The Vanishing Violin Caper

Whodunnit? · Functions & Transformations Name: _____

Opening night at Harmony Hall was a sellout. At intermission the chandeliers flickered, and when the lights came back up the glass case at the front of the stage was empty. The **Aurelia violin**, three hundred years old and worth more than the hall itself, was gone!

Six people had backstage passes that evening, each was seen in a different part of the hall, and there are six clever ways to smuggle a violin out of a packed concert. You are the lead detective. Find out **who** took it, **where** they were, and **how** they got it away.

How to crack the case

1. Your teacher will post **10 clue cards** around the room. Each card has a math problem and four answer choices. Every choice is paired with a clue.
2. Solve the problem on the **Show Your Work** page. Find your answer among the choices and read the clue next to it. If your answer is not there, check your work.
3. Use the clue to cross out suspects, places or methods on the case board below. Write the card number beside what it cleared.
4. After all 10 cards, exactly one suspect, one place and one method are left. Those three boxes name the culprit. If you end up with none, or more than one, a clue went wrong: recheck your math!

The Suspects	The Places	The Methods
☐ Celeste Duarte Conductor	☐ Grand Lobby	☐ Stuffed in a cello case
☐ Wen Ling Concertmaster	☐ Orchestra Pit	☐ Swapped for a prop violin
☐ Fitz Albrecht Stagehand	☐ Box Office	☐ Wrapped in sheet music
☐ Rosalind Achebe Music Critic	☐ Tuning Room	☐ Hidden inside the tuba
☐ Bartholomew Pike Piano Tuner	☐ Stage Wings	☐ Tucked under the piano lid
☐ Jules Navarro Box Office Manager	☐ Balcony	☐ Rolled in a velvet curtain

The culprit is _____ in _____ using _____

Show Your Work

The Vanishing Violin Caper · Show every step in the matching box.

Name: _____

1. Choice _____	**2.** Choice _____
3. Choice _____	**4.** Choice _____
5. Choice _____	**6.** Choice _____
7. Choice _____	**8.** Choice _____
9. Choice _____	**10.** Choice _____

Clue #1

The Vanishing Violin Caper

Evaluate the function at the given input.

$f(x) = -2x^2 + 3x - 4$ Find $f(-3)$

A. $f(-3) = -31$	Celeste Duarte was tuning the cellos in the Orchestra Pit. Forty musicians watched her the whole intermission.
B. $f(-3) = 5$	Wen Ling was tuning her violin on the Balcony. The sound crew recorded every note of it.
C. $f(-3) = -13$	Security checked the sheet music folders at the gate. Every page was plain paper, with nothing wrapped inside.
D. $f(-3) = 23$	Rosalind Achebe was drafting her review in the Grand Lobby. Three ushers saw her typing at the same table all evening.

Solve the problem, find your answer, and read its clue. Cross it off on your case board.

✂ cut here

Clue #2

The Vanishing Violin Caper

Find the domain of the function. Write it in interval notation.

$$h(x) = \frac{\sqrt{(2x - 6)}}{x - 5}$$

A. $(3, 5) \cup (5, \infty)$	Celeste Duarte was greeting donors on the Balcony. A donor's phone video shows her there the whole time.
B. $[3, 5) \cup (5, \infty)$	Every cello case was opened at the stage door. Inside were only cellos and a few stray rosin cakes.
C. $(-\infty, 5) \cup (5, \infty)$	The music librarian counted every score on the cart. No stack was thick enough to hide a violin.
D. $[3, \infty)$	Rosalind Achebe was interviewing the oboist in the Orchestra Pit. The recording has her questions from start to finish.

Solve the problem, find your answer, and read its clue. Cross it off on your case board.

Clue #3

The Vanishing Violin Caper

The point $(-3, 8)$ is on the graph of $y = f(x)$. Find the matching point on the graph of g.

$$g(x) = -2f(x + 1) + 3$$

A. $(-4, 19)$	The program bundles were opened and flipped through. Nothing was rolled up inside any of the pages.
B. $(-4, -22)$	Fitz Albrecht was fixing a spotlight on the Balcony. The work order is signed by the electrician standing beside him.
C. $(-2, -13)$	Rosalind Achebe was buying a ticket for the next concert at the Box Office. The receipt is stamped at the exact minute of the theft.
D. $(-4, -13)$	Wen Ling was warming up in the Tuning Room. A metronome app on her phone logged every minute of it.

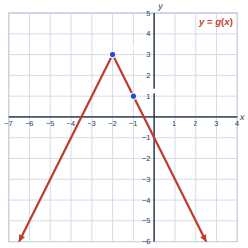
Solve the problem, find your answer, and read its clue. Cross it off on your case board.

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Clue #4

The Vanishing Violin Caper

The graph shows $y = g(x)$, a transformation of the parent function $y = |x|$. Write the equation of g.



A. $g(x) = -2\|x + 2\| + 3$	The prop violin was found on its shelf in the original case, dusty and numbered. Nobody swapped it.
B. $g(x) = 2\|x + 2\| + 3$	Bartholomew Pike was hunting for a dropped tuning fork on the Balcony. Two ushers helped him look the entire intermission.
C. $g(x) = -\frac{1}{2}\|x + 2\| + 3$	A volunteer weighed the box of spare scores. It matched the library list and held no hidden shape.
D. $g(x) = -2\|x - 2\| + 3$	Rosalind Achebe was borrowing a pencil in the Tuning Room. The sign-in sheet has her name in green ink.

