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## Number-Property Problem Solvers - Year 6

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# Teacher Guide – overview

## Purpose and evidence

Apply prime, composite and square properties to constraints and conjectures.

Success: find all valid solutions, justify a property, give a counterexample and simplify a product efficiently.

## Prerequisites and entry

Retrieve factors, multiplication and square arrays. Ask for squares between 20 and 40 and whether 2 is prime. Re-teach only the insecure prerequisite.

## Equipment and preparation

Counters, tiles, hundred grids or arrays, pencils, R1 display, R2 cards, R3 sheet, R4 cut cards, R5 rehearsal, R6 assessment and R7 rubric.

## Lesson 1 – translate a clue

Model R1: composite square strictly between 20 and 40 gives 25 and 36. Show why both fit, then add even to select 36. Partners explain to model R2 cards; collect one response per learner.

## Lesson 2 – test candidates

List candidate squares first, then test each condition. Model a changed clue with R2. Pupils complete R3 rehearsal and explain why a rejected candidate fails.

# Teacher Guide – lessons 3-5

## Lesson 3 – reject overgeneral claims

Model a complete R4 turn, including the incomplete answer 25 without 36. Use R3 core and R4. Observe whether pupils give a genuine counterexample with a reason.

## Lesson 4 – multi-constraint transfer

Use R3 transfer and R5. Compare 49 and 64, then add an even clue. Regroup  $16 \times 25$  as  $4 \times (4 \times 25) = 400$ . Give criterion-specific feedback.

## Lesson 5 – independent evidence

Use R6 without an answer display. Pupils solve two fresh puzzles, disprove one claim and simplify  $28 \times 25$ . Apply R7 and record observed evidence plus one reverse next step.

## Access and differentiation

Support: pre-list candidates or use a part-filled table without changing the target relation. Core: list and justify independently. Extension: automatically checked unique puzzle or find a counterexample.

## Assessment principles

Accept an accessible response and any mathematically valid alternative explanation. Require the result, a relevant property/reason and transfer to the fresh case.

# Teacher Key and feedback

## Property Puzzle Partners – cards 1-6

1: 25,36. 2: 36. 3: 9. 4: 2. 5: 1. 6: 23,29.

A complete response names every solution and gives square, factor, parity or prime evidence.

## Property Puzzle Partners – cards 7-12

7: 15. 8: 64. 9: 49. 10: 4,9,16. 11: 9 is an odd composite counterexample. 12:  $12 \times 25 = 3 \times (4 \times 25) = 300$ .

## Independent assessment sample key

A  $64 = 8 \times 8$ , even, in range. B  $21 = 3 \times 7$ ,  $84 \div 21 = 4$ , odd and in range. C  $9 = 3 \times 3$  is odd square; accept any odd square. D  $28 \times 25 = 7 \times (4 \times 25) = 700$ .

## Feedback and next step

If a pupil finds only one of 25 and 36, prompt a complete candidate list. If a pupil gives a claim label without evidence, ask for a factor, square, product or counterexample.

## Common cautions

1 is neither prime nor composite, is prime. Square and composite categories overlap. Triangles are better for outside this unit's required target.

# Test every clue

Number-Property Problem Solvers



Translate → list → test → justify

Turn the clues into maths, list possible numbers, test each one and explain your reasoning.

1

## Translate the clue

Write the mathematical meaning.

“Composite square between 20 and 40”

- A square number ( $n^2$ )
- Composite (more than two factors)
- Greater than 20 and less than 40

2

## List possible numbers

List the square numbers between 20 and 40.

The square numbers in this range are 25 and 36.

$$5^2 = 25 \text{ and } 6^2 = 36$$

3

## Test each number

Check the property “composite”.

$$25 = 5 \times 5$$

Factors of 25: 1, 5, 25

25 has more than two factors,  
so it is composite.

$$36 = 6 \times 6$$

Factors of 36: 1, 2, 3, 4, 6, 9, 12, 18, 36

36 has more than two factors,  
so it is composite.

### What about 23?

23 is not a square number because it is not a perfect square. In fact, 23 is prime, with exactly two factors, 1 and 23, so it does not fit the clue.

4

## Justify the solution set

State the numbers that work and explain why.

Both 25 and 36 are composite squares between 20 and 40,  
so the solution set is  $\{25, 36\}$

Always explain  
why each number  
works or does not work.

5

## Add another clue

Now include the clue “even” and test again.

From  $\{25, 36\}$ , only 36 is even. Therefore the new solution is

$\{36\}$

25 is odd,  
36 is even.  
So the additional clue  
filters the solution set  
to 36.



Use the clues. Be systematic. Explain your reasoning.



Numbers reward  
good reasoning.

## Number-Property Problem Solver

Year 6

**Clue:**

**Square,  $20 < n < 40$**

$$n = k \times k$$

A square number is a number multiplied by itself.



**Answer:**

**25 and 36**

**Justification:**

$$5 \times 5 = 25 \text{ and } 6 \times 6 = 36.$$

Both are square numbers and are between 20 and 40.



## Number-Property Problem Solver

Year 6

**Clue:**

**Composite square,  $20 < n < 40$**

A composite number has more than two factors.



**Answer:**

**25 and 36**

**Justification:**

25 and 36 are square numbers between 20 and 40, and each has more than two factors.

25: 1, 5, 25      36: 1, 2, 3, 4, 6, 9, 12, 18, 36



## Number-Property Problem Solver

Year 6

**Clue:**

**Even composite square,  $20 < n < 40$**

An even number is divisible by 2.



**Answer:**

**36**

**Justification:**

36 is a square number, it is composite, and it is even ( $36 \div 2 = 18$ ).

25 is a square number but it is odd, so it does not fit.

4

## Number-Property Problem Solvers

Year 6  
MathematicsOdd square,  $20 < n < 40$ 

## Clue

Find a whole number  $n$  such that:

- $n$  is a perfect square
- $n$  is odd
- $20 < n < 40$

## Answer

25

It is  $5 \times 5$   
and it is odd.

## Test evidence

$$5 \times 5 = 25$$

$$20 < 25 < 40$$

25 is odd

(it does not end in 0, 2, 4, 6 or 8).

5

## Number-Property Problem Solvers

Year 6  
MathematicsPrime,  $20 < n < 30$ 

## Clue

Find the whole number(s)  $n$  such that:

- $n$  is a prime number
- $20 < n < 30$

## Answer

23 and 29

There are two  
valid solutions.

