

¶ 2.1

PHIL 110 B: How Science Works

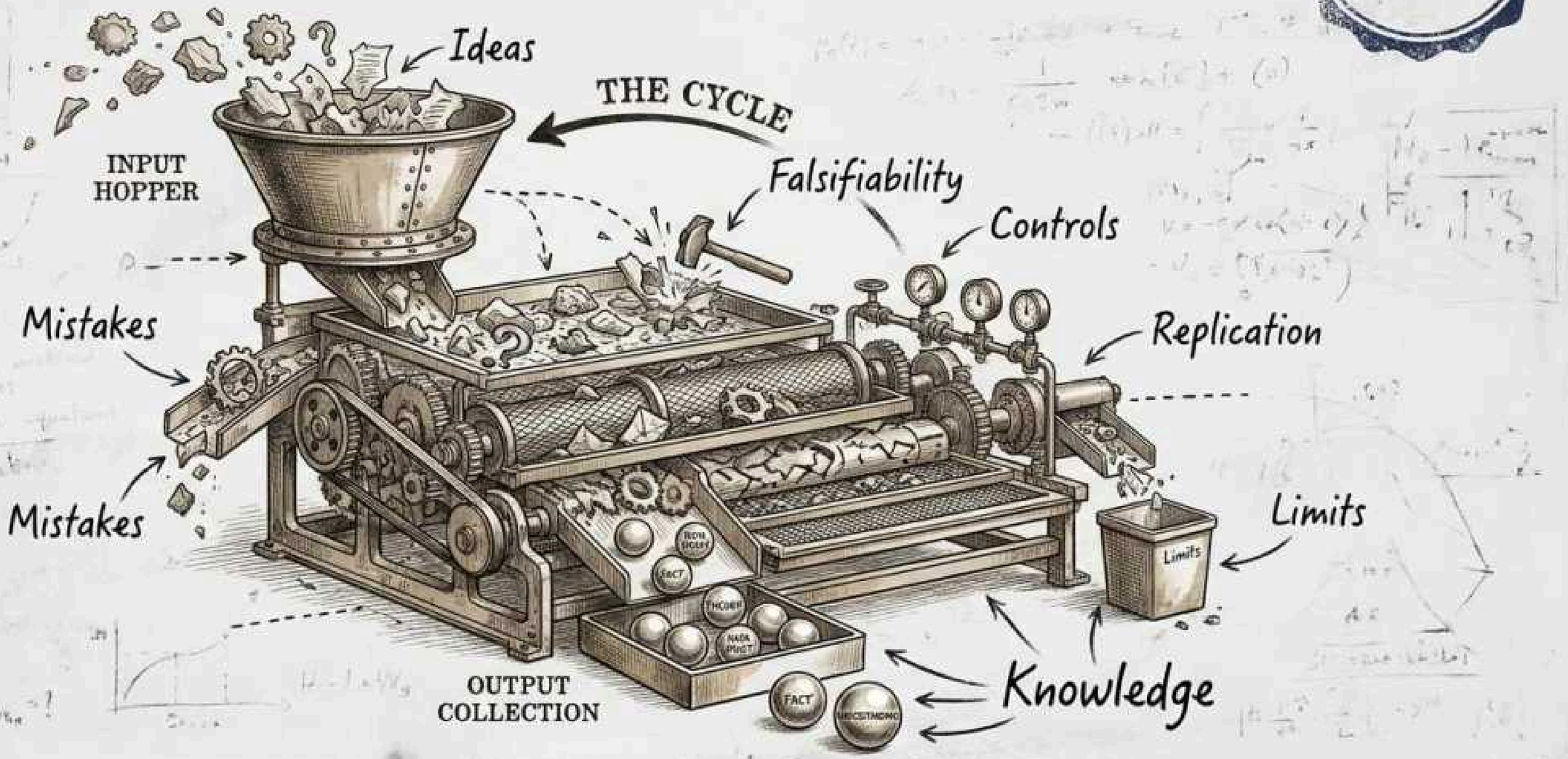
Welcome to Lecture 2.



