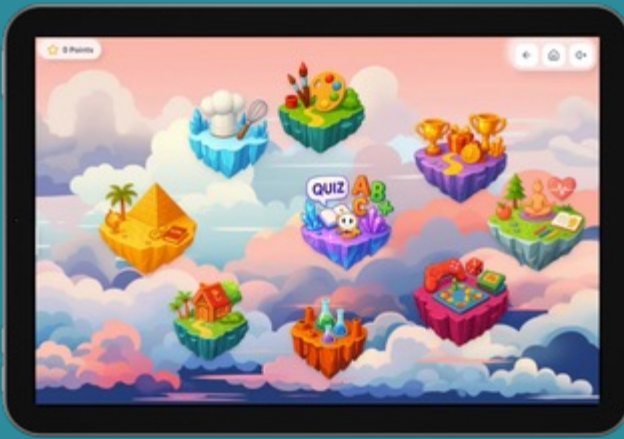


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Debug, Compare, Explain - Year 6

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Teacher guide: purpose and preparation

The teaching question

How does changing one decision or operation change the outputs of a finite algorithm?

Learners compare two rules on the same ordered input set, identify the first divergence and support a precise revision with a trace. This unit maps each input once. It does not repeatedly update one value.

Before lesson 1

Prepare the colour comparison display, worked cards, step cards, worksheet copies and pencils. Cut the 12 partner challenge cards. Copy the game trace sheets needed for all 12 turns. Keep the matching red answer pages for teacher checking. No device or count is required.

Lesson 1: predict two outputs

Show the rule with its finite domain and stop. Elicit two diagnostic responses before showing answers: is $1 < 1$ true, and what is $1 \div 2$? Model $x = 0.5$, then contrast $x = 1$. Partners predict from two further worked cards. Ask each learner to name the branch and explain one output.

Lesson 2: systematic finite testing

Revisit only the insect prerequisite. Model the first guided trace. Learners complete the guided page, then explain the change in their own words. Have learners record all five inputs in order before comparing the two output columns.

Teacher guide: lessons and access

Lesson 3: locate the divergence

Demonstrate a complete game turn, including a wrong prediction and constructive correction. Learners complete the independent trace and play the 12-card affected-branch challenge. Listen for a stated condition, branch, calculation and reason, not merely a correct number.

Lesson 4: revise and retest

Use the fresh comparison sheet before the tested-revision sheet. Change one component at a time. Ask learners to predict affected inputs, calculate the old and new outputs and say why other listed cases stay unchanged. Give one correction and to their role and ask for a fresh attempt.

Lesson 5: evidence and next step

Recall the success criteria without displaying the final answer. Learners independently complete the assessment, explaining the boundary and limiting their claim to the tested set. Use the rubric to record actual evidence and a targeted next step. Accept an oral, typed or scribed explanation when writing load requires the mathematics.

Support and extension

Support: physical steps, rough partial trace table and partner rehearsal. Core: an independent finite trace with a reason. Extension: compare a second precise threshold or give a counterexample to an overbroad claim. Do not turn extension into uncontrolled infinite trials.

Teacher key and assessment decisions

Partner challenge key: cards 1-6

1: only $x = 1$. 2: only $x = 1$. 3: only $x = 0.5$. 4: $x = 0$ and 0.5 . 5: $x = 1, 1.5$ and 2 . 6: same output 1 at $x = 2$. For every card, require the changed test or operation and at least one valid calculation.

Partner challenge key: cards 7-12

7: both output 0.5 . 8: Rule A outputs 0.5 ; B outputs 1.5 . 9: $x = 1.5$ takes NO and outputs 0.75 . 10: $x = 0.5$ takes YES and outputs 0.75 . 11: $x = 1.5$ is above both thresholds so both halve it. 12: take the next listed input; stop after five outputs.

Assessment marking

For $0.5, 1, 1.5, 2, 2.5$, Rule E outputs $1, 1.5, 0.75, 1, 1.25$. Rule F outputs $1, 1.5, 2, 1, 1.25$. The first divergence is $x = 1.5$. E halves it; F adds 0.5 . A valid revision changes $<$ to $\leq$, retests the affected boundary and states the claim is rejected in this finite set.

Use the rubric

Record observed evidence for concept, procedure, reason and transfer. Target met independently means score for each trace plus a connected explanation and tested revision. Do not grade handwriting, neatness, accent or an accessible response mode.

Debug, Compare, Explain

Follow the rule. Check the outputs. What's the same? What's different? Why?

Input set

0, 0.5, 1, 1.5, 2

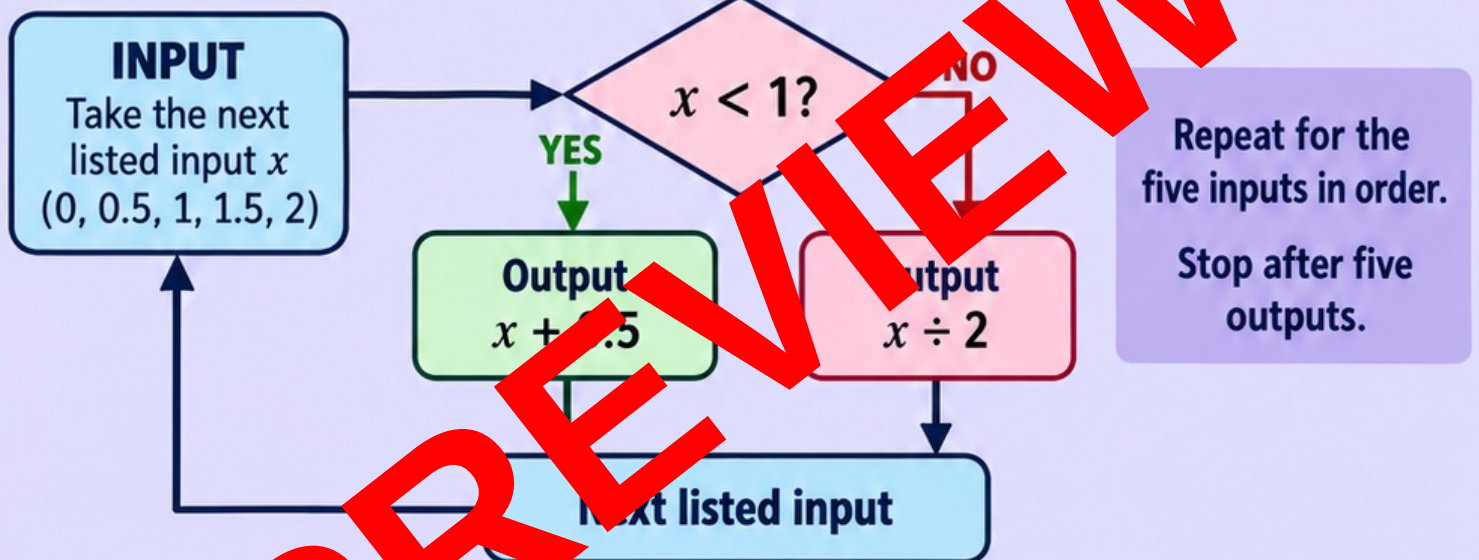
These five inputs are processed **once each in order**.