## Test evidence

23 is prime:

It has exactly two factors,  
1 and 23.

$$20 < 23 < 30$$

29 is prime:

It has exactly two factors,  
1 and 29.

$$20 < 29 < 30$$

6

## Number-Property Problem Solvers

Year 6  
MathematicsComposite factor of 100,  $20 < n < 30$ 

## Clue

Find a whole number  $n$  such that:

- $n$  is a factor of 100
- $n$  is composite
- $20 < n < 30$

## Answer

25

It is a factor of 100  
and it is composite,  
because  $25 = 5 \times 5$ .

## Test evidence

$$100 \div 25 = 4$$

So 25 is a factor of 100.

$$25 = 5 \times 5$$

It has more than two factors  
(1, 5, 25), so it is composite.

$$20 < 25 < 30$$

**7****Number-Property Problem Solvers****Find a counterexample!****Claim:** Every square is composite.**FALSE****Counterexample:**

$$1 = 1 \times 1$$

1 is a square.

**Reason:**

1 is neither prime  
nor composite.

**So, the claim is false.****8****Number-Property Problem Solvers****Find a counterexample!****Claim:** Every composite is even.**FALSE****Counterexample:**

$$9 = 3 \times 3$$

9 is odd and a composite.

**Reason:**

9 is composite  
and it is odd.

**So, the claim is false.****9****Number-Property Problem Solvers****Find a counterexample!****Claim:** Every prime is odd.**FALSE****Counterexample:**

2 is even and prime.

**Reason:**

2 is a prime number  
and it is even.

**So, the claim is false.**

# Number-Property Problem Solvers

## Year 6 Mathematics

Numbers  
have patterns  
— use them!

Think  
Reason  
Solve

### 10 Square, $10 < n < 20$

#### Clue

Find the whole number  $n$  such that  $10 < n < 20$  and  $n$  is a square number.

#### Answer

**16**

#### Reason

$4 \times 4 = 16$ , and 16 is between 10 and 20. It is a square number.

### 11 Even square, $40 < n < 70$

#### Clue

Find the whole number  $n$  such that  $40 < n < 70$  and  $n$  is a square number that is even.

#### Answer

**64**

#### Reason

$8 \times 8 = 64$ , and 64 is between 40 and 70. It is a square number and it is even.  
49 is a square number but it is odd, so it does not work.

### 12 Simplify $12 \times 25$

#### Clue

Simplify  $12 \times 25$ .  
Show your working and explain why grouping  $4 \times 25$  is efficient.

#### Answer

**300**

#### Reason

$12 = 3 \times 4$ , so  
 $12 \times 25 = 3 \times (4 \times 25)$   
 $= 3 \times 100$   
 $= 300$ .  
Grouping  $4 \times 25$  is efficient because  $4 \times 25 = 100$ , which is an easy number to multiply by 3.

Look for number properties. They can make problem solving easier!

# Guided candidate investigation

Use number properties to work through the questions. Show your thinking and working.

- ① List all square numbers with  $20 < n < 40$ .

Hint:  $5 \times 5 = 25$

- ② Test each candidate from Question 1 for composite status using factors.  
Write the factors of each number and state whether it is composite or not, giving a reason.

| Number | Factors | Composite or not? Give a reason. |
|--------|---------|----------------------------------|
|        |         |                                  |
|        |         |                                  |
|        |         |                                  |
|        |         |                                  |

- ③ Now add the clue: the number is even.  
From your candidates in Question 1, circle the number that remains.  
Explain in one sentence why this number fits all the clues.

- ④ Test the claim: "Every prime is odd."  
Give one counterexample and explain why it shows the claim is not true.

Counterexample: \_\_\_\_\_

Explanation:

## Guided candidate investigation

Use number properties to work through the questions. Show your thinking and working.

- ① List all square numbers with  $20 < n < 40$ .

Hint:  $5 \times 5 = 25$

**25 and 36, since  $5 \times 5 = 25$  and  $6 \times 6 = 36$ .**

- ② Test each candidate from Question 1 for composite status using factors.  
Write the factors of each number and state whether it is composite or not, giving a reason.

| Number    | Factors                             | Composite or not? Give a reason.                        |
|-----------|-------------------------------------|---------------------------------------------------------|
| <b>25</b> | <b>1, 5, 25</b>                     | <b>Composite, because it has more than two factors.</b> |
| <b>36</b> | <b>1, 2, 3, 4, 6, 9, 12, 18, 36</b> | <b>Composite, because it has more than two factors.</b> |
|           |                                     |                                                         |
|           |                                     |                                                         |

- ③ Now add the clue: **the number is even.**  
From your candidates in Question 1, circle the number that remains.  
Explain in one sentence why this number fits all the clues.

**36 only, because 36 is even and 25 is odd.**

- ④ Test the claim: "Every prime is odd."  
Give one counterexample and explain why it shows the claim is not true.

Counterexample: **2**

Explanation: **2 is even and prime, with exactly two positive factors 1 and 2.**

Name: \_\_\_\_\_

## Independent candidate investigation

Use the candidate set below to answer the clues.

**Candidate set:** {1, 2, 4, 9, 16, 23, 25, 29, 36, 49, 64}

For each clue, write ALL numbers from the candidate set that fit, and give a brief reason.  
A clue may have more than one answer.

1. **Odd square,  $20 < n < 40$ .**

Number(s): \_\_\_\_\_

Reason: \_\_\_\_\_

2. **Even square,  $20 < n < 40$ .**

Number(s): \_\_\_\_\_

Reason: \_\_\_\_\_

3. **Prime,  $20 < n < 30$ .**

Number(s): \_\_\_\_\_

Reason: \_\_\_\_\_

4. **Composite square,  $n < 20$ .**

Number(s): \_\_\_\_\_

Reason: \_\_\_\_\_

5. **Odd composite factor of 100,  $20 < n < 30$ .**

Number(s): \_\_\_\_\_

Reason: \_\_\_\_\_

6. **Composite square factor of 36.**

Number(s): \_\_\_\_\_

Reason: \_\_\_\_\_

Name: **ANSWERS**

## Independent candidate investigation

Use the candidate set below to answer the clues.

**Candidate set:** {1, 2, 4, 9, 16, 23, 25, 29, 36, 49, 64}

For each clue, write ALL numbers from the candidate set that fit, and give a brief reason. A clue may have more than one answer.

