

EQUIPMENT BUILD PLAN ENERGY

Rolling vs. Sliding Batteries

One D-cell battery rolls down an incline on its own. An identical battery has a small toy car's wheel set glued to it, so it travels without turning, almost as if it were sliding. The non-rolling battery wins, which opens up a discussion of translational and rotational kinetic energy and rotational inertia. It takes about ten minutes to build.

Written from Bruce's original workshop handout. Bruce's final review of this plan is in progress.



<div>DIFFICULTY</div> <div>Beginner</div>	<div>BUILD TIME</div> <div>15 minutes plus glue drying time</div>
<div>COST</div> <div>About \$5</div>	<div>SAFETY</div> <div>Everyday care</div>
<div>GOOD FOR</div> <div>Teachers, Families</div>	

What it shows

Two identical batteries race down a gentle slope: one rolls, one rides on tiny toy-car wheels. Most people bet on the wrong one.

Key ideas: translational kinetic energy, rotational kinetic energy, rotational inertia, friction, inclined plane

Safety (Everyday care). Use ordinary alkaline batteries, never lithium or rechargeable packs, and don't drill, heat or puncture them. A grown-up should handle strong glue (epoxy or super glue) in a ventilated area. Toy car parts are small; keep them away from young children.

CONSTRUCTION

Build it

Materials

- ☐ **D-cell alkaline batteries** · 2, identical
Used batteries work fine
- ☐ **Mini die-cast toy car** · 1
Small Hot Wheels-type car
- ☐ **Book or block** · 1
To raise one end of the table or board

Tools

- Small screwdriver
- Strong glue (epoxy or thick super glue)
- A board or table that can be tilted slightly

1

Pick a donor car

Find a small die-cast car whose wheel set is about as long as the battery is wide.



2

Take the car apart

Most small cars are held together by a single screw or rivet underneath. Remove it and lift off the body, keeping the wheel and axle assembly in one piece.



3

Glue the wheels to the battery

Glue the wheel assembly to the side of one battery so its wheels roll in the same direction the battery would roll. Center it so the battery sits level.



4

Let it dry

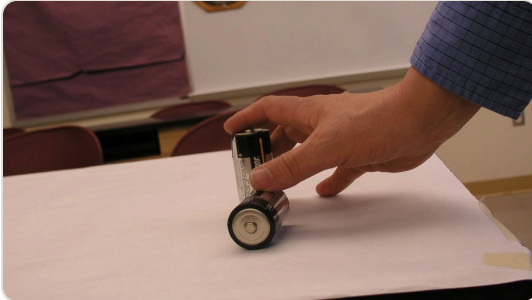
Let the glue cure fully. Check that the battery rides on the wheels without touching the table.



5

Set up the slope

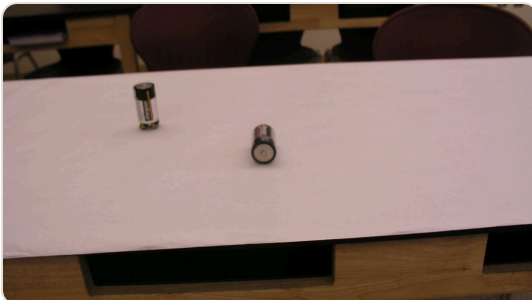
Raise one end of a table or board slightly. A very gentle slope gives the clearest race.



6

Race

Ask for predictions, then release both batteries side by side from the same line at the same moment.



THE PHYSICS

How it works

Both batteries start with the same gravitational potential energy, and both turn it into kinetic energy as they move down the slope.

The battery on wheels only moves from place to place: almost all of its energy goes into

Using it

- Show both batteries and ask which will reach the bottom first and why.

translational kinetic energy, the energy of moving along. The tiny wheels spin, but they are so light that they take very little energy.

The bare battery has to roll. Friction with the table makes it turn, and because it has rotational inertia (a resistance to starting to spin), part of its energy goes into rotational kinetic energy. Less energy is left for moving down the slope, so it falls behind.

An object sliding with no friction at all would be the fastest of all. The wheeled battery is a close stand-in, but its wheels still have a little friction.

Have students write down a prediction and a reason.

- After the race, ask: if the batteries weigh nearly the same, where did the rolling battery's energy go?
- Students sometimes point out that the wheeled battery isn't really sliding. Ask what would happen with no friction at all.
- Use it to introduce a 'roller derby' lab: students find or build objects that roll down a table as fast as possible, and as slowly as possible.
- Race a solid can against a hollow can and discuss where the mass is placed.

GO FURTHER

Variations

- Tape the battery onto the roof of a small toy car instead of gluing on the wheels.
- Glue the battery crosswise onto a whole toy car.
- Use the same idea with other cylinders, such as a can or a dowel.

IF IT DOESN'T WORK

Troubleshooting

IF THIS HAPPENS

The wheeled battery veers off course.

TRY THIS

Re-glue the wheel set so it is centered and square to the battery.

IF THIS HAPPENS

The rolling battery wins.

TRY THIS

Check that the wheels spin freely and the battery body doesn't drag on the table. Use a gentler slope.

IF THIS HAPPENS

TRY THIS

The batteries roll off the side.

Line them up straight down the slope, or add a rail along each side.

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