Rule A

If $x < 1$,
output $x + 0.5$;
otherwise output $x \div 2$.

Stop after five outputs
(when all inputs have been processed).

Flow diagram for Rule A



Repeat for the five inputs in order.
Stop after five outputs.

Example 1 (Rule A)

Input: $x = 0.5$

Is $x < 1$? **YES**

Output: $x + 0.5 = 0.5 + 0.5 = 1$

Example 2 (Rule A)

Input: $x = 1$

Is $x < 1$? **NO**

Output: $x \div 2 = 1 \div 2 = 0.5$

Rule B (only change $<$ to $\leq$)

If $x \leq 1$,
output $x + 0.5$;
otherwise output $x \div 2$.

At $x = 1$, Rule B gives
 $1 + 0.5 = 1.5$.

Equality changes the branch.

A value of 1 goes to a different branch when we use $\leq$ instead of $<$.

Debug, Compare, Explain

Year 6
Mathematics

Follow the rule, make a prediction, then check the result.

1

Rule A: If $x < 1$, output $x + 0.5$,
otherwise output $x \div 2$.

Input

$x = 0$

Branch

Is $x < 1$?
YES

Calculation

$0 + 0.5$

Your prediction

What do you think
the output will be?
Talk with a partner
and give a reason.

Output

0.5

2

Rule A: If $x < 1$, output $x + 0.5$,
otherwise output $x \div 2$.

Input

$x = 0.5$

Branch

Is $x < 1$?
YES

Calculation

$0.5 + 0.5$

Your prediction

What do you think
the output will be?
Talk with a partner
and give a reason.

Output

1

3

Rule A: If $x < 1$, output $x + 0.5$,
otherwise output $x \div 2$.

Input

$x = 1$

Branch

Is $x < 1$?
NO

Calculation

$1 \div 2$

Your prediction

What do you think
the output will be?
Talk with a partner
and give a reason.

Output

0.5

Same rule. Different inputs. What do you notice? What can you explain?

Year 6 Mathematics

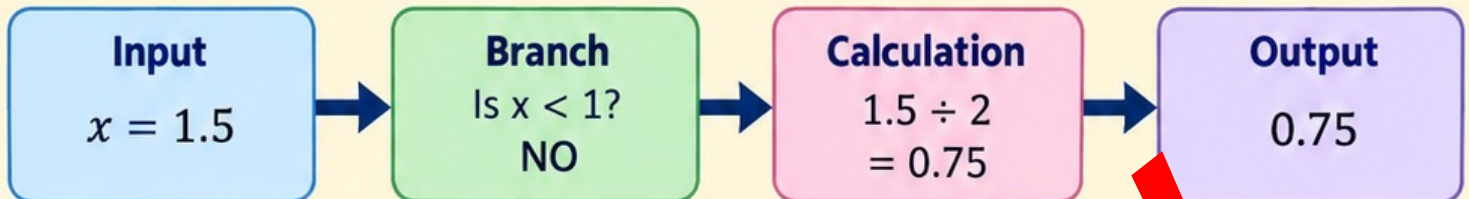
Debug, Compare, Explain

Follow the rules, work through the steps and think about what happens.

Card 4

Rule A

If $x < 1$, output $x + 0.5$,
otherwise output $x \div 2$.



Partner prediction: What do you think the output will be? Why?

Card 5

Rule A

If $x < 1$, output $x + 0.5$,
otherwise output $x \div 2$.

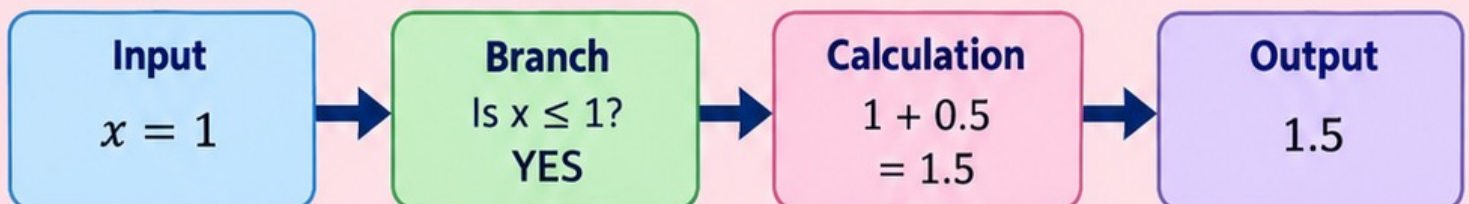


Partner prediction: What do you think the output will be? Why?

Card 6

Rule B

If $x \leq 1$, output $x + 0.5$,
otherwise output $x \div 2$.



Partner prediction: What do you think the output will be? Why is the answer different in this card compared with Card 4?

Year 6 Mathematics

Debug, Compare, Explain

Same rule structure.
A small change can make a difference!

7 Compare the rules for input 0.5

Input	Rule A: If $x < 1$	Rule B: If $x \leq 1$	Outputs
$x = 0.5$	Is $0.5 < 1$? YES ↓ Calculate: $x + 0.5$ $0.5 + 0.5 = 1$ Output = 1	Is $0.5 \leq 1$? YES ↓ Calculate: $x + 0.5$ $0.5 + 0.5 = 1$ Output = 1	Rule A output 1 Rule B output 1

Talk with a partner: What do you predict will happen? Do the outputs match? Explain why.

8 Compare the rules for input 1

Input	Rule A: If $x < 1$	Rule B: If $x \leq 1$	Outputs
$x = 1$	Is $1 < 1$? NO ↓ Calculate: $x + 2$ $1 + 2 = 3$ Output = 0.5	Is $1 \leq 1$? YES ↓ Calculate: $x + 0.5$ $1 + 0.5 = 1.5$ Output = 1.5	Rule A output 0.5 Rule B output 1.5

Talk with a partner: What do you predict will happen? Do the outputs match? Explain why.

9 Compare the rules for input 2

Input	Rule A: If $x < 1$	Rule B: If $x \leq 1$	Outputs
$x = 2$	Is $2 < 1$? NO ↓ Calculate: $x \div 2$ $2 \div 2 = 1$ Output = 1	Is $2 \leq 1$? NO ↓ Calculate: $x \div 2$ $2 \div 2 = 1$ Output = 1	Rule A output 1 Rule B output 1

Talk with a partner: What do you predict will happen? Do the outputs match? Explain why.

