





Slipping, Sliding, and Scaling: The Science of Friction and Inclined Planes

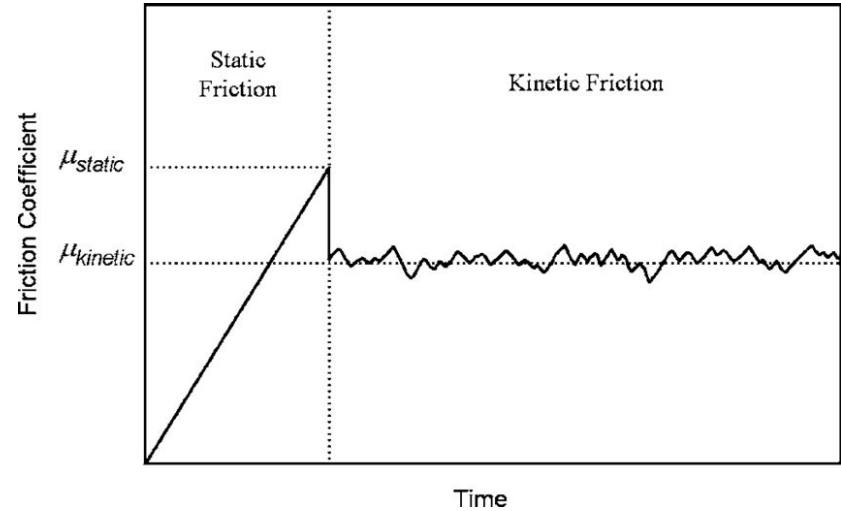


Learning Goals

- Find examples of friction in everyday life
- Use what we already know about friction to understand new situations
- Build intuition about what affects how much friction there is

What Do We
Already Know?

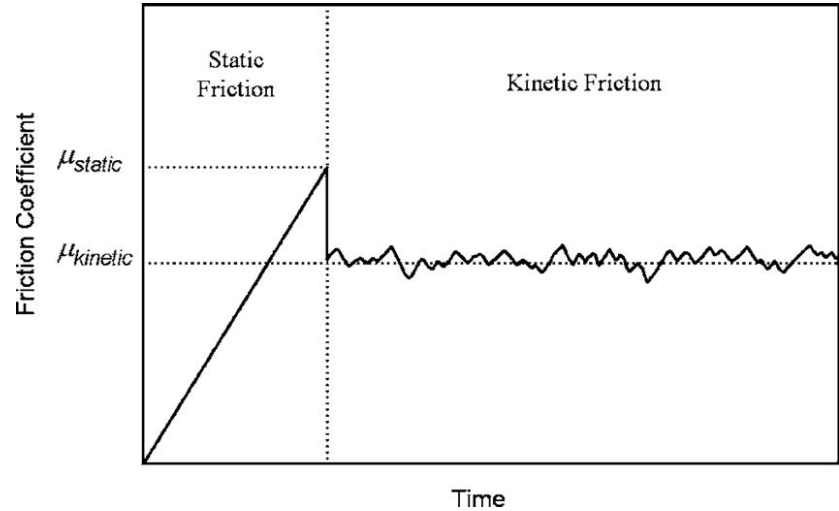
What Do We Already Know?



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Static friction is an *inequality*; coefficient μ_s is not a constant

$$F_s \leq \mu_s F_N$$



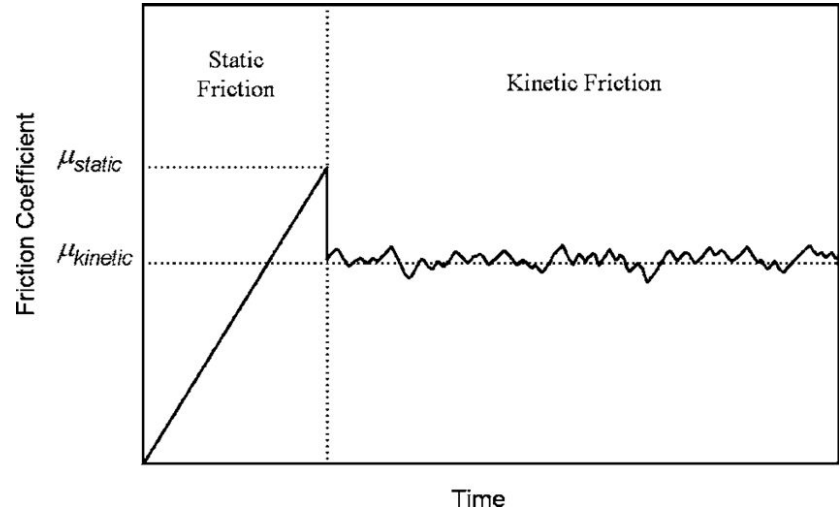
What Do We Already Know?

