Friction

IB PHYSICS | FORCES

Types of Forces | Friction

F_f *Always opposes motion

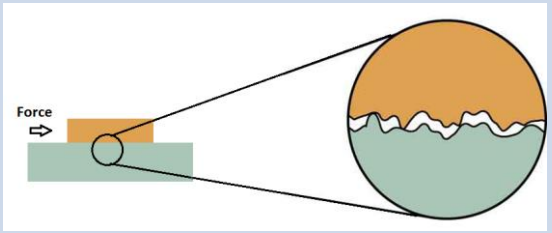
What is Friction?

The force opposing the motion between two objects that are in contact.

Types of Friction

Static Friction-

Not Moving



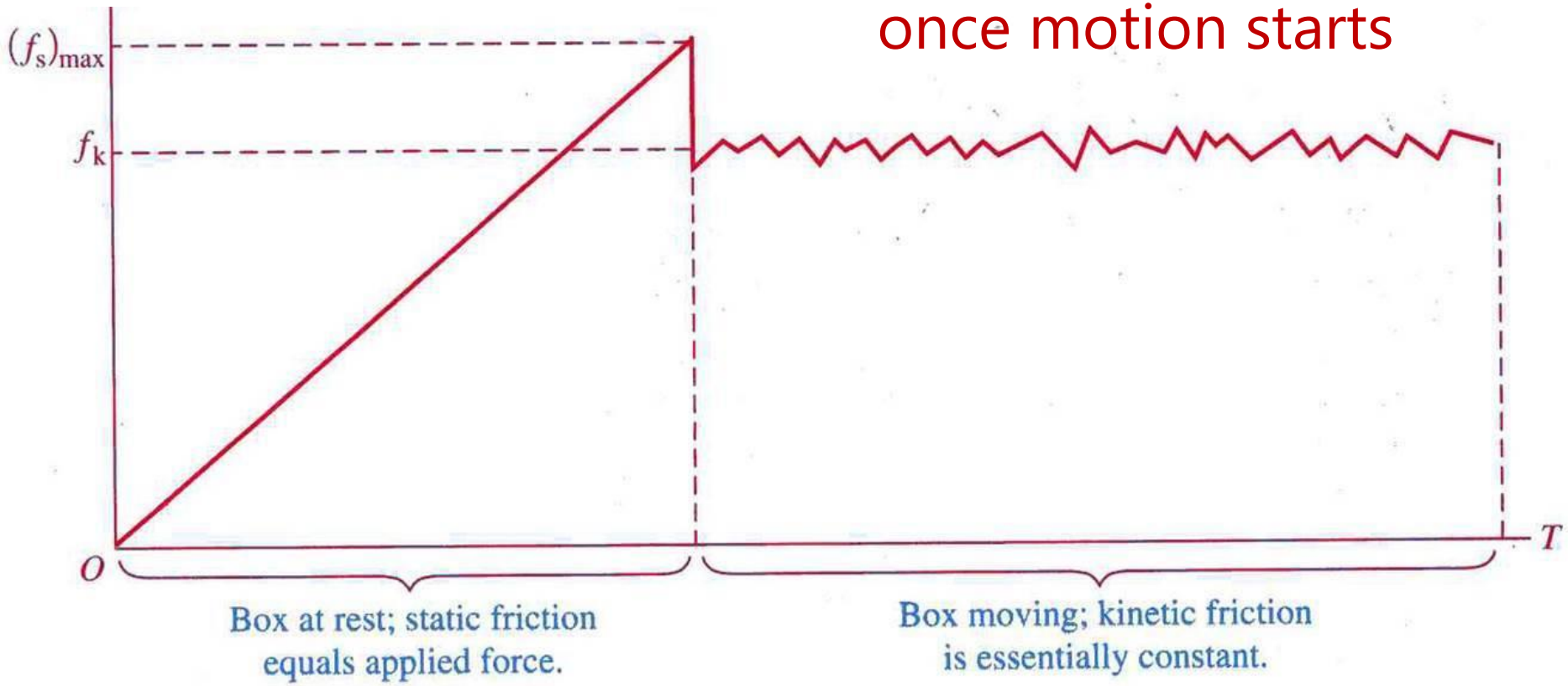
Dynamic (Kinetic) Friction-

In Motion

Static > Dynamic

Static vs. Dynamic Friction

Friction decreases once motion starts



How do we Calculate Friction?