The Error-Correcting Engine

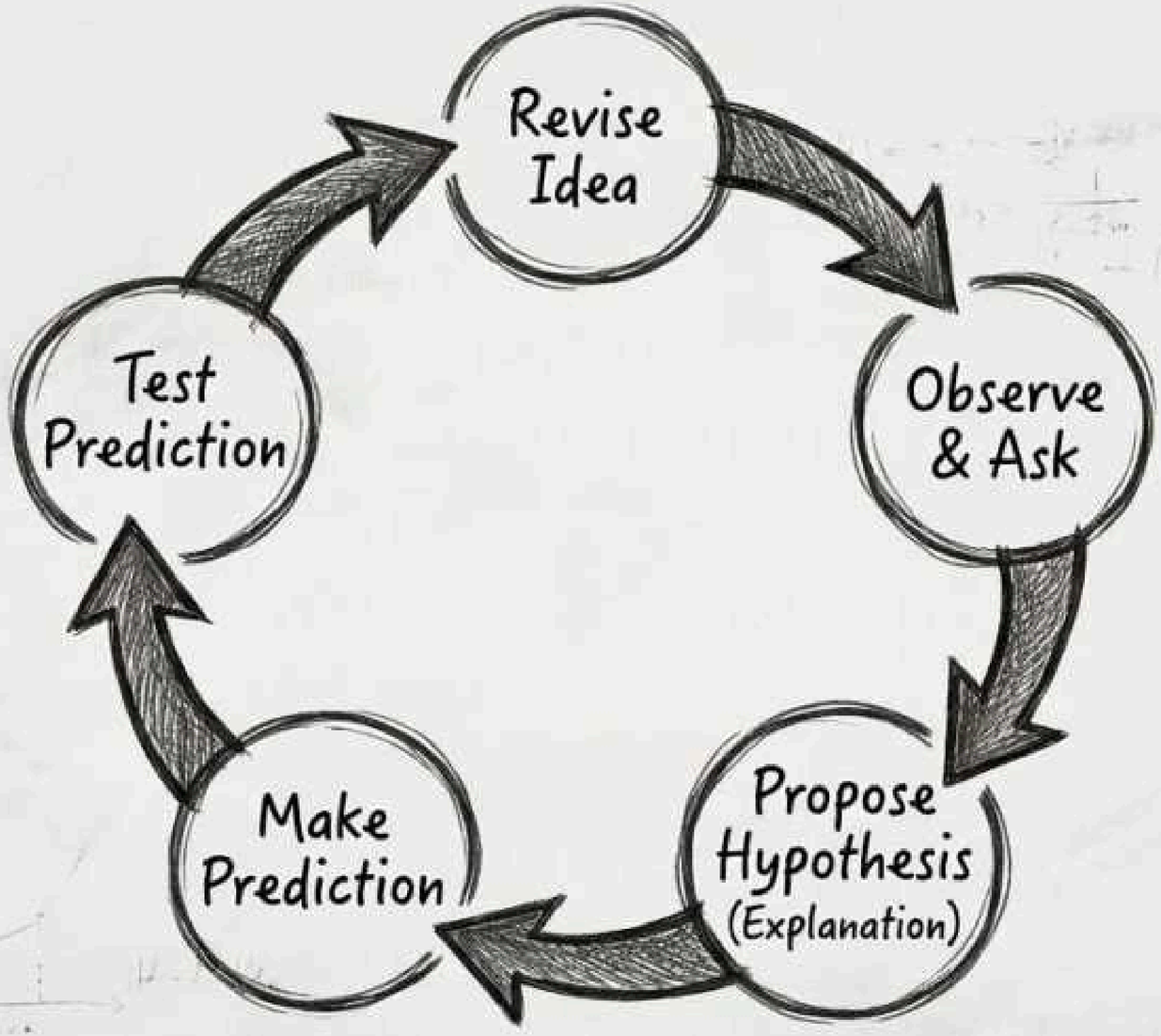
¶ 2.2

Science is the most successful method we have for finding out how the world works. It is not a pile of facts. It is a way of testing ideas so that mistakes get found and fixed.



The Cycle of Science

¶ 2.3

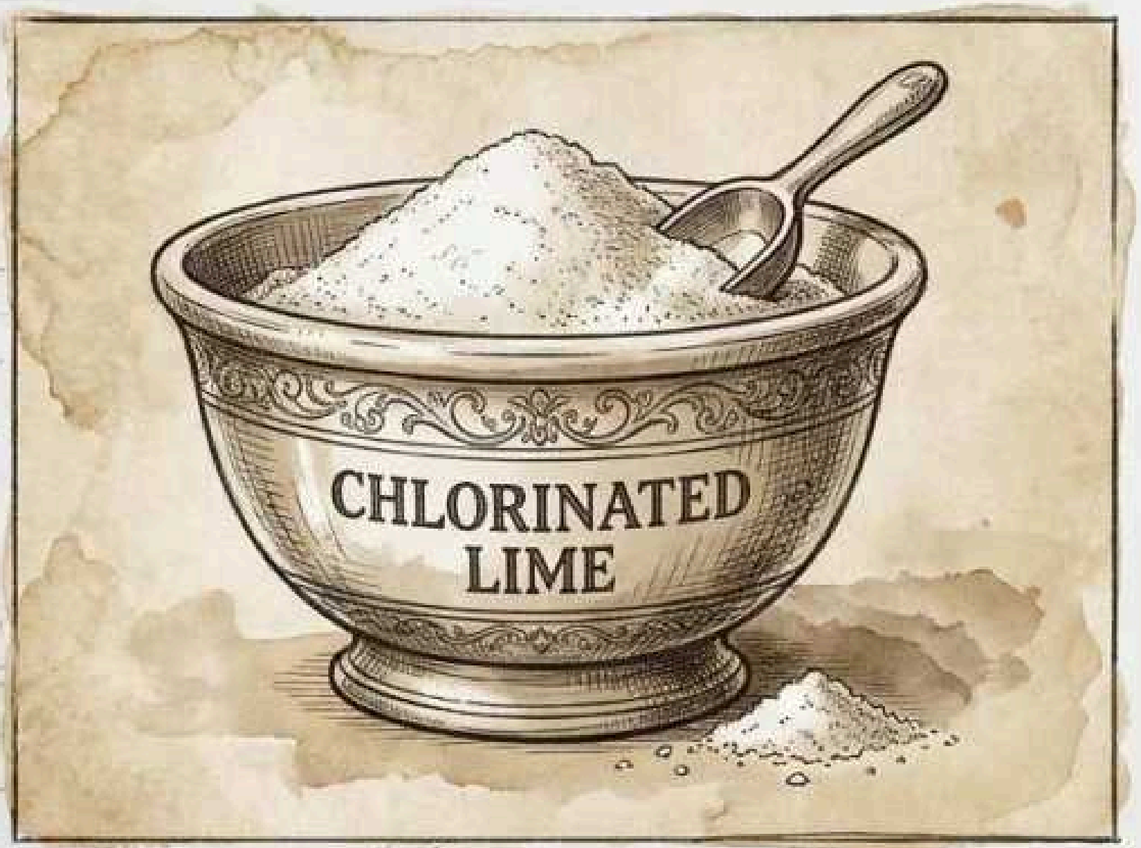


No step is final, and the loop keeps running for as long as people care about the question.

A Hypothesis is a Testable Explanation

¶ 2.4

Vienna, 1847: Ignaz Semmelweis observed mothers dying more often in doctor-run wards than midwife-run wards. His prediction: doctors carried something from autopsies; washing hands in chlorinated lime would help.





A hypothesis makes a prediction that could turn out false.

The Litmus Test: Falsifiability

¶ 2.5

Karl Popper (1934) argued that what marks a claim as scientific is that some possible observation could show it to be false.

A good theory sticks its neck out.
It forbids certain outcomes. A claim that fits every possible outcome tells us nothing.

