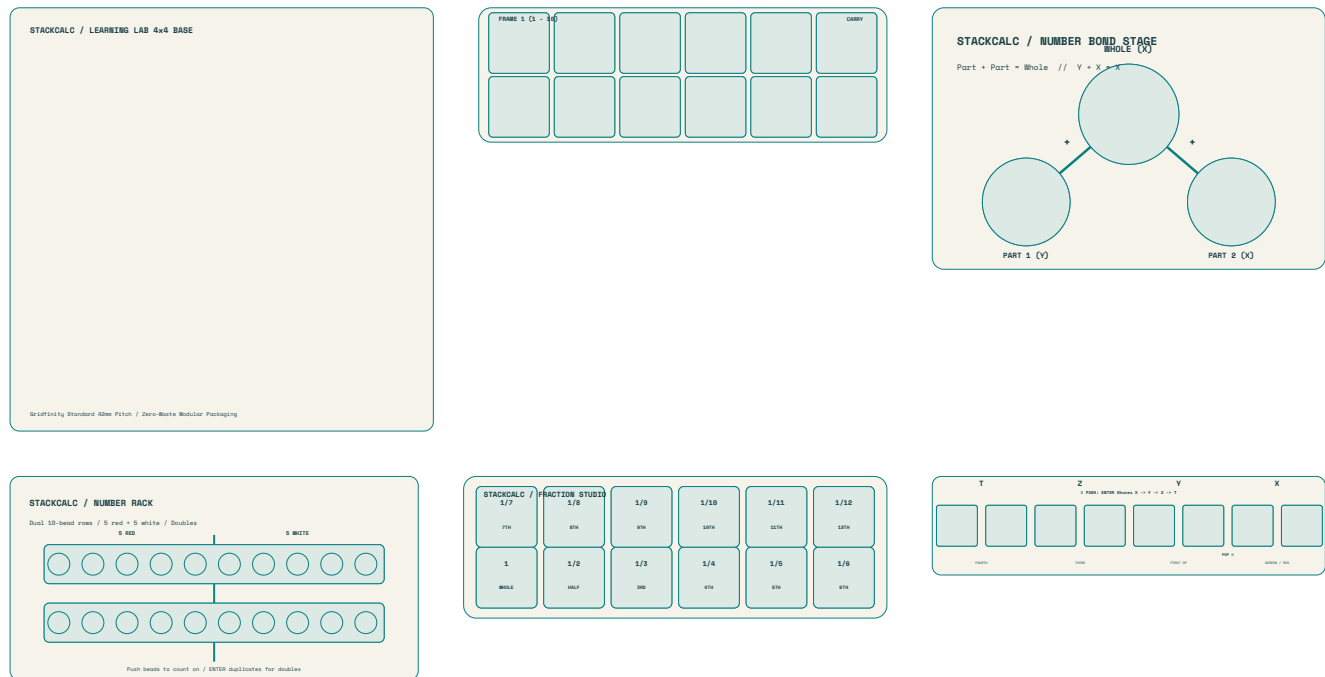


Make the Math Tangible.

Modular Gridfinity manipulatives and chapter-by-chapter lesson plans from Pre-K to Grade 12+.



ZERO-WASTE MODULAR PACKAGING: THE BOX IS THE LAB

All activity stages adhere to the open-source 42.0 mm Gridfinity standard. The storage baseplate provides rock-solid physical support during classroom use and nests all manipulatives for compact storage. No disposable packaging.

SINGLE-OPERATION FDM PRINTING: 0.6 MM DEBOSSSED TEXT

Numerals, labels, and coordinate grids are debossed directly into top surfaces (0.6 mm deep, exactly 3 layers at 0.20 mm). Prints cleanly in PLA or PETG without secondary laser marking or multi-material setup.

FULL EDUCATIONAL SPAN: PRE-K TO AP COMPUTER SCIENCE & CALCULUS

StackCalc connects early arithmetic (counting on, number bonds, ten-frames, rekenreks) directly to middle school algebra, high school trigonometry, exponential growth, combinatorics, and computer architecture.

Singapore Dimensions Math Master Pacing Concordance

Find your current Dimensions Math PK–8 book, chapter, and lesson number to locate the matching Gridfinity stage and book pages.

Grade	Textbook Ref	Topic & Objective	Manipulative	Keystrokes	Book Pages
Pre-K	Dimensions PK Book A,	Counting to 5 with Concrete	Ten-Frame Stage	[1] [ENTER] [1]	pp. 5–7
Pre-K	Dimensions PK Book B,	Comparing Quantities: More o	Ten-Frame Stage	[6] [ENTER] [2]	pp. 5–7
Kindergarten	Dimensions KA, Ch 1, L	One-to-One Counting & Frames	Ten-Frame Stage	[1] [ENTER] [1]	pp. 5–7
Kindergarten	Dimensions KA, Ch 2, L	Zero and Empty Sets	Ten-Frame Stage	[0] / [C]	pp. 5–7
Kindergarten	Dimensions KA, Ch 4, L	Number Bonds of 5	Math Domino Stu	[3] [ENTER] [2]	pp. 8–10
Kindergarten	Dimensions KB, Ch 7, L	Addition within 10 on the St	Math Domino Stu	[4] [ENTER] [3]	pp. 8–10
Kindergarten	Dimensions KB, Ch 8, L	Subtraction as Missing Part	Math Domino Stu	[1][0] [ENTER] [	pp. 8–10
Grade 1	Dimensions 1A, Ch 1, L	Counting & Comparing Numbers	Ten-Frame Stage	[1] [ENTER] [1]	pp. 5–7
Grade 1	Dimensions 1A, Ch 2, L	Making Number Bonds to 6 and	Math Domino Stu	[6] [ENTER] [3]	pp. 8–10
Grade 1	Dimensions 1A, Ch 2, L	Making Number Bonds to 10	Math Domino Stu	[7] [ENTER] [3]	pp. 8–10
Grade 1	Dimensions 1A, Ch 2, L	Decomposing Numbers & Missin	Math Domino Stu	[1][0] [ENTER] [	pp. 8–10
Grade 1	Dimensions 1A, Ch 3, L	Addition as Part-Part-Whole	Math Domino Stu	[PART 1] [ENTER]	pp. 8–10
Grade 1	Dimensions 1A, Ch 4, L	Subtraction as Comparing Set	Ten-Frame Stage	[LARGE] [ENTER]	pp. 5–7
Grade 1	Dimensions 1A, Ch 7, L	Ten-Frames & Place Value (11	Ten-Frame Stage	[1][0] [ENTER] [	pp. 11–13
Grade 1	Dimensions 1A, Ch 8, L	Making 10 to Add	Ten-Frame Stage	[1][0] [ENTER] [	pp. 11–13
Grade 1	Dimensions 1A, Ch 8, L	Bridging Through 10	Ten-Frame Stage	[8] [ENTER] [2]	pp. 11–13
Grade 1	Dimensions 1B, Ch 12,	Multiplication as Equal Grou	Number Rack	[N] [ENTER] [+]	pp. 14–16
Grade 1	Dimensions 1B, Ch 14,	Halves & Fourths (Equal Shar	Fraction Studio	[. 1 . 2] / [. 1	pp. 20–22
Grade 2	Dimensions 2A, Ch 2, L	Mental Addition with Number	Math Domino Stu	[P1] [ENTER] [P2	pp. 8–10
Grade 2	Dimensions 2A, Ch 4, L	Doubles & Multiplying by 2	Number Rack	[N] [ENTER] [+]	pp. 14–16
Grade 2	Dimensions 2B, Ch 6, L	Near-Doubles Strategies (Dou	Number Rack	[N] [ENTER] [+]	pp. 14–16
Grade 2	Dimensions 2B, Ch 7, L	Unit Fractions (Halves, Thir	Fraction Studio	Compare 42mm / 2	pp. 20–22
Grade 3	Dimensions 3A, Ch 2, L	Multi-Digit Addition on Stac	Place Value Stu	[A] [ENTER] [B]	pp. 17–19

Using the Singapore Math Pacing Index

Locate your lesson above for this week's class. Turn to the listed pages in this guide: Page 17 provides the Core Lesson Plan, Page 18 the Extension, and Page 19 the reproducible Student Activity Sheet.

