

FORCES AND NEWTON'S LAWS



Force

- Any push or pull on an object caused by physical contact or force field
- The cause of an acceleration or change in an object's motion
- A vector quantity
- SI unit: Newton (N)
- 1 N accelerates 1kg at 1 m/s^2
- $1 \text{ N} = .225 \text{ lb}$

Types of Forces

- Contact Forces

→ REQUIRES ONE OBJECT TO TOUCH ANOTHER
TO TRANSFER ENERGY

- At a Distance (Field) Forces

DOES NOT

Weight

- Force of gravity on a mass
- Always directed downward
- $F_g = mg$
- Units
 - Newtons (N)
 - pounds(lbs)
- Conversions
 - 2.2 lbs in 1kg (on earth)
 - 4.45 N in 1 lb

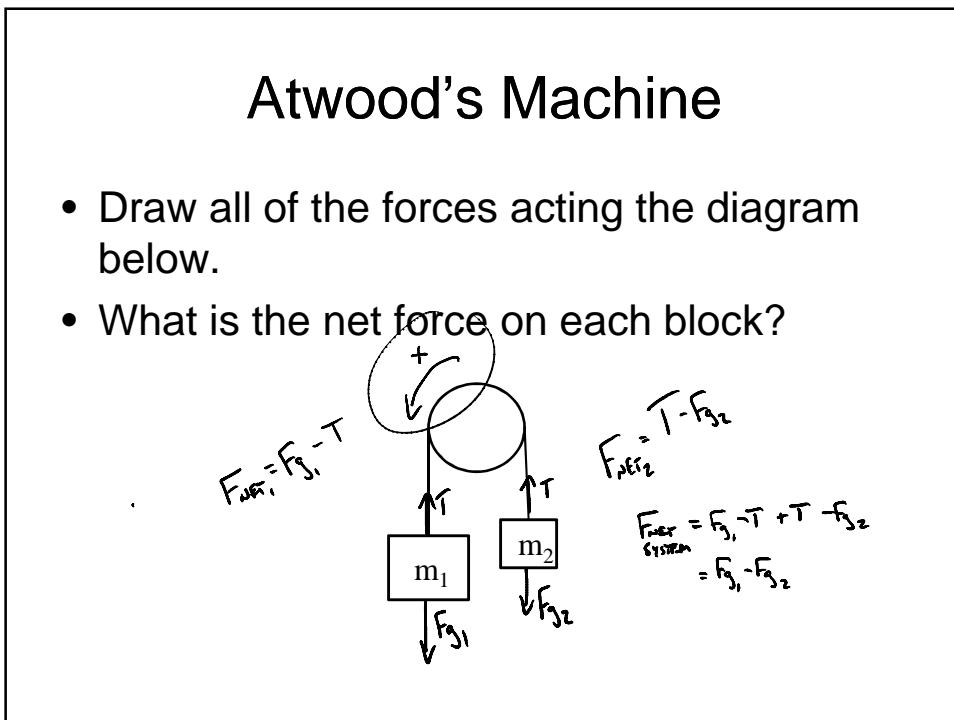
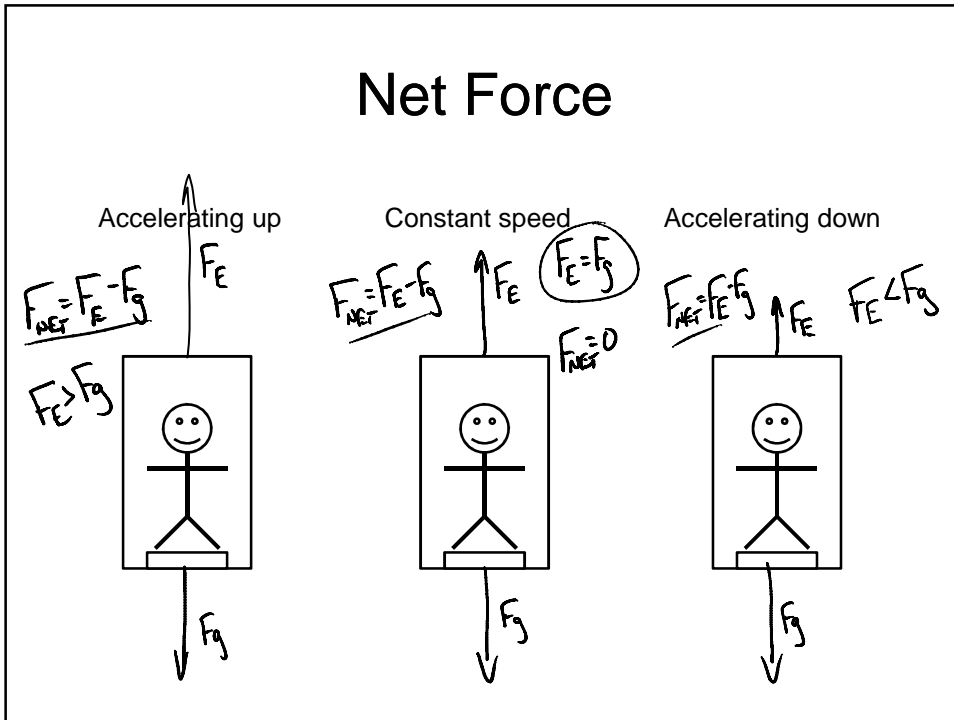
Newton's First Law

- Law states:
 - An object at rest will stay at rest, an object in motion will stay in motion, unless acted on by an outside force.
- Known as the Law of Inertia
 - Inertia is the ability of an object to maintain its current state of motion
 - Inertia is caused by the mass of an object. The more mass, the more inertia.

Net Force

- Definition
 - the “sum” of all forces acting on an object.
- Result
 - an acceleration in the direction of the force.
 - If zero, the object is at rest or moving with a constant velocity.





Newton's Second Law

- Law states:
 - any net force applied to an object will cause the object to accelerate in the direction of the force.
 - $F_{net} = ma$
 - When an object has a constant speed or no speed at all, the net force on the object is zero.

Net Force Problem

- You pull a box along a table with a force of 20 N. Assuming the table has a frictional force of 8 N which opposes the direction of the box's motion, and the box is 9 kg, what is the acceleration of the box? What is the box's speed after 2 m?

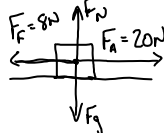
X	2
X ₀	0
V	
V ₀	0
A	1.33 m/s ²
t	

$$v^2 = v_0^2 + 2A(x - x_0)$$

$$v^2 = 0^2 + 2(1.33)(2)$$

$$v^2 = 5.33$$

$$v = 2.3 \text{ m/s}$$



$$F_{net} = F_A - F_F$$

$$F_{net} = 20 \text{ N} - 8 \text{ N} = 12 \text{ N}$$

$$F_{net} = 12 \text{ N}$$

$$MA = 12 \text{ N}$$

$$(9 \text{ kg})A = 12 \text{ N}$$

$$A = 1.33 \text{ m/s}^2$$

Newton's Third Law

- Law States
 - For every action, there is an equal and opposite reaction.
 - When you push on a wall, do you exert a force? If you do, does the wall move? Why not?
 - Due to gravity, the Earth pulls on you. Using Newton's 3rd Law, do you exert a force on the Earth? In which direction? What is the magnitude?