1. **Odd square**,  $20 < n < 40$ .

Number(s): **25**

Reason:  **$5 \times 5 = 25$  and odd.**

2. **Even square**,  $20 < n < 40$ .

Number(s): **36**

Reason:  **$6 \times 6 = 36$  and even.**

3. **Prime**,  $20 < n < 30$ .

Number(s): **23, 29**

Reason: **each has only 1 and itself as positive factors.**

4. **Composite square**,  $n < 20$ .

Number(s): **4, 9, 16**

Reason: **Each listed number is a square and composite.**

5. **Odd composite factor of 100**,  $20 < n < 30$ .

Number(s): **25**

Reason:  **$100 \div 25 = 4$ , 25 odd/composite.**

6. **Composite square factor of 36**.

Number(s): **4, 9, 36**

Reason: **each is square/composite and divides 36.**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Transfer: test and justify

Use your knowledge of number properties to solve each problem. Show your working and explain your reasoning clearly.

- 1 Find the odd square with  $40 < n < 70$ .  
Show the product that proves it is a square.

Working:

Explanation:

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- 2 A learner says, "Every prime number is odd."  
Give a counterexample and explain why it refutes the claim.

Working:

Explanation:

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- 3 Find the odd composite factor of 60 with  $10 < n < 30$ .  
Show factor evidence and a check that it divides 60.

Working:

Explanation:

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Name: **ANSWERS**

Date: \_\_\_\_\_

## Transfer: test and justify

Use your knowledge of number properties to solve each problem. Show your working and explain your reasoning clearly.

- ① Find the odd square with  $40 < n < 70$ .  
Show the product that proves it is a square.

Working:

49, since  $7 \times 7 = 49$ .

Explanation:

49 is odd and lies between  
40 and 70.

- ② A learner says, "Every prime number is odd."  
Give a counterexample and explain why it refutes the claim.

Working:

2.

Explanation:

2 is prime with factors 1 and 2,  
but it is even, so the claim is false.

- ③ Find the odd composite factor of 60 with  $10 < n < 30$ .  
Show factor evidence and a check that it divides 60.

Working:

15.

$15 = 3 \times 5$  so composite  
and odd.

$60 \div 15 = 4$ .

Explanation:

$10 < 15 < 30$ .



# Property Puzzle Partners

Discuss • Reason • Justify • Score Together



## Aim

Use number properties to find all possible answers to each challenge, justify your thinking and score points with your partner.

## Equipment



Challenge cards



Counters



Pencils



Teacher key

## How to Play

1

### Choose a card.

Take a challenge card and read it aloud.

2

### Privately list ALL possible answers.

Each player writes down every number that could be a solution.

3

### State a property and evidence.

Take turns to share one of your answers. State a relevant number property and give evidence to explain why it works.

4

### Partner checks with teacher key.

Your partner uses the teacher key to check that the answer is correct and the justification is valid.

5

### Earn 1 point, then switch turns.

You earn 1 point only if your answer is correct, all possible answers for the card are given, and your justification is complete. Then it's your partner's turn.

## Worked Turn

### Challenge card:

Composite square,  $20 < n < 40$

### Player 1 privately lists:

25, 36

### Player 1 states answer, property and evidence)

25 and 36.

They are both square numbers ( $5^2$  and  $6^2$ ) and both are composite because they have more than two factors.

### Why one solution alone is incomplete

If I only said 25, that is incomplete because 36 also fits the clue. Both 25 and 36 must be named and justified to get the point.

### Note:

Accept multiple valid solutions only when all are named and justified.



## Finish the Game

After six turns each, the game ends.

The player with the highest score for justified complete answers wins!



THINK TOGETHER  
ACHIEVE MORE



# Property Puzzle Partners

## YEAR 6 MATHEMATICS



Work with a partner. Use number properties to find all possible numbers for each clue. Explain your evidence.

1

Square,  $20 < n < 40$ .

Working out:

2

Even composite square,  
 $20 < n < 40$ .

Working out:

3

Odd square,  $5 < n < 20$ .

Working out:

4

Even prime number.

Working out:

5

Square but not composite.

Working out:

6

Prime,  $20 < n < 30$ .

Working out:

PREVIEW

Name all valid solutions and justify.



# Property Puzzle Partners

## Year 6 Mathematics



Use number properties, logical reasoning and clear working to solve each challenge.

**7**

Odd composite factor  
of 60,  $10 < n < 30$ .

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**8**

Even square,  
 $40 < n < 70$ .

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**9**

Odd square,  
 $40 < n < 70$ .

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**10**

Composite square,  
 $10 < n < 20$ .

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**11**

Give a counterexample:  
Every composite is even.

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**12**

Regroup  $12 \times 25$   
to calculate efficiently.

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**PREVIEW**



Name all valid solutions and justify.



# Property puzzle rehearsal 1

Name: \_\_\_\_\_

1. List ALL square numbers that are strictly between 40 and 70.  
Show the square products for each one.

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2. Now add the extra clue: the number is even.  
Which of your solutions from Question 1 remains? Explain why.

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3. Simplify  $16 \times 25$  by regrouping factors.  
Show why  $4 \times 25$  helps.

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4. The following claim is false:  
“Every prime is odd.”  
Repair the claim by giving a counterexample and explaining why it shows the claim is not true.

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# Property puzzle rehearsal 1

Name: **ANSWERS**

1. List ALL square numbers that are strictly between 40 and 70.  
Show the square products for each one.

$$49 = 7 \times 7$$

$$64 = 8 \times 8$$

2. Now add the extra clue: the number is even.  
Which of your solutions from Question 1 remains? Explain why.

64 only, since 64 is even while 49 is odd.

3. Simplify  $16 \times 25$  by regrouping factors.  
Show why  $4 \times 25$  helps.

$$16 \times 25 = 4 \times (4 \times 25)$$

$$= 4 \times 100$$

$$= 400$$

Grouping makes 100.

4. The following claim is false:  
“Every prime is odd.”  
Repair the claim by giving a counterexample and explaining why it shows the claim is not true.

2 is an even prime (its factors are 1 and 2),  
so the claim is false.

# Property puzzle rehearsal 2

Name: \_\_\_\_\_

Read each problem carefully. Show your working and write your answers in the spaces provided.

- 1** 60 has several composite factors.  
Find the odd composite factor of 60  
that is greater than 10 and less than 30.

Write the factor and show division evidence  
to confirm it is a factor of 60.