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Kinetic friction is always smaller than maximum static friction

$$F_k = \mu_k F_N$$

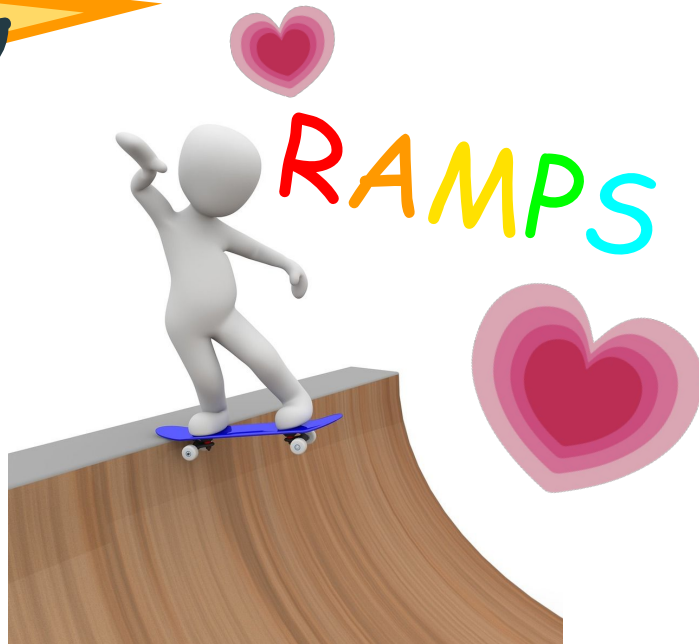




INTRODUCING

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RAMPS





Why would increasing the
angle of the ramp cause the
block to slide?

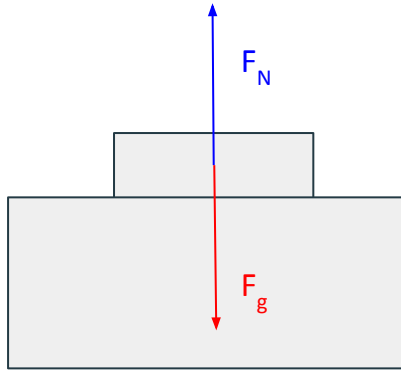


Friction Depends on Normal Force!

Normal force acts to **prevent objects from passing through each other**, and will only be as large as necessary to do so.