Solve the problem, find your answer, and read its clue. Cross it off on your case board.

Clue #5

The Vanishing Violin Caper

Use the piecewise function to evaluate the expression.

$$f(x) = \begin{cases} x^2 - 1 & \text{if } x < 2 \\ 3x - 2 & \text{if } 2 \le x < 5 \\ 20 - 2x & \text{if } x \ge 5 \end{cases}$$

$$f(-3) + f(2) + f(5)$$

A. 25	Jules Navarro was counting ticket stubs on the Balcony. The security camera has him there for the entire hour.
B. 21	Rosalind Achebe was chatting with the crew in the Stage Wings. The stage manager logged her visitor badge.
C. 22	Fitz Albrecht was resetting the spotlights in the Stage Wings. The lighting console timestamped each cue he ran.
D. 4	Every stand was checked and the sheet music on it was shaken out. Nothing was tucked between the pages.

Solve the problem, find your answer, and read its clue. Cross it off on your case board.

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Clue #6

The Vanishing Violin Caper

Let $f(x) = x^2 - 4x$ and $g(x) = 2x + 3$. Write the composite function as an expression in x.

$$(f \circ g)(x) = ?$$

A. $(f \circ g)(x) = 2x^2 - 8x + 3$	Rosalind Achebe was posing for the hall photographer in the Grand Lobby. Her face is in every picture from intermission.
B. $(f \circ g)(x) = 2x^3 - 5x^2 - 12x$	Wen Ling was signing autographs on the Balcony. A line of fans stood with her until the lights came back.
C. $(f \circ g)(x) = 4x^2 + 8x + 9$	The orchestra's score cabinet was emptied onto the floor. Only paper and a single paper clip came out.
D. $(f \circ g)(x) = 4x^2 + 4x - 3$	The tuba was turned upside down and shaken. Out fell a mouthpiece and a peppermint, but no violin.

Solve the problem, find your answer, and read its clue. Cross it off on your case board.

Clue #7

The Vanishing Violin Caper

Use the table to evaluate the expression.

x	1	2	3	4	5
$f(x)$	3	5	1	4	2
$g(x)$	2	4	1	5	3

$$(f \circ g)(4) + g^{-1}(3)$$

A. 3	Celeste Duarte was reviewing the score on the Balcony. Her assistant's notes have the exact times.
B. 10	Rosalind Achebe was asking about subscription seats at the Box Office. The clerk wrote down the whole conversation.
C. 7	Bartholomew Pike was greeting patrons in the Grand Lobby. The hall photographer has him in every shot.
D. 9	A page turner looked through the opera folio and found only loose sheets. Nothing was wrapped in the music.

Solve the problem, find your answer, and read its clue. Cross it off on your case board.

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Clue #8

The Vanishing Violin Caper

Find the inverse function.

$$f(x) = \sqrt[3]{(x - 1)} + 2$$

A. $f^{-1}(x) = \dfrac{1}{\sqrt[3]{(x - 1)} + 2}$	The printed encore booklets were bundled and checked. They were flat, light and completely empty.
B. $f^{-1}(x) = (x - 2)^3 - 1$	Rosalind Achebe was admiring the harp in the Orchestra Pit. A security camera shows her there until the lights came up.
C. $f^{-1}(x) = (x + 2)^3 + 1$	Bartholomew Pike was testing the acoustics from the Balcony. His notebook has a reading for every minute.
D. $f^{-1}(x) = (x - 2)^3 + 1$	The piano lid was lifted by the tuner himself. Strings, hammers and felt, but nothing else.

Solve the problem, find your answer, and read its clue. Cross it off on your case board.

Clue #9

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A jacket costs $135. A $20 coupon is applied first, and then 15% off the reduced price. Let $g(x) = x - 20$ for the coupon and $f(x) = 0.85x$ for the 15% discount. Find the final price.

$$f(g(135)) = ?$$

A. $114.75	Fitz Albrecht was hanging a banner over the Balcony rail. Three stagehands held the ladder for him.
B. $97.75	Jules Navarro was selling programs at the Box Office. The register log shows a sale every few seconds.
C. $94.75	Rosalind Achebe was waiting for a backstage tour in the Stage Wings. Two guides stood beside her the entire time.
D. $100.00	Police fanned through the whole stack of concert programs. Nothing was folded around a violin.

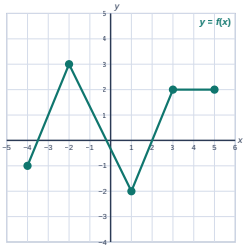
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Clue #10

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The graph shows $y = f(x)$. Let $g(x) = 2f(x - 1) + 3$. Find $g(2)$.



A. $g(2) = -1$	The velvet curtain was unrolled and shaken out in front of the crew. It was only dusty fabric.
B. $g(2) = 1$	Jules Navarro was seating late guests on the Balcony. The usher's clipboard has his initials on every row.
C. $g(2) = 7$	Rosalind Achebe was testing a viola in the Tuning Room. The luthier's receipt has her signature at that minute.
D. $g(2) = 2$	The sheet music rolls in the lobby display were unrolled. Each one held only a poster inside.

Solve the problem, find your answer, and read its clue. Cross it off on your case board.