

Kinetic Friction Lab: μ_k

Purpose

Measure the coefficient of kinetic friction μ_k for several objects/surface textures by timing motion **from release to full stop** on a flat surface if timing starts when the object begins its **unforced** slide at the **start line** and ends at full stop. Mass cancels; but it may be easier to calculate if the mass is measured. Initial speed is eliminated by timing to rest and using v_f instead.

Equipment

- **Objects** with different **contact textures** (e.g., wood block, rubber-bottom block, cloth-wrapped block, sandpaper underside, plastic tub lid).
- Flat test lane (2–4 m) of each surface you want to test (e.g., desktop, vinyl floor, craft paper strip).
- **Stopwatch**.
- **Measuring tape**; masking tape.
- **Balance** (to record each object's mass).

Setup

1. **Mark a Start Line** across the lane.
2. **Practice the release:** Hold the object, give a **short, gentle push** before the Start Line, and **let go before** the front edge reaches the Start Line.
 - The timer **starts** when the **front edge** reaches the Start Line (no hands on the object after that).
 - This makes the motion after the Start Line **unforced**, so $F_A=0$ applies.
3. Do a couple of practice runs to get a **stopping distance** $d \geq 1.5$ m. Longer d reduces percent timing error.

Procedure (repeat for each object/surface)

1. Record **object ID**, **surface**, and **mass** of object.
2. From ~30 cm before the Start Line, give a quick **push**, **let go** before the line, then:
 - **Start** timing as the **front edge** reaches the Start Line.
 - **Stop** timing at **full stop**.
 - Measure the **distance** d from Start Line to the nose at rest.
3. Repeat **6 trials**. Pick different objects and different surfaces for each trial.

Surface	Object	Mass	Time t (s)	Distance d (m)

Analysis Steps (For each trial)

1. Compute each trial's initial velocity using $d = \left(\frac{v_f + v_i}{2}\right) t$.
2. Calculate acceleration using $v_f = v_i + at$.
3. Draw a free body diagram showing all the forces.
4. Compute μ_k algebraically, Remember that $F_A = 0$.

Reflection:

1. Why doesn't mass matter in the calculation $F_{NET} = F_A + F_F$?
2. Which uncertainty dominates here: time or distance? ie. Which one causes more error in your calculations? How could you tell?
3. If the surface had a tiny downhill slope, would you expect your computed μ_k be too be bigger or smaller? Explain.
4. If you had a faster starting speed but same object/surface. Should μ_k change? Defend your claim.
5. Try two masses on the same texture (e.g., add weights to a block). Does μ_k change?