Dry Friction

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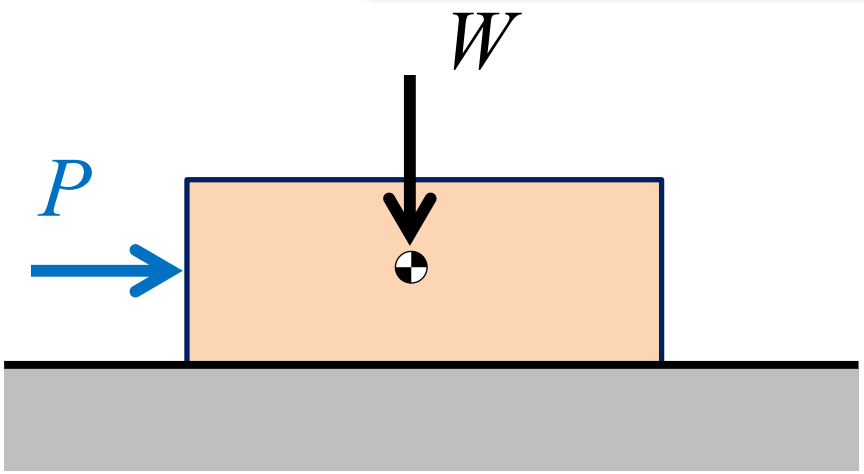
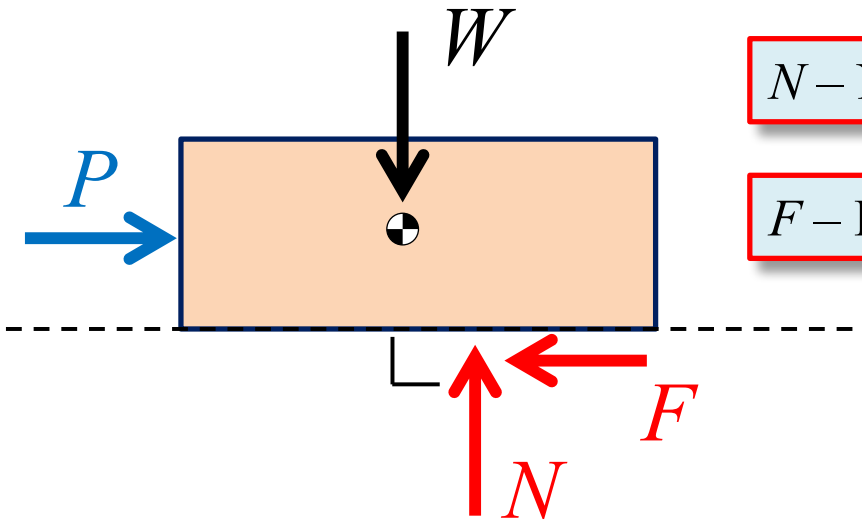


Consider a block of weight, *W,* sitting on a rough surface. a force, *P*, parallel to the surface, acts on the block.

Free-Body Diagram of the block

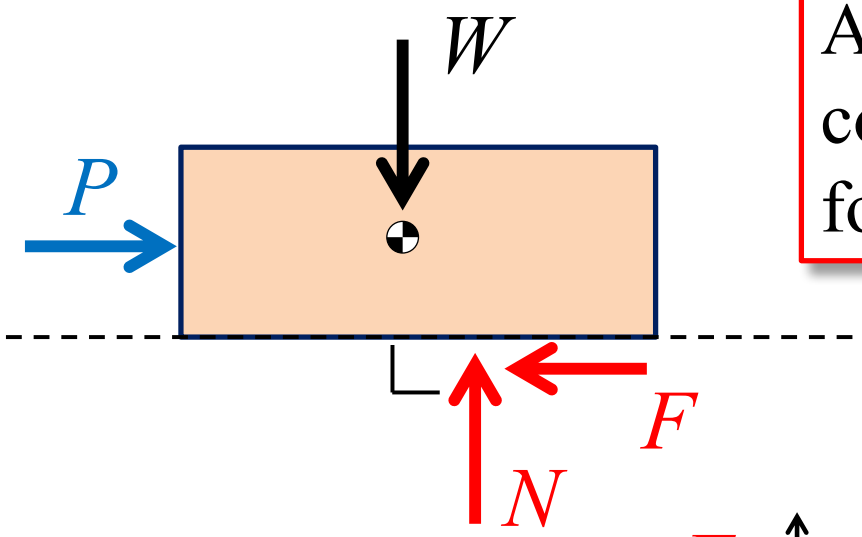


N – Normal Force (perpendicular to the surface)

