

Function Machines

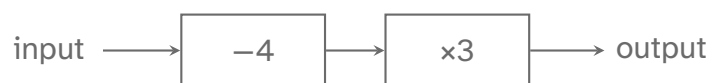
Solutions

For Pearson Edexcel GCSE Mathematics (1MA1) • Foundation tier

Each question is shown in grey, followed by the working, one step per line. The final answer is in a box. *Marks* shows how the marks are usually given in the exam, and **Tip** points out a common mistake.

1 (5 marks)

Here is a number machine.



(a) Work out the output when the input is 10

Go through the machine in order, left to right.

$$10 - 4 = 6$$

$$6 \times 3 = 18$$

Answer: 18

(b) Work out the input when the output is -6

Work backwards from the output.

Undo each operation, starting with the last one.

Undo $\times 3$: $-6 \div 3 = -2$

Undo -4 : $-2 + 4 = 2$

Check: $2 - 4 = -2$ and $-2 \times 3 = -6$ ✓

Answer: 2

Tip: Do not put -6 into the machine as the input. Start at the output and do **both** inverse operations, in reverse order.

Marks: 1 mark for $-6 \div 3$ then $+4$. 1 mark for 2.

- (c) Ffion puts a number into the machine.
The output is double the number she put in.
Find the number Ffion put in.

Call Ffion's number x .

The machine subtracts 4, then multiplies by 3, so the output is $3(x - 4)$.

The output is double the number, so $3(x - 4) = 2x$

Expand the bracket: $3x - 12 = 2x$

Subtract $2x$ from both sides: $x - 12 = 0$

So $x = 12$

Check: $12 - 4 = 8$, $8 \times 3 = 24$, and $24 = 2 \times 12$ ✓

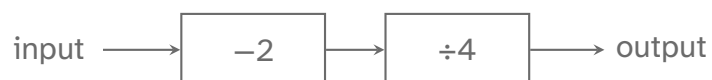
Answer: 12

Tip: The output is $3(x - 4)$, not $3x - 4$: the machine subtracts 4 **before** multiplying.

Marks: 1 mark for $3(x - 4) = 2x$ (or for trying inputs and comparing the output with double the input). 1 mark for 12.

2 (3 marks)

Here is a number machine.



- (a) Find the output when the input is 30

Subtract 2 first: $30 - 2 = 28$

Then divide by 4: $28 \div 4 = 7$

Answer: 7

Tip: Follow the machine's order, not BIDMAS. The -2 happens first.

- (b) Find the input when the output is -3

Work backwards from the output.

Undo $\div 4$: $-3 \times 4 = -12$

Undo -2 : $-12 + 2 = -10$

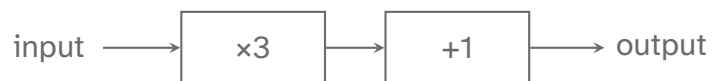
Check: $-10 - 2 = -12$ and $-12 \div 4 = -3$ ✓

Answer: -10

Marks: 1 mark for -3×4 then $+2$. 1 mark for -10 .

3 (2 marks)

Here is a number machine.



Complete the table.

input	2	5	10
output	7	16	31

Input 5: $5 \times 3 = 15$, then $15 + 1 = 16$

For the output 31, work backwards:

Undo $+1$: $31 - 1 = 30$

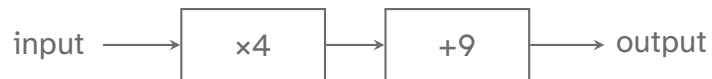
Undo $\times 3$: $30 \div 3 = 10$

Answer: Output 16. Input 10.

Marks: 1 mark for 16. 1 mark for 10.

4 (3 marks)

Here is a number machine.



- (a) Find the output when the input is 7

$$7 \times 4 = 28$$

$$28 + 9 = 37$$

Answer: 37

- (b) Find the input when the output is -15

Work backwards from the output.

$$\text{Undo } +9: -15 - 9 = -24$$

$$\text{Undo } \times 4: -24 \div 4 = -6$$

$$\text{Check: } -6 \times 4 = -24 \text{ and } -24 + 9 = -15 \checkmark$$

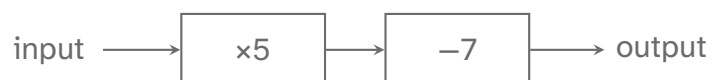
Answer: -6

Tip: Take care with the negatives: $-15 - 9 = -24$ (not -6), and a negative divided by a positive is negative.

Marks: 1 mark for $-15 - 9$ then $\div 4$. 1 mark for -6 .

5 (2 marks)

Here is a number machine.



When the input is 6, the output is 23

Complete the number machine.

Go through the first box: $6 \times 5 = 30$

The second box must change 30 into 23.

