Read an invented friction comparison

Which variables need controlling before a surface comparison is useful?

Read a completely invented steady-pull table, calculate its averages and identify what a real comparison would need to hold consistent.

Investigate | 15–25 minutes, or one table row | Paper and a pencil or pen, The supplied fictional force table; no pulling test or equipment required

Start here Copy this invented record in newtons (N): surface A, 2, 2, 2; surface B, 4, 4, 4. The model uses the same sliding block at steady speed on a level surface.

Fictional steady-pull records · not an experiment

Surface	1 (N)	2 (N)	3 (N)	Mean (N)
A	2	2	2	2
B	4	4	4	4

Same block · same load · level surface · steady speed

Mean difference: 4 − 2 = 2 N; ratio: 4 ÷ 2 = 2

Invented steady-pull table

1 State the model conditions

Assume the same block, contact face, added load, level track and steady speed for both surface labels. Each entry represents the horizontal pull needed to balance sliding friction in this simplified model.

2 Read and calculate

There are three fictional entries per surface. A averages (2 + 2 + 2) ÷ 3 = 2 N. B averages (4 + 4 + 4) ÷ 3 = 4 N. Keep the unit beside each result.

3 Make a bounded comparison

In this table, B needs 2 N more pull and twice A's average pull. These labels do not identify real materials. The table does not establish that a rough-looking surface always has a larger friction force.

4 Identify missing evidence

Name one condition that would need checking in a real investigation, such as a consistent load or speed. Do not turn invented entries into actual observations. You can finish by annotating the supplied table.

Fictional steady pull records

All six numbers were invented to practise reading a controlled comparison. Horizon did not perform a friction experiment.

• Surface A: 2, 2, 2 N; mean = 2 N. Surface B: 4, 4, 4 N; mean = 4 N.

• Difference of the means: 4 - 2 = 2 N. Ratio: 4 ÷ 2 = 2.

• At the assumed steady speed, the forward pull and backward sliding-friction force balance. Equal opposite forces do not mean the block is stationary.

What this example can show This model does not measure a coefficient of friction, test named materials or establish measurement precision. Real records can vary; constant invented numbers are not evidence of perfect measurement.

A different way

Read one row aloud, point to the larger mean or have someone scribe your explanation. Use only the invented records; no practical test is needed.

If you want to go further

Try another explicitly invented table: A: 1, 3, 2 N and B: 3, 5, 4 N. Both means remain 2 and 4 N, but each set now has a range of 2 N. Explain how a mean can hide variation.

Something to notice

Am I describing what the invented records say, or claiming an experiment happened?