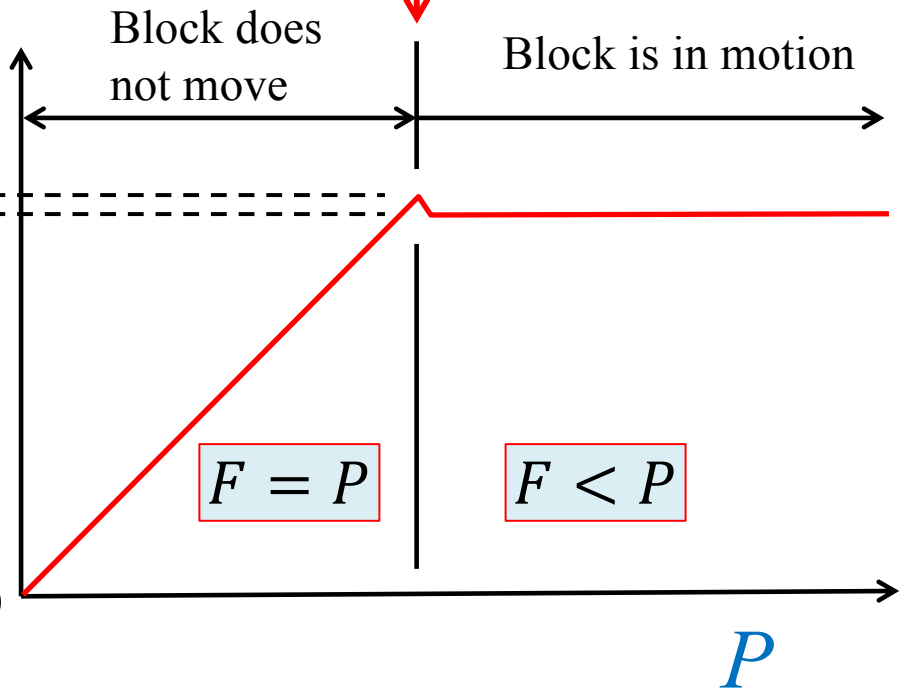
F – Friction Force (parallel to the surface)

Friction Force

As the force, P, increases; consider how the friction force changes:



Impending motion



$F = F_m = \mu_s N$

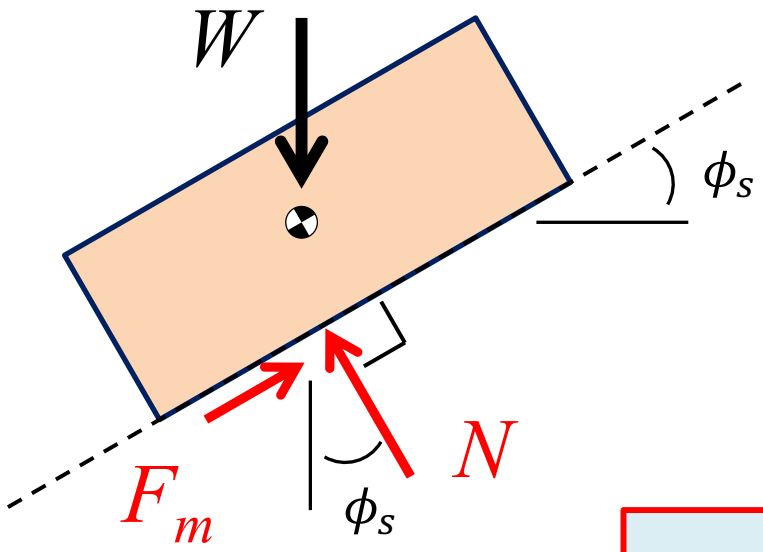
$F = F_k = \mu_k N$

μ_s– Coefficient of static friction

μ_k– Coefficient of kinetic friction

Coefficient of Static Friction

One can find the Coefficient of Static Friction by placing a block on a surface and tilting the surface until the block just begins to slide down the incline (impending motion)



