Common Exam 1

Feb. 27th, Wednesday
Time: To Be Announced
Room: To Be Announced

Check your NJIT e-mail and course website

HW due every Monday
Quiz every Thursday

Today

Newton’s Second Law of Motion

Newton’s Third Law of Motion

Forces

Gravity force (weight)
Normal force
Chapter 4
The Laws of Motion

Last class….

Newton’s First Law of Motion

If the net force on an object is zero,

- An object at rest remains at rest
- An object moving with constant velocity continues to move with the same speed and in the same direction (the same velocity).

In equation,

If $\vec{F}_{\text{net}} = 0$, $\vec{v}$ does not change.

An additional force is NOT required to keep a cart moving with a constant speed on a frictionless track!
What if the net force on an object is NOT zero?

\[ \Rightarrow \text{Newton's Second Law of Motion} \]

Newton’s Second Law of Motion

- **Unbalanced forces** cause object to accelerate.
- An object of mass \( m \) has an acceleration \( \vec{a} \), equal to the net force \( \vec{F} \), divided by the mass of the object, \( m \).

\[ \vec{a} = \sum \vec{F} = \frac{\vec{F}_{\text{net}}}{m} \]
\[
\vec{a} = \frac{\sum \vec{F}}{m} = \frac{\vec{F}_{net}}{m} \Rightarrow \vec{F}_{net} = m\vec{a}
\]

\[
[1\text{N}] = [1\text{kg}] \times \left[ \frac{1\text{m}}{s^2} \right]
\]

SI unit of force is a Newton: \(1\text{N} \equiv 1\text{kg m/s}^2\)

Non-SI unit for force: pound (lb) \(1\text{N} = 0.225\text{ lb}\)

Newton’s 2\textsuperscript{nd} law for each component

\(F_{net,x} = ma_x\); \(F_{net,y} = ma_y\); \(F_{net,z} = ma_z\)

Quick quiz

True or false? If the net force acting on an object is in the positive \(x\)-direction, the object moves only in the positive \(x\)-direction.

**Answer:** False

For example, consider projectile motion.

Example 1: Force and Acceleration \(\rightarrow\) see note
Newton’s 3rd Law

When object A exerts a force \( \vec{F} \) on object B, then object B exerts force \( -\vec{F} \) on object A

\[ \vec{F}_{B \text{ on } A} = -\vec{F}_{A \text{ on } B} \]

Equal magnitude and opposite direction

Newton’s Third Law of Motion

- **Forces always appear in pairs**: for every force exerted by object A on object B there is an equal and opposite force exerted by B on A (action-reaction pair).
- The 3rd law pair of forces are always applied to **different** objects!

(Net force in 1st and 2nd laws is the sum of forces on the same object.)

\[ \vec{F}_{A \text{ on } B} = -\vec{F}_{B \text{ on } A} \]
Find reaction force for the gravity on the cantaloupe
Since the gravity is Force on the cantaloupe from the earth….
Answer: (Gravity) Force on the earth from the cantaloupe!
Forces:

- **Gravitational Force**: \( F = mg \)
- Archimedes Force
- Friction Force:
- Tension Force
- Spring Force
- Normal Force
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.

*Weight* is a vector quantity, it has a magnitude and direction (unit : N)
\[ (\text{weight}) = (\text{mass}) \times g \]

Normal Force: \( \vec{N} \)

Force from a solid surface which keeps objects from falling through

Direction:
\( \vec{N} \perp \text{surface} \)

Force on surface = - \( \vec{N} \)

Magnitude:
Determined by analyzing forces

From surface on objects in contact
Example 2: Person in an elevator

Picture of Situation

A person with a mass 50 Kg in an elevator is moving upward with an acceleration $a = 1.1 \, m/s^2$

Identify all forces on the person and find magnitude and direction for each.

Example 3: Object on an inclined surface (see note)
Today, we learned

Newton’s Second Law of Motion

Newton’s Third Law of Motion

Forces

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Normal force