

Lesson 110 ALGEBRA

Input and output: number rules shown as a table

CURRICULUM ALIGNMENT

ALG.PRR.3a

identify rules that describe the structure of a pattern and use these rules to make predictions.

ALG.PRR.3b

represent the relationships between quantities.

INTERACTIVES Function Machine · challenge, display, explore

WHAT THIS LESSON TEACHES

A number machine follows one rule for every number that goes in. The number going in is the input and the number coming out is the output. Read the pairs to spot the rule.

- Put 4 into an 'add 3' machine and 7 comes out.
- Input 5, rule 'multiply by 2', output 10.

MODEL THIS ON THE BOARD

FINDING A HIDDEN RULE

- 1 The table shows in 1 → out 4 and in 2 → out 5.
- 2 $1 + 3 = 4$ and $2 + 3 = 5$, so the rule is add 3.
- 3 Use the rule: $3 + 3 = 6$, so out is 6.

In	1	2	3
Out	4	5	

DISCUSSION STARTER

REFLECT Once you spotted a rule, did you test it on another row before filling the gaps?

LESSON ARC

Open on the IWB with a tiny 1→4, 2→5 table and hold out for pupils naming what the machine does, not just the next output. Run four rule-machines (+3, ×2, -2, ×10), reading each pair down the table. Together work an 'add 5' machine forwards, then reverse it from output 8. Pupils build a ×3 table in their copies. Class Challenge banks four machines, ending on running a rule backwards.

TEACHING MOVES

1. **Getting Started.** Show the 1→4, 2→5 table and give five seconds of silent think-time before any hands. Take two or three answers, but don't accept 'six' for the next output — push for 'it adds 3'. Naming the action, not the number, is the whole point of the beat.
2. **Watch and Notice.** Send numbers through each machine one at a time and read the pairs down the table. On the +3 machine ask 'what stays the same each time?'; watch the ×2 machine for pupils who add instead of double. Pause before the last input on the ×10 machine and take a prediction — it jumps fastest and makes the strongest talking point.
3. **Try It Together.** Set the rule to +5 and send 3, 6, 9, then 0 — pupils predict before each lands. Zero catches people out, so let someone try '0' and correct it: adding 5 to nothing still gives 5. Then point to output 8 and ask 'what went in?', showing that taking 5 away undoes the add — this is exactly the reverse thinking the Class Challenge needs.

4. **Build the Table in Your Copy.** Pupils rule a two-column input|output table for $\times 3$, write the rule at the top, and fill the four outputs themselves. Glance down the column as you walk — check the rule is written and the outputs go down cleanly. This is practice, not marking.
5. **Class Challenge.** Brisk practice round: pupils take turns at the board, tap Check, and the class confirms before moving on. For the hidden-rule machines, push pupils to probe a fresh input before guessing. On the final reverse machine, remind them it runs the rule backwards like the $+5$ machine earlier — for a times rule you divide the output by the rule number.
6. **What Did We Notice?.** Pose the output-only question and listen for pupils realising 8 alone doesn't fix the rule — it could be 'add 5' from 3 or 'times 2' from 4. Revoice: 'so we need the input beside the output to be sure what the machine did.' Display-only discussion, no writing.

COMMON MISCONCEPTIONS

⚠ On the $\times 2$ machine a pupil reads $5 \rightarrow 10$ and calls the rule 'add 5' — they've matched the gap to an addition instead of testing whether it doubles.

Send a second input through and put both pairs side by side: $5 \rightarrow 10$ but $3 \rightarrow 6$. 'If it added 5, three would give eight — but it gave six.' Two rows kills the single-guess habit; make probing a fresh input the routine before naming any hidden rule.

⚠ When 0 goes into the 'add 5' machine, a pupil says 0 comes out — 'nothing plus nothing'.

Slow the machine on that row and read it aloud as 'nothing, add five'. Show the output five and ask 'did the rule change for this number?' The rule holds for every input, zero included — that's what makes it a rule.

⚠ Running the rule backwards, a pupil finds the input for a $\times 5$ output by subtracting 5 (carrying over the $+5$ undo from Try It Together).

Point back to the $\times 5$ pairs already in the table: $2 \rightarrow 10$, $3 \rightarrow 15$. Ask 'what undoes times 5?' Draw out that a times rule reverses by dividing, an add rule by subtracting — the undo has to match the operation.

DIFFERENTIATION

EMERGING

- Stay on the single-step add machines ($+3$, $+5$) while the class moves to the times rules; the pupil predicts each output aloud before it lands.
- In the copybook table, pre-write the rule and the first output ($2 \rightarrow 6$) so the pupil only continues the pattern down the column.

DEVELOPING

- After the $\times 3$ copybook table, add input 10 and input 0 and ask which output surprises them and why.
- Give a table with the rule hidden and only two rows shown — can they find the rule from fewer clues than the Class Challenge gives?

PROFICIENT

- Narrate a harder variant at the board: a two-step machine ($\times 2$ then $+1$) and ask them to describe what it does in words after seeing two pairs.
- Pose: 'invent a rule where 6 comes out — how many different rules can make 6, and what input does each need?' Work it in the copybook.

✂ **Cross-curricular:** Tie to STE — a coin-sorting or vending machine is a real 'rule machine': one action every time, same input gives the same output.

ANSWER KEY

a) add 5

b) inputs 3, 6, 9, 0

c) 8, 11, 14, 5

Q1: 12

Q2: 11

Q3: 16

Q4: 9, 18, 27, 0

Q5: add 7

Spot: Cian saw $1 \rightarrow 5$ and thought $\times 5$, but $2 \times 5 = 10$, not 6. The rule is add 4. When the input is 4, the output is 8.

EXTENSION SHEET · STRETCH ANSWERS

S1: 23

S2: 141

S3: $\times 3 + 2$

S4: 68

S5: 68

Investigation: Invent a secret rule — open-ended; scan pupils' working for valid solution paths rather than a single answer.