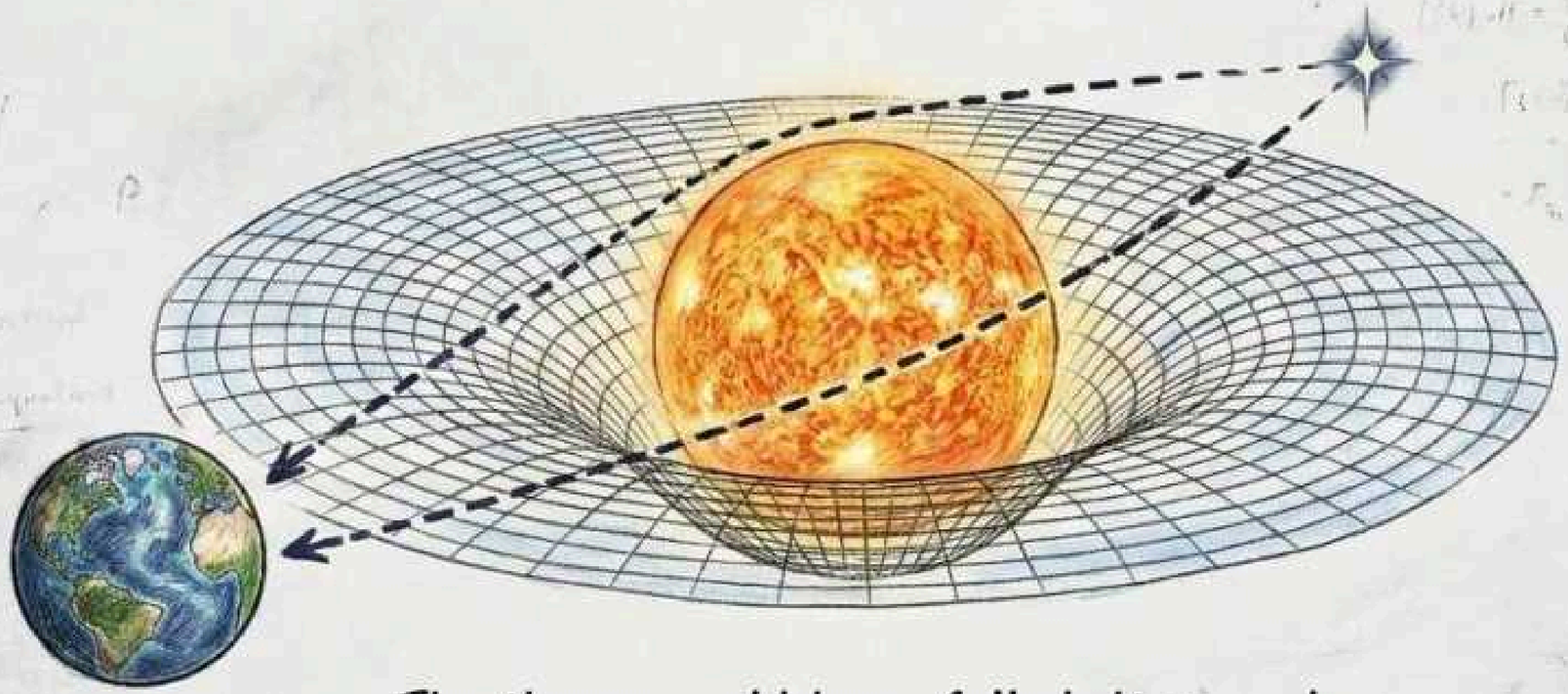


The Risky Prediction (1919)

¶ 2.6

Einstein's general relativity predicted starlight passing close to the Sun would bend by a specific amount.

Arthur Eddington photographed a solar eclipse to test it.



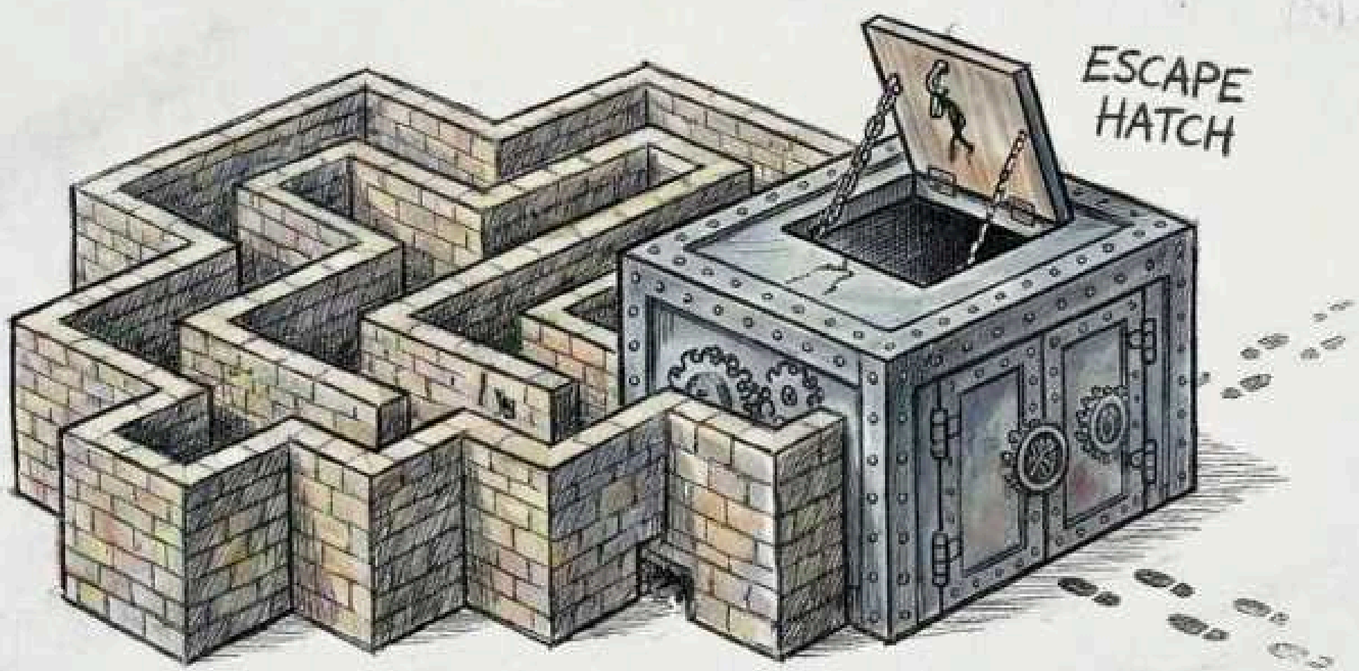
The theory could have failed. It passed.

A risky prediction that succeeds is far stronger support than a safe one.

The Escape Hatch

¶ 2.7

Someone claims psychic powers fail whenever skeptics are watching. Whatever happens, the claim survives: success proves the power, failure proves the watchers interfered.

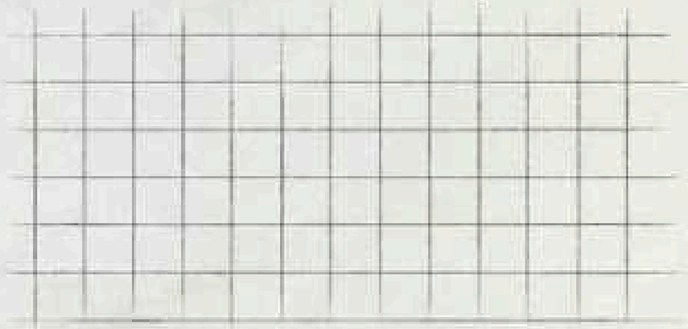


If every result counts as confirmation, no result teaches anything. Watch for explanations that quietly rule out any test.

Isolating Variables: The Controlled Trial

¶ 2.8

Naval surgeon James Lind (1747) tests scurvy remedies on 12 sailors.

