The Time Capsule Switcheroo

Whodunnit? · Exponential & Logarithmic Functions Name: _____

Millbrook waited 100 years for this moment. The whole town crowded into the square as the old time capsule was pried open at the centennial. Inside: letters, photographs, a rusty harmonica, and an empty velvet box. The **Founders' Pocket Watch**, the capsule's priceless centerpiece, was gone!

Six people had special access to the capsule that morning, each was seen in a different spot, and there are six sneaky ways to carry a pocket watch out of a crowded square. 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
☐ Dr. Imani Okoye Town Historian	☐ Town Hall Steps	☐ Hidden in a top hat
☐ Mayor Renata Voss Town Mayor	☐ Clock Tower	☐ Swapped for a replica
☐ Ezra Lindgren Museum Curator	☐ Bank Vault	☐ Tucked in a hollow book
☐ Priya Nambiar Gazette Reporter	☐ Museum Annex	☐ Sewn into the banner
☐ Tobias Quill Clockmaker	☐ Gazette Office	☐ Stashed in the scissors case
☐ Dottie Marsh Bank Manager	☐ Bandstand	☐ Buried in a flower bouquet

The culprit is _____ in _____ using _____

Show Your Work

The Time Capsule Switcheroo · 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 Time Capsule Switcheroo

Find the horizontal asymptote:

$$y = 2(\frac{1}{2})^{x+1} - 3$$

A. $x = -3$	The museum gift table was searched and every book was a solid hardcover. Nothing hollow, nothing hidden.
B. $y = -3$	Dr. Okoye was cataloguing donated letters in the Museum Annex. The sign-in sheet has her handwriting on every page.
C. $y = 3$	Ezra Lindgren was dusting display cases in the Museum Annex all morning. Three volunteers say he never left.
D. $y = 0$	Tobias Quill was tuning the carillon controls at the Bandstand. A trumpet player videoed him the entire time.

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

✂ cut here

Clue #2

The Time Capsule Switcheroo

Evaluate without a calculator:

$$\log_8 4$$

A. $\frac{1}{2}$	Dr. Imani Okoye was reading the town charter aloud at the Bandstand. The microphone log has her voice for the full hour.
B. $\frac{3}{2}$	Ezra Lindgren was climbing the Clock Tower stairs with a tour group. The guide counted him at every landing.
C. 2	The library cart was inventoried item by item. No book had been cut open or hollowed out.
D. $\frac{2}{3}$	Every top hat in the parade was checked at the gate. The only thing under them was hair.

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

Clue #3

The Time Capsule Switcheroo

Solve for x:

$$\log_3 x = -2$$

A. $x = \frac{1}{9}$	Mayor Voss was cutting the ribbon on the Town Hall Steps in front of two hundred cameras.
B. $x = 9$	Ezra Lindgren was holding the ribbon for the mayor on the Town Hall Steps. Every news photo shows him there.
C. $x = -9$	Mayor Renata Voss was posing for portraits at the Bandstand until noon. The photographer's timestamps back her up.
D. $x = -6$	A gift-table volunteer insists no book left the museum table. Every title was accounted for at closing.

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

✂ cut here

Clue #4

The Time Capsule Switcheroo

A deposit of \$2,000 earns 4% interest compounded quarterly. Using $A = P(1 + \frac{r}{n})^{nt}$, find the balance after 5 years, to the nearest cent.

A. \$4,382.25	Dottie Marsh was handing out commemorative coins at the Bandstand. A line of forty kids can vouch for her.
B. \$2,440.38	The velvet box held its original tag. The Watch was not swapped for a replica; the box was simply empty.
C. \$2,102.02	Police shook out every book on the display shelf. Pages fluttered, but no watch fell out.
D. \$2,433.31	Ezra Lindgren was handing the Gazette a quote in the Gazette Office. The editor logged the call at the time of the theft.

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

Clue #5

The Time Capsule Switcheroo

Evaluate:

$$\log_3 6 + \log_3 9 - \log_3 2$$

A. $\log_3 108$	A hollow-book hunt came up empty: security flipped through every volume and found only ordinary pages.
B. $\log_3 13$	Priya Nambiar was interviewing the brass band at the Bandstand. Her recorder has the whole conversation.
C. 3	Priya Nambiar was filing her story from the Gazette Office. The server stamped her upload at the exact minute of the theft.
D. 27	Ezra Lindgren was admiring the capsule’s coins inside the Bank Vault. The vault camera shows him with the guards.

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

✂ cut here

Clue #6

The Time Capsule Switcheroo

Evaluate to the nearest thousandth:

$$\log_3 20$$

A. 6.667	Mayor Renata Voss was waiting to cut the cake at the Bandstand. A dozen councilors stood right beside her.
B. 1.301	The hollow-book idea is a dead end: the only book with a cavity was a prop in the window display, and it was empty.
C. 0.367	Ezra Lindgren was relabeling exhibits in the Museum Annex. The curator’s time card has him clocked in all morning.
D. 2.727	The centennial banner was unstitched and shaken out. Nothing was sewn inside.

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

Clue #7

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Solve for x:

$$4^{x+1} = 8^{x-1}$$

A. $x = 4$	The town's book drive was weighed and checked. No book felt too light, and none had a hidden pocket.
B. $x = -1$	Ezra Lindgren was winding the Clock Tower's antique pendulum with Mr. Quill. Both signed the maintenance log.
C. $x = 5$	Tobias Quill was repairing the big clock in the Clock Tower. The gears were still oily when the police arrived.
D. $x = 3$	Dottie Marsh was announcing raffle winners at the Bandstand. The microphone log shows she never left the stage.

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

✂ cut here

Clue #8

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Solve for x to the nearest thousandth:

$$6 \cdot 2^x = 150$$

A. $x \approx 2.016$	Security X-rayed the museum's book crate at the gate. Every book was solid paper and nothing metal showed up.
B. $x \approx 4.644$	The ribbon-cutting scissors case was opened by the mayor's aide. It held only scissors.
C. $x \approx 7.229$	Ezra Lindgren was introducing the speakers on the Town Hall Steps. The livestream shows him the entire hour.
D. $x \approx 1.609$	Dr. Imani Okoye was signing history pamphlets at the Bandstand. A long line of readers waited with her.

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

Clue #9

The Time Capsule Switcheroo

Solve for x and check for extraneous solutions:

$$\log_2 x + \log_2(x - 2) = 3$$

A. $x = 4$	Dottie Marsh was counting centennial coins in the Bank Vault. The vault door log shows she never stepped out.
B. $x = 4$ or $x = -2$	Tobias Quill was testing the speakers at the Bandstand. The sound engineer recorded him at the mixing board.
C. $x = -2$	Ezra Lindgren was proofreading the commemorative edition in the Gazette Office. The editor has his corrections in red pen.
D. $x = 3$	Every book on the donation table was shaken, flipped and measured. None was hollow.

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

✂ cut here

Clue #10

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\$5,000 is invested at 6% interest compounded continuously, using $A = Pe^{rt}$. How many years will it take to double, to the nearest tenth of a year?

A. 0.04 years	The hollow book on the gift table turned out to be a plastic prop with a sealed lid. It was sealed and empty.
B. 33.3 years	Priya Nambiar was photographing the band at the Bandstand. Her camera roll has them every thirty seconds.
C. 11.6 years	Every bouquet was sniffed, shaken and pulled apart. Not a single watch chain in the roses.
D. 11.9 years	Ezra Lindgren was signing the vault guestbook in the Bank Vault. Ms. Marsh’s pen is still on the page.

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