$$F_m = \mu_s N$$

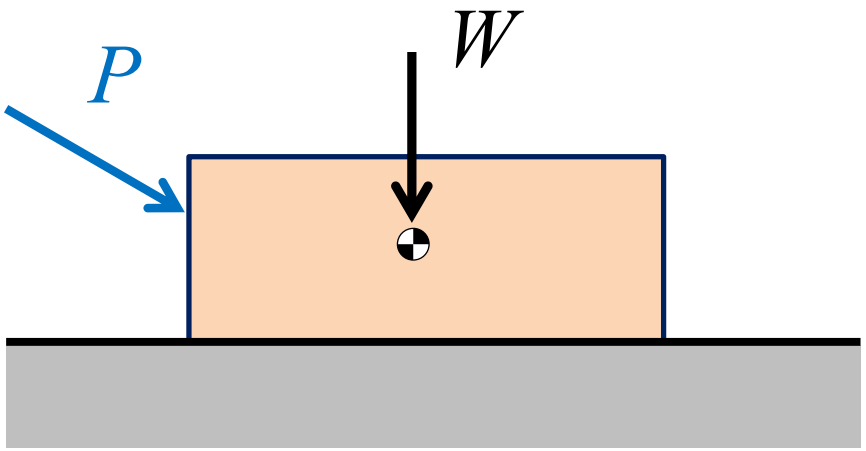
The Coefficient of Static Friction is a property of the contact surfaces:

Approximate Values of Coefficient of Static Friction for Dry Surfaces

Metal on metal	0.15–0.60
Metal on wood	0.20–0.60
Metal on stone	0.30–0.70
Metal on leather	0.30–0.60
Wood on wood	0.25–0.50
Wood on leather	0.25–0.50
Stone on stone	0.40–0.70
Earth on earth	0.20–1.00
Rubber on concrete	0.60–0.90

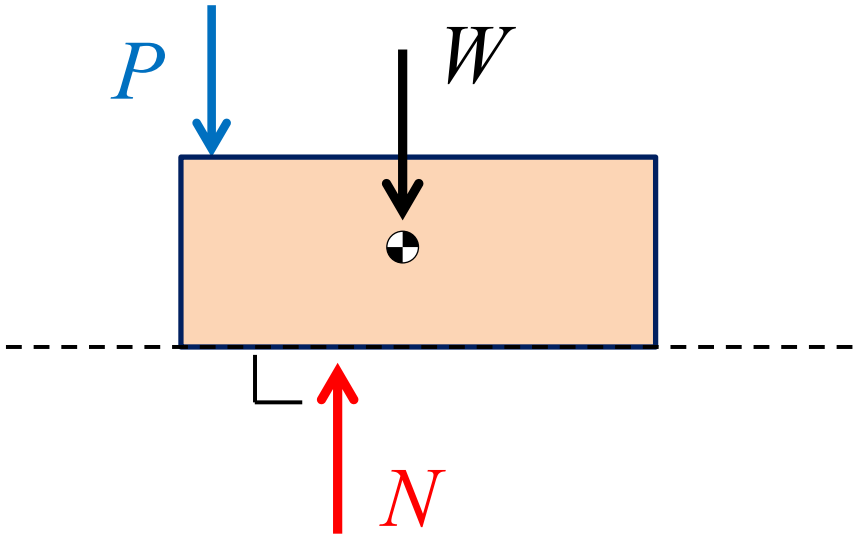
$$\tan\phi_s = \frac{F_m}{N} = \frac{\mu_s N}{N} = \mu_s$$

Possible Situations in Friction Problems



Now consider the block of weight, *W*, sitting on a rough surface subjected to an inclined force, *P*. Examine the following possibilities:

