Function Machines

A GUIDE

Feed a number in, a new number pops out. Your job: catch the secret rule the machine uses every single time.

Meet the Machine

Picture a box with a slot on each side. You drop a number in the left slot, the box hums for a second, and a new number slides out the right slot. That box is a function machine.

Here is the big promise a function machine makes: it uses the SAME rule on every number you feed it. If it adds 6 to one number, it adds 6 to all of them. It never gets tired, never changes its mind, and never plays favorites.

Watch this machine work. Its rule is "add 6", so whatever goes in comes out exactly 6 bigger.

IN (△)	→	OUT (□)
1	→	7
4	→	10
10	→	16

Rule: □ = △ + 6

Be a Rule Detective

Now for the fun part. Usually nobody tells you the rule — you get a few in-and-out pairs, and you have to figure it out. That makes you a detective, and the pairs are your clues.

Start with one pair and ask: what could turn this in-number into this out-number? Maybe the machine added something. Maybe it multiplied. Make a guess, then test it on the OTHER pairs. A real rule works for every pair, not just one.

That test step is the key move. If 2 becomes 6, the rule could be "+ 4" or "× 3" — you can't tell from one clue. But if 5 becomes 15, then "+ 4" is busted and "× 3" survives. Case closed.

IN (△)	→	OUT (□)
2	→	6
5	→	15
7	→	21
10	→	30

Rule: □ = △ × 3

Worked example A machine turned 2 into 10, 3 into 15, and 5 into 25. What is its rule?

1. The outputs are much bigger than the inputs, so try multiplying first.
2. Check the first pair: 2 × 5 = 10, so the rule might be "× 5".
3. Test it on the others: 3 × 5 = 15 and 5 × 5 = 25 — it works every time.

Answer: × 5

Running the Machine Backward

Sometimes you know the rule and you know what came OUT — but not what went in. No problem. Just run the machine in reverse.

To go backward, you undo the rule. Adding is undone by subtracting. Multiplying is undone by dividing. If the machine's rule is "− 5" and 15 came out, then going backward means adding 5 back: the input was 20.

Here is a "− 5" machine running forward. Cover the in column and see if you can rebuild it from the outs — that's backward thinking.

IN (△)	→	OUT (□)
12	→	7
20	→	15
9	→	4

Rule: □ = △ − 5

Worked example A machine's rule is "× 4". The number 36 came out. What went in?

1. The machine multiplied by 4, so undo that by dividing by 4.
2. 36 ÷ 4 = 9, so the input was probably 9.
3. Check by running it forward: 9 × 4 = 36 — it matches.

Answer: 9

Two-Step Machines

Ready to level up? Some machines do TWO things to each number — like "multiply by 2, then add 1". The promise still holds: both steps happen to every single input, in the same order.

Cracking a two-step rule takes one extra clue. Look at how the outputs grow: if the input goes up by 1 and the output jumps by 2 every time, there is a "× 2" hiding inside. Then check what you still need to add or subtract to land on the exact output.

Going backward through a two-step machine works too — just undo the steps in REVERSE order, like taking off your shoes before your socks. Last step first.

IN (△)	→	OUT (□)
3	→	7
5	→	11
10	→	21

Rule: □ = △ × 2 + 1

Worked example A machine turned 1 into 5, 2 into 7, and 3 into 9. What is its two-step rule?

1. Each time the input grows by 1, the output grows by 2, so the rule starts with "× 2".
2. But 1 × 2 = 2, and the output was 5 — that's 3 more, so the second step is "+ 3".
3. Test the full rule: 2 × 2 + 3 = 7 and 3 × 2 + 3 = 9 — both match.

Answer: × 2, then + 3

Remember

★ A rule must work for EVERY pair — one matching pair can be a coincidence, so always test your guess on all the clues.

★ If the outputs are way bigger than the inputs, try multiplying first; if they're only a little bigger, try adding.

★ To run a machine backward, undo its rule: undo + with −, and undo × with ÷.

★ For a two-step machine running backward, undo the LAST step first — shoes off before socks.

Now you try

1) A machine's rule is "+ 8". You put in 7. What comes out?

Answer: _____

2) A machine's rule is "× 6". You put in 9. What comes out?
Answer: _____

3) A machine turns 5 into 2, 9 into 6, and 14 into 11. What is its rule?
Answer: _____

4) A machine turns 3 into 12, 5 into 20, and 8 into 32. What is its rule?
Answer: _____

5) A machine's rule is "− 7". The number 25 came out. What went in?
Answer: _____

6) A machine's rule is "× 8". The number 56 came out. What went in?
Answer: _____

7) A machine's rule is "× 3, then + 2". You put in 6. What comes out?
Answer: _____

8) A machine's rule is "× 2, then + 5". The number 21 came out. What went in?
Answer: _____

Answers — check yourself

1. 15
2. 54
3. − 3
4. × 4
5. 32
6. 7
7. 20
8. 8