Factor: \_\_\_\_\_

Division evidence:

- 2** 20 is a factor of 60, but it does not fit  
the odd clue in Question 1.

Explain why 20 fails the odd clue,  
even though it is a factor of 60.

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- 3** Simplify  $6 \times 25$  using  $6 = 3 \times 2$ .  
Show the grouping and your working.

$$6 \times 25 =$$

- 4** The statement "1 is prime" is not correct.  
Repair the statement by explaining  
how many positive factors 1 has and  
why this means it is not a prime number.

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# Property puzzle rehearsal 2

Name: ANSWERS

Read each problem carefully. Show your working and write your answers in the spaces provided.

- 1** 60 has several composite factors.  
Find the odd composite factor of 60  
that is greater than 10 and less than 30.

Write the factor and show division evidence  
to confirm it is a factor of 60.

Factor: 15

Division evidence:  $60 \div 15 = 4$

$15 = 3 \times 5$ , so it is composite and odd.

$10 < 15 < 30$ .

- 2** 20 is a factor of 60, but it does not fit  
the odd clue in Question 1.

Explain why 20 fails the odd clue,  
even though it is a factor of 60.

20 is an even number, so it fails  
the odd condition.

However,  $60 \div 20 = 3$  so it is  
a factor of 60.

- 3** Simplify  $6 \times 25$  using  $= 3 \times$   
Show the regrouping and your working.

$$\begin{aligned} 6 \times 25 &= (3 \times 2) \times 25 \\ &= 3 \times (2 \times 25) \\ &= 3 \times 50 \\ &= 150 \end{aligned}$$

- 4** The statement "1 is prime" is not correct.  
Repair the statement by explaining  
how many positive factors 1 has and  
why this means it is not a prime number.

1 has exactly one positive factor, 1.  
A prime number has exactly two  
positive factors, so 1 is not a  
prime number. It is neither prime  
nor composite.

# Independent property puzzle assessment

Name: \_\_\_\_\_

## A. Even square

Find the even square number  $n$  with  $50 < n < 90$ .

Justify why your number is a square and why it is even.

## B. Odd composite factor

Find the odd composite factor of 84 with  $10 < n < 30$ .

Justify why your number is a factor of 84 and why it is composite.

## C. Counterexample

Give a counterexample to the statement "All square numbers are even".

Explain why your counterexample shows the statement is not always true.

## D. Efficient calculation

Calculate  $28 \times 25$  efficiently by grouping a factor of four.

Show the equivalent calculation and explain why the grouping helps.

**Self-check:** Have you tested each condition in your answer? Yes ☐ No ☐

# Independent property puzzle assessment

Name: **ANSWERS**

## A. Even square

Find the even square number  $n$  with  $50 < n < 90$ .

Justify why your number is a square and why it is even.

$$n = 64.$$

$64 = 8 \times 8$ , so it is a square number.

64 is even, and  $50 < 64 < 90$ .

## B. Odd composite factor

Find the odd composite factor of 84 with  $10 < n < 30$ .

Justify why your number is a factor of 84 and why it is composite.

$$n = 21.$$

$84 \div 21 = 4$ , so 21 is a factor of 84.

$21 = 3 \times 7$ , so it is composite and odd, and  $10 < 21 < 30$ .

## C. Counterexample

Give a counterexample to the statement "All square numbers are even".

Explain why your counterexample shows the statement is not always true.

$9 = 3 \times 3$  is a square number and it is odd.

This shows the statement is not always true because 9 is a square number that is not even.

## D. Efficient calculation

Calculate  $28 \times 25$  efficiently by grouping a factor of four.

Show the equivalent calculation and explain why the grouping helps.

$$28 \times 25 = (7 \times 4) \times 25 = 7 \times (4 \times 25) = 7 \times 100 = 700.$$

The grouping helps because  $4 \times 25 = 100$ , which makes the calculation easier.

Accept equivalent valid reasoning.

**Self-check:** Have you tested each condition in your answer? Yes ☐ No ☐

# Number-Property Problem Solvers — Learning Evidence Rubric

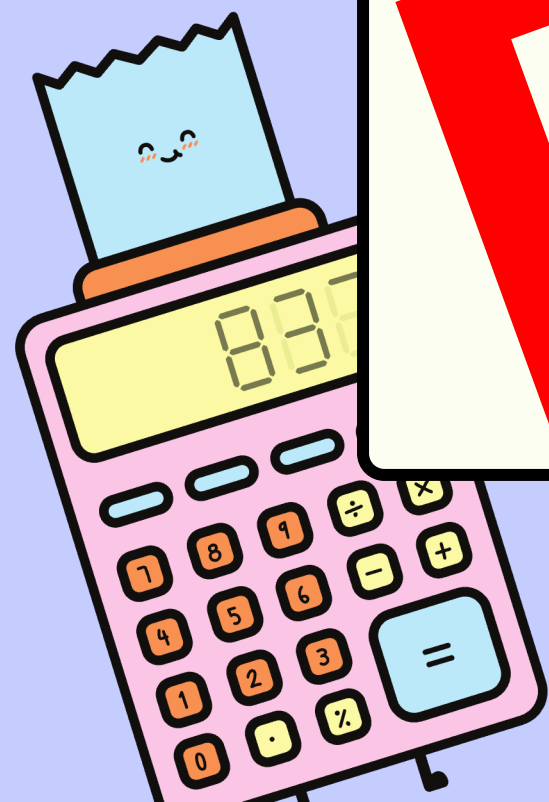
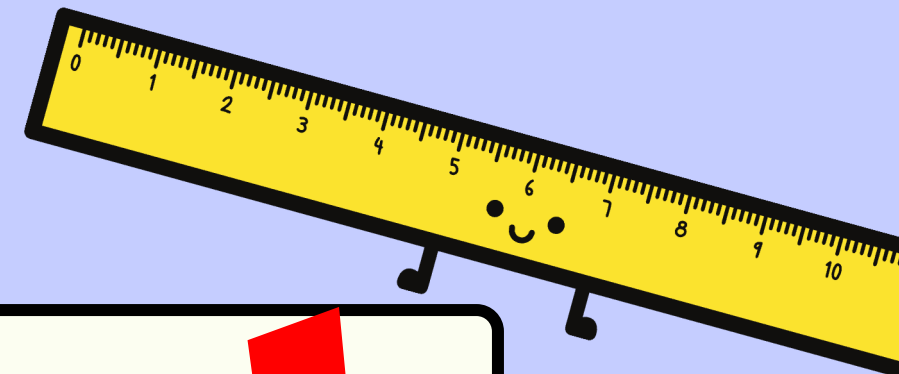
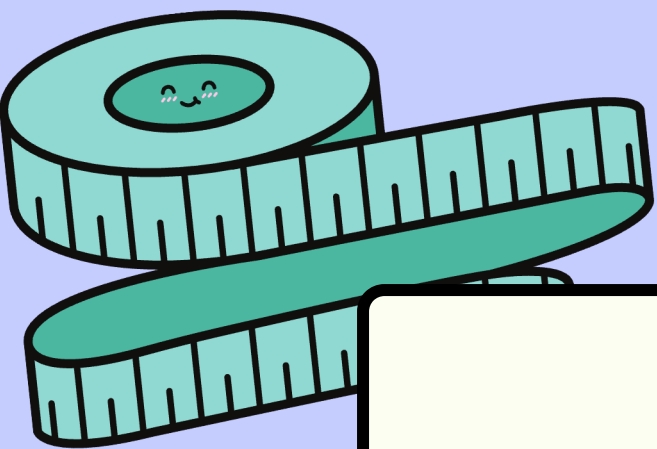
Student: \_\_\_\_\_