Bridges in Mathematics Master Pacing Concordance

Find your current unit, module, and daily session number to locate the matching Gridfinity stage and book pages.

Grade	Textbook Ref	Topic & Objective	Manipulative	Keystrokes	Book Pages
Kindergarten	Unit 1, Mod 1, Session	Welcome to Math: Counting Ob	Ten-Frame Stage	1 peg = 1 count	pp. 5-7
Kindergarten	Unit 1, Mod 1, Session	Counting & Five-Frames	Ten-Frame Stage	Top row = 5	pp. 5-7
Kindergarten	Unit 1, Mod 2, Session	Ten-Frames & Counting On	Ten-Frame Stage	[1] [ENTER] [1]	pp. 5-7
Kindergarten	Unit 1, Mod 2, Session	Zero & The Empty Ten-Frame	Ten-Frame Stage	[0] / [C]	pp. 5-7
Kindergarten	Unit 1, Mod 3, Session	The Step Counter: Adding One	Ten-Frame Stage	[1] [ENTER] [1]	pp. 5-7
Kindergarten	Unit 2, Mod 1, Session	Comparing Sets: Which Has Mo	Ten-Frame Stage	[5] [ENTER] [2]	pp. 5-7
Kindergarten	Unit 2, Mod 2, Session	Number Bonds to 5	Math Domino Stu	Part-Part-Whole	pp. 8-10
Kindergarten	Unit 4, Mod 2, Session	Part-Part-Whole Addition	Math Domino Stu	[P1] [ENTER] [P2]	pp. 8-10
Grade 1	Unit 1, Mod 2, Session	Ten-Frames & Subitizing	Ten-Frame Stage	Instant recognit	pp. 11-13
Grade 1	Unit 2, Mod 1, Session	Combinations to Ten	Ten-Frame Stage	[1][0] [ENTER] [	pp. 11-13
Grade 1	Unit 2, Mod 1, Session	Finding the Missing Addend	Math Domino Stu	[WHOLE] [ENTER]	pp. 8-10
Grade 1	Unit 2, Mod 3, Session	Making 10 Addition Strategie	Ten-Frame Stage	Bridging 8 + 5 =	pp. 11-13
Grade 1	Unit 3, Mod 1, Session	Introducing the Number Rack	Number Rack	5 red + 5 white	pp. 14-16
Grade 1	Unit 3, Mod 1, Session	Double Flips on the Number R	Number Rack	[6] [ENTER] [+]	pp. 14-16
Grade 1	Unit 3, Mod 1, Session	Doubles Plus or Minus One	Number Rack	[6] [ENTER] [+]	pp. 14-16
Grade 1	Unit 3, Mod 2, Session	5-Structure on the Rack	Number Rack	Subitizing 5 gro	pp. 14-16
Grade 1	Unit 6, Mod 1, Session	Two-Row Rack Comparisons	Number Rack	Difference betwe	pp. 14-16
Grade 1	Unit 7, Mod 1, Session	Place Value: Tens & Ones	Ten-Frame Stage	10 + N on the st	pp. 11-13
Grade 2	Unit 1, Mod 1, Session	Number Rack Fact Fluency	Number Rack	[N] [ENTER] [+]	pp. 14-16
Grade 2	Unit 1, Mod 1, Session	Near-Doubles Fact Strategies	Number Rack	[N] [ENTER] [+]	pp. 14-16
Grade 2	Unit 1, Mod 2, Session	Combinations to 20	Number Rack	Dual row combina	pp. 14-16
Grade 2	Unit 3, Mod 2, Session	Two-Digit Subtraction on Sta	SC-32 Hardware	[Y] [ENTER] [X]	pp. 17-19
Grade 3	Unit 1, Mod 2, Session	Multi-Step Addition & Subtra	Place Value Stu	Chained operatio	pp. 17-19

Using the Bridges in Mathematics Pacing Index

Locate your lesson above for this week's class. Turn to the listed pages in this guide: Page 17 provides the Core Lesson Plan, Page 18 the Extension, and Page 19 the reproducible Student Activity Sheet.

Big Ideas Math & AP Master Pacing Concordance

Find your current grade, chapter, and section number to locate the matching Gridfinity stage and book pages.

Grade	Textbook Ref	Topic & Objective	Manipulative	Keystrokes	Book Pages
Kindergarten	Chapter 1, Section 1.2	Count and Write 1 to 5	Ten-Frame Stage	[1] [ENTER] [1]	pp. 5-7
Kindergarten	Chapter 3, Section 3.1	Model and Count 6 to 10	Ten-Frame Stage	5 top + N bottom	pp. 5-7
Kindergarten	Chapter 5, Section 5.1	Number Bonds to 10 on the Fr	Math Domino Stu	Part 1 in Y, Par	pp. 8-10
Kindergarten	Chapter 7, Section 7.2	Represent Addition as Puttin	Math Domino Stu	[P1] [ENTER] [P2]	pp. 8-10
Grade 1	Chapter 1, Section 1.4	Part-Part-Whole Addition	Math Domino Stu	[4] [ENTER] [3]	pp. 8-10
Grade 1	Chapter 2, Section 2.3	Think Addition to Subtract	Math Domino Stu	[1][0] [ENTER] [	pp. 8-10
Grade 1	Chapter 3, Section 3.1	Doubles Strategies with ENTE	Number Rack	[6] [ENTER] [+]	pp. 14-16
Grade 1	Chapter 3, Section 3.2	Doubles Plus 1 & Doubles Min	Number Rack	[6] [ENTER] [+]	pp. 14-16
Grade 1	Chapter 3, Section 3.4	Make a 10 to Add on Ten-Fram	Ten-Frame Stage	[1][0] [ENTER] [	pp. 11-13
Grade 1	Chapter 4, Section 4.2	Use 10 to Subtract	Ten-Frame Stage	Bridging through	pp. 11-13
Grade 2	Chapter 1, Section 1.2	Mental Math: Doubles & Near-	Number Rack	[N] [ENTER] [+]	pp. 14-16
Grade 2	Chapter 1, Section 1.4	Make a Ten Addition Strategi	Ten-Frame Stage	Complements on f	pp. 11-13
Grade 2	Chapter 3, Section 3.3	Two-Digit Addition with Lift	Place Value Stu	Register lift on	pp. 17-19
Grade 3	Chapter 1, Section 1.3	Multiplication as Repeated A	Place Value Stu	[N] [ENTER] [+]	pp. 17-19
Grade 3	Chapter 8, Section 8.2	Equal Parts & Unit Fractions	Fraction Studio	Block heights co	pp. 20-22
Grade 3	Chapter 8, Section 8.5	Equivalent Fractions on Bloc	Fraction Studio	Equal tower heig	pp. 20-22
Grade 4	Chapter 3, Section 3.4	Solve Multi-Step Word Problem	SC-32 Hardware	[15] [ENTER] [6]	pp. 17-19
Grade 4	Chapter 3, Section 3.5	Order of Operations Without	SC-32 Hardware	Auto-lift retain	pp. 17-19
Grade 4	Chapter 8, Section 8.3	Add & Subtract Common Fracti	Fraction Studio	[. 1 . 4] [ENTER	pp. 20-22
Grade 4	Chapter 8, Section 8.6	Mixed Numbers: Two-Dot Entry	Fraction Studio	[2 . 1 . 2] = 2	pp. 20-22
Grade 5	Chapter 5, Section 5.2	Add Fractions with Unlike De	Fraction Studio	Common tower hei	pp. 20-22
Grade 5	Chapter 6, Section 6.2	Multiply Fractions & Height	Fraction Studio	[. 3 . 4] [ENTER	pp. 20-22
Grade 5	Chapter 6, Section 6.5	Divide Fractions with Recipr	Fraction Studio	['/'] inverts di	pp. 20-22

Using the Big Ideas Math Pacing Index

Locate your lesson above for this week's class. Turn to the listed pages in this guide: Page 20 provides the Core Lesson Plan, Page 21 the Extension, and Page 22 the reproducible Student Activity Sheet.