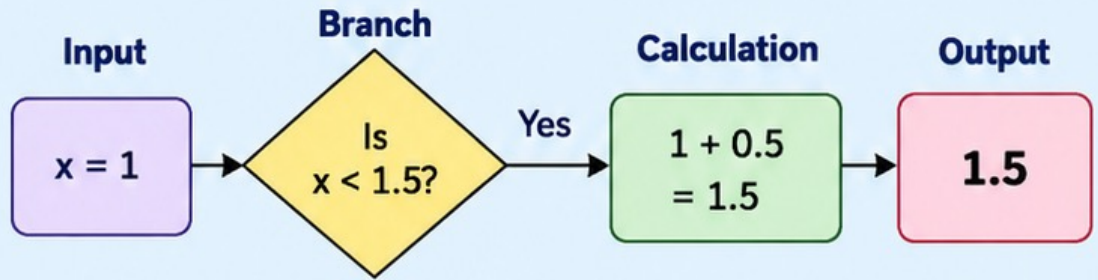
Same structure. Different rule. Compare, predict, explain!

Card 10**Debug, Compare, Explain**

Threshold changed

Rule

If $x < 1.5$ then
 $x + 0.5$
 else
 $x \div 2$

**Partner task**

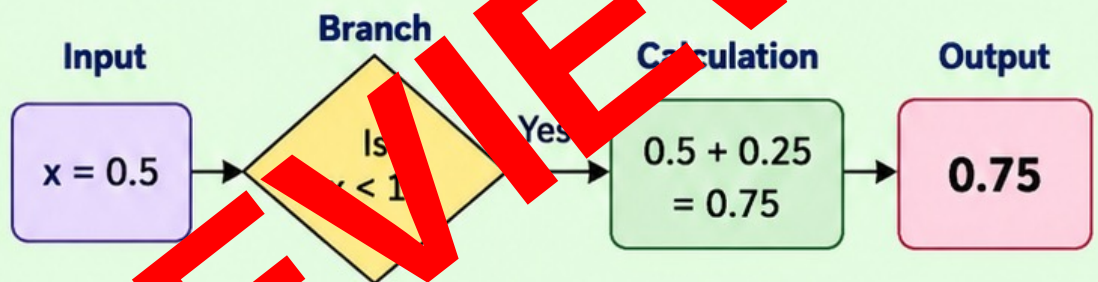
What changed in this card compared with the original rule?
 Why does the input 1 give an output of 1.5?

Card 11**Debug, Compare, Explain**

Yes calculation changed

Rule

If $x < 1$ then
 $x + 0.25$
 else
 $x \div 2$

**Partner task**

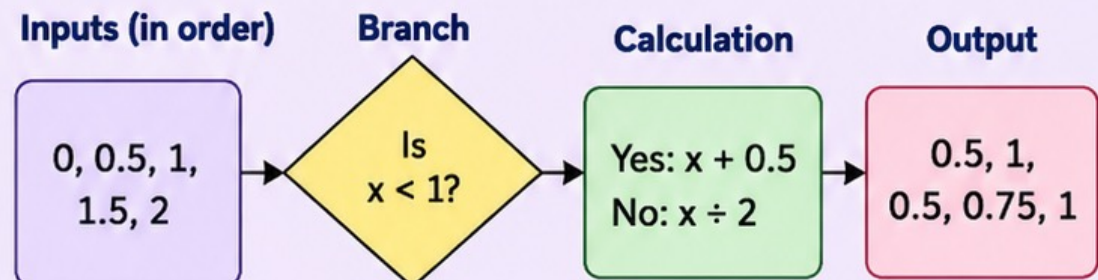
What changed in this card compared with the original rule?
 Why does the input 0.5 give an output of 0.75?

Card 12**Debug, Compare, Explain**

Finite run (do each once)

Rule

If $x < 1$ then
 $x + 0.5$
 else
 $x \div 2$

**Partner task**

This program is a *finite run*. We use the inputs 0, 0.5, 1, 1.5, 2 in order, process each one once, then stop after five outputs.
 What changed in this card compared with the original rule? Why?

Boundary trace: guided

Rule A: if $x < 1$, output $x + 0.5$; otherwise, output $x \div 2$.
Rule B: same rule, but the test changes only to $x \leq 1$.

1 Rule A, $x = 0.5$

Is the test true or false?	Which operation?	Output?
$0.5 < 1$		

2 Rule A, $x = 1$

Is the test true or false?	Which operation?	Output?

3 Rule B, $x = 1$

Is the test true or false?	Which operation?	Output?

4 Rule B, $x = 1.5$

Is the test true or false?	Which operation?	Output?

Why does equality at $x = 1$ matter?

Name: **ANSWERS**

Date: _____

Boundary trace: guided

Rule A: if $x < 1$, output $x + 0.5$; otherwise, output $x \div 2$.**Rule B:** same rule, but the test changes only to $x \leq 1$.**1** Rule A, $x = 0.5$

Is the test true or false?	Which operation?	Output?
$0.5 < 1$ TRUE	$x + 0.5$	1

2 Rule A, $x = 1$

Is the test true or false?	Which operation?	Output?
FALSE	$x \div 2$	0.5

3 Rule B, $x = 1$

Is the test true or false?	Which operation?	Output?
TRUE	$x + 0.5$	1.5

4 Rule B, $x = 1.5$

Is the test true or false?	Which operation?	Output?
FALSE	$x \div 2$	0.75

Why does equality at $x = 1$ matter?

At $x = 1$, $<$ is false but $\leq$ is true, so the branch and output change.

Name: _____

Date: _____

Boundary trace: independent

Two rules use a test, then an operation.

Rule A

If $x < 1$, then the output is $x + 0.5$.
If not, the output is $x \div 2$.

Rule B

If $x \leq 1$, then the output is $x + 0.5$.
If not, the output is $x \div 2$.

For each case, complete the table. Decide whether the test is true or false, write the operation used, and the output.

Case	Rule used	Input x	Test result (True or False)	Operation used	Output
1	A	0			
2	B	0.5			
3	A	1			
4	B	1			
5	A	1.5			
6	B	2			

Which of these cases shows the rules diverging? Explain using the branch.

Boundary trace: independent

Two rules use a test, then an operation.

Rule A
If $x < 1$, then the output is $x + 0.5$.
If not, the output is $x \div 2$.

Rule B
If $x \leq 1$, then the output is $x + 0.5$.
If not, the output is $x \div 2$.

For each case, complete the table. Decide whether the test is true or false, write the operation used, and the output.

Case	Rule used	Input x	Test result (True or False)	Operation used	Output
1	A	0	TRUE	$x + 0.5$	0.5
2	B	0.5	TRUE	$x + 0.5$	1
3	A	1	FALSE	$x \div 2$	0.5
4	B	1	TRUE	$x + 0.5$	1.5
5	A	1.5	FALSE	$x \div 2$	0.75
6	B	2	FALSE	$x \div 2$	1

Which of these cases shows the rules diverging? Explain using the branch.