Date: \_\_\_\_\_

| Criterion                     | Needs teaching                                    | Developing with support                                  | Target met independently                                      |
|-------------------------------|---------------------------------------------------|----------------------------------------------------------|---------------------------------------------------------------|
| <b>Concept/accuracy</b>       | inaccurate property or representation             | correct familiar model with prompt but insecure contrast | correctly applies relation to fresh case                      |
| <b>Application/procedure</b>  | cannot yet complete meaningful puzzle/calculation | completes with model or step prompts                     | completes actual puzzle and calculation independently         |
| <b>Reason/evidence</b>        | guess or label only                               | relevant detail but connection needs prompting           | explains with specific property, number fact, model or reason |
| <b>Transfer/communication</b> | response unclear or method does not transfer      | clear with support but fresh case insecure               | coherent explanation and same method in fresh matched context |

Evidence observed:

Next teaching step:



**PREVIEW**

**Number-Property  
Problem Solvers**



# Our learning goal

Use prime, composite and square properties to solve ques

Find every valid solution and justify it.

Entry: Which squares lie between 20 and 4

Entry: Is 2 prime composite or neither? Why?

PREVIEW



# Words we will use

Factor: a whole number that divides another exactly

Prime: exactly two positive factors. Composite: more than two

Square: a whole number multiplied by itself

Counterexample: one word or claim that disproves a claim.

Simplifying: finding an efficient equivalent calculation.



# Test every clue

Translate the clue into properties.

List all candidate numbers in the range.

Test each condition systematically.

Justify the complete solution.

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## Two valid solutions

Clue: composite square,  $20 < n < 40$ .

$25 = 5 \times 5$  and has factors 1, 5, 25.

$36 = 6 \times 6$  and has more than two factors.

Both 25 and 36, the value is unique.



# One extra condition

Add the clue EVEN.

36 is even; 25 is odd. So 36 is the unique solution.

Contrast: 23 is prime, but it is not a square.

A candidate must satisfy evenness, not just oddness.



# Your turn: list candidates

Find every square number with  $40 < n < 70$ .

Show the product that makes each a square.

Pause and compare complete solution sets

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# Check and explain

$49 = 7 \times 7$  and  $64 = 8 \times 8$ .

Both lie strictly between 40 and 70.

The solution set is  $\{49, 64\}$ .

An added even number would lead to 64.



# Test candidates systematically

Use a candidate table: number | square? | prime/composite? | other clue?

For 25 and 36, test each property in turn.

Cross out a number only when a named condition fails.

Keep a reason beside every cross out.



# A complete game turn

Card: composite square,  $20 < n < 40$ .

Player privately lists 25 and 36.

Player says why both are square and composite.

Partner checks the teacher's completely justified answer earns a point.



# Independent challenge

Claim: Every prime number is odd.

Find a counterexample.

Explain both why it is prime and why it denies the claim

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# Fix the misconception

2 is even AND prime: its only positive factors are 1 and 2.

1 is neither prime nor composite: it has one positive factor.

Squares and composites can overlap: 4, 9, 16, 25, 36...

Use a counterexample to reject an overgeneralization.



# Transfer to a fresh case

Find the odd composite square with  $40 < n < 70$ .

Check both 49 and 64, then test oddness.

Simplify  $16 \times 25$  by grouping a factor of four with 25.

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# Choose a route

Support: use pre-listed candidate squares and test each one.

Core: list and test candidates independently.

Extension: write a new clue and check it is unique.

Give a counter example to a claim.

Explain and justify a proposition.



# Show independent evidence

Solve two fresh property puzzles with reasons.

Give one counterexample to a claim.

Show an efficient equivalence relation.

Use the assessment to prove independently; explain every condition.



# Reflect on your evidence

Where did you translate a clue accurately?

Did you find every solution, not just the first?

Which number fact made your calculation efficient?

