Physics 2A

Applying Newton's Laws

Gravity
Friction

Gravitational Force

⇒ Every object (with mass) in the universe exerts an attractive force on every other object (with mass) in the universe.

⇒ The gravitational force between two objects with mass is given by:

$$F = \frac{G m_1 m_2}{r^2}$$

m_1 & m_2 → masses of each object

r → distance between objects

G = 6.673×10^{-11} Nm^2/kg^2

Gravitational Force

weight ⇒ the gravitational force that the earth exerts on an object

$$F = \frac{G m_1 m_2}{r^2} \longrightarrow w = \frac{G M_{earth} m}{R_{earth}^2}$$

G = 6.673×10^{-11} Nm^2/kg^2
$M_{earth} = 5.98 \times 10^{24}$ kg
$R_{earth} = 6.38 \times 10^{6}$ m

$$\longrightarrow w = (9.8\,\text{m/s}^2)\,m$$

$$\boxed{w = mg}$$

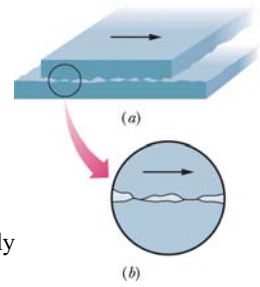
Friction

⇒ There are two types of friction forces:

static friction (f_s)
kinetic friction (f_k)

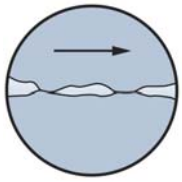
⇒ Frictional forces arise because of the bonded contact of the surface atoms of two surfaces in contact.

⇒ The two surfaces will literally fuse at the contact points.



Friction

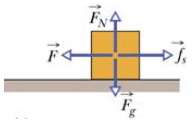
⇒ For reference, the "hills" are ~100 atomic diameters high.

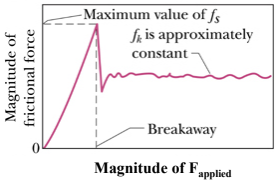


⇒ The adhesive forces become negligible at distances of about 4 – 5 atomic diameters.

Cool Fact: If two highly polished and carefully cleaned metal surfaces were brought together in a very good vacuum, the surfaces would cold-weld together instantly and form a single piece of metal.

Friction





⇒ If $F < f_{s,max}$, then $f_s = F$.

$$f_{s,max} = \mu_s N$$

$$f_k = \mu_k N$$