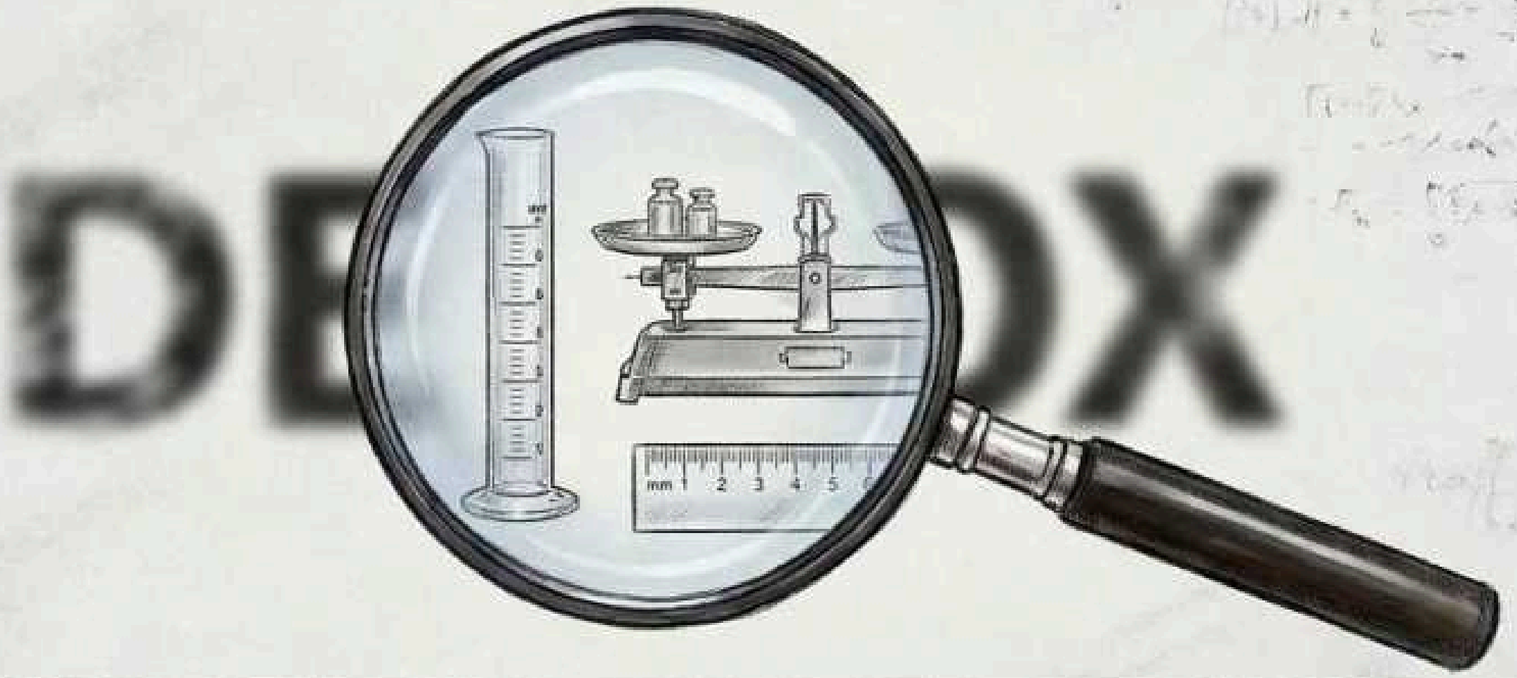
Constant Variables: Sailors, Scurvy, Ship environment.	
Control Group	**Treatment Group**
Standard remedies (no citrus).	Given oranges and a lemon.
	
Result: Remained sick.	Result: Recovered fastest.

To test a cause, change one thing and keep everything else the same.

Operational Definitions

¶ 2.9

Claims must be precise enough to test.
If a product promises to "detox" your body, ask:
Which toxin? How much of it? How is the change measured?



An operational definition describes exactly how you would measure the thing. If a claim cannot be measured, it cannot be checked.

The Community Filter: Replication

¶2.10

A result seen once could be luck, error, or fraud.
Science trusts results that other people can get again.

1989: Chemists Fleischmann and Pons announced nuclear fusion in a small jar at room temperature. Other laboratories tried to repeat it and could not. The claim faded.

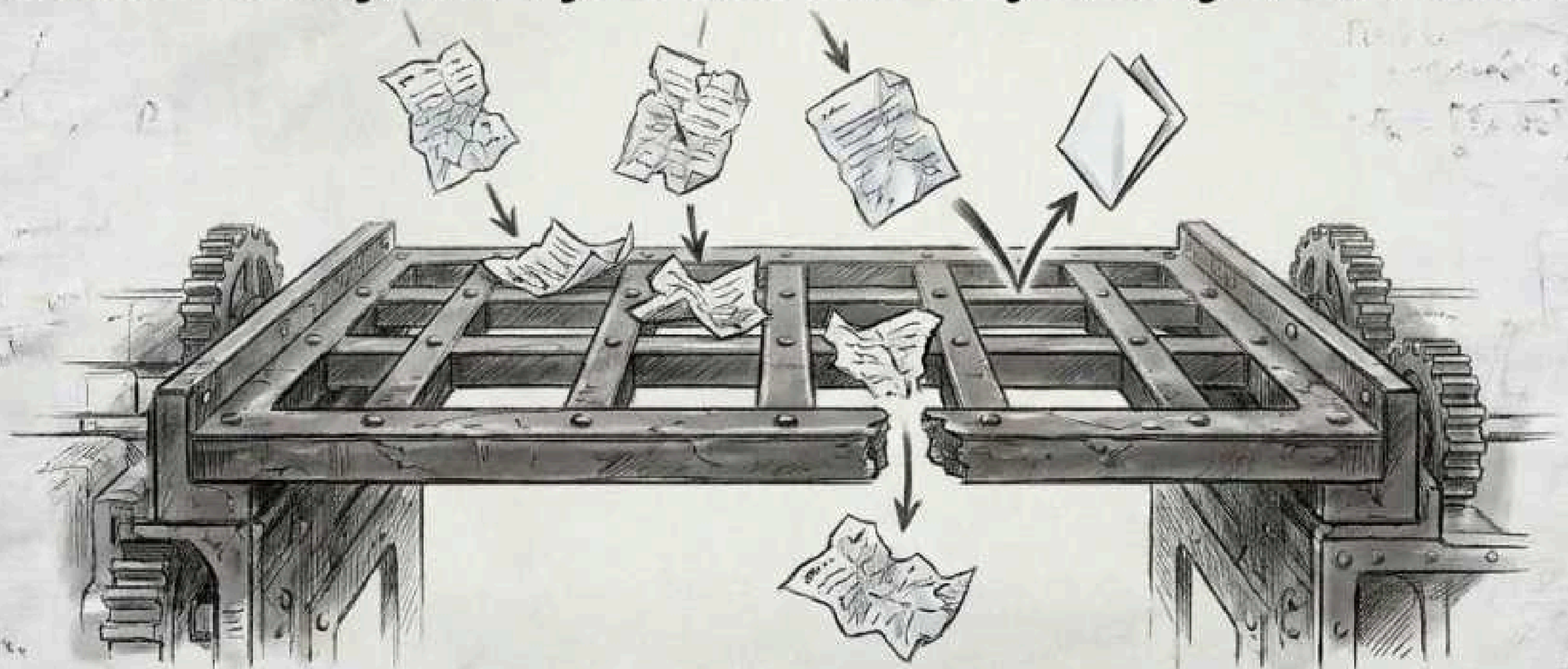


Peer Review: A Filter, Not a Guarantee

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Before research is published, other experts review the methods and reasoning, often asking for changes.