Name one previous step in your reasoning



# What problem solvers do

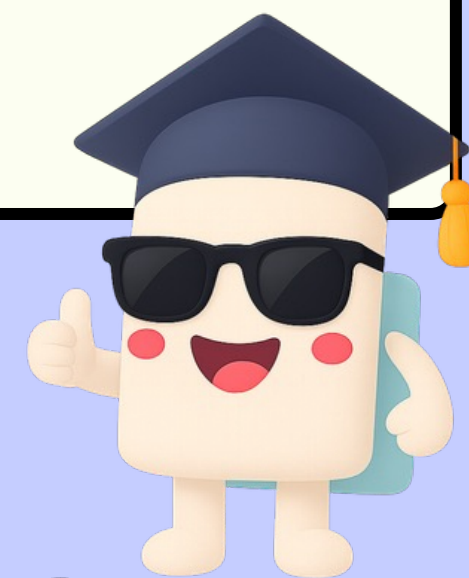
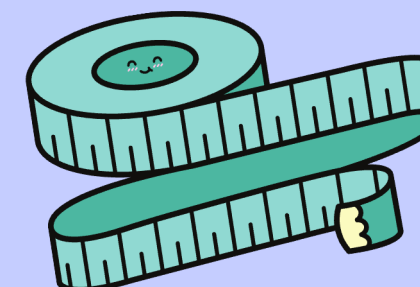
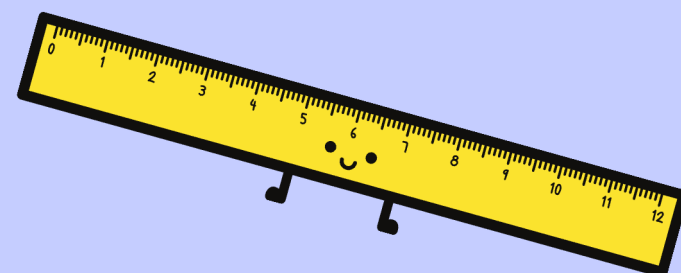
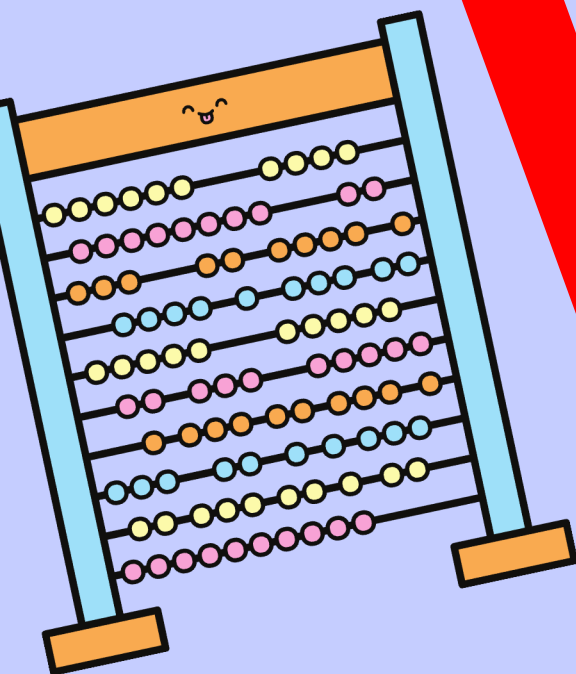
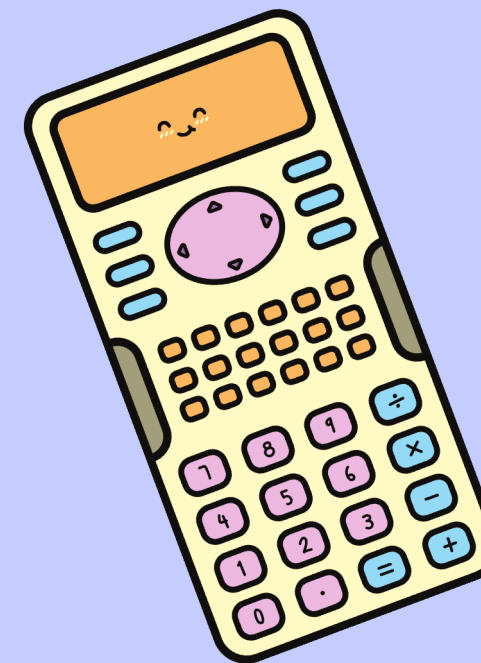
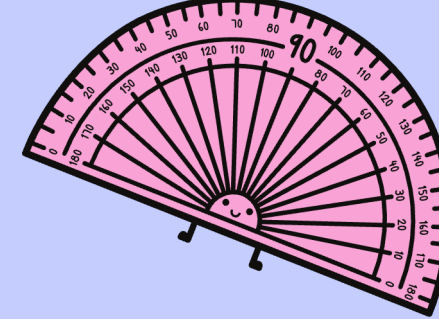
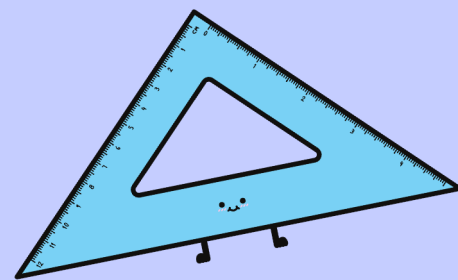
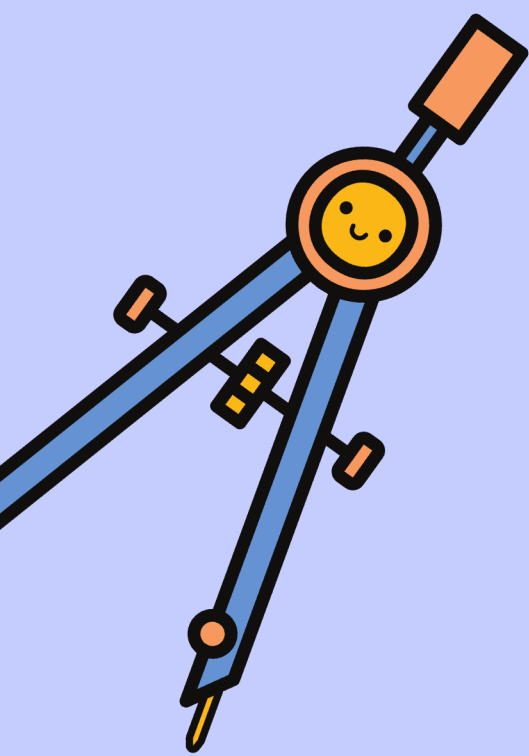
Translate → list → test → justify.

A counterexample defeats an overgeneral claim.