1-to-1 Correspondence: The Concrete Step Count

Numbers to 5 & 10 • Standard: CCSS.MATH.K.CC.B.4

1. CONCRETE MANIPULATIVE SETUP

Manipulative: Ten-Frame Stage (4x2 Gridfinity)

Place 1 peg into the first well of the Ten-Frame. Have students observe the single object.

2. STUDENT PREDICTION (BEFORE PRESSING)

When we place 1 more peg into the next well, how many pegs will be on our frame? (Prediction: 2)

3. CALCULATOR ACTION (HARDWARE TRAPEZOID KEYCAPS)

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect (T, Z, Y, X)
	1	First peg placed: 1 enters register X
	1	1 copied to register Y: holds the current count
	1	Second peg placed: 1 enters register X
	2	Press [+]: 1 + 1 = 2! Screen verifies 2 pegs on board
	1	Third peg placed in frame: 1 enters X
	3	Press [+]: 2 + 1 = 3! Frame and screen match perfectly

4. MATHEMATICAL EXPLANATION & RPM ADVANTAGE

Each physical counter corresponds to a single increment. The calculator's stack preserves the running count in Y while new items enter X.

Classroom Investigation Problem:

Place 4 pegs on your Ten-Frame. Add 1 more peg. Write the keystrokes to show 4 + 1 on the calcu

More, Less & Zero: Finding Differences

Comparing Sets & Magnitude • Standard: CCSS.MATH.K.CC.C.6

1. ADVANCED INVESTIGATION SETUP

Manipulative: Ten-Frame Stage (4x2 Gridfinity)

Place 5 pegs in the top row (Row 1) and 2 pegs in the bottom row (Row 2).

2. HYPOTHESIS & MATHEMATICAL PREDICTION

Look at the two rows. Which row has more? How many more pegs are in Row 1 than Row 2?

3. CALCULATOR ACTION & REGISTER TRANSFORMATION

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect
	5	Row 1 quantity (5) enters register X
	5	5 lifted to register Y (first set)
	2	Row 2 quantity (2) enters register X
	3	Minus subtracts X from Y: Row 1 has 3 more pegs!

4. EXTENSION ANALYSIS & DEEPER CONNECTIONS

Comparison subtraction answers 'how many more?'. Register Y holds the larger group and register X holds the smaller group.

Extension Investigation Challenge:

Row 1 has 6 pegs and Row 2 has 2 pegs. How many more pegs in Row 1? Write the keystrokes.

Counting, Cardinality & The One-More Step Count

Name: _____ Date: _____ Class: _____

STUDENT REFERENCE GUIDE: HOW COUNTING MAPS TO THE CALCULATOR

- Every peg placed on the frame matches one count on the calculator screen.
- An empty ten-frame represents zero [0]. Press [C] to start a fresh count.
- To step count by 1: press [1] [ENTER] [1] [+], then press [1] [+] to see the count advance!

Calculator Shortcut: [1] [ENTER] [1] [+] = 2, then [1] [+] = 3, [1] [+] = 4...

Problem 1: Place 3 pegs on your frame. Add 2 more. Write the keystrokes to find the total.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 2: A frame has 5 pegs. If you remove 2 pegs, how many remain?

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 3: Clear the calculator by pressing [C]. What number represents an empty ten-frame?

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 4: Step count by ones starting at 1: [1] [ENTER] [1] [+]. Press [1] [+] two more times. What is X?

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Composing Numbers: Part + Part = Whole

Number Bonds & Part-Part-Whole • Standard: CCSS.MATH.1.OA.C.6

1. CONCRETE MANIPULATIVE SETUP

Manipulative: Math Domino Studio (12-Frame Tray)

Place the [4|3] domino in the 12-frame tray. Count 4 pips on the left (Part 1) and 3 pips on the right (Part 2).

2. STUDENT PREDICTION (BEFORE PRESSING)

Combine both parts on the tray: $4 + 3 = 7$ total pips.

3. CALCULATOR ACTION (HARDWARE TRAPEZOID KEYCAPS)

Keystroke Flow:    

Key Pressed	Screen (X)	Internal 4-Level Stack Effect (T, Z, Y, X)
	4	Part 1 (4) enters register X
	4	4 copied up to register Y; represents Part 1
	3	Part 2 (3) enters register X
	7	Plus combines Part 1 (Y) + Part 2 (X) = Whole (7) in X!

4. MATHEMATICAL EXPLANATION & RPN ADVANTAGE

The RPN stack has dedicated registers for parts: register Y holds Part 1, register X holds Part 2, and [+] merges them into the Whole.

Classroom Investigation Problem:

Pick the [5|4] domino tile. Place it on your 12-frame tray to find the whole. Write the keystro

Decomposing the Whole: Finding the Missing Part

Developing Number Sense • Standard: CCSS.MATH.1.OA.B.4

1. ADVANCED INVESTIGATION SETUP

Manipulative: Math Domino Studio (12-Frame Tray)

Place 10 counters in the 12-frame tray. Cover or slide 6 counters to represent known Part 1.

2. HYPOTHESIS & MATHEMATICAL PREDICTION

How many counters remain uncovered in the tray? ($10 - 6 = 4$).

3. CALCULATOR ACTION & REGISTER TRANSFORMATION

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect
	1	Enter Whole (10)
	10	10 in register X
	10	Whole (10) lifted to register Y
	6	Known Part 1 (6) enters register X
	4	Minus subtracts known Part from Whole: Missing Part is 4!

4. EXTENSION ANALYSIS & DEEPER CONNECTIONS

Finding a missing addend is inverse addition. Placing the Whole in Y and subtracting known Part in X yields the missing part in X.

Extension Investigation Challenge:

The whole is 8. Part 1 is 5. Find the missing Part 2 using the calculator.

Part-Part-Whole & Doubles: The Math Domino Study

Name: _____ Date: _____ Class: _____

STUDENT REFERENCE GUIDE: HOW DOMINOES FIT THE STACK

- Part 1 lives in register Y. Part 2 enters register X.
- Pressing [+] combines both parts into the Whole in register X.
- To find a missing part: start with Whole in Y, enter Part 1 in X, and press [-]!

Calculator Shortcut: [PART 1] [ENTER] [PART 2] [+] = [WHOLE]

Problem 1: Make 6: Part 1 is 2. What is Part 2? Write the keystrokes.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 2: Part 1 is 7, Part 2 is 2. What is the Whole?

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 3: Three parts make a whole: 2, 3, and 4. Add them on the stack.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 4: The Whole is 10. Part 1 is 7. What is Part 2?

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Complements to 10: Making Ten

Addition Strategies to 10 • Standard: CCSS.MATH.1.OA.C.6

1. CONCRETE MANIPULATIVE SETUP

Manipulative: Ten-Frame Bin (3x1 Gridfinity)

Place 7 unnumbered counters into the Ten-Frame: fill the top row of 5, then place 2 in the bottom row.

2. STUDENT PREDICTION (BEFORE PRESSING)

Look at the empty wells without counting one-by-one. 3 empty spaces mean $7 + 3 = 10$.

3. CALCULATOR ACTION (HARDWARE TRAPEZOID KEYCAPS)

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect (T, Z, Y, X)
	1	Enter 1
	10	Full frame capacity (10) in X
	10	10 lifted to Y
	7	Occupied counters (7) in X
	3	$10 - 7 = 3$: Exactly 3 empty wells to make 10!

4. MATHEMATICAL EXPLANATION & RPN ADVANTAGE

The ten-frame physically structures 10 as two groups of 5. Subtraction verifies the visual complement.

Classroom Investigation Problem:

A ten-frame has 6 counters. How many more counters are needed to make 10?

Bridging Through 10: The Make-Ten & Carry Strategy

Addition Within 20 • Standard: CCSS.MATH.1.OA.C.6

1. ADVANCED INVESTIGATION SETUP

Manipulative: Ten-Frame Bin (3x1 Gridfinity)

Place 8 unnumbered counters in Ten-Frame 1. Prepare 5 counters beside the board.

2. HYPOTHESIS & MATHEMATICAL PREDICTION

Take 2 from the 5 to fill Ten-Frame 1 to 10. Trade the full frame for one '10' block in the Carry Bay! 3 loose counters remain. $10 + 3 = 13$.