At $x = 1$, Rule A uses $\div 2$ and gives 0.5; Rule B uses $+ 0.5$ and gives 1.5.

Name: _____

Date: _____

Boundary trace: change one thing

Three similar rules. Each rule takes a number x and gives an output.

Rule A (original)

If $x < 1$
 output $x + 0.5$
 otherwise
 output $x \div 2$

Rule C (different test)

If $x < 1.5$
 output $x + 0.5$
 otherwise
 output $x \div 2$

Rule D (different yes operation)

If $x < 1$
 output $x + 0.25$
 otherwise
 output $x \div 2$

For each task, trace the rule step by step, then compare with Rule A at the same input.
 Fill in the boxes and write a short sentence to explain whether the output is changed or unchanged.

1. Trace Rule C at $x = 1$ and compare with Rule A at $x = 1$.

Rule C at $x = 1$

Chosen branch: Calculation: Output: Explain: Is the output changed or unchanged?

Rule A at $x = 1$

Chosen branch: Calculation: Output: Explain: Is the output changed or unchanged?

2. Trace Rule C at $x = 1.5$ and compare with Rule A at $x = 1.5$.

Rule C at $x = 1.5$

Chosen branch: Calculation: Output: Explain: Is the output changed or unchanged?

Rule A at $x = 1.5$

Chosen branch: Calculation: Output: Explain: Is the output changed or unchanged?

3. Trace Rule D at $x = 0.5$ and compare with Rule A at $x = 0.5$.

Rule D at $x = 0.5$

Chosen branch: Calculation: Output: Explain: Is the output changed or unchanged?

Rule A at $x = 0.5$

Chosen branch: Calculation: Output: Explain: Is the output changed or unchanged?

Name: _____

ANSWERS

Date: _____

Boundary trace: change one thing

Three similar rules. Each rule takes a number x and gives an output.

Rule A (original)

If $x < 1$
output $x + 0.5$
otherwise
output $x \div 2$

Rule C (different test)

If $x < 1.5$
output $x + 0.5$
otherwise
output $x \div 2$

Rule D (different yes operation)

If $x < 1$
output $x + 0.25$
otherwise
output $x \div 2$

For each task, trace the rule step by step, then compare with Rule A at the same input. Fill in the boxes and write a short sentence to explain whether the output is changed or unchanged.

1. Trace Rule C at $x = 1$ and compare with Rule A at $x = 1$.**Rule C at $x = 1$** Chosen branch: **YES**Calculation: **$1 + 0.5$** Output: **1.5**

Explain: Is the output changed or unchanged?

Rule A at $x = 1$ Chosen branch: **NO**Calculation: **$1 \div 2$** Output: **0.5****The output is changed because the threshold moved.****2. Trace Rule C at $x = 1.5$ and compare with Rule A at $x = 1.5$.****Rule C at $x = 1.5$** Chosen branch: **YES**Calculation: **$1.5 + 0.5$** Output: **2.0**

Explain: Is the output changed or unchanged?

Rule A at $x = 1.5$ Chosen branch: **NO**Calculation: **$1.5 \div 2$** Output: **0.75****The output is unchanged.****3. Trace Rule D at $x = 0.5$ and compare with Rule A at $x = 0.5$.****Rule D at $x = 0.5$** Chosen branch: **YES**Calculation: **$0.5 + 0.25$** Output: **0.75**

Explain: Is the output changed or unchanged?

Rule A at $x = 0.5$ Chosen branch: **YES**Calculation: **$0.5 + 0.5$** Output: **1****The output is changed because the yes operation changed.**

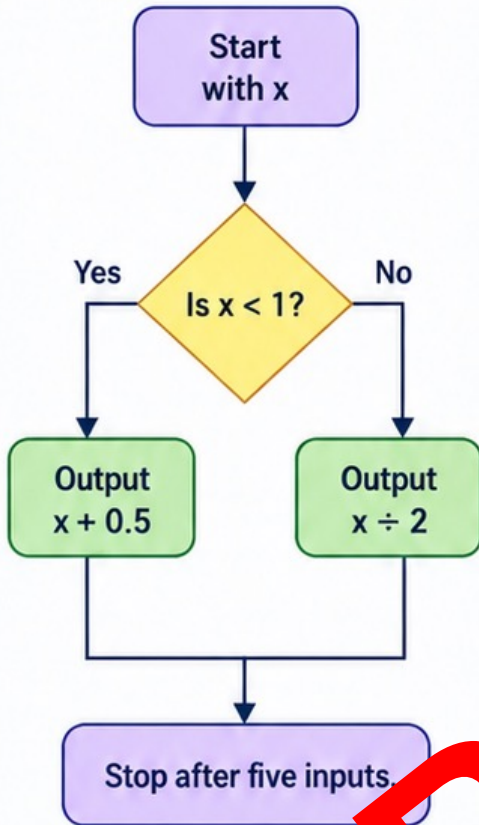
Debug only the affected branch

Investigate how a change to a rule affects only part of the flow.

Work with a partner to find, compare and explain the effects of small changes.

Rule A (reference)

For each input in {0, 0.5, 1, 1.5, 2}:



Game instructions

- 1 Take turns with your partner.
- 2 On your turn, draw a challenge card and read the one change to Rule A.
- 3 Predict which of the listed inputs may change.
- 4 Trace only the needed case(s) using the flow diagram.
- 5 Your partner checks using the teacher key.
- 6 Explain your answer with branch and operation reason (e.g. "x = 1 now uses the $\div 2$ branch because...").
- 7 If your trace and reason are correct, award one point.
- 8 Swap roles and draw the next card.
- 9 Finish after 12 cards or an agreed time. Make an effort every turn — this is about reasoning, not chance!

Equipment

- Rule A reference
- 12 challenge cards
- Pencils
- Trace record (below)

What if we change?

Change: replace $<$ with $\leq$.

- 1 Which inputs may change?
Only $x = 1$, because it was the boundary.
- 2 Trace the needed case.
At $x = 1$:
Original A: $x \geq 1$, so output $1 \div 2 = 0.5$
Revised rule: $x \leq 1$, so output $1 + 0.5 = 1.5$
- 3 Other inputs (0, 0.5, 1.5, 2) stay the same.
- 4 Reason: changing to $\leq$ only affects the branch taken at $x = 1$.

Trace record

Use one row per turn. Copy this trace sheet as needed for all 12 turns.

Card number	Changed input (e.g. 1)	Old output (from Rule A)	Revised output (after change)	Reason (branch and operation)
1				
2				
3				
4				
5				

Debug challenge cards

Rule A: if $x < 1$, output $x + 0.5$; otherwise output $x \div 2$. Rule B changes only $<$ to $\leq$.
Inputs: 0, 0.5, 1, 1.5, 2.