$$F_f = \mu \times R$$

Normal Reaction Force

Coefficient of Friction

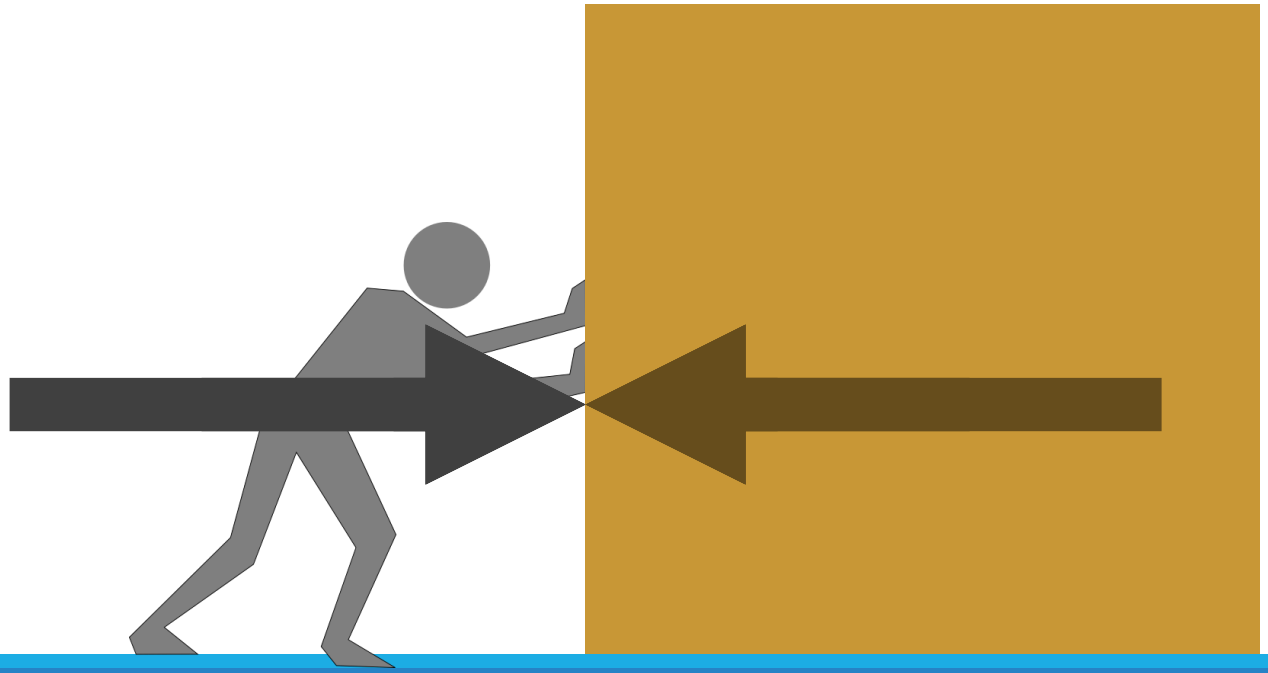
**unitless*

Large μ → "Sticky"
Small μ → "Slippery"

Materials	μ_s	μ_d
Steel on ice	0.1	0.05
Steel on steel (dry)	0.6	0.4
Steel on steel (greased)	0.1	0.05
Rope on wood	0.5	0.3
Teflon on steel	0.04	0.04
Shoes on ice	0.1	0.05
Climbing boots on rock	1.0	0.8

Static Friction

$\mu_s \times R$ calculates the limit of static friction but below that, it will be equal and opposite to external force



Physics Data Booklet

Sub-topic 2.2 – Forces

$F = ma$

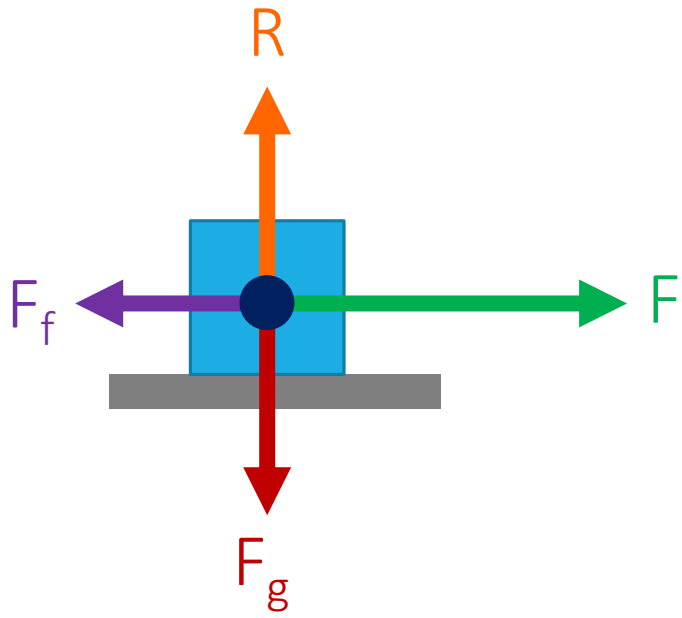
$F_f \leq \mu_s R$

$F_f = \mu_d R$

$F_f = \mu R$

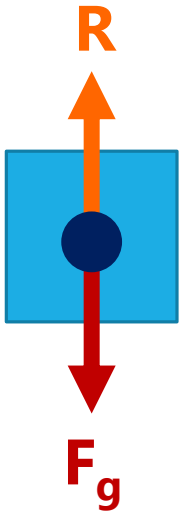
How do we Calculate Friction?

