HW#5: Newton's Laws (Due 11 pm central time, 10/7, Tuesday).

Chapter 4: The Laws of Motion

Force, Net force

Newton's 1st Law: If $\vec{F}_{net} = 0$, $\vec{v}$ does not change.

Newton's 2nd Law: $\vec{F}_{net} = ma$

Newton's 3rd Law: Action-reaction

Today:

Various Forces

Application of Newton's Laws
Motivation

\[ \vec{F}_{\text{net}} = \vec{F}_1 + \vec{F}_2 + \ldots = m\vec{a} \]

To find the motion, we need to add various forces on a single object of mass \( m \).

Various Forces

- Gravitational Force
- Normal Force
- Tension Force
- Friction Force
- Spring Force
- Other forces...
Gravitational Force (Weight):

Weight: From the Earth on objects near Earth Surface

Magnitude:
\[ F = mg, \text{ where } g = 9.8 \text{ m/s}^2 \]

Direction: Pointing downward

- **Weight**: The force that the Earth is pulling the object with near the surface of the Earth.

iClicker Quiz

A block of mass \( m \) is on an inclined surface as below. What is the direction of the gravity force on the block?

\( \text{Ans: d} \)
Normal Force: $\vec{N}$
Force from a solid surface which keeps objects from falling through

**Direction:**

$\vec{N} \perp$ surface

**Force on surface** $= -\vec{N}$

**Magnitude:**
Determined by analyzing forces

From surface on objects in contact

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iClicker Quiz
A block of mass $m$ is on an inclined surface as below. What is the direction of the normal force on the block?

\[ \theta \]

(a) $\vec{N}$
(b) $\vec{F}_g$
(c) $\vec{F}_N$
(d) $\vec{F}_x$
(e) $\vec{F}_y$

Ans: b
Tension: $T$

A taut rope exerts forces on whatever holds its ends

\[ |F_{\text{on } A}| = T = |F_{\text{on } B}| \quad \text{From the rope on objects at both ends} \]

**Direction:** pulls along the rope

**Magnitude:** Constant along a single rope, determined by analyzing forces

Tension in ropes going over pulleys

**Direction:** pulls along the rope

**Magnitude:** Constant along a single rope, determined by analyzing forces
What is the direction of tension force on the sliding block?

(a) Up  
(b) down  
(c) left  
(d) right  
(e) zero magnitude

Ans: d

What is the direction of tension force on the hanging block?

(a) Up  
(b) down  
(c) left  
(d) right  
(e) zero magnitude

Ans: a
Friction force

**Force from surface on objects in contact with**
[parallel to surface, against (attempted) motions]

Frictional forces are bad:
~20% of gasoline in automobile is used to counteract friction in the engine and drive train.

Friction forces are good:
You need friction force to walk.

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**Static Friction**

(a) \( \vec{F}_N \) \( \vec{F}_F \) \( \vec{F}_G \)

(b) \( \vec{F}_N \) \( \vec{F}_F \) \( \vec{F}_G \) \( \vec{F}_k \)

(c) \( \vec{F}_N \) \( \vec{F}_F \) \( \vec{F}_G \)

No motion

**Kinetic Friction**

(d) \( \vec{F}_N \) \( \vec{F}_F \) \( \vec{F}_G \) \( \vec{F}_k \)

(e) \( \vec{F}_N \) \( \vec{F}_F \) \( \vec{F}_G \) \( \vec{F}_k \)

(f) \( \vec{F}_N \) \( \vec{F}_F \) \( \vec{F}_G \) \( \vec{F}_k \)

Acceleration

Constant velocity