1

Change $x < 1$ to $x \leq 1$.
Which listed input changes output?

Prediction and reason:

2

Change $x < 1$ to $x < 1.5$.
Which listed inputs change output?

Prediction and reason:

3

Change $x < 1$ to $x < 0.5$.
Which listed inputs change output?

Prediction and reason:

4

Keep $x < 1$; change the YES operation from $+0.5$ to $+0.25$.
Which inputs change output?

Prediction and reason:

5

Keep $x < 1$; change the NO operation from $\div 2$ to $+0.5$.
Which inputs change output?

Prediction and reason:

6

Compare Rule A and Rule B at $x = 2$. Same or different output?

Prediction and reason:

Debug challenge cards

Rule A: if $x < 1$, output $x + 0.5$; otherwise output $x \div 2$. Rule B changes only $<$ to $\leq$.
Inputs: 0, 0.5, 1, 1.5, 2.

7

Compare Rule A and Rule B at $x = 0$.
Same or different output?

Prediction and reason:

8

Compare Rule A and Rule B at $x = 1$.
Explain the difference.

Prediction and reason:

9

With the revised test $x < 1.5$,
trace $x = 1.5$.

Prediction and reason:

10

With the YES operation changed
to $+0.25$, trace $x = 0.5$.

Prediction and reason:

11

Why does changing $<$ to $\leq$ leave
 $x = 1.5$ unchanged?

Prediction and reason:

12

A learner feeds the last output back in
as a new input. Debug this mistake using
the next listed input and the stop after five outputs.

Prediction and reason:

Precise comparison: fresh inputs

Two similar rules give outputs for the same inputs. Trace the calculations, then answer the question.

Rule P	Rule Q
If $x < 1$, output $x + 0.5$; otherwise output $x \div 2$.	If $x \leq 1$, output $x + 0.5$; otherwise output $x \div 2$.

Inputs (in order): 0.25, 0.75, 1, 1.25, 1.75
Process each input once and stop after five.

Input, x	P branch	P output	Q branch	Q output
0.25				
0.75				
1				
1.25				
1.75				

Circle the first input where outputs diverge. Explain why equality matters.

Name: ANSWERS

Date: _____

Precise comparison: fresh inputs

Two similar rules give outputs for the same inputs. Trace the calculations, then answer the question.

Rule P
If $x < 1$, output $x + 0.5$; otherwise output $x \div 2$.

Rule Q
If $x \leq 1$, output $x + 0.5$; otherwise output $x \div 2$.

Inputs (in order): 0.25, 0.75, 1, 1.25, 1.75

Process each input once and stop after five.

Input, x	P branch	P output	Q branch	Q output
0.25	YES	0.75	YES	0.75
0.75	YES	1.25	YES	1.25
1	NO	0.5	YES	1.5
1.25	NO	0.625	NO	0.625
1.75	NO	0.875	NO	0.875

Circle the **first** input where outputs diverge. Explain why equality matters.

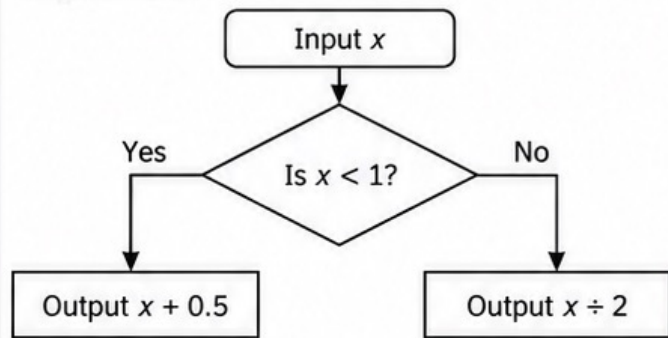
First divergence is $x = 1$: P uses the NO branch and gives 0.5; Q uses the YES branch and gives 1.5.

A tested revision

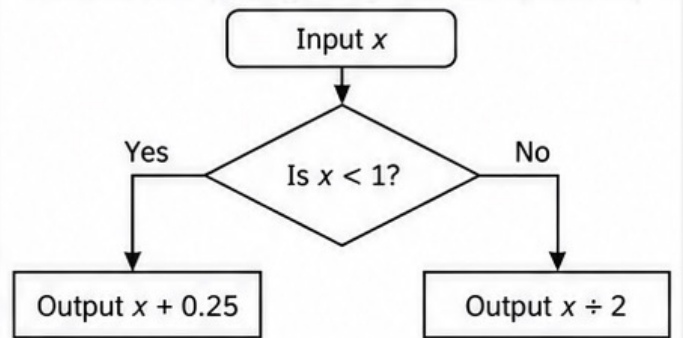
Name: _____

Date: _____

Original rule P



Revised rule (change only the YES operation)



Use the same five inputs: 0.25, 0.75, 1, 1.25, 1.75

1 Predict and explain

Which of the five inputs do you think may give a different output after the revision?
Explain your thinking using the decision ($x < 1$).

2 Retest only those inputs

Retest the inputs you identified in Question 1. Show the outputs from the original rule and the revised rule.

Input					
Original output					
Revised output					

3 Repair the claim

A student makes the claim about the revised rule:

'After each output, feed it back as the next input.'

Why is this claim not correct for this investigation? Write a better statement.

4 What the test shows

State what the five-input test does prove about the effect of the revision, and what it does not prove.

It does prove: _____

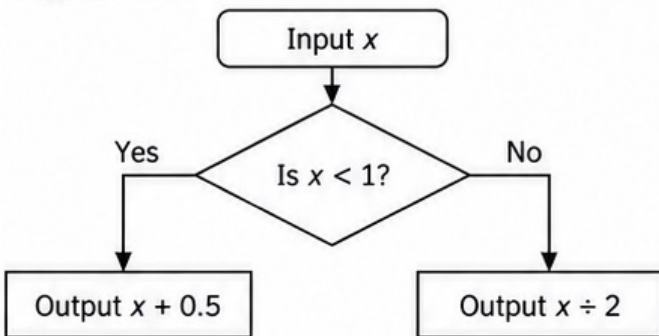
It does not prove: _____

A tested revision

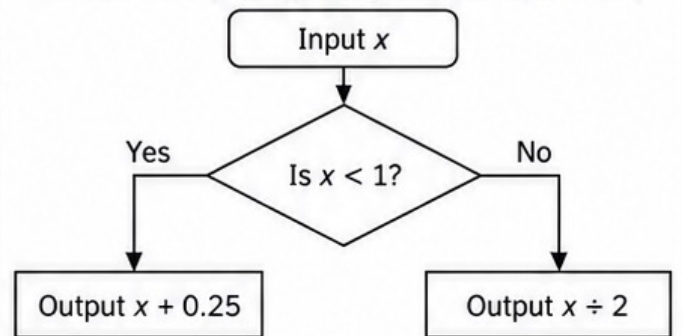
Name: **ANSWERS**

Date: _____

Original rule P



Revised rule (change only the YES operation)



Use the same five inputs: 0.25, 0.75, 1, 1.25, 1.75

1 Predict and explain

Which of the five inputs do you think may give a different output after the revision?
Explain your thinking using the decision ($x < 1$).