3. CALCULATOR ACTION & REGISTER TRANSFORMATION

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect
	8	8 counters on frame
	8	8 lifted to Y
	2	2 counters borrowed to make 10
	10	$8 + 2 = 10$ (Full frame traded for '10' carry block!)
	3	Remaining 3 counters
	13	$10 + 3 = 13$ total!

4. EXTENSION ANALYSIS & DEEPER CONNECTIONS

Bridging decomposes $8 + 5$ into $(8 + 2) + 3$. On RPN, intermediate sums remain in the accumulator register.

Extension Investigation Challenge:

Use the Make-Ten strategy to solve $9 + 6$ on your calculator.

Ten-Frames: Complements to 10 & 5-Structure

Name: _____ Date: _____ Class: _____

STUDENT REFERENCE GUIDE: TEN-FRAME 5-STRUCTURE & CARRY RULES

- The 2x5 grid holds unnumbered counter blocks. Spatial position builds visual subitizing without numeral distraction.
- Subitizing: 7 is seen immediately as 5 on top plus 2 on bottom.
- Dual 10-Frame Trays: Students use two dedicated 10-frame trays (strictly 10 slots each, solid bottoms) side-by-side on the calculator.

Calculator Shortcut: 10 [ENTER] [N] [-] = [COMPLEMENT TO 10]

Problem 1: What is the complement to 10 for 4? Write the keystrokes.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 2: Solve 7 + 5 using Make-Ten: first make 10, then add 2.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 3: A ten-frame has 9 counters. How many to make 10?

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 4: Solve 8 + 6 using Make-Ten on the calculator.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Doubles Strategy: The ENTER Duplicate Key

Number Racks & Fact Strategies • Standard: CCSS.MATH.1.OA.C.6

1. CONCRETE MANIPULATIVE SETUP

Manipulative: Number Rack Stage (4x2 Gridfinity)

Push 6 beads on the top row (5 red, 1 white). Push 6 beads on the bottom row.

2. STUDENT PREDICTION (BEFORE PRESSING)

Observe the matching rows. $6 + 6 = (5 + 5) + (1 + 1) = 10 + 2 = 12$.

3. CALCULATOR ACTION (HARDWARE TRAPEZOID KEYCAPS)

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect (T, Z, Y, X)
	6	Top row quantity (6) enters register X
	6	ENTER duplicates 6 into register Y! Both rows now on stack
	12	Plus combines top and bottom rows: $6 + 6 = 12$!

4. MATHEMATICAL EXPLANATION & RPN ADVANTAGE

ENTER creates an instant identical copy of register X in register Y. This perfectly represents a physical double.

Classroom Investigation Problem:

Push 7 beads on each row of the Number Rack. Use [ENTER] [+] to double it on the calculator.

Near-Doubles: Doubles Plus One

Fact Fluency & Near Doubles • Standard: CCSS.MATH.2.OA.B.2

1. ADVANCED INVESTIGATION SETUP

Manipulative: Number Rack Stage (4x2 Gridfinity)

Push 7 beads on top row (5 red, 2 white). Push 8 beads on bottom row (5 red, 3 white).

2. HYPOTHESIS & MATHEMATICAL PREDICTION

7 and 8 is double 7 plus 1 more: $14 + 1 = 15$.

3. CALCULATOR ACTION & REGISTER TRANSFORMATION

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect
	7	Enter base number 7
	7	Duplicate 7
	14	Double: $7 + 7 = 14$
	1	Near-double difference (1)
	15	$14 + 1 = 15!$

4. EXTENSION ANALYSIS & DEEPER CONNECTIONS

Near-doubles build upon doubles fluency. The calculator executes the base double, then accumulates the offset.

Extension Investigation Challenge:

Use the near-doubles strategy to solve $6 + 7$ on the calculator.

Number Racks (Rekenrek): 5-Structure & Doubles

Name: _____ Date: _____ Class: _____

STUDENT REFERENCE GUIDE: NUMBER RACK & ENTER DUPLICATE RULES

- Each row has 5 red beads and 5 white beads.
- Pushing beads to the left counts them. 5 red + 5 white = 10 per row.
- Doubles shortcut: Enter a number, press [ENTER] to duplicate, then press [+].

Calculator Shortcut: [N] [ENTER] [+] = [DOUBLES (2 * N)]

Problem 1: Calculate double 8 using [ENTER] [+].

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 2: Solve near-double 8 + 9: double 8 then add 1.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 3: Calculate double 9 using [ENTER] [+].

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 4: Solve 5 + 6 using doubles plus one.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Multi-Step Word Problems Without Parentheses

Multi-Step Word Problems • Standard: CCSS.MATH.4.OA.A.3

1. CONCRETE MANIPULATIVE SETUP

Manipulative: SC-32 Hardware LCD Stack & Place Value Studio

Use Place Value Studio unit blocks to represent quantities alongside the SC-32 4-line LCD screen.

2. STUDENT PREDICTION (BEFORE PRESSING)

Problem: $(8 - 3) * 2$. Predict: $8 - 3 = 5$, then $5 * 2 = 10$.

3. CALCULATOR ACTION (HARDWARE TRAPEZOID KEYCAPS)

Keystroke Flow:      

Key Pressed	Screen (X)	Internal 4-Level Stack Effect (T, Z, Y, X)
	8	8 in X
	8	8 copied to Y
	3	3 entered into X
	5	$8 - 3 = 5$ in X
	2	Automatic lift! 5 lifts to Y; 2 enters X
	10	$5 * 2 = 10$ in X!

4. MATHEMATICAL EXPLANATION & RPN ADVANTAGE

Unlike traditional algebraic calculators that require parenthesis keys, RPN evaluates inner expressions first, lifting results naturally.

Classroom Investigation Problem:

A baker has 15 cookies, sells 6, and packs the rest into 3 bags. How many per bag? Keystrokes f

Automatic Stack Lift & Register Retention

Order of Operations & Stack Lift • Standard: CCSS.MATH.4.OA.A.3

1. ADVANCED INVESTIGATION SETUP

Manipulative: SC-32 Hardware LCD Stack & Place Value Studio

Observe the 4-line hardware LCD screen as values automatically lift into register Y: $(12 \div 4) + 7$.

2. HYPOTHESIS & MATHEMATICAL PREDICTION

$12 \div 4 = 3$. Entering 7 will lift 3 to Y. $3 + 7 = 10$.

3. CALCULATOR ACTION & REGISTER TRANSFORMATION

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect
	12	12 entered in X
	12	12 copied to Y
	4	4 enters X
	3	$12 \div 4 = 3$ in X
	7	7 entered: 3 lifts to Y automatically!
	10	$3 + 7 = 10$!

4. EXTENSION ANALYSIS & DEEPER CONNECTIONS

Automatic lift prevents unnecessary ENTER presses between sequential chained operations.

Extension Investigation Challenge:

Calculate $(24 \div 6) + 15$ on the calculator without pressing ENTER twice.

The 4-Register Stack: Four Operations & Automata

Name: _____ Date: _____ Class: _____

STUDENT REFERENCE GUIDE: 4-REGISTER STACK ANATOMY

- Four registers: T (top), Z (third), Y (second/operand), X (screen/bottom).
- ENTER duplicates X into Y and pushes older values up into Z and T.
- Two-number operators (+, -, *, /) combine Y and X, dropping Z to Y and T to Z.

Calculator Shortcut: [Y] [ENTER] [X] [OP] -> Drops stack and displays result in X

Problem 1: Calculate $(14 - 5) * 3$ on the stack.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 2: Calculate $30 / (2 + 3)$: add denominator first!

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 3: Calculate $(9 + 7) / (8 - 4)$ using 4 registers.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 4: A farmer collects 20 eggs, breaks 2, and divides among 6 cartons.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Mixed Numbers & Height Equivalence: $\frac{3}{4} + 2\frac{1}{2}$

Fraction Addition & Mixed Numbers • Standard: CCSS.MATH.5.NF.A.1

1. CONCRETE MANIPULATIVE SETUP

Manipulative: Fraction Studio (3x3 Gridfinity Bin)

Place three $\frac{1}{4}$ blocks ($3 * 21 = 63$ mm). Beside them, stack two Whole blocks and one $\frac{1}{2}$ block ($84 + 84 + 42 = 210$ mm).