Factors can simplify a product.  $12 \times 25 = 300$  ( $4 \times 5$ ) = 300

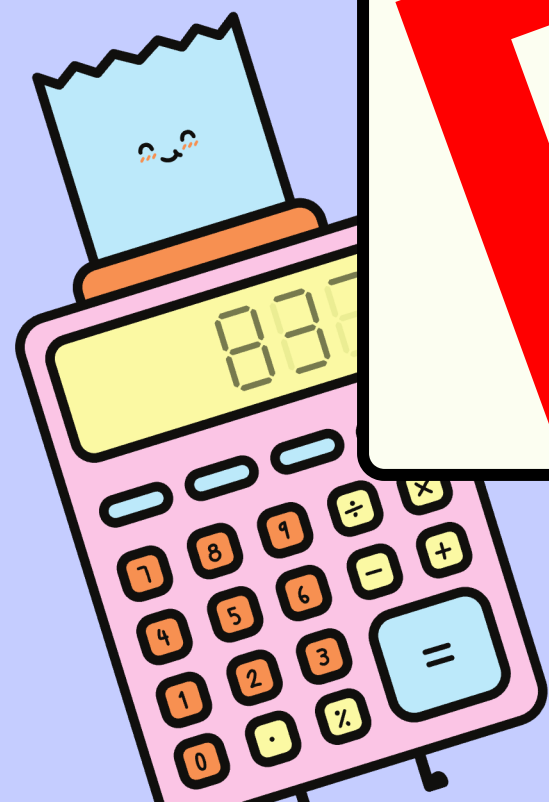
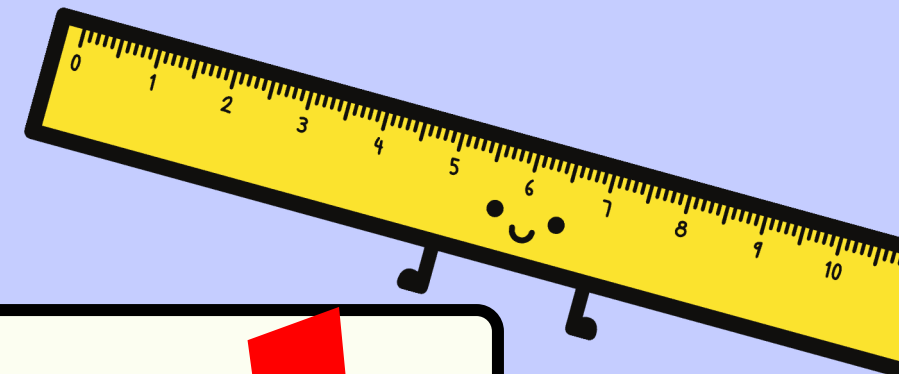
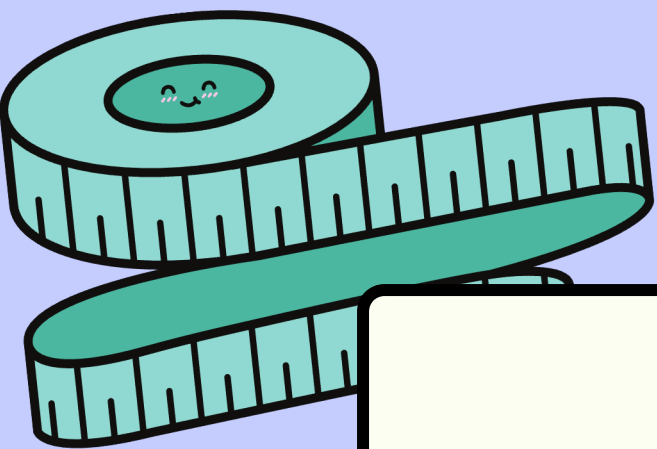
Check the context of the solution.





**PREVIEW**

We'll Do  
Test every cide.



**PREVIEW**

Number-Property  
Problem Solvers Quiz



**Q1: Is the clue unique?**

Does 'composite square,  $20 < n < 40$ ' identify only one number?

List every solution and give a reason.

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## A1: Two solutions

No. 25 =  $5 \times 5$  and  $36 = 6 \times 6$ .

Both are composite squares between 20 and 40

The complete solution set is  $\{25, 36\}$ .

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## Q2: Add one clue

Which extra clue makes 36 the unique answer: odd or even?

Explain how it changes the solution set.

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## A2: Even

Add 'even'. 36 is even, while 25 is odd.

The new solution set is {36}.

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## Q3: Calculate efficiently

Simplify  $12 \times 25$  by using a useful factor group.

Show an equivalent calculation and explain the choice.

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## A3: Make 100

$$12 \times 25 = (3 \times 4) \times 25$$

$$= 3 \times (4 \times 25) = 3 \times 100 = 300.$$

Grouping  $4 \times 25$  makes 100

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## Q4: Odd square

Find the odd square with  $20 < n < 40$ .

Show evidence for both properties.

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**A4: 25**

$25 = 5 \times 5$ , so it is a square.

25 is odd and satisfies  $20 < 25 < 40$ .

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## Q5: Change one condition

Now make the square in Q4 even, still  $20 < n < 40$ .

What changes, and why?

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A5: 36

$36 = 6 \times 6$  and is even.

25 fails the changed even condition.

The solution changes from 25 to 36.

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## Q6: Correct a wrong claim

A learner says, '1 is prime.'

Identify the error and correct the classification.

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## A6: Neither

1 has only one positive factor: 1.

A prime number must have exactly two

So 1 is neither prime nor composite.

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## Q7: Game challenge

Find the odd composite factor of 60 with  $10 < n < 30$ .

Give factor and range evidence.

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**A7: 15**

$15 = 3 \times 5$ , so it is odd and composite.

$60 \div 15 = 4$  and  $10 < 15 < 30$ .

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## Q8: Compare cases

Compare 49 and 64.

Name one property they share and one property that differ

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## A8: Shared and different

Both are square and composite:  $49 = 7 \times 7$ ,  $64 = 8 \times 8$

49 is odd; 64 is even.

A valid comparison names a difference for both

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## Q9: Fresh puzzle

Find the even square with  $90 < n < 130$ .

List nearby candidate squares first.

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**A9: 100**

Nearby squares are  $100 = 10 \times 10$  and  $121 = 11 \times 11$ .

Only 100 is even, so the solution is 100.

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## Q10: Prove Q9

What observations prove the Q9 result is correct?

A guess or a label alone is not enough.

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## AI0: Give evidence

$100 = 10 \times 10$ , so it is square.

$100 \div 2 = 50$ , so it is even.

$90 < 100 < 130$ ; 121 fails evenness.

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## Q1: Reject a claim

A learner says, 'Every prime number is odd.'

Give a counterexample and explain the limitation

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## All: Counterexample 2

2 is a prime number with factors 1 and 2.

It is even, so the claim is false.

All other prime numbers are odd, but 'even' fails at 2.

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## Q12: New checked solution

Find the odd composite factor of 99 with  $20 < n < 40$

Give enough evidence to check every condition.