Inputs 0.25 and 0.75 use the YES branch, so they may change.

2 Retest only those inputs

Retest the inputs you identified in Question 1. Show the outputs from the original rule and the revised rule.

Input	0.25	0.75			
Original output	0.75	0.375			
Revised output	0.475	1.0			

3 Repair the claim

A student makes the claim about the revised rule:

'After each output, feed it back as the next input.'

Why is this claim not correct for this investigation? Write a better statement.

Process the next listed input, not the previous output; stop after five inputs.

4 What the test shows

State what the five-input test does prove about the effect of the revision, and what it does not prove.

It does prove: **The test proves these two listed YES-branch outputs changed.**

It does not prove: **It does not prove a claim about all rational inputs.**

Debug, compare, explain

Name: _____

Date: _____

Two rules are given below. They take an input number x and produce an output number.

Rule E

If $x < 1.5$, output $x + 0.5$;
otherwise, output $x \div 2$.

Rule F

If $x \leq 1.5$, output $x + 0.5$;
otherwise, output $x \div 2$.

Use the input set below. Process each input once using each rule and stop after five inputs.

Input set (in order): 0.5, 1, 1.5, 2, 2.5

Input, x	Rule E branch (< 1.5 or otherwise)	Rule E output	Rule F branch (≤ 1.5 or otherwise)	Rule F output
0.5				
1				
1.5				
2				
2.5				

1. Where is the difference? Explain the boundary.

2. State one precise revision and retest the affected input.

3. What can you claim from this finite set, and what can you not claim?

Debug, compare, explain

Name: ANSWERS

Date: _____

Two rules are given below. They take an input number x and produce an output number.

Rule E

If $x < 1.5$, output $x + 0.5$;
otherwise, output $x \div 2$.

Rule F

If $x \leq 1.5$, output $x + 0.5$;
otherwise, output $x \div 2$.

Use the input set below. Process each input once using each rule and stop after five inputs.

Input set (in order): 0.5, 1, 1.5, 2, 2.5

Input, x	Rule E branch (< 1.5 or otherwise)	Rule E output	Rule F branch (≤ 1.5 or otherwise)	Rule F output
0.5	YES	1	YES	1
1	YES	1.5	YES	1.5
1.5	NO	0.75	YES	2
2	NO	1	NO	1
2.5	NO	1.25	NO	1.25

1. Where is the divergence? Explain the boundary.

First divergence at $x = 1.5$: E halves to 0.75; F adds 0.5 to make 2.

2. State one precise revision and retest the affected input.

Change the test to $x \leq 1.5$, retest $x = 1.5$ to get 2;
other listed inputs remain.

3. What can you claim from this finite set, and what can you not claim?

The claim applies to this finite tested set, not every possible input.

Name: _____

Date: _____

Learning evidence rubric

Year 6 Mathematics — Debug, Compare, Explain

Criterion	Needs teaching	Developing with support	Target met independently
Concept / accuracy	Inaccurate representation.	Familiar model with prompt but insecure contrast.	Correct fresh case.
Application / procedure	Cannot complete task.	Completes with model or prompts.	Completes independent trace and tested revision.
Reason / evidence	Guess or label only.	Relevant detail but link needs prompt.	Specific trace detail explains finding.
Transfer / communication	Response not interpretable or no transfer.	Clear with support, fresh context, secure	Coherent fresh matched explanation.

Actual evidence

Feedback

Next step

Debug, Compare,
Explain



Purpose and starting check

We will predict two rules' outputs, test a boundary and explain a precise revision.

Diagnostic 1: At $x = 1$, is $x < 1$ true?

Diagnostic 2: What is $1 < 2$?

Record what you think before seeing the worked trace.



Words for debugging

Predicate: a test that is true or false.

Branch: the instruction selected by that test.

Boundary: the value where a comparison changes.

Trace: a written record of each decision and output.

Termination: the statement stopping point. Output: the result.



One finite rule

Inputs in order: 0, 0.5, 1, 1.5, 2.

For each input x : if $x < 1$, output $x \times 0.5$.

Otherwise, output $x \div 2$.

Record that output, then take the next listed input.

Stop after all five inputs. Each input is used once.



First trace: $x = 0.5$

Test the decision: $0.5 < 1$ is true.

Take the YES branch: add 0.5.

Output: $0.5 + 0.5 = 1$.

Record 1 beside input 0.

Then move to the next input.



Contrast: $x = 1$

Test the same decision: $1 < 1$ is false.

Take the NO branch: halve the input.

Output: $1 \div 2 = 0.5$.

Equality is the boundary. Rule A does not include it in the YES branch.



Guided decision: pause

From the first guided trace, use Rule A and $x = 0$.

Rule A tests $x < 1$. YES adds 0.5; NO halves.

Is the test true or false? Which operation follows?

Record the output before advancing.

Tell a partner what is a 2-input trace, not a repeated update.



Guided decision: explain

At $x = 0.5$, the test $0.5 < 1$ is true.

Take the YES branch and add 0.5.

Output: $0.5 + 0.5 = 1$.

Record 1 beside input 0. Then take the next listed input.

The output is not false, so the rule.



Fresh boundary case

Now use Rule B at $x = 1$.

Rule B tests $x \leq 1$; YES adds 0.5 and NO halves.

Equality makes the test true

Output: $1 + 0.5 = 1.5$.

Compare with Rule A at $x = 1$ which outputs 0.5.



One complete game turn

Draw a challenge card and name its single run challenge.

Predict which listed inputs could be affected.

Worked turn: change $<$ to $\leq$ only $x = 1$ changes branch.

Trace it: original output revised output 1.5.

Tell your partner what you think. Check the teacher key.



Independent challenge

Change the test from $x < 1$ to $x < 1.5$.

Keep both operations the same.

Which inputs from 0, 0.5, 1, 1.5 need testing?

Trace the affected input and explain the boundary.



A misleading trace

Wrong: take the last output and feed it back in repeatedly.

That creates a new sequence and changes the target.

Correct: take each input from the given list once, in order.

Record one output beside each input.

Stop after the fifth input.



Fresh comparison

New inputs: 0.25, 0.75, 1, 1.25, 1.75.

Rule P uses $x < 1$; Rule Q uses $x \leq 1$.

YES adds 0.5; NO halves the input.

Predict the first divergence between the two rules.

Explain why the other outputs stay the same.