Read or explore more

Horizon topic Friction Surfaces

https://launchhorizonhq.com/learn/friction-surfaces/

Horizon topic Forces Motion

https://launchhorizonhq.com/learn/forces-motion/

Horizon topic Physics

https://launchhorizonhq.com/learn/physics/

Institute of Physics, IOPSpark Friction

https://spark.iop.org/friction

National Institute of Standards and Technology SI Units

https://www.nist.gov/pml/owm/metric-si/si-units

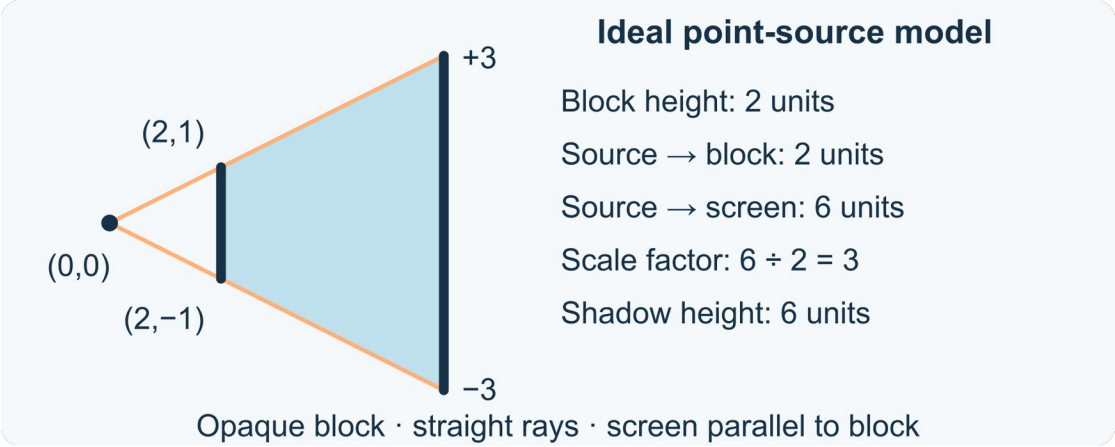
Explain a drawn shadow

How can a ray diagram show what a shadow model assumes?

Use a complete point-source drawing to locate a shadow region and explain what an ideal ray model leaves out.

Explore | 15–25 minutes, or two rays | Paper and a pencil or pen, The supplied coordinate model; no lamp, laser, sunlight viewing or experiment needed

Start here Use a drawn point source at (0, 0), an opaque vertical block at x = 2 from y = -1 to 1, and a parallel screen at x = 6. All coordinates use the same arbitrary unit.



Point-source shadow: an ideal drawing

1 Draw the boundary rays

Join the source to the block's top (2, 1) and bottom (2,-1). Continue each straight line to the screen. These construction lines just skim the edges; they do not pass through the block.

2 Find the shadow limits

The screen is three times as far from the source as the block: 6 ÷ 2 = 3. The upper boundary reaches y = 3 and the lower y = -3, so the ideal shadow height is 6 units.

3 Label the assumptions

State point source, opaque block, straight rays in one uniform medium, parallel screen and no other illumination. Mark the region between the boundaries on the screen as missing direct light.

4 Explain one limit

A large real light source, surrounding reflected light or different geometry can give a different or blurred boundary. Keep this a paper model; it is not a photograph or a test of an actual lamp.

Constructed ray model a threefold scale factor

The coordinates and diagram are original ideal geometry, not experimental observations. Source-to-block distance is 2 units; source-to-screen distance is 6.

• Upper boundary: y/x = 1/2, so at x = 6, y = 3. Lower boundary: y/x = -1/2, so y = -3.

• The block's height is 1 - (-1) = 2 units. The screen's ideal shadow height is 3 - (-3) = 6 units.

• The height ratio is 6 ÷ 2 = 3. The shadow is a region with direct light blocked, not a second object travelling from the block.

What this example can show A point source is an idealisation. This two-dimensional construction does not include an extended source, scattering, diffraction or ambient reflected light.

A different way

Trace the supplied rays with a finger, have the coordinates read aloud or discuss only the blocked region. Accurate ruler work is optional.

If you want to go further

Keep the source and block fixed but draw the screen at x = 4. The same model gives boundaries y = ±2 and a 4-unit shadow height. Compare the new ratio with the original without performing a light test.

Something to notice

Which features belong to this ideal drawing rather than every real shadow?

