

ROLLING VERSUS SLIDING

Separate teacher key

Preparation and learning goal

Keep this file separate from the two student sheets. Give each learner the relevant sheet; retain the key for discussion. All essential ideas are printed on the sheets, so no account, internet or previous article is required. Free copies for classroom or home use.

Observable goal: distinguish travelling and spinning from the stronger claim of rolling without slipping, and justify that distinction using contact evidence. MS scaffolds naming, labelled sketch and one transfer; HS evaluates evidence, ideal-contact reasoning, a comparison and limits on transferring a cylinder result.

Prerequisites: recognise an object center and read a direction arrow. Introduce by pointing to the center and a surface dot in the drawing. No algebra, calculus, measurement dataset or specialist equipment is needed.

Vocabulary and discussion

Translation: travelling of the center. Rotation: turning around the center. Skidding/slipping: touching surfaces slide relative to one another. Static contact here: no relative sliding at contact; the whole ball can still move. Ideal stationary rigid track: a simplified model without track motion or deformation. Movement energy: energy associated with travelling and spinning.

Prediction: "What can a turning mark tell us before we see contact?" Explanation: "Which two surfaces are you comparing?" Application: "Would that same evidence justify a no-slip caption for a bowling ball?" Ask for evidence before showing the corresponding answer. A plausible initial answer is material for revision, not a learner failure.

Paper activity and home route

Materials and setup: student sheet and pencil, or spoken/typed responses; keep the teacher key out of the prediction stage. Steps: predict MS01/HS01; read core and compare diagram; complete MS04 sketch or HS04 evidence plan; compare reasoning with the key; revisit the opening claim. Observable response: labels and explanations that separate the two motions from contact evidence. A drawing is not measured apparatus evidence, and the task supplies no real result.

Safety and alternatives: no physical run, small parts, tools, loads, vehicles or bowling trial is required. Use the complete paper/text route rather than imitating a motion example. For one learner, let them think silently, describe evidence, then consult the key. For siblings, each makes a private prediction before discussion; one can name/draw while another critiques the evidence. Neither needs to run equipment.

Simpler route: focus on MS02 and draw just the center arrow before adding spin. Read questions aloud, allow oral responses and prompt "What does the dot do relative to the center?" Deeper route: use HS03/HS06 and require a condition as well as a conclusion; do not introduce a numerical formula beyond this package.

Likely misconceptions: "spinning means no slipping" is tempting because the dot is so visible; ask what the hidden contact could be doing. "Static means the ball stands still" confuses contact with the whole object; ask relative to which surface. "All friction drains motion energy by sliding" misses the ideal no-slip condition. "Every round body shares energy the same way" overlooks shape and mass distribution. Ask for the condition before correcting the wording.

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Middle school answer guidance

MS01 - An initial prediction is not scored for correctness. A reasonable provisional answer may say the dot indicates spin but leave contact uncertain. If the learner assumes no slip, ask what they actually see and let MS06 document revision.

MS02 - A shows translation (center travels) and rotation (dot turns). B shows translation with no turning in this depicted case. Accept "moves forward and spins" or "travels, no spin" with matching labels. Do not generalise B to every sliding object: the core also allows a spinning ball to skid.

MS03 - The turning dot establishes rotation; travelling center plus dot shows both motions. It does not establish no slipping. Additional information must show that the touching surfaces are not sliding relative to one another. Accept "check whether the bottom slips along the track"; distinguish that from whether the whole center moves.

MS04 - The ball sketch needs a center travelling arrow and a spin arrow; the sliding-block sketch needs travel with unchanged orientation. Text labels or an oral account with both motions are acceptable. Arrow length need not match a measured speed; labels should say motion, not force. Ask about an unlabeled arrow before marking the concept missing.

MS05 - The same inference limit applies to a bowling ball: establish that contact does not slide relative to the stationary lane before using the no-slip label. Travelling and spinning alone fit skidding too. Accept a cautious statement when contact cannot be observed; this question describes a hypothetical clip, not a trial.

MS06 - Supported: center travels and ball spins. Unestablished: contact does not slip (and any numerical speed, force or energy value). Accept a final claim that keeps the distinction even if the initial prediction was different. Explanation matters more than repeating the exact vocabulary.

Handling unexpected answers

If a learner says a sliding block could rotate, agree that the diagram depicts a specific no-turning case, not a universal definition of sliding. If they cannot see contact in a proposed clip, "I cannot establish no slip from that view" is a strong evidence-bound response. Ask for which claim is supported, rather than requiring a guessed result.

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High school answer guidance

HS01 - Preserve the provisional reasoning and defer judging it until HS07. Travel and spin do not by themselves establish no slip because contact may slide. A plausible mistaken prediction is an invitation to examine the missing evidence.

HS02 - Direct descriptions: center travels right and surface mark turns clockwise. Unresolved inference: no slipping relative to the track. Both non-slipping rolling and a travelling, spinning skidding ball can fit those descriptions. Accept a clear claim/evidence/limitation account without formal terminology.