2. STUDENT PREDICTION (BEFORE PRESSING)

Combine heights: $63\text{ mm} + 210\text{ mm} = 273\text{ mm}$. In wholes: $3\frac{1}{4}$ ($273 / 84 = 3.25$).

3. CALCULATOR ACTION (HARDWARE TRAPEZOID KEYCAPS)

Keystroke Flow:

Key Pressed	Screen (X)	Internal 4-Level Stack Effect (T, Z, Y, X)
	0.	Leading dot indicates 0 wholes
	0.3	Numerator = 3
	0.3.	Second dot sets fraction entry mode
	$\frac{3}{4}$	Denominator = 4: displays $\frac{3}{4}$ (or 0.75)
	$\frac{3}{4}$	$\frac{3}{4}$ lifted to register Y
	2	Whole = 2
	2.	Dot
	2.1	Numerator = 1
	2.1.	Dot
	$2\frac{1}{2}$	Denominator = 2: displays $2\frac{1}{2}$
	$3\frac{1}{4}$	Plus combines: $3\frac{1}{4}$ (decimal 3.25)!

4. MATHEMATICAL EXPLANATION & RPN ADVANTAGE

Two dots eliminate ambiguity between decimals and fractions. Physical block heights provide an infallible self-check against the bin wall guides.

Classroom Investigation Problem:

Build $\frac{1}{2}$ and $\frac{1}{4}$ with blocks. Enter .1.2 [ENTER] .1.4 [+] on the calculator.

Fraction Multiplication & The Reciprocal Key [

Fraction Multiplication & Inverses • Standard: CCSS.MATH.5.NF.B.4

1. ADVANCED INVESTIGATION SETUP

Manipulative: Fraction Studio (3x3 Gridfinity Bin)

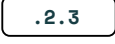
Set up 3/4 of a tower and divide into 3 parts, taking 2 parts: (3/4) * (2/3).

2. HYPOTHESIS & MATHEMATICAL PREDICTION

3/4 * 2/3 = 6/12 = 1/2. The resulting block height should match exactly one 1/2 block (42 mm).

3. CALCULATOR ACTION & REGISTER TRANSFORMATION

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect
	3/4	First fraction in Y
	3/4	Lifted
	2/3	Second fraction in X
	1/2	Multiplication gives 1/2! Exactly matches 42 mm block

4. EXTENSION ANALYSIS & DEEPER CONNECTIONS

Multiplying fractions scales the height. Dividing by 2/3 is identical to multiplying by its reciprocal 3/2 using [¹/□].

Extension Investigation Challenge:

Calculate 4/5 * 5/8 on the calculator. Predict whether the result is greater or less than 1/2.

Fraction Studio: Height Equivalence & Two-Dot

Name: _____ Date: _____ Class: _____

STUDENT REFERENCE GUIDE: TWO-DOT FRACTION ENTRY & TOWER EQUIVALENCE

- All fraction blocks share a standard 1x1 Gridfinity footprint (41.5 x 41.5 mm). One Whole is exactly 84 mm tall (12U double-height).
- Fraction heights: 1/2 is 42 mm, 1/3 is 28 mm, 1/4 is 21 mm, 1/5 is 16.8 mm, 1/6 is 14 mm, 1/7 is 12 mm, 1/8 is 10.5 mm, 1/9 is 9.3 mm.
- All 9 fraction towers stack to exactly 84 mm, fitting seamlessly into the 3x3 Gridfinity bin. Multiple 12U bins stack on top of each other.

Calculator Shortcut: `[. 3 . 4]` = 3/4 | `[2 . 1 . 2]` = 2 1/2

Problem 1: Add 1/3 + 1/6 using two-dot notation.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 2: Calculate 1 1/2 - 3/4. What block height corresponds to this?

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 3: Enter 3/8 on the calculator. What is its decimal equivalent?

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 4: Multiply 2/3 * 3/4. Check against your fraction blocks.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Chained Operations: $(a + b) * (c - d)$ on the H

Algebraic Expressions & Properties • Standard: CCSS.MATH.6.EE.A.2

1. CONCRETE MANIPULATIVE SETUP

Manipulative: Interlocking Cubes (Stack Towers) & SC-32 Hardware LCD Stack

Build cube towers to represent operands: tower 'a'=6, tower 'b'=1; tower 'c'=9, tower 'd'=5.

2. STUDENT PREDICTION (BEFORE PRESSING)

Left sub-expression: $6 + 1 = 7$. Right sub-expression: $9 - 5 = 4$. Combined: $7 * 4 = 28$.

3. CALCULATOR ACTION (HARDWARE TRAPEZOID KEYCAPS)

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect (T, Z, Y, X)
	6	Value a (6) placed into Register X
	6	ENTER lifts 6 into Register Y
	1	Value b (1) placed into Register X
	7	Left operator (+): Combines Y(6) + X(1) = 7 in X
	9	Value c (9) entered into X; 7 lifted to Y
	9	ENTER lifts 9 into Z and 7 into T
	5	Value d (5) placed into Register X
	4	Right operator (-): Combines Z/Y(9) - X(5) = 4 in X; 7 drops t
	28	Root operator (*): Combines Y(7) * X(4) = 28 in X!

4. MATHEMATICAL EXPLANATION & RPN ADVANTAGE

Parantheses exist in written algebra only to compensate for linear notation. On the 4-line hardware stack, precedence is intrinsic.

Classroom Investigation Problem:

Evaluate $(8 + 2) * (14 - 9)$ using postfix order on the hardware stack. Write the keystrokes.

Deep Stack Evaluation & Register Limits

Order of Operations & Stack Evaluation • Standard: CCSS.MATH.6.EE.A.2

1. ADVANCED INVESTIGATION SETUP

Manipulative: Interlocking Cubes (Stack Towers) & SC-32 Hardware LCD Stack

Track the 4 stack registers (T, Z, Y, X) for $(12 - 4) / (2 * (1 + 1))$.

2. HYPOTHESIS & MATHEMATICAL PREDICTION

Numerator: $12 - 4 = 8$. Denominator: $2 * 2 = 4$. Result: $8 / 4 = 2$.

3. CALCULATOR ACTION & REGISTER TRANSFORMATION

Keystroke Flow:

Key Pressed	Screen (X)	Internal 4-Level Stack Effect
12 ENTER 4 - 8		Numerator evaluated and held in stack
2 ENTER	2	Denominator subterm pushed up to Y
1 ENTER 1 + 2		Innermost term: $1 + 1 = 2$
.	4	Denominator combined: $2 * 2 = 4$
=	2	$8 / 4 = 2!$

4. EXTENSION ANALYSIS & DEEPER CONNECTIONS

The 4-register stack can evaluate nested expressions up to depth 4 without spilling to storage registers.

Extension Investigation Challenge:

Write the postfix RPN keystrokes for $(15 - 5) / (3 + 2)$.

Postfix Evaluation & Chained Operations: The H

Name: _____ Date: _____ Class: _____

STUDENT REFERENCE GUIDE: POSTFIX EVALUATION & STACK REGISTER RULES

- In postfix evaluation, operands are entered first, followed immediately by operators.
- Evaluation order matches mathematical precedence: evaluate inner sub-expressions first.
- RPN keystroke sequence evaluates complex expressions naturally without parenthesis keys.

Calculator Shortcut: Postfix Sequence: [Operand 1] [ENTER] [Operand 2] [Operator]

Problem 1: Evaluate $(4 + 3) * (10 - 6)$ on the stack. Write keystrokes.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 2: Solve $(20 - 4) / (2 * 4)$ using postfix sequence.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 3: Explain why $(a + b) * c$ requires no parentheses in RPN.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 4: Evaluate $5 + (3 * 4)$ on RPN. Which operation goes first?