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**A12: 33**

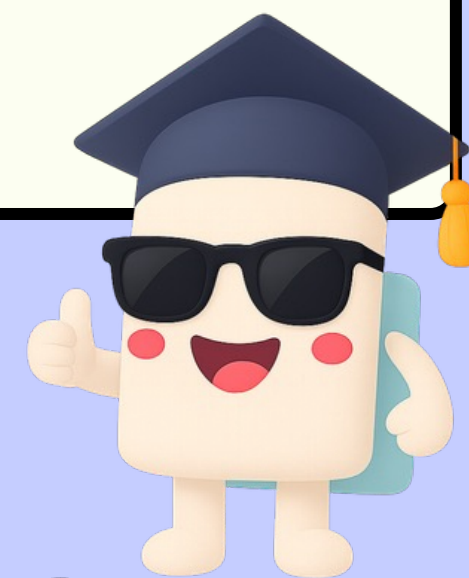
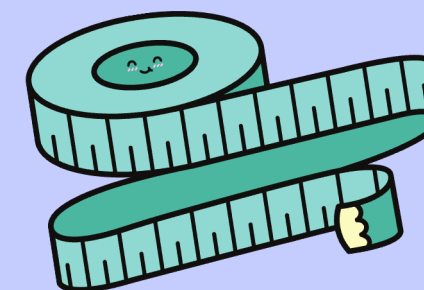
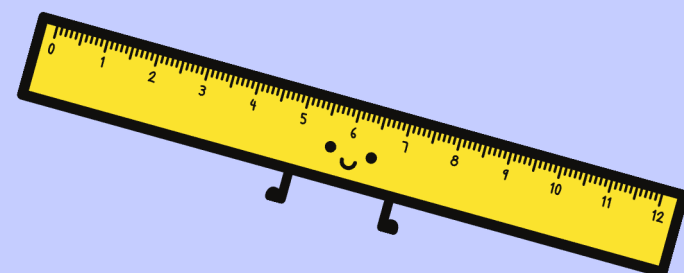
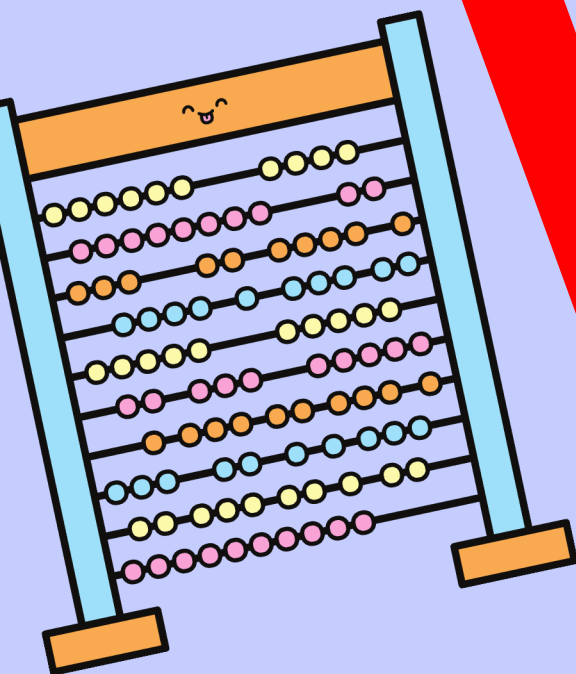
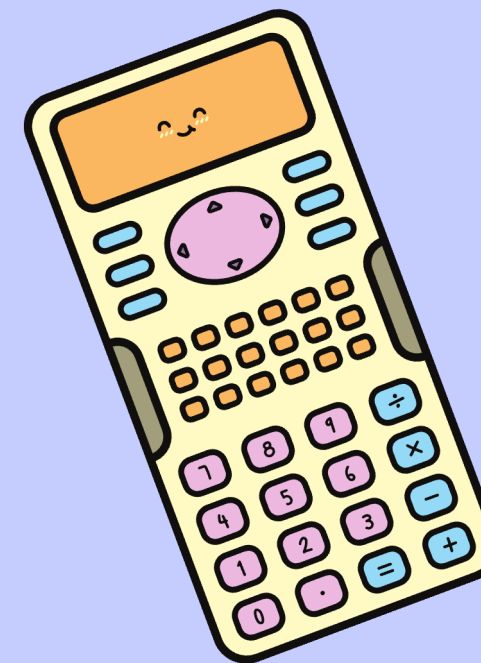
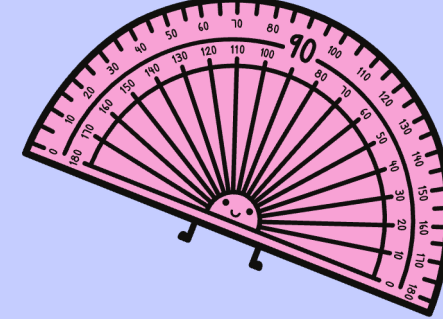
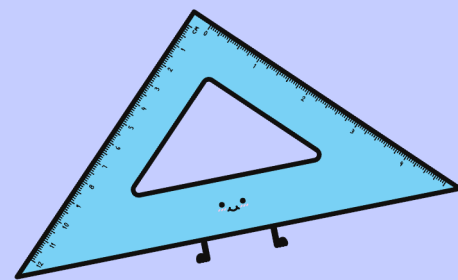
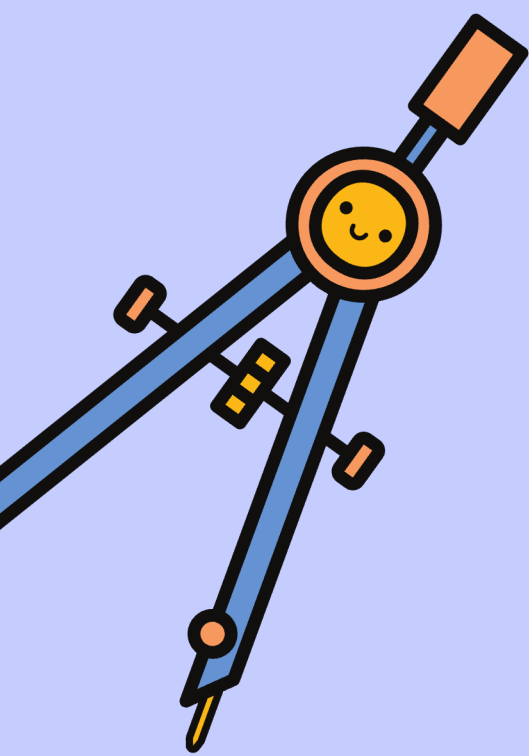
$33 = 3 \times 11$ , so it is odd and composite.

$99 \div 33 = 3$ , so it is a factor of 99.

$20 < 33 < 40$ ; accept equivalent valid reasoning.

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**PREVIEW**

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Test every cide.