F	External Force
F_g	mg ← g = 9.81 m s^{-2}
R	F_g *when flat
F_f	μR



Calculate Friction | Try This…

Santa's Sleigh is loaded up with toys for all the good little girls and boys until it has a total mass of 2000 kg. What is the **static friction** force that must be overcome if μ_s is 0.1?



$F_g = mg = (2000)(9.81) = 19{,}620\ N$

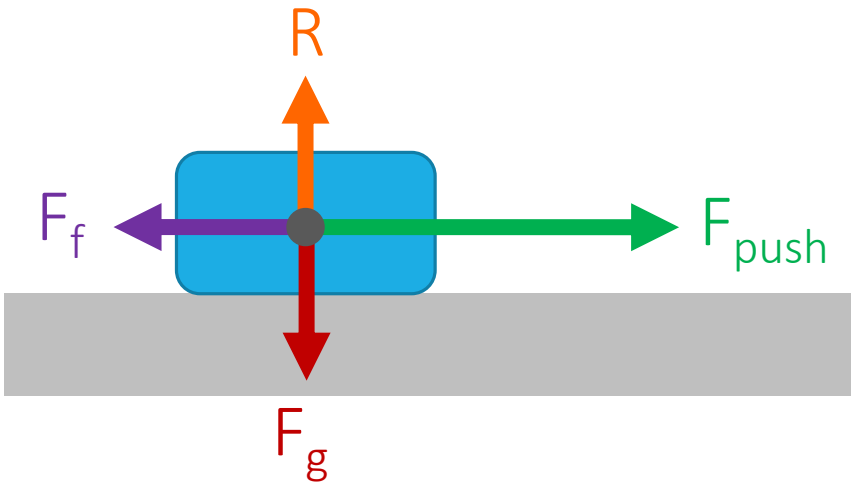
$R = F_g = 19{,}620\ N$

$F_f = \mu R = (0.1)(19{,}620) = \mathbf{1{,}962\ N}$

Calculating Acceleration w/ Friction

Step 1:
Find the Force from Friction

- $F_g = mg$
- $R = F_g$
- $F_f = \mu \times R$



Step 2:
Find F_{net}

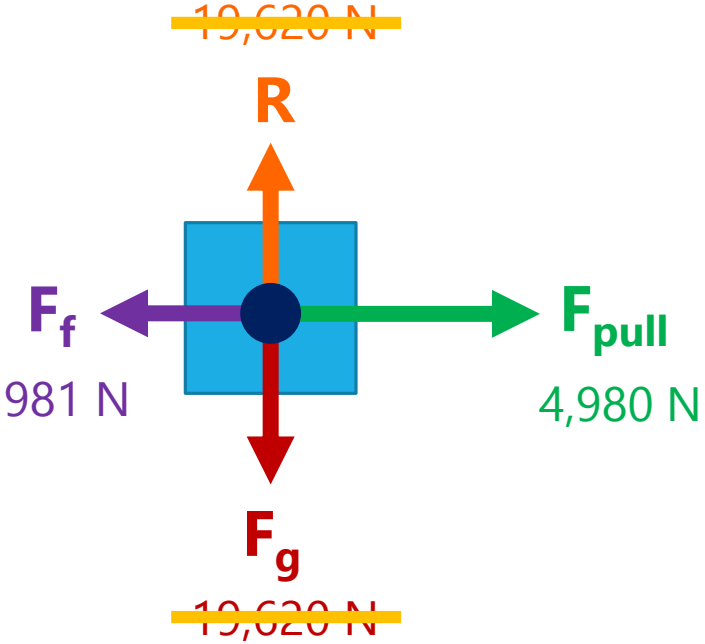
- $F_{net} = F_{push} - F_f$

Step 3:
Find acceleration

$F_{net} = ma$ ➡ $a = F_{net} / m$

Calculate Friction | Try This…

Santa's reindeer pull his 2000 kg sleigh with a force of 4980 N. How fast does the sleigh accelerate if the coefficient of kinetic friction (μ_k) is 0.05?



$F_g = mg = (2000)(9.81) = 19{,}620$ N

$R = F_g = 19{,}620$ N

$F_f = \mu R = (0.05)(19{,}620) = 981$ N

$F_{net} = 4980 - 981 = 3999$ N

$a = F/m = 3999/2000 =$ **$2\ m\ s^{-2}$**

Lesson Takeaways

- ❑ I can calculate the force of friction when given the reaction force and coefficient of friction
- ❑ I can quantitatively compare surfaces based on their coefficients of friction
- ❑ I can calculate the acceleration of an object with friction based on the external force and mass