

What does the endpoint tell you?

Vertical Drop versus Distance | High school worksheet

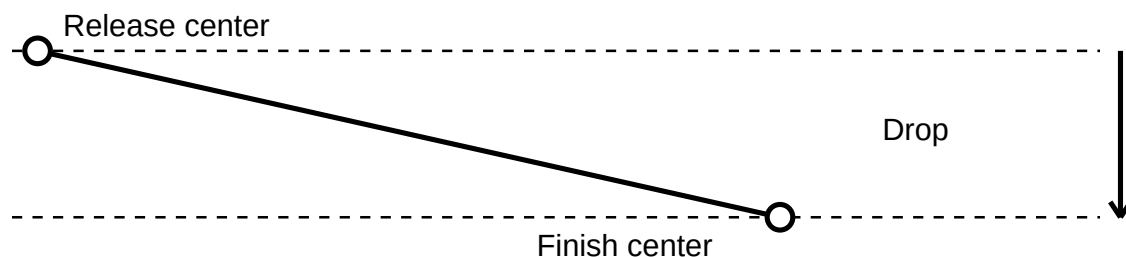
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Name: _____ Date: _____

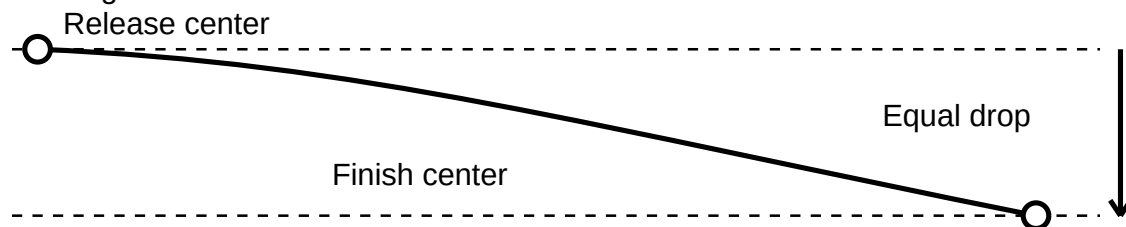
HS01 - Commit to a prediction

HS01 Two downhill routes have equal center-height drops, but B is longer. Would extra distance alone establish a lower finish speed? Give a reason and identify information you would want before making a real-track prediction.

A - shorter route



B - longer route



Schematic side views; no measured scale. Dots mark center positions.

Two side-view route sketches: A is shorter, B is longer. Each marble center starts the same vertical distance above its finish center. Dotted horizontal guides mark these center heights. Vertical arrows show the drop; the route lines show travel distance. Schematic, not measured or to scale.

The claim you will evaluate

Vertical drop: the downward separation between the marble center at release and at the finish. Route length: distance along the track. Finish speed: how fast the marble center moves at the finish, rather than how long the whole trip takes. Ideal model: a deliberately simplified comparison with stated conditions.

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For this ideal comparison near Earth: use the same marble (same shape and mass distribution), release from rest without a push, maintain rolling without skidding and contact with a stationary track, neglect track losses and air resistance, and add no powered push. The start-to-finish vertical drop supplies the same gravitational energy when it is equal. A rolling marble moves forward and spins. Keeping the same marble keeps the relationship between those motion energies fixed. With these conditions, equal drops give equal finish speeds. Route length alone does not determine that finish speed. Real tracks can change losses and contact; their results need checking.

Separate the claim from its conditions

HS02 Build a qualitative argument from gravitational energy to finish speed. Explain why keeping the same marble and rolling condition matters. Then give one changed condition that would make the equal-speed conclusion unsupported.

HS03 - A result with more than one explanation

Hypothetical report, not measured data: "After we added track, the marble finished slower." The report does not say whether endpoint heights, joints or release method stayed the same.

HS03 Does this report isolate route length as the cause? Identify two competing explanations and one piece of missing information that could distinguish them. Explain why a real result need not contradict the ideal comparison.

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Transfer the relationship

HS04 A display designer redraws a downhill marble route to reach a finish farther sideways at the same height. Draft a recommendation: what can the ideal comparison establish, what must remain fixed, and what real outcome still needs checking? Do not claim a catch guarantee.

HS05 Someone replaces the marble with a different rolling shape and says, "The endpoints are unchanged, so the original same-marble argument still proves equal finish speed." Diagnose the missing assumption. Explain why a changed body cannot simply borrow the original conclusion. No equation is required.

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Keep exploring, if you want

Everything needed for these questions is on the worksheet. Online reading is optional.

Source micro-lesson: Vertical Drop versus Distance

<https://thisworldexplained.com/okay-but/vertical-drop-versus-distance/>

Story application: One More Take - Quinn changes the layout and checks it

<https://thisworldexplained.com/okay-but/one-more-take/#quinn-layout-application>

Sources for the explanation

MIT: Potential Energy and Conservation of Energy - section 14.2

https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/mit8_01scs22_chapter14.pdf

MIT: Rigid Body Dynamics - Example 21.4 (rolling cylinder model)

https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/mit8_01scs22_chapter21.pdf

OpenStax: Rolling Motion - energy and rolling conditions

<https://openstax.org/books/university-physics-volume-1/pages/11-1-rolling-motion>