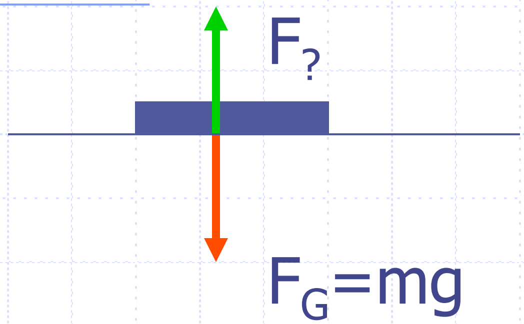
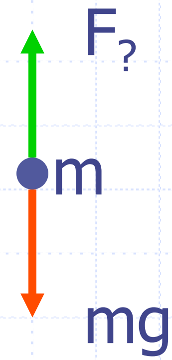
Chapter 6: 1D Dynamics

The Normal Force

- Consider the textbook on the table





- Consider Newton's 2nd law in y-direction:

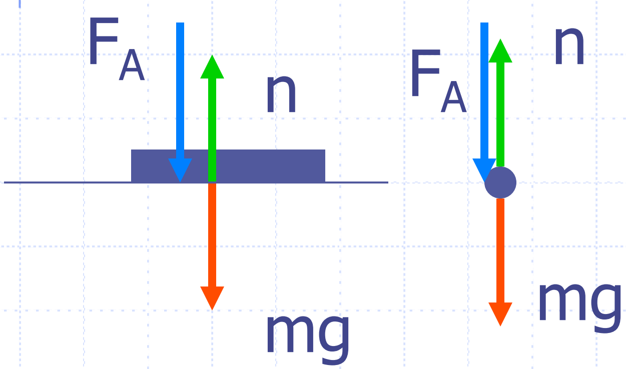
$$\sum F_y = F_? - mg = ma_y$$

but book is at rest. So, a_y=0, gives

$$\sum F_y = F_? - mg = 0 \rightarrow F_? = mg$$

New force has same magnitude as the weight, but opposite direction

- New force is a result of the *contact* between the book and the table
- New force is called the *Normal Force*, **n**, **N** or $\mathbf{F}_N$
- ***In general it is not equal to mg***,
  - we must usually solve for **n**
- ``Normal" means ``perpendicular" (to the surface of contact)
- Now, apply an additional force, F_A to the book



$$\sum F_y = n - mg - F_A = 0$$

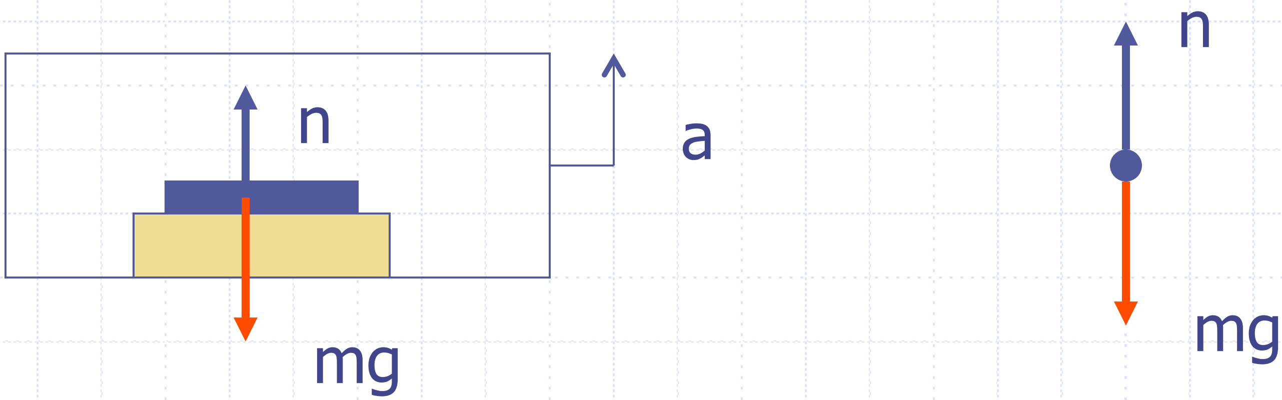
$$n = mg + F_A$$

The normal force is not *mg*!

Normal Force (Revisited)

Demos 4 and 7

- Put textbook on a scale in an elevator



- If elevator is at rest or moving with a constant velocity up or down, a=0. Then Newton's 2nd law gives:

$$\sum F_y = n - mg = 0 \quad \text{or} \quad n = mg = W$$

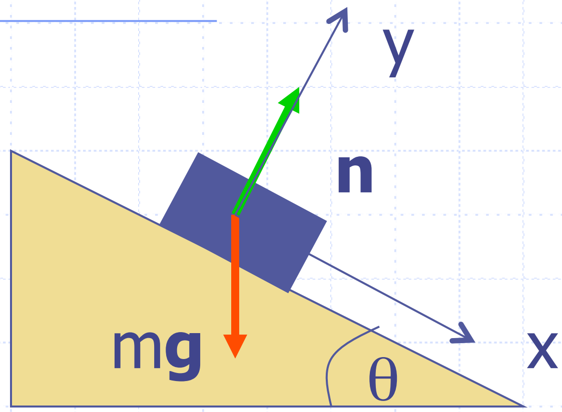
- If elevator is accelerating?

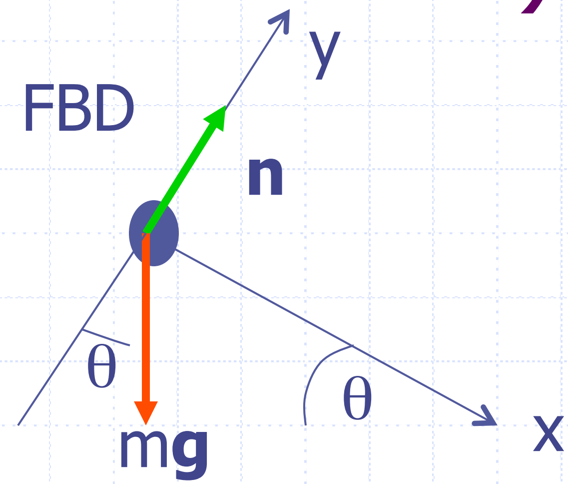
$$\sum F_y = n - mg = ma \text{ or } n = mg + ma$$

$$n = m(g + a)$$

- If a > 0, n > mg
- If a < 0, n < mg
- If a = -g, n = 0 ("weightless")

Book on an Incline (Frictionless)





- Using Newton's 2nd Law, find the normal force and the acceleration of the book
- As we did for 2D kinematics, break problem into x- and y-components

$$\sum F_x = ma_x \qquad \sum F_y = ma_y$$

$$mg\sin\theta = ma_x \qquad n - mg\cos\theta = ma_y = 0$$

$$a_x = g\sin\theta \qquad n = mg\cos\theta$$

- If $\theta \to 0°$, $a_x = 0$ and $n = mg$
- If $\theta \to 90°$, $a_x = g$, $n = 0$

Frictional Forces

- Two types:
  - *static* – applies to stationary objects
  - *kinetic* – applies to sliding (moving) objects
- Like n, the Frictional Force is a contact force, but acts parallel to the interface of two objects