Read or explore more

Horizon topic Light Optics

https://launchhorizonhq.com/learn/light-optics/

Horizon topic Refraction Lenses

https://launchhorizonhq.com/learn/refraction-lenses/

Horizon topic Physics

https://launchhorizonhq.com/learn/physics/

Science Learning Hub, University of Waikato Light basics

https://www.sciencelearn.org.nz/resources/171-light-basics

Science Learning Hub, University of Waikato Light and shadows

https://www.sciencelearn.org.nz/resources/2771-light-and-shadows

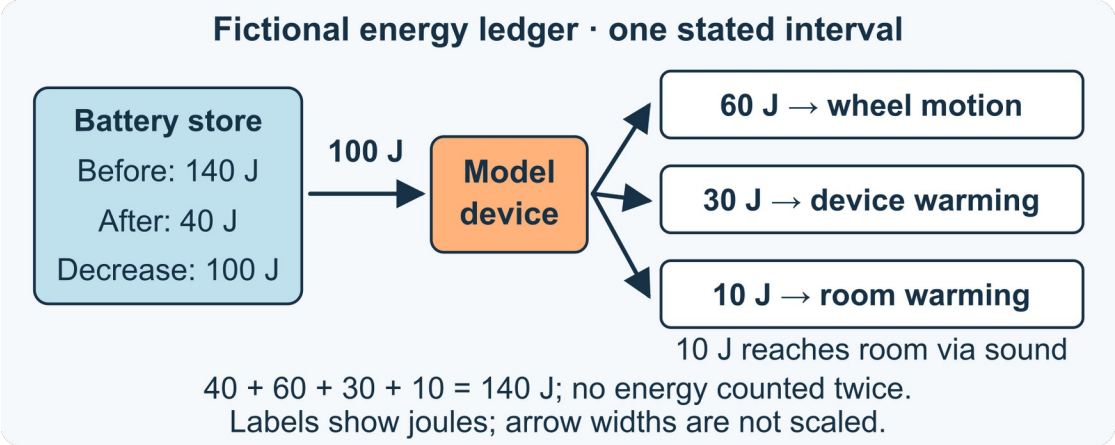
An energy transfer explanation

Which transfers belong in a clear model of an invented machine?

Complete a fictional machine's energy ledger, distinguish transfers from stores and account for every stated joule without building anything.

Investigate | 15–25 minutes, or one balance | Paper and a pencil or pen, The supplied invented energy account; no battery, circuit or moving device needed

Start here Draw a fictional battery-driven wheel and its surroundings as one model boundary. The battery's chemical store begins at 140 J and ends at 40 J during one stated interval.



Fictional ledger: every joule accounted for

1 Account for the decrease

Calculate 140 − 40 = 100 J transferred from the battery during that interval. J means joules, a unit of energy; these are invented values, not instrument readings.

2 Allocate the stated transfers

The model assigns 60 J to an increase in the wheel's kinetic store, 30 J to increased thermal stores of the device, and 10 J transferred by sound then absorbed into the room's thermal store.

3 Check both balances

The assigned transfers total 60 + 30 + 10 = 100 J. Including the 40 J left in the battery gives 40 + 60 + 30 + 10 = 140 J. Do not add the sound transfer again as another permanent store.

4 Name what the model cannot show

Explain which quantities were supplied rather than measured. The ledger balances, but does not establish the machine's design, speed, temperature or performance. Choose a label or diagram change that would make the account clearer.

Fictional machine keep all 140 J accounted for

This is an invented energy ledger over one interval. It is not a measured machine, construction plan or claim about a real battery.

• Before: 140 J in the battery's chemical store. After: 40 J remains there, 60 J is in wheel motion, 30 J increases device thermal stores, and 10 J ends in the room's thermal store after sound is absorbed.

• Battery decrease = 100 J; stated destinations = 60 + 30 + 10 = 100 J. The complete before/after total is 140 J.

• Sound is a transfer process here, not a separate store to count twice. Energy in the surroundings remains part of the account even when it is less useful for turning the wheel.

What this example can show Numerical balance is necessary for this account, but is not evidence that a machine with these values exists. Arrow labels carry the numbers; their widths in this simple diagram are not a scaled Sankey chart.

A different way

Use four labelled boxes, point to each amount or dictate the sums. A spoken account is enough; no building, noise-making or electricity is needed.

If you want to go further

Create a new explicitly fictional balanced account with the same 140 J start and 40 J battery remainder: 70 J to wheel motion, 20 J to device warming and 10 J via sound to the room. State which numbers changed and check the totals again.

Something to notice

Have I followed the stated energy to its destination without counting a transfer twice?

Read or explore more

Horizon topic Energy Power

https://launchhorizonhq.com/learn/energy-power/

Horizon topic Waves Sound

https://launchhorizonhq.com/learn/waves-sound/

Horizon topic Models Explanations

https://launchhorizonhq.com/learn/models-explanations/

Institute of Physics, IOPSpark The law of conservation of energy

https://spark.iop.org/law-conservation-energy

Institute of Physics, IOPSpark The Sankey diagram

https://spark.iop.org/sankey-diagram