NEWTON'S LAWS OF MOTION

An object's velocity will not change unless a net, external force acts on it.

1. Every object tends to continue doing what it is doing – being at rest, or moving with constant speed in a straight line—unless a net, external force compels it to change. (The Law of Inertia)

INERTIA: Inertia is the tendency of all objects to continue in their existing state of rest or constant motion in a straight line. Inertia is a *property* of all material objects. We can think of inertia as the tendency of all objects to continue what they're doing, to resist *changes* in their state of motion or state of rest, i.e., to resist acceleration. Some examples: a rolling ball tends to continue rolling in a straight line, a rotating planet tends to keep on rotating, and your stationary physics book tends to keep on being stationary. Sufficient net external forces applied to an object can, however, overcome an object's inertia and change its state of motion.

2. The change in motion (acceleration) of an object is proportional to the net force acting on the object, is inversely proportional to the mass of the object, and occurs in the direction in which the net force acts.

FORCE: Force is anything that can compel an object to change its state of motion or its state of rest. Some examples: a rolling ball can slow down, speed up or move in a curved path if acted upon by one or more forces, a rotating planet can slow down due to tidal forces exerted by one or more of its moons, and a stationary book will move if pushed or pulled.

Mass: A quantity or aggregate of matter. (Not a very good definition.)

Matter: A material substance that occupies space and has mass.

MASS: Mass is a *property* of all physical objects. It is quantified in terms of the resistance of an object to acceleration by a force. We may therefore ***define mass to be a measure of the inertia of an object***.

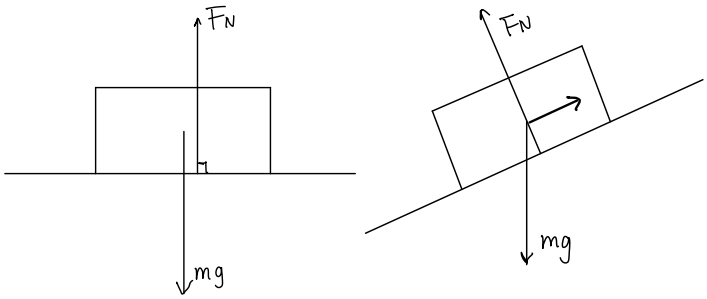
For example, compared to an object whose mass is 1 kg, an object whose mass is 100 kg has 100 times the inertia.

3. All forces occur in pairs. If object 1 exerts a force on object 2, then object 2 exerts simultaneously an equal force (but opposite in direction) on object 1.

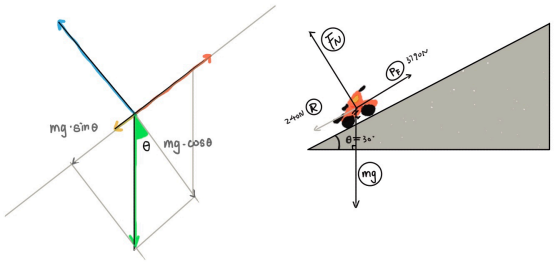
Single, isolated forces do not exist. Forces always come in pairs and always appear as interactions between two or more objects.

$$F_g = ma$$

$$\sum \vec{F} = m\vec{a}$$



4.78 A 314-kg motorcycle is accelerating up along a ramp that is inclined 30.0° above the horizontal. The propulsion force pushing the motorcycle up the ramp is 3790 N, and air resistance produces a force of 240 N that opposes the motion. Find the magnitude of the motorcycle's acceleration.



$\vec{a} = a_x \cdot \hat{x} + a_y \cdot \hat{y}$

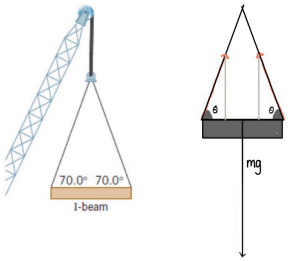
$a_y = 0$

$\sum \vec{F}_x = ma_x$

$a_x = \frac{P_F - R}{m} - g\sin\theta$

$a_x = 6.41\ m/s^2$

5.54 The steel I-beam in the figure below has a weight of 8.00 kN and is being lifted at constant velocity. Calculate the tension in each cable attached to the ends.



$\sum \vec{F}_y = ma_y$

$2T_y - mg = m(0)$

$T = \frac{mg}{2\sin\theta} = 4260\ N$

4.42 A woman stands on a scale in a moving elevator. Her mass is 51.0 kg, and the combined mass of the elevator and scale is an additional 703 kg. Starting from rest, the elevator accelerates upward. During the acceleration, the tension in the hoisting cable is 9540 N.

a) What does the scale read (in N) during the acceleration?

b) If the maximum tension the cable can withstand without breaking is 9,990 N, what is the maximum acceleration of the elevator?

Woman: $\Sigma F_y = m_w a_y$

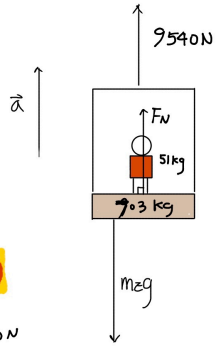
* focus on woman

$F_w = F_N$

$F_N - mg = ma_y$

$F_N = mg + ma_y$

$= m(g + a_y)$



Elevator: $\Sigma F_y = m_E a_y$

$F_E - m_E g = m_E a_y$

$T - m_E g = m_E a_y$ (9540 N)

$F_w = m\left(g + \frac{T}{M_E} - g\right) = \frac{m}{M_E} * T = 645N$

703+51