$30 - 23 = 7$, so the second box is -7 .

Answer: -7

Tip: Write the operation in the box with its sign: -7 , not just 7.

Marks: 1 mark for $6 \times 5 = 30$. 1 mark for -7 .

6 (3 marks)

The input of this number machine is x .



- (a) Write an expression, in terms of x , for the output.

Multiply x by 6: $6x$

Then subtract 1: $6x - 1$

Answer: $6x - 1$

- (b) The output is 53
Find the value of x .

Set the output equal to 53: $6x - 1 = 53$

Add 1 to both sides: $6x = 54$

Divide both sides by 6: $x = 9$

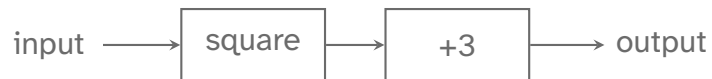
Check: $6 \times 9 - 1 = 53$ ✓

Answer: $x = 9$

Marks: 1 mark for $6x - 1 = 53$ or $(53 + 1) \div 6$. 1 mark for 9.

7 (3 marks)

Here is a number machine.



- (a) Find the output when the input is -4

Square -4 : $(-4)^2 = -4 \times -4 = 16$

Then add 3: $16 + 3 = 19$

Answer: 19

- (b) The output is 52
Find the two possible inputs.

Work backwards from the output.

Undo $+3$: $52 - 3 = 49$

Undo “square”: find the numbers that square to 49.

$7^2 = 49$ and $(-7)^2 = 49$

Answer: 7 and -7

Marks: 1 mark for 49. 1 mark for both 7 and -7 .

8 (1 mark)

Here is a number machine.



Find the output when the input is 8

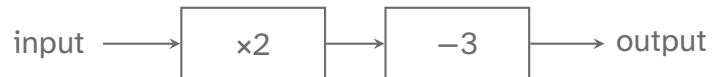
$8 \div 5 = 1.6$

$$1.6 + 1.2 = 2.8$$

Answer: 2.8

9 (1 mark)

Here is a number machine.



Maya says,

‘For any whole number input, the output is always odd.’

Is Maya correct?

You must give a reason for your answer.

Call the input n .

The output is $2n - 3$.

$2n$ is always even (it is a multiple of 2).

An even number minus 3 is always odd.

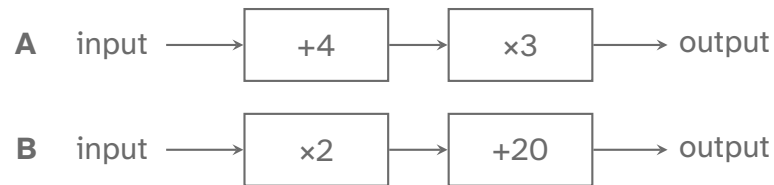
So every whole number input gives an odd output.

Answer: Yes. The output is $2n - 3$, which is an even number minus an odd number, so it is always odd.

Tip: Trying a few numbers does not show it is true for **every** whole number. Give a reason that works for all of them.

10 (3 marks)

Here are two number machines.



The two machines have the same input.

They give the same output.

Work out the input.

Call the input x .

Machine A adds 4, then multiplies by 3: $3(x + 4)$

Machine B gives $2x + 20$.

The outputs are the same, so $3(x + 4) = 2x + 20$

Expand the bracket: $3x + 12 = 2x + 20$

Subtract $2x$ from both sides: $x + 12 = 20$

Subtract 12 from both sides: $x = 8$

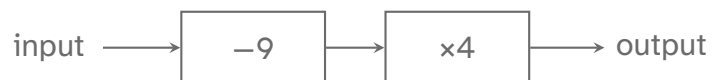
Check: A gives $3 \times 12 = 36$, B gives $16 + 20 = 36$ ✓

Answer: 8

Marks: 1 mark for $3(x + 4)$ or $2x + 20$. 1 mark for $3(x + 4) = 2x + 20$. 1 mark for 8.

11 (3 marks)

Here is a number machine.



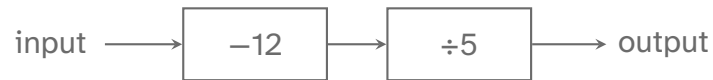
(a) Work out the output when the input is 6

$$6 - 9 = -3$$

$$-3 \times 4 = -12$$

Answer: -12

- (b) This number machine has a missing operation.



An input of 42 gives an output of 6
Complete the number machine.

Work backwards from the output.

Undo $\div 5$: $6 \times 5 = 30$

So the first box turns 42 into 30.

$42 - 30 = 12$, so the missing number is 12.

Answer: -12

Tip: Start from the output. Undo the $\div 5$ first, because it is the last step in the machine.

Marks: 1 mark for 6×5 ($= 30$). 1 mark for 12.
