Lesson 103 ALGEBRA

Tables of values — input → output

CURRICULUM ALIGNMENT

ALG.PRR.4b represent mathematical structures in multiple ways, including verbal expressions, diagrams and symbolic representations.

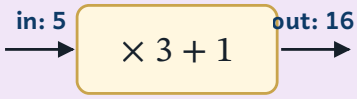
ALG.PRR.4a identify, explain and apply generalisations, including properties of operations, mathematical models and patterns.

INTERACTIVES Function Machine · challenge, display, explore

WHAT THIS LESSON TEACHES

A **table of values** shows what a rule does. The rule is a **function machine**: a number goes in, the rule is applied, a new number comes out.

→ Rule '× 3 + 1': Input **1** → output 4. Input **2** → 7. Input **5** → 16.



LESSON ARC

Open with a quick box-and-arrows × 3 machine on the IWB and take hands-up for inputs 4 and 7. Move to the function-machine interactive and walk four rules in turn, anchoring the two-step rule (× 2 then + 1) on order. Four pupils drive the × 3 machine at the board, then the class draws two tables in copybook with the given inputs. Class Challenge runs five rules; Student Activity Book page follows for seat-work.

TEACHING MOVES

1. **Getting Started.** Sketch a box with an arrow in and an arrow out, write × 3 inside, and give five seconds of quiet think-time before any hands go up. Take three answers for input 4, then three for input 7 — don't move on until you hear someone say 'times three' in pupil-voice.
2. **Watch and Notice.** Walk each machine aloud, one row at a time. On Example 1, point to 0 → 0 and say 'even zero obeys the rule.' Between Examples 2 and 3, pause and ask 'what did the + 5 machine do?' in one short sentence — revoice the best answer before you open the two-step rule. On Example 3 narrate 'double it first, THEN add 1' and say aloud 'same numbers, different order, different answer.'
3. **Try It Together.** Four pupils at the board in turn, one per job: small whole number, bigger whole number, zero, then a decimal. After each turn ask the class 'what did the machine do?' or 'does the same rule still work?' On the decimal turn, ask the class to predict the output before the pupil types — anchor back to place-value shift if needed.
4. **Draw the tables in your copy.** Inputs are on the IWB so pupils don't invent them — everyone is on the same eight calculations and the pace stays even. Walk the room glancing at the rule label at the top of each table and the in/out column alignment. No marking. If a pupil finishes early, they add one more row with an input of their own choosing.
5. **Class Challenge.** One pupil per challenge; read the rule aloud as a class before the first input is typed ('this machine multiplies by 3'). After each output the class confirms or corrects out loud, then swap pupils. Listen for 'add 1 first then double' on the two-step rule and revoice 'double FIRST, then add 1.'
6. **What Did We Notice?.** Write both rules on the IWB before opening the prompt. Confirm together that both give 7 when 3 goes in. Steer the class toward trying an input far from 3 — test 10 against both rules live (21 vs 14) and revoice 'the further apart the inputs, the more likely two rules are to disagree.'

COMMON MISCONCEPTIONS

⚠ On the two-step rule × 2 then + 1, pupils do the addition first: 'three plus one is four, doubled is eight' instead of 'three doubled is six, plus one is seven.'

Stop and redraw the machine as two boxes in a row on the IWB — a × 2 box feeding an + 1 box. Send the input through one box at a time, naming the number that lands between the boxes. Then swap the boxes round and run the same input — different output. 'Same numbers, different order, different answer.'

⚠ On the × 10 machine with decimals, pupils write 0.5 → 0.50 or 0.05 → 0.050 — they add a zero on the end rather than shifting the digit's place.

Pause the challenge and rebuild 0.5 with place-value blocks on the IWB. Slide the 5-digit one column to the left to make 5. Re-voice: 'the digit moves up a column; the rule is times ten, not add-a-zero.' Run 0.05 → 0.5 the same way.

⚠ When given the input 0 into the × 3 machine, pupils stall or guess 3 — they expect 'something must come out.'

On the IWB, drag three groups of zero counters into view. Three lots of nothing is still nothing. Confirm 0 → 0 and revoice 'even zero obeys the rule.'

DIFFERENTIATION

EMERGING

- During the copybook task, give these pupils only the × 3 table; skip the two-step rule for now and let them consolidate the one-step idea.
- Pre-draw the two-column in/out shell on the IWB and ask them to copy the structure first, then fill it — the table doesn't have to be invented and filled at the same time.

DEVELOPING

- After the copybook tables, swap the × 3 rule for × 4 and ask them to predict the outputs for the same four inputs before checking — pattern-spotting between the two columns.
- Pose a missing-input puzzle: 'a × 3 machine gave 27 out — what went in?' Same rule, working backwards.

PROFICIENT

- Direct fast finishers to the extension bank on their device while you circulate.
- Pose: 'invent a two-step rule that gives 10 out when 4 goes in.' More than one answer exists — can they find two different rules that both work?

Cross-curricular: Tie to STE — a function machine is the same idea as a science 'if-then' rule: input a temperature in °C, output the same temperature converted to °F.

ANSWER KEY

a) 1: 4

b) 2: 7

c) 3: 10

d) 5: 16

e) 10: 31

f) 20: 61

g) 100: 301

Q1: 32

Q2: 15

Q3: 129

Q4: 68

EXTENSION SHEET · STRETCH ANSWERS

S1: 63

S2: 94

S3: 64