Choose a route

Support: use step cards and a partially completed trace.

Core: complete the finite trace and explain the boundary.

Extension: compare $x < 1$ with $x < 1.5$.

In every route, state the input, selected branch, output and reason.



Independent assessment

Take each listed input once and stop after five

Trace both rules in aligned columns

Mark the first divergent output and explain the equality case.

Revise one test precisely when request the affected input.

State the limit of the finite evidence



Check your evidence

Which exact input caused the first difference?

Which branch did each rule take there?

Do your recorded calculations support the claim?

What next case would you test if the input set expanded?

Write one targeted test



What this unit establishes

A changed comparison can alter a boundary case.

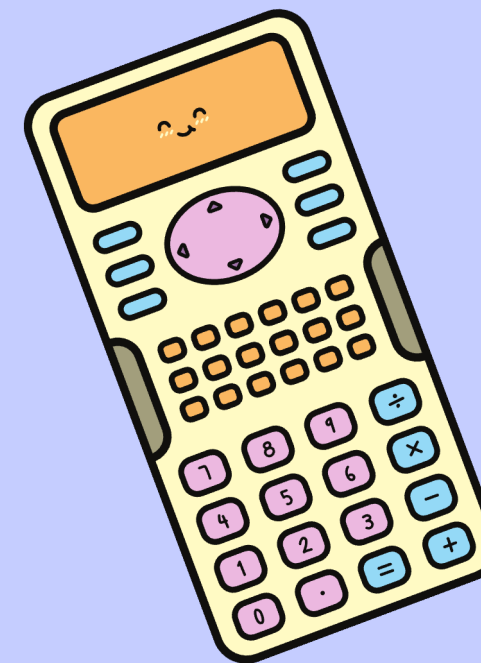
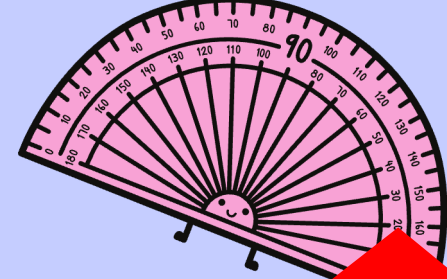
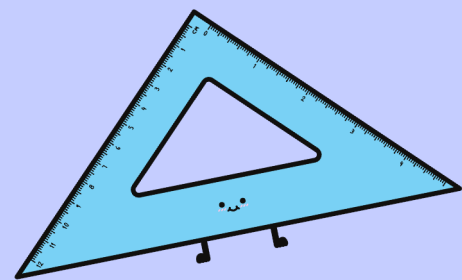
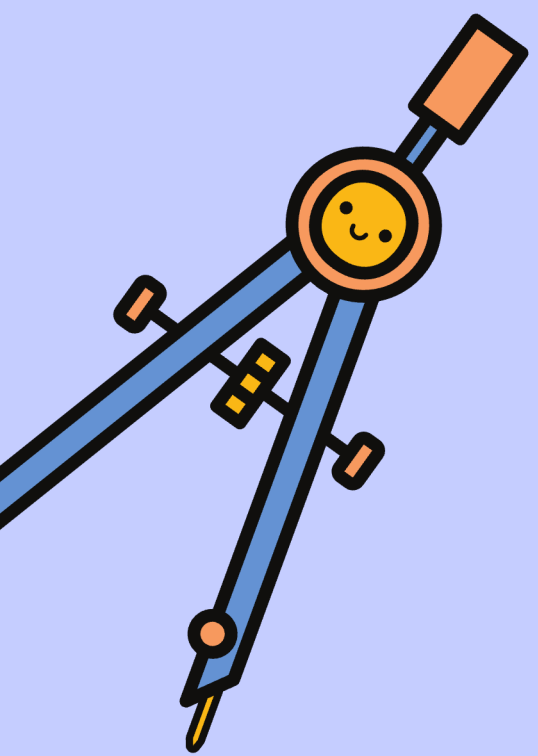
A finite trace locates the first divergence.

Retest the affected case after the previous revision.

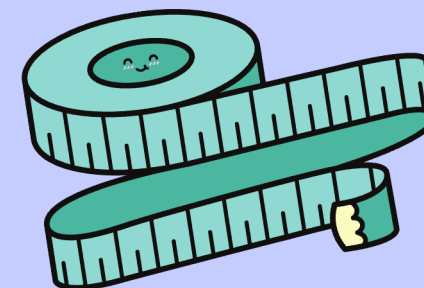
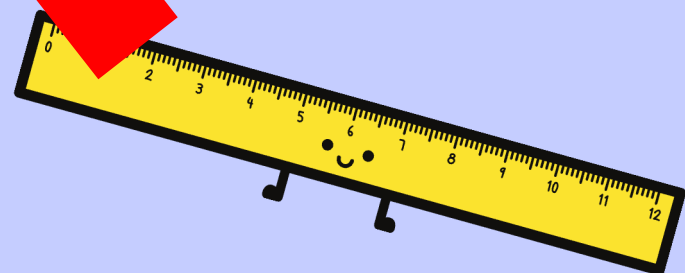
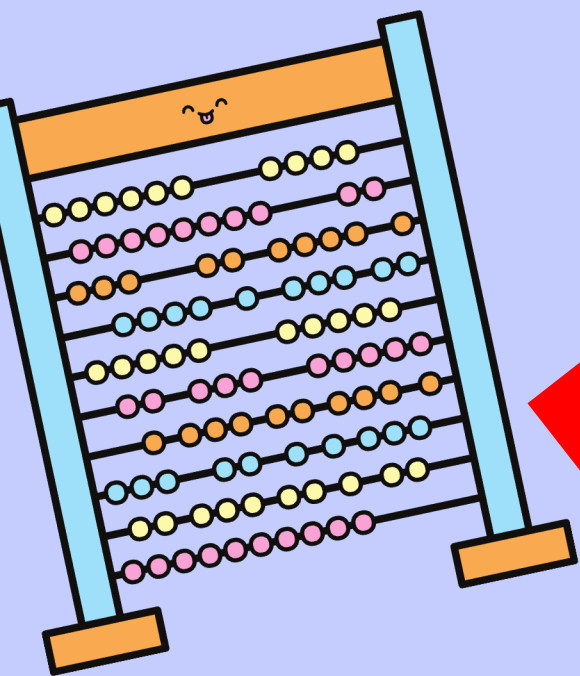
Use the recorded output to explain the finding.

Do not claim the finite test outputs have every possible input.





Well Done!



Debug, Compare,
Explain



Question 1

Where do Rules A and B first diverge in the list set?



Answer 1

At input 1. Rule A tests $x < 1$; Rule B tests $x \leq 1$. Qualifier changes only this listed input's branch.



