Chapter 5: Force and Motion — 1

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General

Quantities

$$\begin{aligned}\vec{F} &= \text{net force}\\ m &= \text{mass}\\ a &= \text{acceleration}\\ g &= \text{magnitude of free-fall acceleration}\\ W &= \text{weight}\\ N &= \text{normal force}\\ T &= \text{tension}\end{aligned}$$

Constants

$$g = 9.8\,\mathrm{m/s^2}$$

1 Newton's First and Second Laws

Newton's First Law If no force acts on a body, the body's velocity cannot change; that is, the body cannot accelerate.

Newton's Second Law The net force on a body is equal to the product of the body's mass and its acceleration.

$$\vec{F}_{\text{net}} = m\vec{a} \tag{1}$$

$$F_{\text{net,x}} = ma_x \quad F_{\text{net,y}} = ma_y \quad F_{\text{net,z}} = ma_z \tag{2}$$

2 Some Particular Forces

Weight The weight W of a body is equal to the magnitude F_g of the gravitational force on the body.

$$W = F_g = mg \tag{3}$$

Normal Force When a body presses against a surface, the surface (even a seemingly rigid one) deforms and pushes on the body with a normal force $\vec{F}_N$ that is perpendicular to the surface.

$$N = F_N = mg \tag{4}$$

Friction If we either slide or attempt to slide a body over a surface, the motion is resisted by a bonding between the body and the surface.

Tension When a cord (or a rope, cable, or other such object) is attached to a body and pulled taut, the cord pulls on the body with a force $\vec{T}$ directed away from the body and along the cord.

3 Applying Newton's Laws

Newton's Third Law When two bodies interact, the forces on the bodies from each other are always equal in magnitude and opposite in direction.

$$F_{AB} = F_{BA} \tag{5}$$