

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 machine takes a number in as the input, does the same rule to it every time, and gives a new number out as the output. We list the pairs in a table of values.

→ $A \times 3$ machine takes 4 in and gives 12 out.

→ $A + 5$ machine takes 12 in and gives 17 out.

MODEL THIS ON THE BOARD

FEED THE $\times 3$ PLAY MACHINE

- 1 The rule on the game machine is $\times 3$. Drop in input 4.
- 2 Work out $4 \times 3 = 12$. The output that rolls out is 12.
- 3 Write the pair in the table: $4 \rightarrow 12$.
- 4 Next drop in 7. Work out $7 \times 3 = 21$. Add the pair $7 \rightarrow 21$.

LESSON ARC

Open with a $\times 3$ function machine on the IWB — drop a 4 in, ask what rolls out, push for how they got it. Demo four machines ($\times 3$, $+ 5$, $\times 2$ then $+ 1$, $\times 10$ with 0.5), dwelling on the two-step and decimal rows. Build the $\times 3$ table together with pupils driving the machine, then pupils draw four tables in their copy. The Work Backwards beat introduces the detective move — one pair can fool you, test a second. Student Activity Book follows.

TEACHING MOVES

1. **Getting Started.** Drop a 4 into the $\times 3$ machine and give five seconds of quiet think-time before any hands go up. When a pupil says 12, ask 'how did you get it?' before confirming — you want the rule named, not just the answer.
2. **Watch and Notice.** Move briskly through $\times 3$ and $+ 5$, then slow right down. On $\times 2$ then $+ 1$, have the class name both steps aloud in order — 'double, then add one' — before you reveal the output. On $\times 10$, ask them to say what 0.5 ten times makes before you press send: half, ten times, is a whole 5.
3. **Try It Together.** Keep the rule visible at $\times 3$. Bring pupils up in turn to slide an input in; the class predicts the output before you press send, then you add the row. Watch for pupils adding 3 instead of multiplying — head it off with 'three lots of this number, or three more than this number?'
4. **Draw the Tables in Your Copy.** Walk the room glancing that each rule label is at the top and each output actually matches its rule. This is copybook practice, not marking — keep moving.
5. **Work Backwards Together.** Show input 3 gives 7 and collect rules that fit — pupils will offer both $+ 4$ and $\times 2$ then $+ 1$. Make the key point visible: send 5 through each on the board and let the class watch them part company (9 versus 11). One pair can fool us; a second pair settles it.

6. **Class Challenge.** Pupils take turns at the board completing each table; the class confirms before moving on. Keep it brisk. On the work-backwards stretch (input 6, output 25), hold the class to testing a second pair before they commit to $\times 4$ then $+ 1$ — don't let anyone commit off one pair.
7. **What Did We Notice?.** Pose the question and listen for the pupil who realises one test input isn't enough. Revoice a strong answer: 'so one pair can fool us; we need a second pair to be sure of the rule.'

COMMON MISCONCEPTIONS

- ⚠ Pupils run a $\times 3$ machine but add instead — they take 7 in and call out 10, treating ' $\times 3$ ' as ' $+ 3$ '. Stop and ask 'three lots of this number, or three more than this number?' Run the same input through both on the board so the class sees $7 \rightarrow 21$ versus $7 \rightarrow 10$ side by side — the gap makes the difference obvious.
- ⚠ On the $\times 2$ then $+ 1$ machine, pupils do only one step — they double to get 6 and call that the output, dropping the $+ 1$. Make the class name both steps aloud, in order, before any output is revealed: 'double, then add one'. Show the middle value on the board — 3 doubles to 6, then $6 + 1 = 7$ — so the in-between number is visible, not skipped.
- ⚠ Pupils commit to a rule from a single pair — they see $3 \rightarrow 7$, decide it's ' $+ 4$ ', and stop. Send a second number through on the board: a $+ 4$ machine gives $5 \rightarrow 9$, but $\times 2$ then $+ 1$ gives $5 \rightarrow 11$. Let the class watch the two rules part company, then name the move — always test a second pair.

DIFFERENTIATION

EMERGING

- Keep these pupils on the one-step $\times 3$ and $+ 5$ tables in the copybook while the rest add the two-step and decimal rows; the table structure is already drawn so they only place the outputs.
- When the two-step machine appears, have them say just the first step ('double it') aloud with you and let the machine show the $+ 1$ — split the load.

DEVELOPING

- After the Class Challenge, give a missing-input variant: ' $\times 4$ then $+ 1$ gave 25 — what went in?' so they unwind the machine rather than run it forwards.
- Ask them to write, beside one table, why a $\times 3$ machine and a $+ 5$ machine can never give the same output for two different inputs.

PROFICIENT

- Pose: 'find two different two-step rules that both turn 4 into 9, then find the input where they part company.' Pair this with a copybook moment.
- Narrate a harder work-backwards pair at the board for fast finishers — input 6 gives 25 with $\times 4$ then $+ 1$ — and ask them to prove it with a second pair before the class moves on.

✚ **Cross-curricular:** Tie to STE — a function machine is like a recipe rule: 'cups of flour $\times 2$ then $+ 1$ spoon of sugar', same rule applied to every batch.

ANSWER KEY

a) 1: 4

b) 2: 7

c) 3: 10

d) 5: 16

e) 10: 31

f) 20: 61

g) 100: 301

Q1: 24

Q2: 17

Q3: 10

Q4: 30

a) **Always** : 4 multiplied by 3 is exactly 12 every time.

b) **Always** : Each machine follows one fixed rule for all its inputs.

c) **Sometimes** : It is true for $\times 3$ or $\times 10$ but false for a $+ 5$ machine.

d) **Never** : Many different rules can produce the same single output.

EXTENSION SHEET · STRETCH ANSWERS

S1: 68

S2: 23

S3: 68

S4: 63

S5: 129