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Area Modeling: Factoring $x^2 + 5x + 6$ into $(x +$

Polynomial Equations & Factoring • Standard: CCSS.MATH.HSA.APR.A.1

1. CONCRETE MANIPULATIVE SETUP

Manipulative: Algebra Studio & Factoring Stage (3x1 Gridfinity)

Place 1 x^2 tile, 5 x -tiles, and 6 unit-1 squares on the factoring stage.

2. STUDENT PREDICTION (BEFORE PRESSING)

Arrange into a solid rectangle: width is $(x + 2)$, length is $(x + 3)$. Total Area = $x^2 + 5x + 6$.

3. CALCULATOR ACTION (HARDWARE TRAPEZOID KEYCAPS)

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect (T, Z, Y, X)
	1	Coefficient a = 1 entered into X
	1	1 lifted to Y
	5	Coefficient b = 5 entered into X
	5	b in Y, a in Z
	6	Coefficient c = 6 entered into X
	-2	Press [EQN]: Root 1 = -2 in Y (factor: $x + 2$), Root 2 = -3 in

4. MATHEMATICAL EXPLANATION & RPM ADVANTAGE

The physical dimensions of the rectangle $(x+2)$ and $(x+3)$ correspond to roots $x = -2$ and $x = -3$ solved by the [EQN] quadratic pipeline.

Classroom Investigation Problem:

Arrange tiles for $x^2 + 7x + 12$ into a rectangle. Use [EQN] to verify the factors.

Zero Pairs: Factoring Trinomials with Negative

Factoring Quadratic Trinomials • Standard: CCSS.MATH.HSA.REI.B.4

1. ADVANCED INVESTIGATION SETUP

Manipulative: Algebra Studio & Factoring Stage (3x1 Gridfinity)

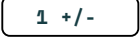
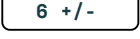
Set up 1 x^2 tile and 6 negative unit tiles for $x^2 - x - 6$.

2. HYPOTHESIS & MATHEMATICAL PREDICTION

Add zero pair (+2x and -3x): forms a rectangle of $(x - 3)$ by $(x + 2)$.

3. CALCULATOR ACTION & REGISTER TRANSFORMATION

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect
	1	Coefficient a = 1
	1	1 lifted to Y
	-1	Coefficient b = -1 in X
	-1	b in Y, a in Z
	-6	Coefficient c = -6 in X
	3	[EQN] solves roots: Root 1 = 3 in Y (factor: $x - 3$), Root 2 =

4. EXTENSION ANALYSIS & DEEPER CONNECTIONS

Zero-pair tiles cancel to zero while allowing rectangular dimensions to complete. [EQN] computes the real roots directly.

Extension Investigation Challenge:

Factor $x^2 - 5x + 6$ using zero pairs and verify on the calculator with [EQN].

Tactile Algebra: Area Models, Polynomials & Quadratics

Name: _____ Date: _____ Class: _____

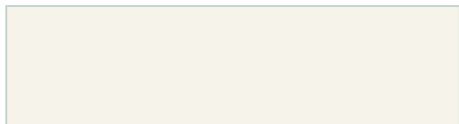
STUDENT REFERENCE GUIDE: AREA MODELING & QUADRATIC FACTORING RULES

- Polynomial tiles represent algebraic terms: large square = x^2 , rectangle = x , small square = 1.
- An algebraic expression factors when tiles form a solid rectangle with dimensions $(x + a)$ by $(x + b)$.
- Zero pairs: positive $(+x)$ and negative $(-x)$ tiles cancel out to zero to complete rectangular arrays.

Calculator Shortcut: [a] [ENTER] [b] [ENTER] [c] [EQN] → Roots in Y and X registers

Problem 1: Factor $x^2 + 6x + 8$ using [EQN] on the calculator.

Manipulative Setup / Notes:



Keystrokes:

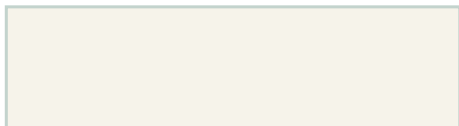


Prediction:

Final X Result:

Problem 2: Factor $x^2 - 4$ (difference of two squares) using [EQN].

Manipulative Setup / Notes:



Keystrokes:

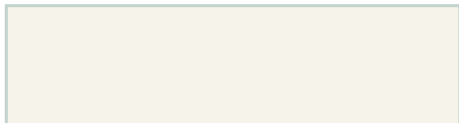


Prediction:

Final X Result:

Problem 3: Factor $x^2 + 5x + 4$ using polynomial tiles and [EQN].

Manipulative Setup / Notes:



Keystrokes:

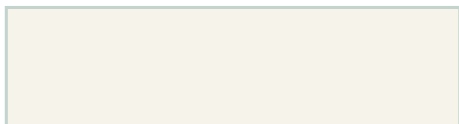


Prediction:

Final X Result:

Problem 4: Factor $x^2 - 5x + 6$ using zero pairs.

Manipulative Setup / Notes:



Keystrokes:



Prediction:

Final X Result:

Vector Magnitude & Direction: Cartesian to Polar

Right Triangle Trigonometry & Vectors • Standard: CCSS.MATH.HSN.VM.A.1

1. CONCRETE MANIPULATIVE SETUP

Manipulative: Unit Circle Trigonometry Volvelle

Align the Unit Circle Volvelle cursor to horizontal run 4 and vertical rise 3 (forming a right triangle with hypotenuse 5).

2. STUDENT PREDICTION (BEFORE PRESSING)

Run = 4, Rise = 3. Predict magnitude: $r = \sqrt{4^2 + 3^2} = 5$. Predict angle: $\arctan(3/4) \approx 36.87^\circ$.

3. CALCULATOR ACTION (HARDWARE TRAPEZOID KEYCAPS)

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect (T, Z, Y, X)
	4	Enter horizontal component $x = 4$
	4	4 lifted to register Y
	3	Enter vertical component $y = 3$ in X
	36.87	Rectangular to Polar! Screen displays angle $\theta = 36.87^\circ$
	5.00	Swap registers: Y displays vector magnitude $r = 5.00!$

4. MATHEMATICAL EXPLANATION & RPN ADVANTAGE

The calculator's built-in polar conversion executes both the Pythagorean magnitude and arctangent angle in a single microcode step.

Classroom Investigation Problem:

A surveyor walks 60 m East and 80 m North. Find the straight-line displacement magnitude and he

2D Vector Addition: Resultant Forces

Vector Addition & Resultant Forces • Standard: CCSS.MATH.HSN.VM.A.3

1. ADVANCED INVESTIGATION SETUP

Manipulative: Unit Circle Trigonometry Volvelle

Use the Unit Circle Volvelle to track component vectors $F1 = \langle 3, 2 \rangle$ and $F2 = \langle 1, 5 \rangle$.

2. HYPOTHESIS & MATHEMATICAL PREDICTION

Add components: $x_{\text{net}} = 3 + 1 = 4$; $y_{\text{net}} = 2 + 5 = 7$. Magnitude $r = \sqrt{4^2 + 7^2} = \sqrt{65} \approx 8.06$.

3. CALCULATOR ACTION & REGISTER TRANSFORMATION

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect
3 ENTER 1 + 4	4	Net horizontal force $x_{\text{net}} = 4$ in Y
2 ENTER 5 + 7	7	Net vertical force $y_{\text{net}} = 7$ in X
	60.26	Resultant angle $\theta = 60.26^\circ$
	8.06	Resultant force magnitude $r = 8.06$

4. EXTENSION ANALYSIS & DEEPER CONNECTIONS

Vectors add component-wise. Stack registers permit component accumulation followed immediately by polar resolution.

Extension Investigation Challenge:

Two cables pull on a post: Vector A is $\langle 5, 2 \rangle$ and Vector B is $\langle -2, 4 \rangle$. Find the resultant vecto

Trigonometry, Vectors & Polar/Rectangular Coordinates

Name: _____ Date: _____ Class: _____

STUDENT REFERENCE GUIDE: VECTOR DECOMPOSITION & POLAR CONVERSION RULES

- A 2D vector $v = \langle x, y \rangle$ has horizontal run x in Y and vertical rise y in X .
- Rectangular to Polar [yellow] $\boxed{\rightarrow_r}$: Converts (x, y) into angle θ (in X) and magnitude r (in Y).
- Trig functions $[\sin]$, $[\cos]$, $[\tan]$ operate on the angle in register X .

