FORCES DAY 5: FRICTION PROBLEM SOLVING

WARMUP **Day 4 Review**

A 6.0 kg box rests on a floor with $\mu_s = 0.40$. You push horizontally with 20 N. Does it slide, and what friction force acts on it?

Physics in the Wild — Why ABS Brakes Win: A rolling tire grips the road with *static* friction; a locked, skidding tire only gets *kinetic* friction — and $\mu_s \geq \mu_k$ (for tires on pavement, μ_s is the larger). Anti-lock brakes release and re-grip many times per second to keep the tire in the static regime, which is why an ABS stop is shorter than a screeching skid. Today: friction inside full Newton's-Second-Law problems.

THE MASS THAT CANCELS

When sliding friction is the *only* horizontal force on level ground:

$$ma = \mu_k mg \rightarrow a = \mu_k g$$

The units prove it: μ is unitless, so μg keeps g's units, m/s² — and the mass is gone. A loaded truck and an empty one skid to a stop in the same distance on the same tires.

WE DO **Exercise 1: Skid Distance**

A car skids at 20 m/s with $\mu_k = 0.40$. **(a)** Find the deceleration. **(b)** Find the stopping distance with Unit 1 kinematics.

YOU DO **Exercise 2: Net of Two Forces**

A 12 kg crate is pushed horizontally with 60 N across a floor with $\mu_k = 0.25$. **(a)** Find F_N and the friction force. **(b)** Find the acceleration. FBD first!

YOU DO **Exercise 3: Find μ from the Motion**

A sled coasting on level snow decelerates at 1.96 m/s² with friction as the only horizontal force. Find μ_k.

Friction's job description: it always opposes the *sliding* (or attempted sliding) — which is not always "backwards." When a box rides a accelerating truck bed without slipping, friction on the box points *forward*. Direction comes from the FBD, not from habit.

THE FULL CHAIN: FORCES → A → MOTION

CHALLENGE **Exercise 4: The Long Slide**

A hockey puck leaves a stick at 8.0 m/s on ice with $\mu_k = 0.10$. Find **(a)** the deceleration, **(b)** how far the puck slides before stopping, and **(c)** how long the slide takes. Three answers, three units — check each.

YOU DO **Exercise 5: Predict, Then Reason**

Two identical crates slide off the same conveyor at the same speed, but one carries double the load. Which crate slides farther before stopping? Answer in one or two sentences using $a = \mu_k g$.

PAPER PRACTICE

PRACTICE PROBLEMS

P1 Stopping Distance

A box slides at 15 m/s on a surface with $\mu_k = 0.30$. How far does it travel before stopping?

P2 Acceleration with Friction

A 5.0 kg crate is pushed with 25 N where $\mu_k = 0.20$. Find its acceleration.

P3 Find μ

Friction alone decelerates a sliding tray at 2.45 m/s² on a level counter. Find μ_k.

P4 The Heavy Puck Myth

A teammate insists a heavier puck "carries farther" on the same ice. Write two or three sentences settling the question with $\Sigma F = ma$ — include why the mass disappears from the answer.