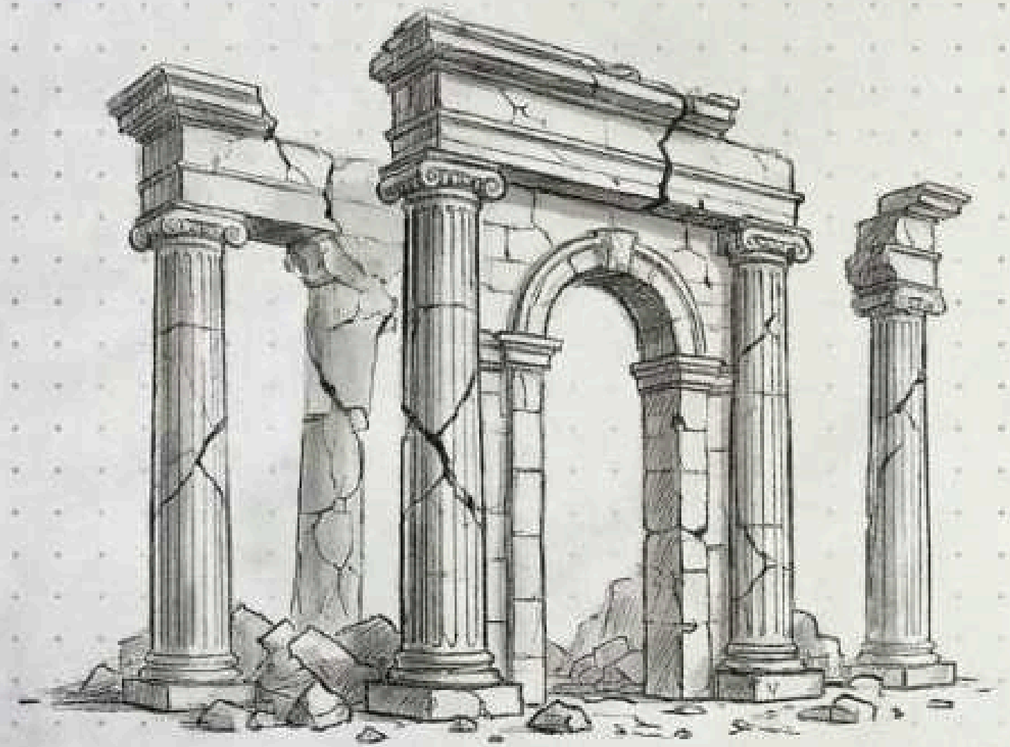
It catches many errors, but not all. A paper that passed review can still be wrong, and a good idea can be rejected by a bad reviewer.



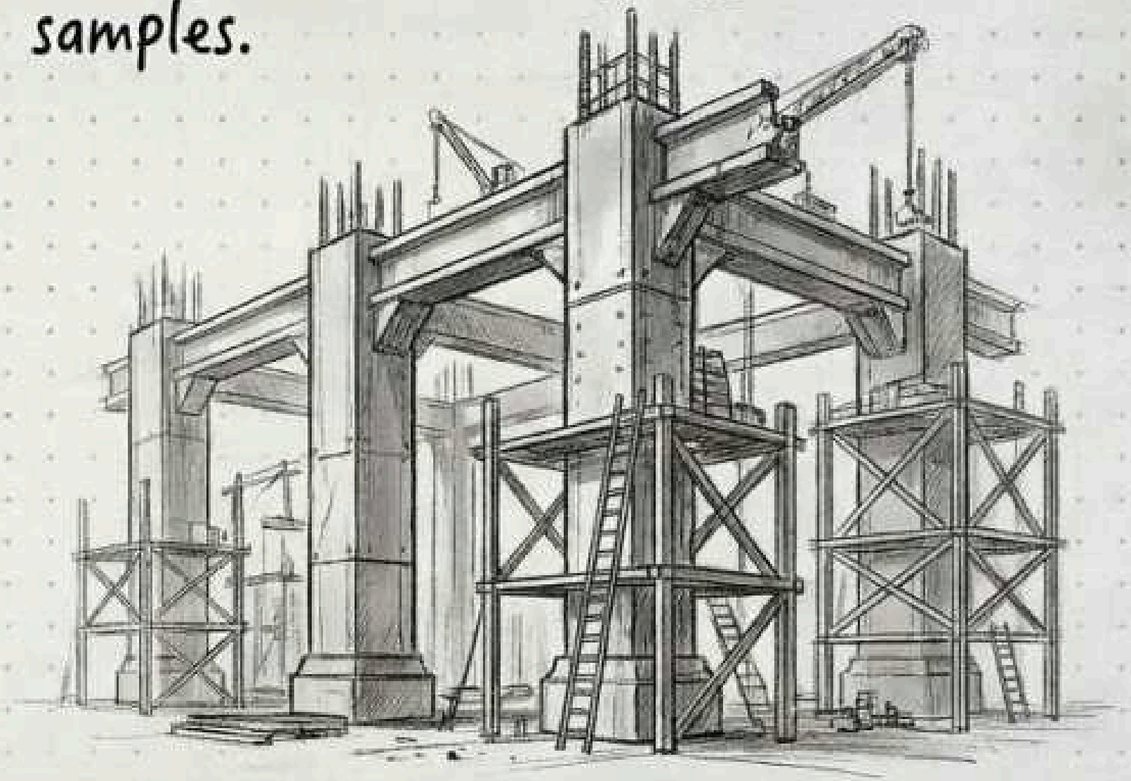
Institutional Self-Correction

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The Crisis (2015): A team tried to repeat 100 published psychology experiments. Only 1/3 to 2/5 reproduced a clear result.



The Response: Researchers began pre-registering plans, sharing data, and using bigger samples.



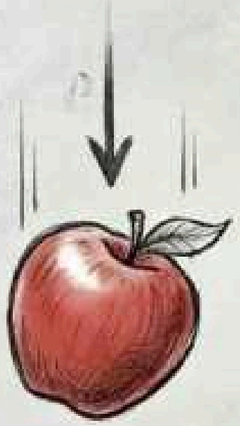
This is not science breaking; this is self-correction at work.