Calculator Shortcut: $[\text{RUN } x] [\text{ENTER}] [\text{RISE } y] [\text{yellow}] \boxed{\rightarrow_r} \rightarrow$ Angle in X , Magnitude in Y

Problem 1: Find magnitude and angle for vector $\langle 12, 5 \rangle$.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 2: Find the hypotenuse of a right triangle with legs 7 and 24.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 3: Calculate $\sin(30^\circ)$ on the calculator.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 4: A vector has magnitude 10 at angle 45° . What are its x and y components?

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Continuous Compounding & Euler's Constant e

Exponential & Logarithmic Functions • Standard: CCSS.MATH.HSF.LE.A.4

1. CONCRETE MANIPULATIVE SETUP

Manipulative: Fraction Studio (Proportional Doubling Towers)

Stack Fraction Blocks representing exponential doubling: 12 mm, 24 mm, 48 mm, 96 mm.

2. STUDENT PREDICTION (BEFORE PRESSING)

Invest \$1,000 at 7% continuous interest for 10 years: $A = 1000 * e^{(0.07 * 10)} = 1000 * e^{0.7}$. Will it double? ($e^{0.7} \approx 2.01$).

3. CALCULATOR ACTION (HARDWARE TRAPEZOID KEYCAPS)

Keystroke Flow:               

Key Pressed	Screen (X)	Internal 4-Level Stack Effect (T, Z, Y, X)
	0.07	Rate r = 0.07
	0.07	Rate in Y
	10	Time t = 10 in X
	0.7	Exponent r * t = 0.70
	2.0138	$e^{0.70} = 2.01375$ (Growth factor: more than doubled!)
	1000	Principal P = 1000 (growth factor lifts to Y)
	2013.75	Total accumulated amount A = \$2,013.75!

4. MATHEMATICAL EXPLANATION & RPN ADVANTAGE

The RPN stack computes nested transcendental functions from innermost exponent out to outer multiplier without parenthesis keys.

Classroom Investigation Problem:

A bacteria culture starts at 500 and triples every hour. Use y^x to calculate population after

Solving for Time: Doubling Time & Natural Log

Logarithms & Inverting Exponentials • Standard: CCSS.MATH.HSF.BF.B.5

1. ADVANCED INVESTIGATION SETUP

Manipulative: Fraction Studio (Proportional Doubling Towers)

Configure stack registers on the 4-line LCD: target multiplier in Y, growth rate in X.

2. HYPOTHESIS & MATHEMATICAL PREDICTION

At 5% growth ($r = 0.05$), doubling time is $t = \ln(2) / 0.05 \approx 0.69315 / 0.05 \approx 13.86$ years.

3. CALCULATOR ACTION & REGISTER TRANSFORMATION

Keystroke Flow:

Key Pressed	Screen (X)	Internal 4-Level Stack Effect
	2	Doubling target factor 2
	0.6931	Natural log $\ln(2) = 0.693147\dots$ in X
	0.05	Rate $r = 0.05$ ($\ln(2)$ lifts to Y)
	13.86	$t = \ln(2) / r = 13.86$ years!

4. EXTENSION ANALYSIS & DEEPER CONNECTIONS

The natural log [LN] is the exact inverse of [e^x]. RPN preserves full floating point precision during the division.

Extension Investigation Challenge:

A radioactive isotope has decay constant $k = 0.035$. Find its half-life: $t = \ln(2) / k$.

Exponential Growth, Compound Interest & Logarithms

Name: _____ Date: _____ Class: _____

STUDENT REFERENCE GUIDE: EXPONENTIALS, CONTINUOUS COMPOUNDING & DOUBLING TIME

- Exponential growth formula: $A = P * e^{(r*t)}$ for continuous growth, or $A = P * (1 + r/n)^{(n*t)}$.
- Natural exponential [e^x] raises Euler's constant e to power X.
- Natural logarithm [LN] inverts exponential growth: $\ln(e^x) = x$.

Calculator Shortcut: [r] [ENTER] [t] [*] [e^x] [P] [*] = [ACCUMULATED AMOUNT A]

Problem 1: Calculate e² on the calculator to 4 decimal places.

Manipulative Setup / Notes:

Keystrokes:

Prediction: _____

Final X Result: _____

Problem 2: Calculate doubling time for an investment growing at 8% continuous interest.

Manipulative Setup / Notes:

Keystrokes:

Prediction: _____

Final X Result: _____

Problem 3: Compute 10^{3.5} using [yellow] [10^x].

Manipulative Setup / Notes:

Keystrokes:

Prediction: _____

Final X Result: _____

Problem 4: Evaluate log₁₀(500) using [yellow] [LOG].

Manipulative Setup / Notes:

Keystrokes:

Prediction: _____

Final X Result: _____

Combinations vs. Permutations: Subsets & Order

Probability, Random Variables & Combinatorics • Standard: CCSS.MATH.HSS.CP.B.9

1. CONCRETE MANIPULATIVE SETUP

Manipulative: Probability Dice & Modular Spinner Set

Use the 4 precision dice and 10-sector spinner to model multi-stage discrete outcomes.

2. STUDENT PREDICTION (BEFORE PRESSING)

How many ways to choose a committee of 3 from 8 candidates? $8C3 = 8! / (3! * 5!) = 40320 / (6 * 120) = 56$.

3. CALCULATOR ACTION (HARDWARE TRAPEZOID KEYCAPS)

Keystroke Flow:        

Key Pressed	Screen (X)	Internal 4-Level Stack Effect (T, Z, Y, X)
	8	Total candidates n = 8
	40320	8! = 40,320 in register X
	3	Subset r = 3 (40320 lifts to Y)
	6	3! = 6 in X
	6720	40320 / 6 = 6720 in X
	5	Remaining n - r = 5 (6720 lifts to Y)
	120	5! = 120 in X
	56	6720 / 120 = 56 combinations!

4. MATHEMATICAL EXPLANATION & RPN ADVANTAGE

The RPN stack handles multi-step factorial simplification effortlessly, preventing arithmetic overflow.

Classroom Investigation Problem:

A lottery draws 4 winning numbers from a pool of 10. How many combinations? Calculate 10C4.

Statistical Accumulation: Mean & Variance with

One-Variable Data Analysis & Summations • Standard: CCSS.MATH.HSS.ID.A.2

1. ADVANCED INVESTIGATION SETUP

Manipulative: Probability Dice & Modular Spinner Set (Statistical Data Generation)

Roll precision dice to generate discrete data points for $\Sigma+$ accumulation: 4, 6, 7, 8, 10.

2. HYPOTHESIS & MATHEMATICAL PREDICTION

Sum = 4 + 6 + 7 + 8 + 10 = 35. Sample size $n = 5$. Mean $\bar{x} = 35 / 5 = 7.0$.

3. CALCULATOR ACTION & REGISTER TRANSFORMATION

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect
4 sigma_plus 1		First score entered: sample size $n = 1$
6 sigma_plus 2		Second score: $n = 2$
7 sigma_plus 3		Third score: $n = 3$
8 sigma_plus 4		Fourth score: $n = 4$
10 sigma_plus 5		Fifth score: $n = 5$ total data points

4. EXTENSION ANALYSIS & DEEPER CONNECTIONS

The $\Sigma+$ key accumulates $\text{sum}(x)$, $\text{sum}(x^2)$, and count n into dedicated background statistical registers.

Extension Investigation Challenge:

Accumulate data points 12, 15, 18, 21 using $\Sigma+$. What is the sample count n and mean?

Combinatorics, Probability & Series Accumulation

Name: _____ Date: _____ Class: _____

STUDENT REFERENCE GUIDE: COMBINATIONS, PERMUTATIONS & STACK FACTORIALS

- Factorial [yellow] [x!] multiplies $n * (n-1) * \dots * 1$.
- Permutations (order matters): $nPr = n! / (n - r)!$.
- Combinations (subsets/groups): $nCr = n! / (r! * (n - r)!)$.

