



The Observatory's Inside-Out Signal



COMPLETE TO COLLECT
Sunstone Cabochon
 Level 3 · 5 Glints

BUILD THE SIGNAL FORWARD

In the Observatory, one instrument turns a raw signal into a displayed echo. All functions take and return real numbers whenever they are used.

At time t , the raw signal is $S(t)$. The instrument acts in this order:

1. The **delay gate** uses the raw reading from 3 seconds earlier.
2. The **lift lens** doubles its input and adds 5.
3. The **calibration lens** applies a function C . The function C has an inverse C^{-1} .

The final displayed echo is $E(t)$.



FORWARD EQUATIONS

Write your equations and reasoning on separate paper.

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|---|---|
| <ul style="list-style-type: none"> Let Δ be the delay map. Define $\Delta(t)$. | <ul style="list-style-type: none"> Let $R(t)$ be the raw signal after the delay gate. Write one equation using S and Δ, then write it again without Δ. |
| <ul style="list-style-type: none"> Let L be the lift lens. Define $L(x)$. | <ul style="list-style-type: none"> Let $A(t)$ be the signal after the lift lens. Write one equation using L and R, then expand it using $S(t - 3)$. |
| <ul style="list-style-type: none"> Write $E(t)$ in terms of C and $A(t)$. | <ul style="list-style-type: none"> Write one fully nested equation for $E(t)$ using C, L, and $S(t - 3)$. |
| <ul style="list-style-type: none"> Write the same instrument as one composition equation using C, L, S, and Δ. State which function acts first. | |



Recover the raw signal

The forward instrument delays, lifts, and calibrates. Now use its displayed output to reconstruct what entered the instrument.

REVERSE EQUATIONS

Continue on separate paper.

- Find the inverse of the lift lens. Write a formula for $L^{-1}(y)$, and verify it by simplifying $L^{-1}(L(x))$. •
- Use the future display $E(t + 3)$ to recover the current raw signal $S(t)$. Write:
 - one equation using L^{-1} and C^{-1} ;
 - the same equation with the formula for L^{-1} substituted;
 - one sentence explaining why C^{-1} must act before L^{-1} .

FINAL AUDIT

Check your recovery equation by sending your result forward through the lift lens, then the calibration lens, and confirming that it returns $E(t + 3)$.