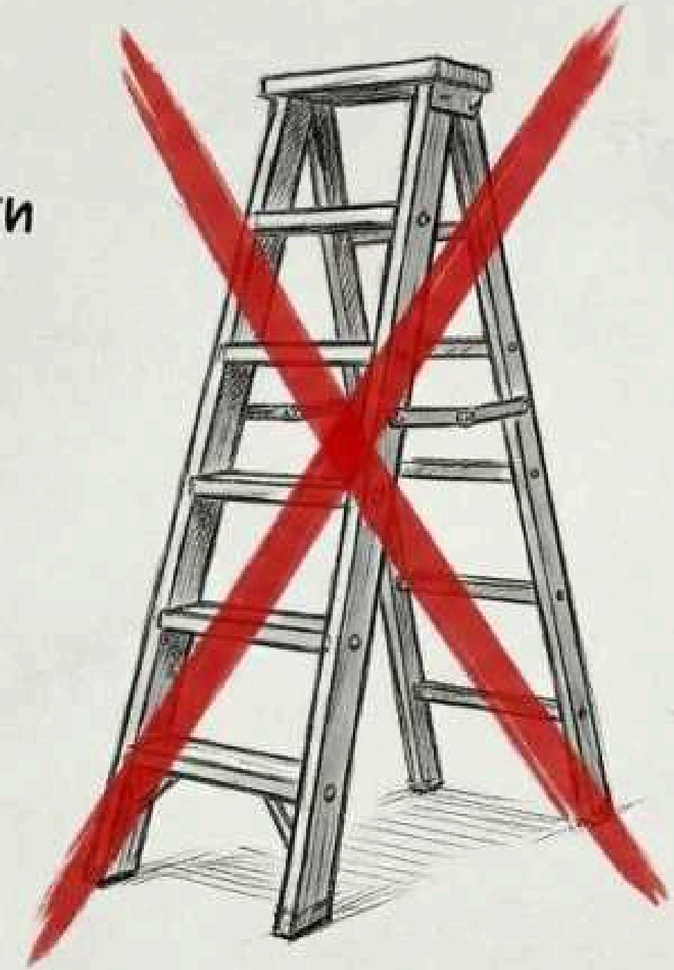
Scientific Lexicon: Theory vs. Law

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LAW

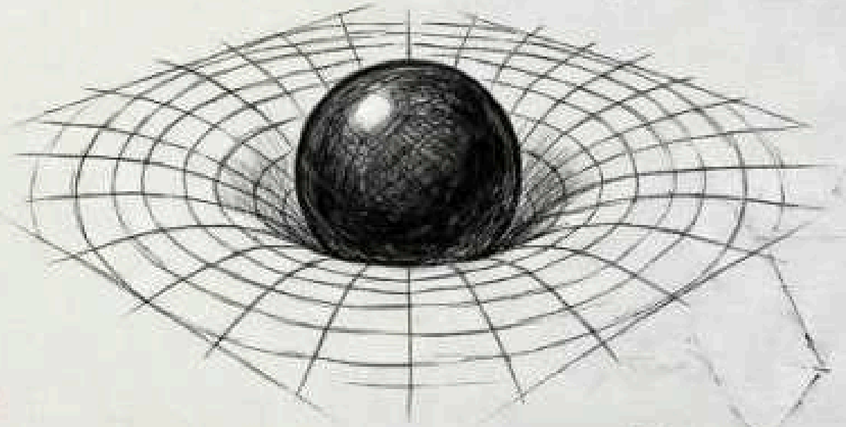
Describes a regular pattern (What happens).





THEORY

A well-tested explanation tying facts together (Why it happens).

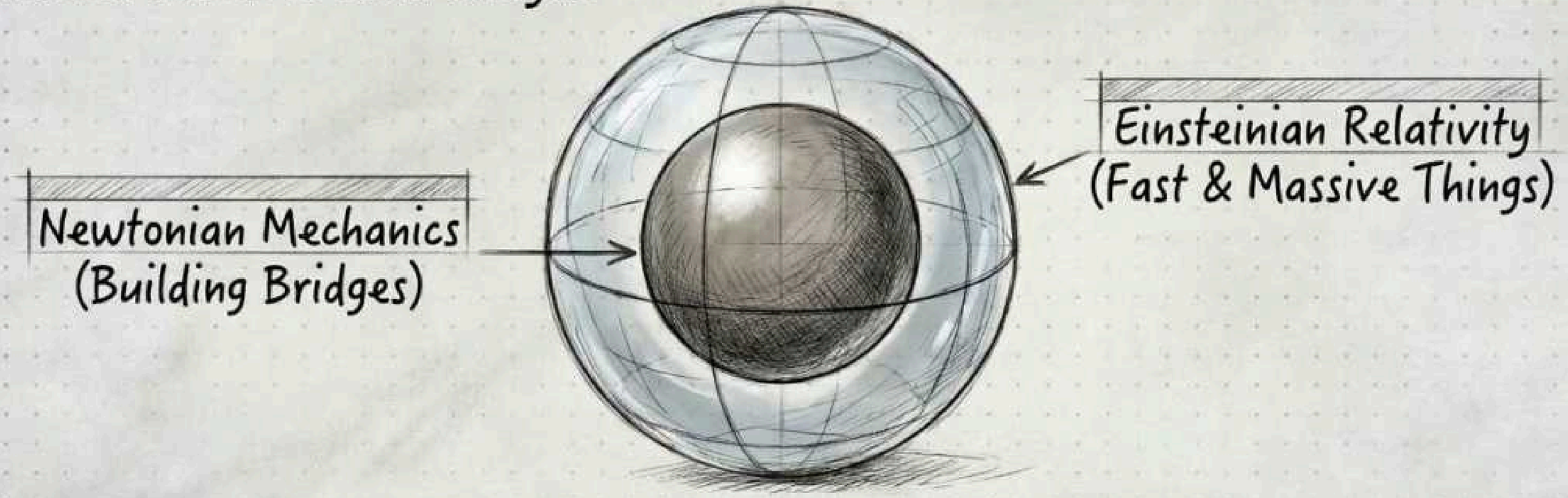


Neither is a rung on a ladder leading to the other.

