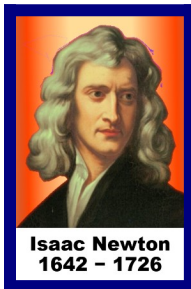


# Newton's Laws of Motion



In 1687, **Isaac Newton** published *Principia* in **Latin**, because most great tomes were from **Roman Antiquity** over 1000 years before. His book described **gravity & 3 Laws of Motion**:

1) "Every object moves in a **straight line** unless acted upon by a force."

2) For a body with **mass** ( $m$ ) under a 3D vector **force** ( $F$ ) & **accelerating** with magnitude ( $a = |a|$ ), then  $F = ma$ .

3) "For every action, there is an equal & opposite reaction."

Newton's Laws adapted for **Center-of-Mass Analyses**:  $\sum F_i = ma$

[Wikipedia.org](http://Wikipedia.org)

## Example: Sliding Block

**N** - normal force  
**a** - acceleration  
**g** - gravity  
**m** - block mass  
 $\mu$  - friction factor  
 $\varphi$  - incline angle

**Free Body Diagram**

$y: m a_y = N - mg \cos \varphi = 0$   
 $y: N = mg \cos \varphi$   
 $x: m a_x = mg \sin \varphi - \mu N$   
 $x: a_x = g (\sin \varphi - \mu \cos \varphi)$   
 $x: a_x = g \cos \varphi (\tan \varphi - \mu)$

$\sum F_i = ma$  Block Slides @  $\varphi > \text{Atan}(\mu)$

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