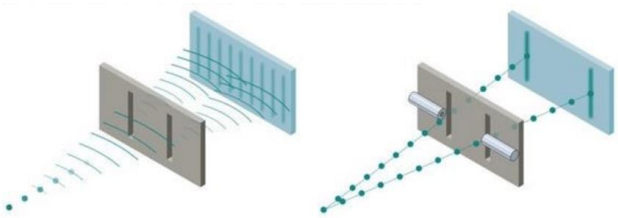
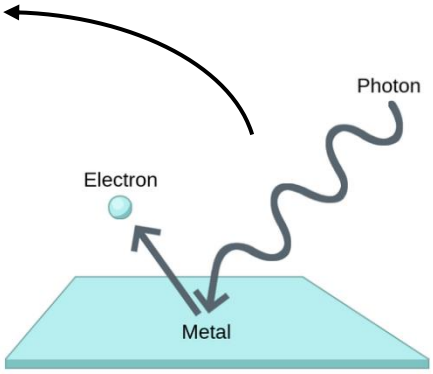
Lesson 5.1: Einstein and Relativity

Unit 5: Special Relativity

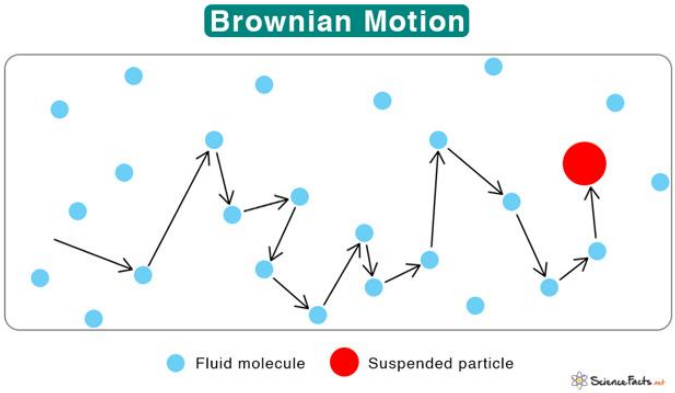
Albert Einstein:

- One of the most important and creative thinkers in history
  - Proposed mass–energy equivalence (_____)
  - Explained light as both waves and particles (_____)

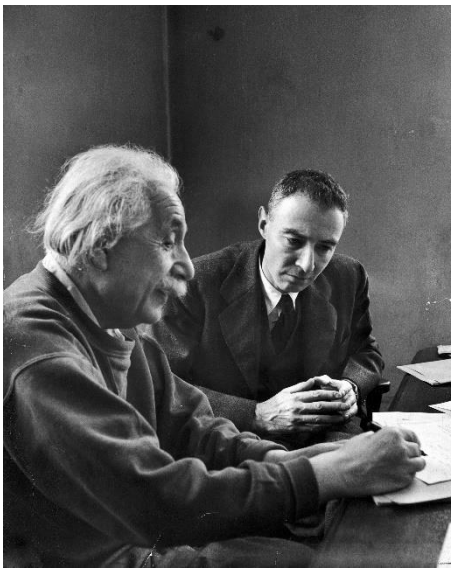




  - Nobel Prize in Physics for _____ Effect (1921)
  - Developed the _____ and _____ Theories of Relativity
  - Predicted bending of light during a solar _____

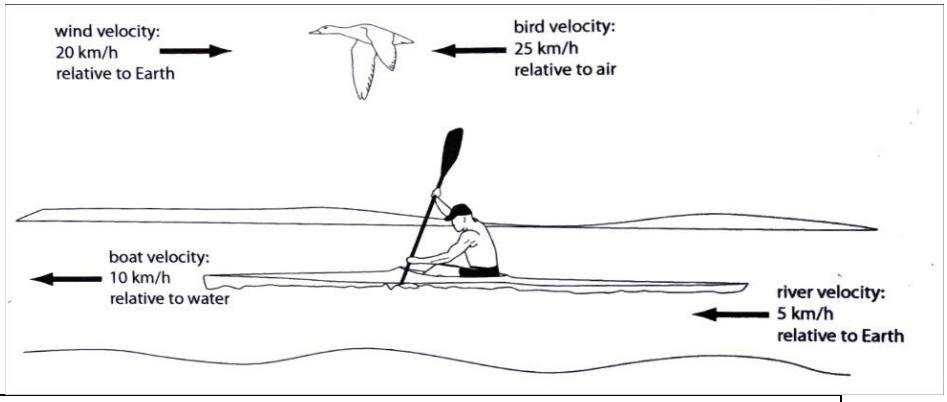


  - Proved existence of atoms (_____ Motion)
  - Later life spent _____ and researching in the U.S.



Frames of Reference:

The position from which an _____ views a particular event.



Quick Check:

1. What is the velocity of the person in the boat relative to:
   a. The water?

   b. Earth's Surface?

2. What is the velocity of the bird relative to:
   a. The air?

   b. The water?

   c. Earth's surface?

3. What is the velocity of the water relative to the bird?

4. What is the velocity of the person in the boat relative to the bird?

5. What would all the velocities in the figure appear to be relative to a camera in a spy satellite in geosynchronous orbit? Its position is "fixed" relative to the point on the rotating earth?