Provisional Knowledge

¶2.14

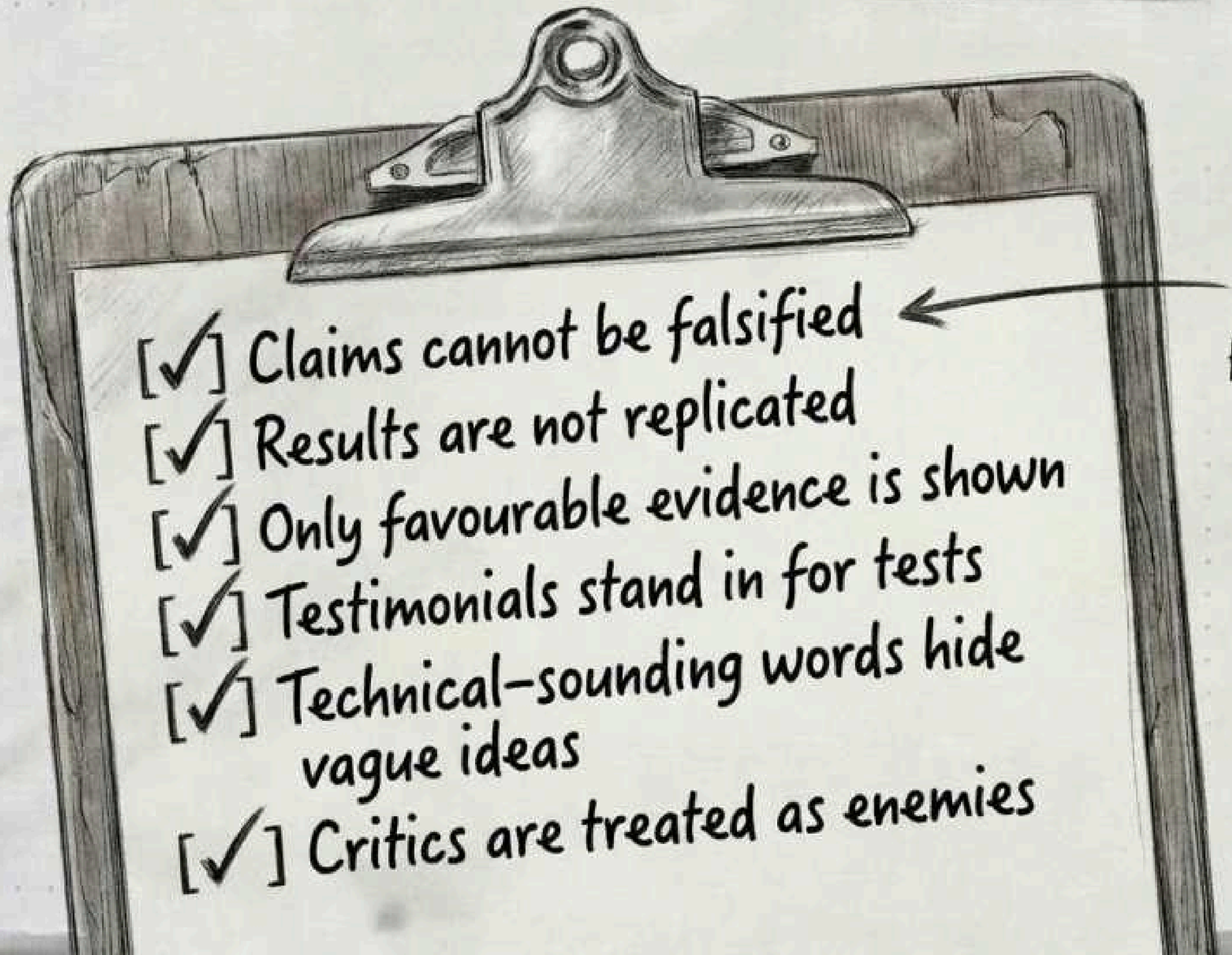
Scientific knowledge is provisional, but not flimsy. Einstein improved on Newton for very fast and massive things, yet engineers still use Newton's laws to build bridges.



A newer theory usually contains the older one as a special case. Science refines itself rather than starting from scratch.

The Pseudoscience Diagnostic

¶2.15



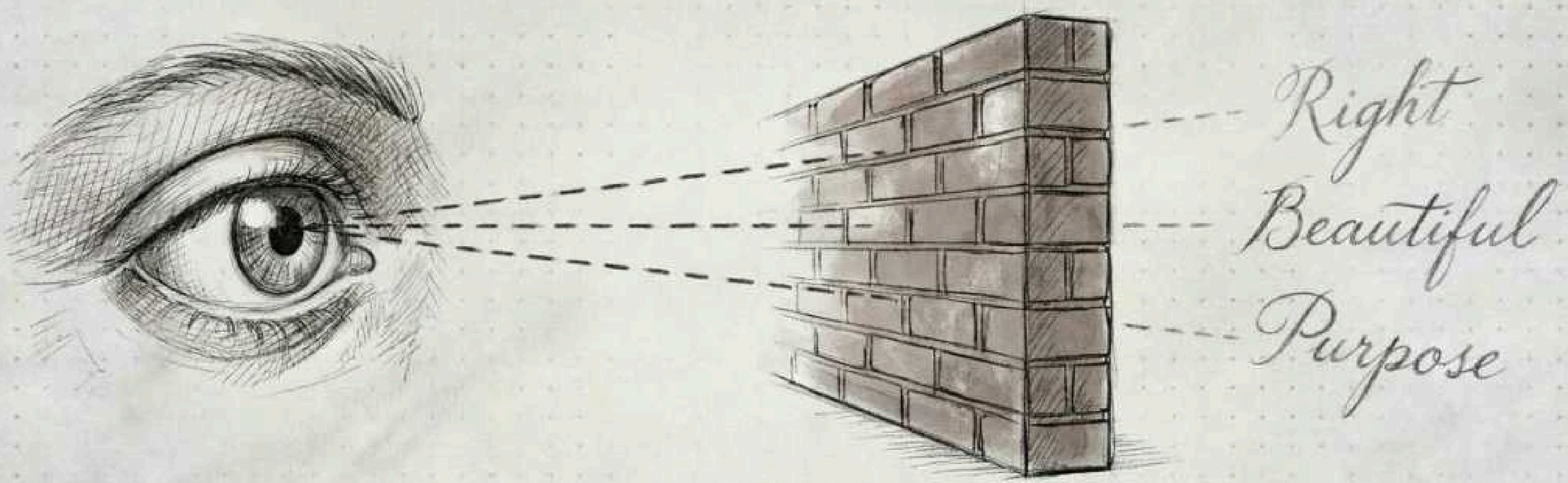
- [✓] Claims cannot be falsified
- [✓] Results are not replicated
- [✓] Only favourable evidence is shown
- [✓] Testimonials stand in for tests
- [✓] Technical-sounding words hide vague ideas
- [✓] Critics are treated as enemies

No single sign proves anything. Think of them as a checklist that tells you where to look harder.