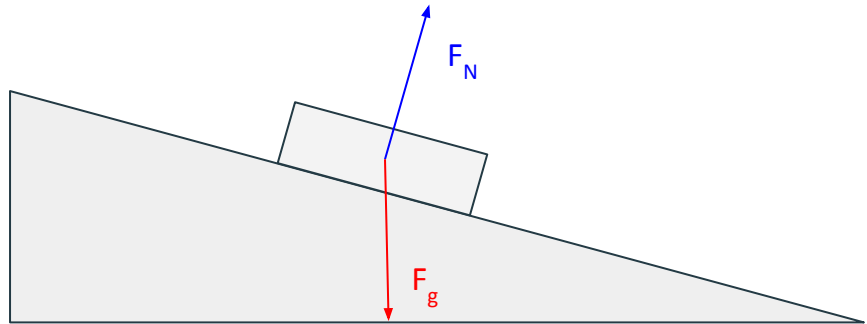
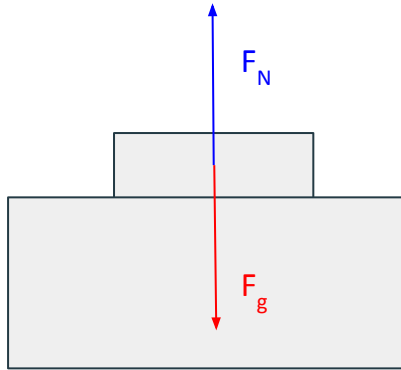
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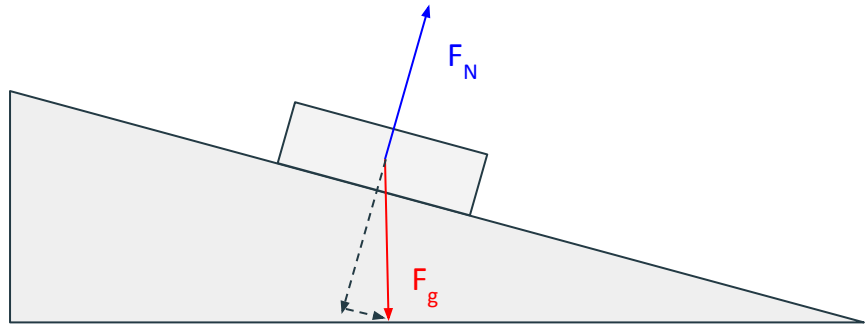
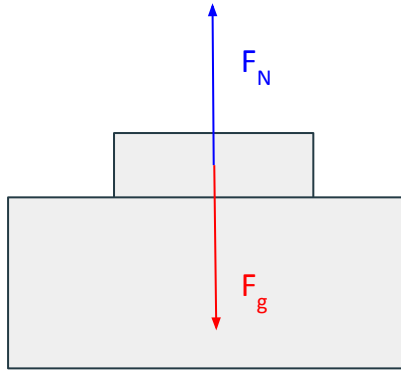
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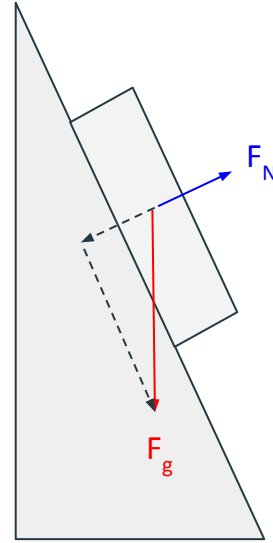
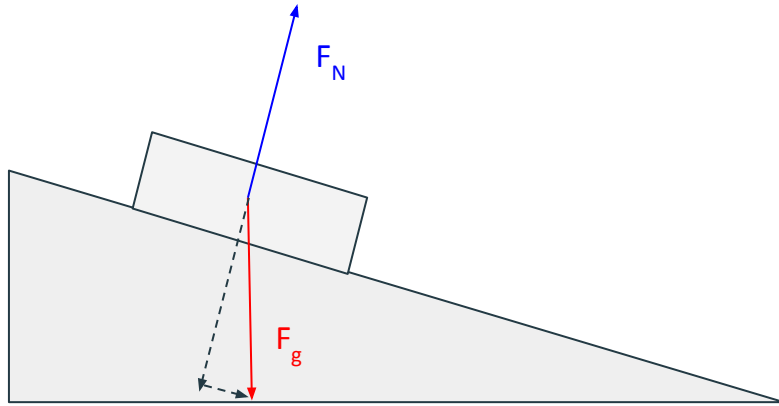


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Greater Angle, Less Normal Force



Let's Race!

	Block	Track
A	Rubber	Wood
B	Plastic	Carpet
C	Plastic	Rubber
D	Carpet	Cork

Now What If We
Wet the Materials...?

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Once we wet the material, we **change its properties**—including the coefficient of friction between it and another surface!



Let's Get Down to Business 🎵 🎵

How we can find the coefficient of friction between two surfaces?

Our Toolkit:

- Free Body Diagrams <3
- Newton's 2nd Law of Motion ($F_{\text{net}} = ma$)
- Trigonometry

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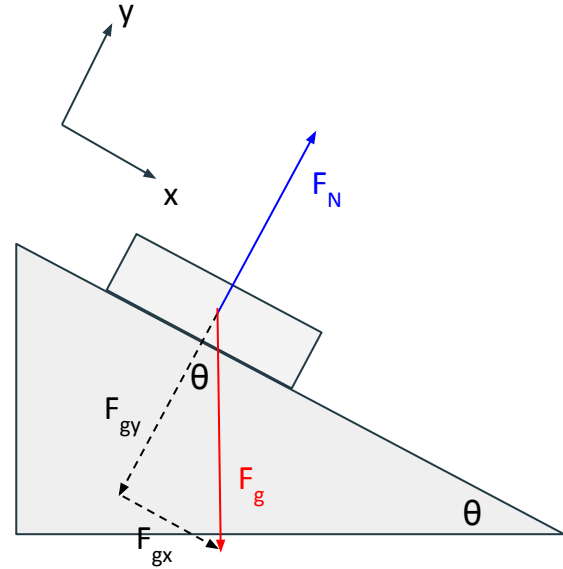
- Free Body Diagrams <3
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The easiest way to do this is to find the angle where acceleration is zero...

A Useful Trick

We can **redefine our axes!**

And that means we must break some of our forces down into x and y components...





There are other types of friction!

But unfortunately we are out of time...





Thanks for your attention!