Relative Motion:

We have discussed relative motion in several units this semester. Make a list of 5 things you are currently in relative motion to and order them from slowest to fastest:

Slowest----------Fastest

Conditions for Special Relativity:

- Einstein's special theory of relativity is based on _____ fundamental assumptions
- Fundamental assumptions = _____
- The special theory of relativity deals only with frames of reference that are moving at _____ velocity relative to each other.
    - No _____!

Quick Check #2: *Provide an example of two objects moving at constant velocity relative to each other (different from the example in the slide).*

The First Postulate of Relativity:

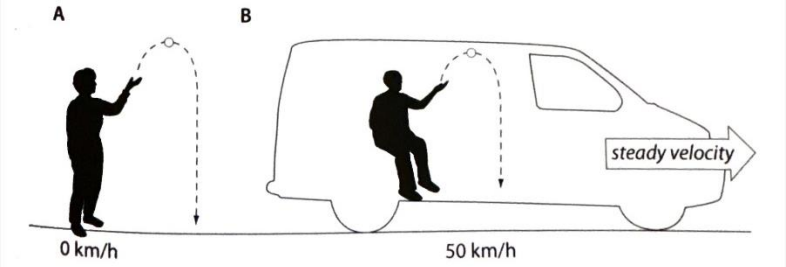
Special Relativity Principle: _____

_____

_____

Comparing Frames of Reference:

Quick Check #3: Look at the figure below and answer the following questions:



1. Both observers in the figure above are moving at constant velocity. What is the velocity of observer A relative to the road?

2. Sketch what the path of the ball thrown in the van would look like to an observer standing on the road looking into the van as it passes.

The Michelson-Morley Experiment:

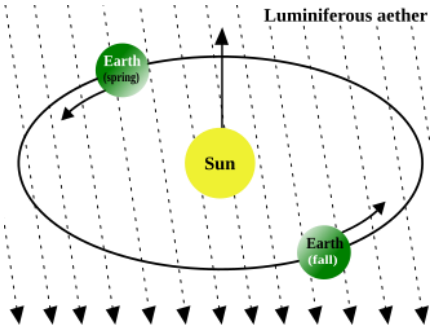
Classical Notion of a Wave:

A disturbance travelling through a _____.

Classical Production of a Wave	Medium the wave travels through
A stone is dropped into water and creates ripples	
A rope fixed at one end is jerked vertically	
Sound waves come out of a groaning physics student	

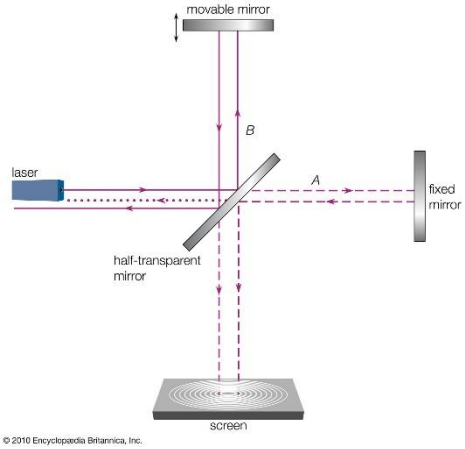
The Mysterious Behaviour of Light:

Thought process of the late 19th century:



- Light moves as a _____
- Waves move through _____
- There must be a mysterious "something" that light moves through called the _____ _____
- This ether is likely the "_____ _____ _____" – a reference frame from which everything in the universe moves relative to

The Michelson-Morley Experiment: Speed of Light Is Constant

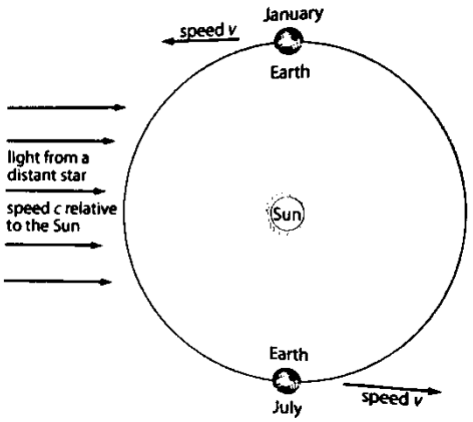


Experiment 1:

- Michelson–Morley tested whether light travels through an ether.
- A half-silvered _____ split light into perpendicular paths.
- No _____ shift was observed.
- Conclusion: _____ ether; speed of light is _____.

Experiment 2:

Another framing of the experiment:



- In January, the Earth moves _____ the distant star with speed v relative to the sun.
  - Predicted speed: _____
- In July, the Earth moves _____ from the distant star with speed v relative to the sun.
  - Predicted speed = _____

- Measured speed (Jan & July) = _____

The Second Postulate of Relativity:

- Einstein predicted the _____ result of Michelson and Morley without being aware of their work.
- He _____ believed in the existence of a fixed reference frame or ether.

Second Postulate:

- The _____ of light in space is the same for any _____ no matter what the velocity of the observer's frame of reference is, and no matter what the velocity of the source of _____ is.

Quick Check #4:

1. **A car is moving forward at 100 km/h. A passenger turns on a flashlight pointing forward.**

   What speed does the driver measure for the light?

   What speed does a stationary observer on the sidewalk measure?

2. **A spaceship moves at 0.8c relative to Earth. It emits a pulse of light forward.**

   What speed does the astronaut measure?

   What speed does the Earth observer measure?