The Limits of the Method

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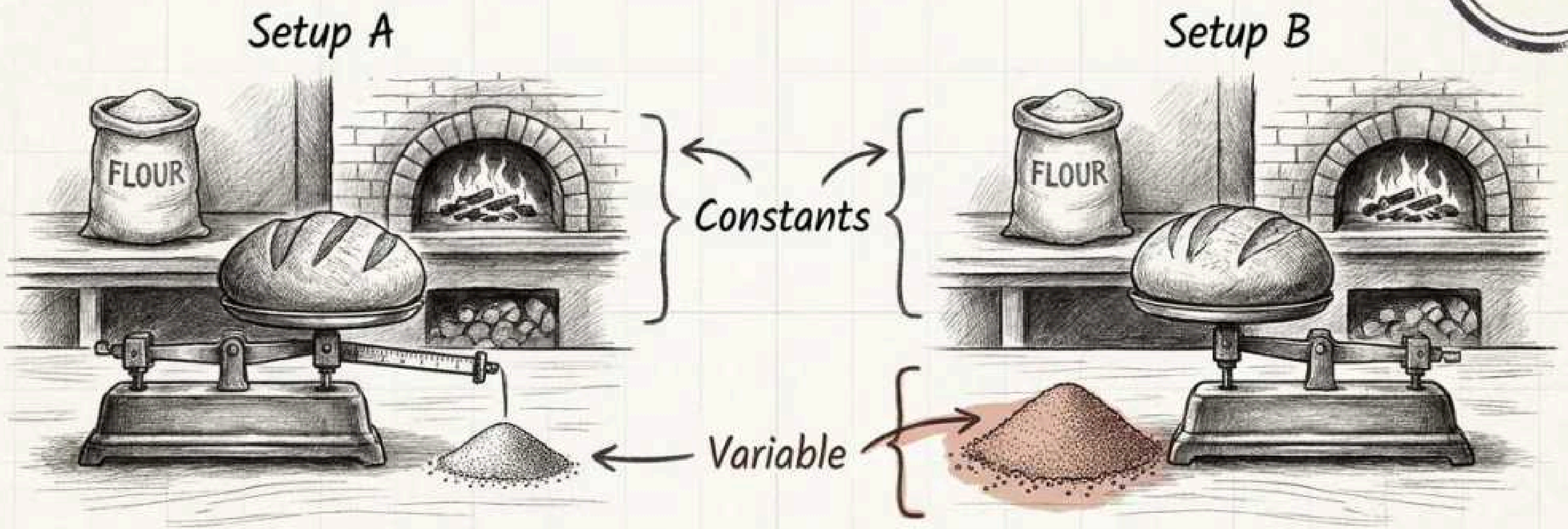
Science answers questions that observation can settle. It cannot tell you by itself what is right, what is beautiful, or what your life is for.



Good decisions about those things should still respect the facts. A skeptic uses science for what it does well, and does not pretend it does more.

Applied Common Sense

¶ 2.17



A cook wanting a better loaf changes the amount of yeast and leaves everything else alone. If she changed the flour, oven, and yeast all at once, she would not know which change mattered. Controlling variables is just common sense, written down and applied with care.

The Power of Measured Uncertainty

¶ 2.18

Science does not ask, 'Is this true for ever?' It asks, 'What does the evidence show so far, and how sure can we be?'

$p < 0.05$

$p = P(Data|H_0)$

$\Delta t = \frac{\text{Confidence Interval}}{p < 0.05}$

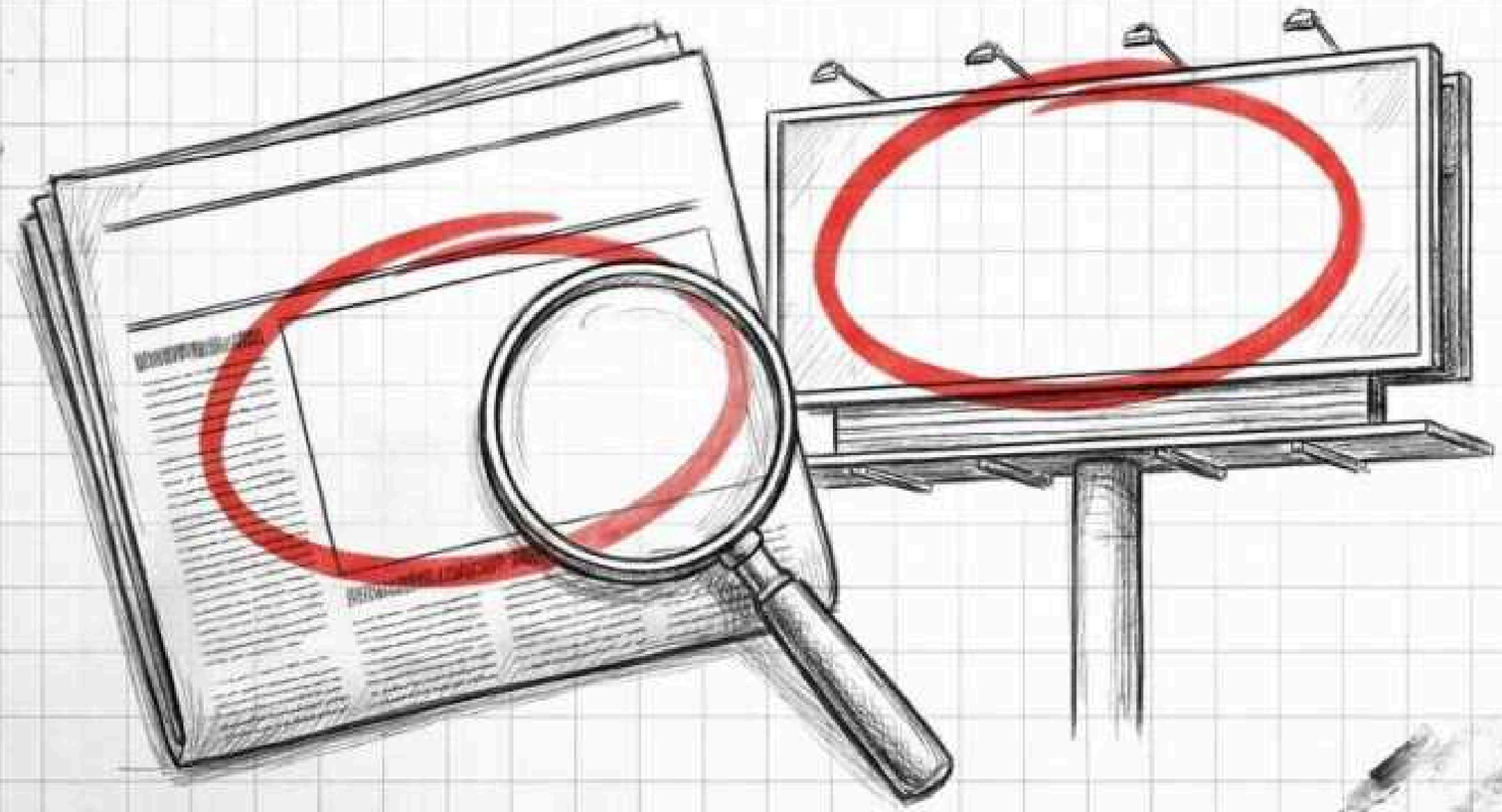


Synthesis insight: That modest wording is a strength. It is why scientific claims come with measured uncertainty, and why a scientist who says "probably" is often being more honest than one who says "definitely".

Apply the Framework

¶ 2.19

Think of a claim you heard recently, perhaps in an advertisement or a news story.



1. What would a fair test of it look like?

2. What result would show that the claim was wrong?

Looking Ahead

¶ 2.20

In Lecture 3, we look closely at evidence and experiments, and at what makes one kind of evidence stronger than another.