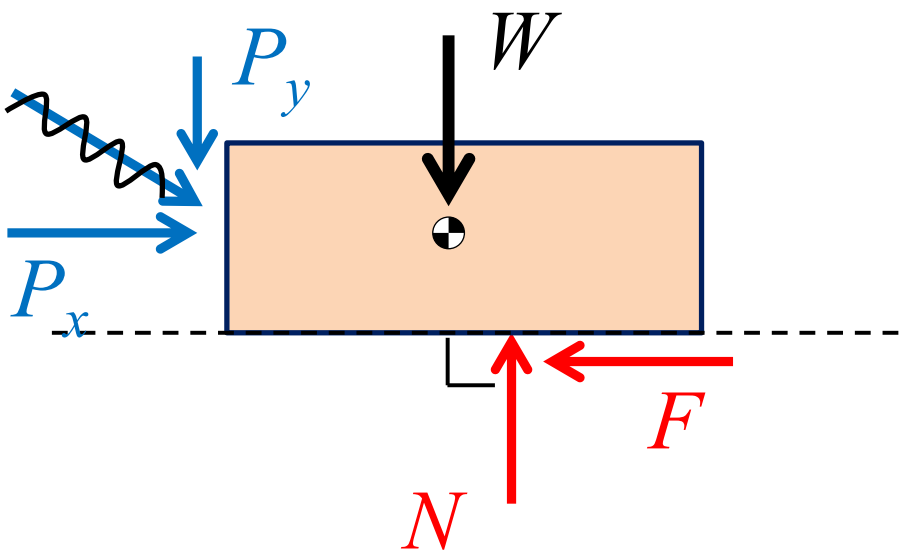
1. No Friction Force



$$F = 0$$
$$N = P + W$$

Possible Situations in Friction Problems

2. No Motion

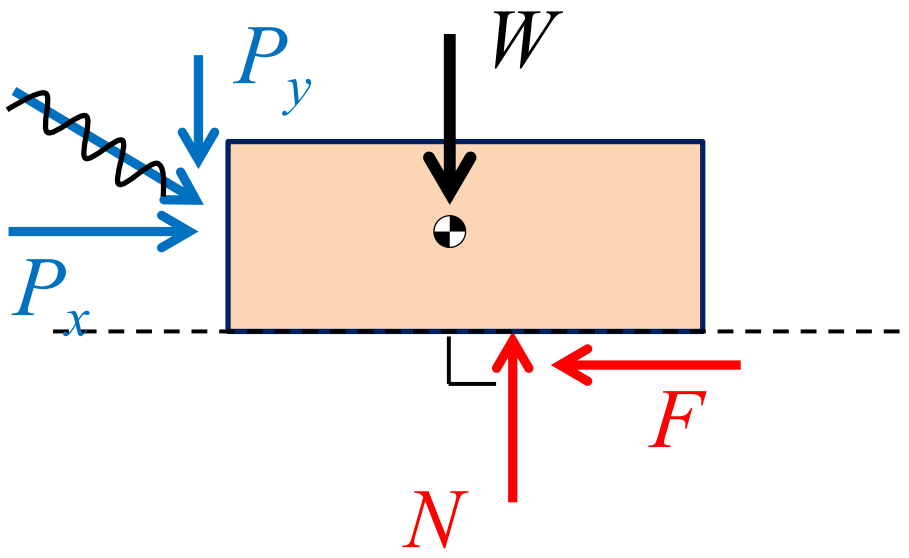


Equations of static equilibrium are satisfied

$$F = P_x$$
$$N = P_y + W$$

Possible Situations in Friction Problems

3. Impending Motion

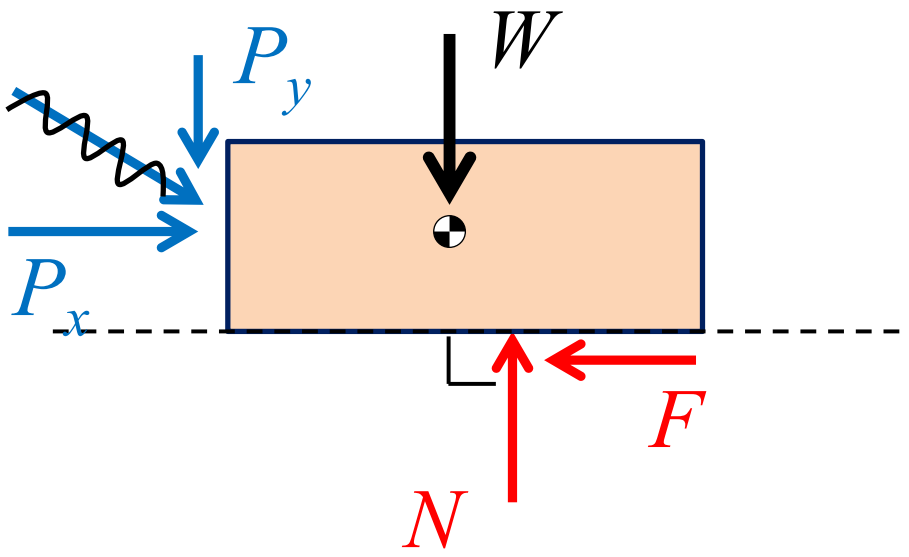


Both the equations of static equilibrium and $F = \mu_s N$ are satisfied

$$F = P_x = \mu_s N$$
$$N = P_y + W$$

Possible Situations in Friction Problems

4. Motion



$$F < P_x$$
$$F = \mu_k N$$
$$N = P_y + W$$