Calculator Shortcut: [n] [yellow] [x!] [r] [yellow] [x!] [÷] [n - r] [yellow] [x!] [÷] = nCr

Problem 1: Calculate 6! (6 factorial) on the calculator.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 2: How many ways can 5 runners finish 1st, 2nd, and 3rd? ($5P3 = 5! / 2!$).

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 3: Calculate $7C2$ (combinations of 2 from 7).

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 4: Accumulate 5 and 15 with [Σ+]. What is the mean?

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Number Representation: Decimal to Binary and Hex

Data Representation & Binary Number Systems • Standard: CCSS.MATH.PRACTICE.MP5

1. CONCRETE MANIPULATIVE SETUP

Manipulative: Ten-Frame Stage (4x2 Gridfinity)

Use the 8 wells of the Ten-Frame as an 8-bit byte. Place pegs in wells for active '1' bits, leave empty for '0'.

2. STUDENT PREDICTION (BEFORE PRESSING)

Place pegs at positions 0, 1, and 3: binary 00001011₂ = 8 + 2 + 1 = 11₁₀. Predict hex value: 0B₁₆.

3. CALCULATOR ACTION (HARDWARE TRAPEZOID KEYCAPS)

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect (T, Z, Y, X)
11	11	Enter decimal integer 11 in DEC mode
[BASE]	HEX 0B	Press [yellow] [BASE]: screen displays Hexadecimal 0B!
[BASE]	BIN 1011	Press [yellow] [BASE]: screen displays Binary 1011!
[BASE]	OCT 13	Press [yellow] [BASE]: screen displays Octal 13!
[BASE]	DEC 11	Press [yellow] [BASE]: returns to Decimal 11

4. MATHEMATICAL EXPLANATION & RPN ADVANTAGE

Computer memory stores identical bit patterns; base conversions alter only the human visual representation.

Classroom Investigation Problem:

Enter decimal 255. Use [yellow] [BASE] to convert to HEX and BIN. What is the binary pattern?

Bitwise Logic: AND Masking & Network Subnets

Boolean Logic & Bitwise Operations • Standard: CCSS.MATH.PRACTICE.MP5

1. ADVANCED INVESTIGATION SETUP

Manipulative: Ten-Frame Stage (4x2 Gridfinity)

Row 1 holds byte A (1100 = 12). Row 2 holds mask B (1010 = 10).

2. HYPOTHESIS & MATHEMATICAL PREDICTION

Bitwise AND: bit 3 (1 & 1 = 1), bit 2 (1 & 0 = 0), bit 1 (0 & 1 = 0), bit 0 (0 & 0 = 0). Result: 1000₂ = 8₁₀.

3. CALCULATOR ACTION & REGISTER TRANSFORMATION

Keystroke Flow: 

Key Pressed	Screen (X)	Internal 4-Level Stack Effect
	12	Enter operand A = 12 (binary 1100)
	12	12 lifted to register Y
	10	Enter operand B = 10 (binary 1010) in X
	8	Bitwise AND evaluates 1100 & 1010 = 1000 (8 decimal)!

4. EXTENSION ANALYSIS & DEEPER CONNECTIONS

Bitwise AND masks bits, clearing unwanted bits to zero. This is the exact operation used in IPv4 subnet masking.

Extension Investigation Challenge:

Calculate bitwise OR for 12 (1100) and 3 (0011). Predict the binary and decimal result.

Digital Logic, Base Conversions & Computer Arch

Name: _____ Date: _____ Class: _____

STUDENT REFERENCE GUIDE: NUMBER BASES & BITWISE LOGIC GATES

- Binary (Base 2): digits 0 and 1. Hexadecimal (Base 16): digits 0-9 and A-F.
- Press [yellow] [BASE] to cycle between DEC (decimal), HEX (hexadecimal), OCT (octal), and BIN (binary).
- Bitwise AND: result bit is 1 only if BOTH bits are 1 (used for masking and subnets).

Calculator Shortcut: [DECIMAL VALUE] [yellow] [BASE] -> Cycles to HEX, BIN, OCT

Problem 1: Convert decimal 42 to binary using [yellow] [BASE].

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 2: Convert hexadecimal 2A to decimal.

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 3: Evaluate bitwise AND: 15 (1111) AND 7 (0111).

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Problem 4: Evaluate bitwise XOR: 12 (1100) XOR 10 (1010).

Manipulative Setup / Notes:

Keystrokes:

Prediction:

Final X Result:

Master Solutions & Keystrokes – Part 1

Complete worked solutions, keystroke sequences, and expected rational results.

Unit 1: Counting, Cardinality & The One-More Step Counter (Pre-K – Kindergarten)

Core Lesson: 5 peps. Keystrokes: [4] [ENTER] [1] [+]

Core Keys:    

Extension: 4 more peps. Keystrokes: [6] [ENTER] [2] [-]

Extension Keys:    

Unit 2: Part-Part-Whole & Doubles: The Math Domino Studio (Grades K–1)

Core Lesson: 9 pips. Keystrokes: [5] [ENTER] [4] [+]

Core Keys:    

Extension: Missing Part is 3. Keystrokes: [8] [ENTER] [5] [-]

Extension Keys:    

Unit 3: Ten-Frames: Complements to 10 & 5-Structure (Grade 1)

Core Lesson: 4 counters. Keystrokes: [1][0] [ENTER] [6] [-]

Core Keys:     

Extension: 15. Keystrokes: [9] [ENTER] [1] [+] [5] [+]

Extension Keys:      

Unit 4: Number Racks (Rekenrek): 5-Structure & Doubles (Grades 1–2)

Core Lesson: 14 beads. Keystrokes: [7] [ENTER] [+]

Core Keys:   

Extension: 13. Keystrokes: [6] [ENTER] [+] [1] [+]

Extension Keys:     

Unit 5: The 4-Register Stack: Four Operations & Automatic Lift (Grades 3–4)

Core Lesson: 3 cookies per bag. Keystrokes: [1][5] [ENTER] [6] [-] [3] [÷]

Core Keys:       

Extension: 19. Keystrokes: [2][4] [ENTER] [6] [÷] [1][5] [+]

Extension Keys:        

Unit 6: Fraction Studio: Height Equivalence & Two-Dot Notation (Grades 4–5)

Core Lesson: $\frac{3}{4}$ (height 63 mm). Keystrokes: [.] [1] [.] [2] [ENTER] [.] [1] [.] [4] [+]

Core Keys:          

Extension: $\frac{1}{2}$. Keystrokes: [.] [4] [.] [5] [ENTER] [.] [5] [.] [8] [×]

Extension Keys:          

Scoring Criteria

Award credit for: (1) Correct concrete manipulative modeling, (2) Accurate prediction prior to calculator entry, (3) Valid RPN key sequence preserving operand order, and (4) Clear explanation of stack flow.

Fabrication & Slicer Profiles

Guidelines for 3D printing the modular Gridfinity Learning Lab set in PLA or PETG.

Material Selection

PLA or PETG. Standard PLA provides crisp debossed text definition. PETG offers superior impact resistance for frequent classroom handling. No multi-material system or laser required.

Slicer Profile Recommendations

Layer height: 0.20 mm. Perimeters: 3. Infill: 15-20% gyroid. Top/bottom solid layers: 4. The 0.6 mm inset debossing creates exactly 3 solid recessed layers for high visual contrast under classroom lighting.

Gridfinity Tolerances

Trays use Zack Freedman's 42.0 mm pitch with standard 0.5 mm bin clearances and 4.0 mm base profiles. Always print the 'fit_coupon.stl' first to test socket clearances on your printer.

Storage & Organization

The 4x4 baseplate (168 x 168 mm) acts as both the activity dock and the storage foundation. Trays stack cleanly into classroom cubbies, completely eliminating disposable cardboard packaging.

Hardware Keycap Parity

All keycaps in this guide are rendered directly from StackCalc firmware simulator definitions (Firmware/Simulator/labels.json) ensuring 100% exact parity with the physical and watch calculator.

Open-Source Repository & STL Downloads

All STLs, OpenSCAD source files, PDFs, and classroom curriculum guides are fully open-source and downloadable at stackcalc.io.