Question 2

What output does each rule give at $x = 1$



Answer 2

Rule A takes NO: $1 \div 2 = 0.5$. Rule B takes YES: $1 \div 0.5 = 2$



Question 3

Must every input be changed after correcting the competition?



Answer 3

No. Retest the affected boundary $x = 1$ and retest the other verified results. At the other listed inputs, both conditions select the same branch.



Question 4

Trace $x = 1.5$ under Rule A. Name the branch and output.



Answer 4

$1.5 < 1$ is false. Take the NO branch and calculate $1.5 \div 2 = 0.75$.



Question 5

Change only the YES operation from $+0.5$ to $+0.5x$. Compute $x = 0.5$.



Answer 5

The predicate remains true. Original output: $0.5 + 0.25 = 0.75$. Revised output: $0.5 + 0.25 = 0.75$.



Question 6

A learner repeats Rule A on its last output. What is the next output?



Answer 6

The task maps each listed input once. Repeating an element creates a different sequence. Take the next listed input and stop after five.



Question 7

With test $x < 1.5$, what happens at $x = 1$?



Answer 7

The test is true. Add 0.5, giving 1.5. Under right-hand Rule, I took NO and gave 0.5.



Question 8

Compare $x = 0.5$ and $x = 1$ under Rule A.



Answer 8

At 0.5, YES gives 1. At 1, NO gives 0.5. Equality puts 1 in the other branch.



Question a

Under tests $x < 1$ and $x \leq 1$, trace $x = 0.75$



Answer 9

Both tests are true. Both rules add 0.5 and output 1.2



Question 10

What evidence supports the answer for 0.7



Answer 10

0.75 is less than 1, so both predicates are true. Both $0.75 + 0.5 = 1.25$.



Question II

Claim: changing $<$ to $\leq$ changes every output. Is it valid?



Answer II

No. $x = 0.5$ stays in the YES branch under both rules and has outputs 1. One counterexample rejects the claim



Question 12

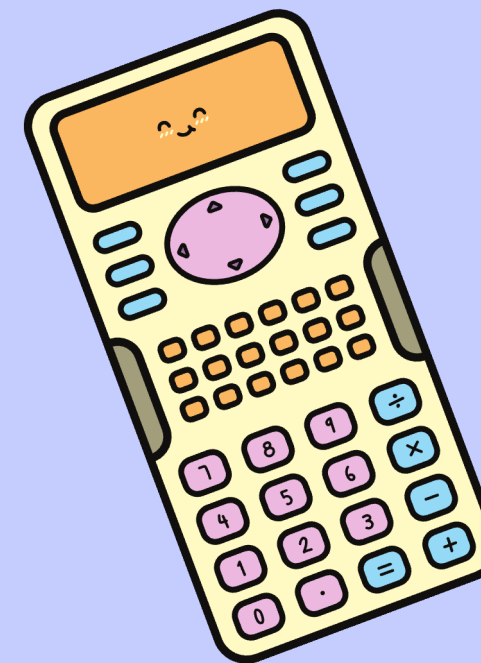
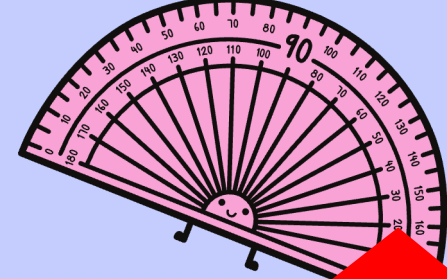
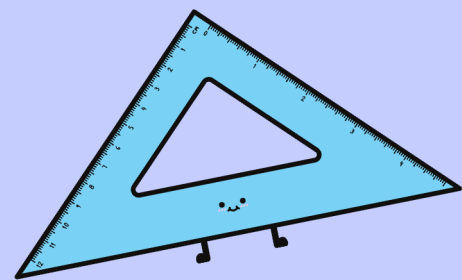
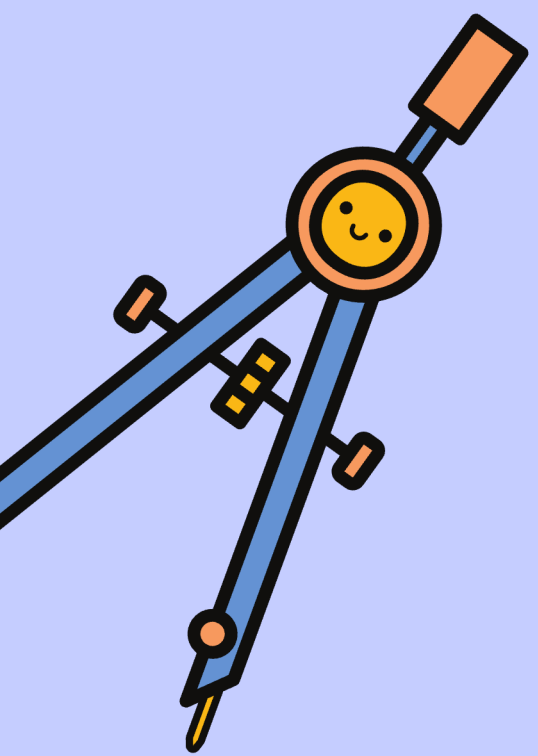
For inputs 0.5, 1, 1.5, 2, 2.5, compare $x < 1$ with $x \leq 1$. IF adds 0.5; NO halves. Where is the first divergence?



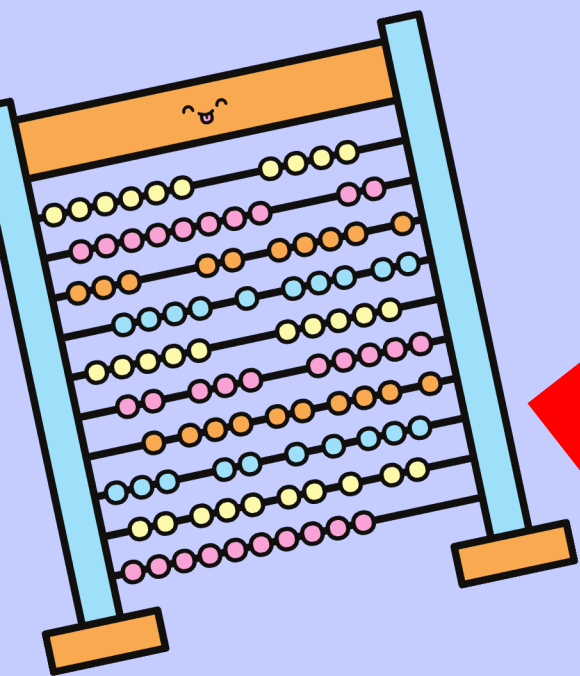
Answer 12

At $x = 1.5$. The $<$ rule takes NO and outputs 0.75. The $\leq$ rule takes YES and outputs 2. Retest that boundary and compare the other listed inputs.





Well Done!



PREVIEW