HS03 - The universal claim fails. For A, ideal non-sliding contact on a stationary rigid track can supply a turning effect without draining movement energy through sliding. For B, contact slides and the sliding-energy distinction applies. Neither card gives a numerical loss. Real deformation, skidding and other transfers require separate consideration; do not conclude all real rolling is loss-free. Accept a comparison with the correct relative-contact distinction.

HS04 - Travel/spin column: track the center relative to the stationary track and a surface mark relative to the center. Contact column: inspect whether touching surfaces slide relative to one another. Explain that a hidden contact leaves the crucial no-slip condition unchecked. Accept a written plan or oral description that keeps frames of reference clear. No particular camera, frame rate or measurement precision is specified or certified.

HS05 - Require evidence of no relative sliding at ball-lane contact. If unavailable, a defensible caption is "the ball travels and spins; slipping is undetermined." Accept a different cautious caption with the same meaning. The mechanism transfers from marble to bowling ball, while material, deformation and observed conditions remain relevant; this is qualitative inference, not a quantitative prediction.

HS06 - Check body shape, how mass is distributed and the model conditions such as non-slipping rolling on a stationary rigid track. A cylinder result includes its own body assumptions; rotation alone does not make a marble that cylinder. Accept "different shape/mass distribution changes the sharing of movement energy" without coefficients or calculations.

HS07 - Final claim: the supplied clip describes translation and rotation, but supplies insufficient contact evidence for rolling without slipping. Accept revision or retention of a sound initial view with reasons. No measured data, real speed ranking or universal friction conclusion is established.

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Takeaways and follow-up

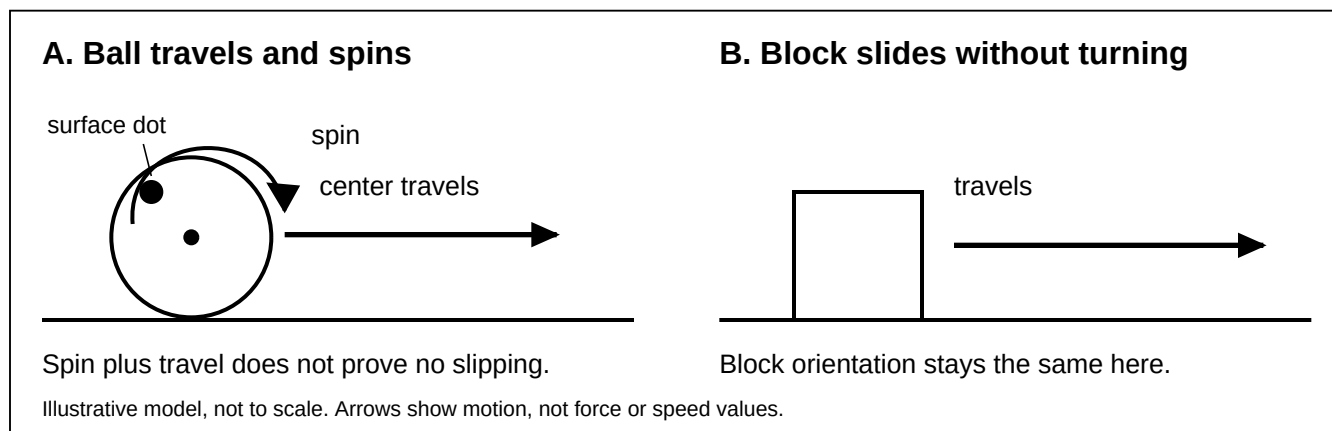


Diagram text: A ball has a rightward arrow for its center travelling and a clockwise arrow for spinning; a marked dot turns around its center. These two motions alone do not establish whether contact slips. A separate block moves right without turning. Arrows describe motion, not forces or measured speeds; the drawing is illustrative and not to scale.

Middle school takeaway: travelling and turning are different motions; a spinning ball can still skid. High school takeaway: an observed motion and a model condition are different kinds of evidence; ideal-contact assumptions must survive transfer. Use MS06/HS07 as short explanation checks, with no claim of validated learning or curriculum alignment.

The next inquiry may ask where motion energy goes in a real system. That requires evidence about the actual conditions; no paper sketch proves a measured loss. Current sheets do not specify a validated completion time, empirical outcomes or numerical formulas.

Optional reading - follow a question

Rolling versus Sliding is the source micro-lesson: revisit the distinction between spin and non-slipping contact.

One More Take is the related ramp story: its explanation mentions travelling and spinning. It does not separately test rolling against sliding. These links are optional; this sheet contains the explanation needed to work offline.

Sources for the explanation

MIT: Rigid Body Dynamics, Examples 21.4-21.5 - rolling contact, spin and the distinction from sliding.

OpenStax: Rolling Motion, section 11.1 - translation and rotation, slipping and the ideal energy boundary.

Source scope: original wording and drawings are authored for this package. MIT and OpenStax provide the physics support; their figures and worked questions are not reproduced. The related story is a narrative connection that mentions the concept, rather than a measured rolling-versus-sliding experiment.