

Lecture 2: Motion

THREE IMPORTANT STEPS:

1. Grab a small whiteboard for yourself! (These are by the doors.)
2. Sit at tables 2, 3, 6, and 7 (the four closest to the center).
3. Grab three large whiteboards for your table!

I will be randomizing your groups today.

A Model for Motion

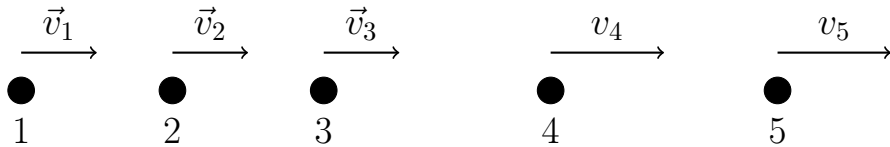
Quantities

- Position: \vec{r}
- Velocity: $\vec{v} = \frac{d\vec{r}}{dt}$
- Acceleration: $\vec{a} = \frac{d\vec{v}}{dt}$

Assumptions

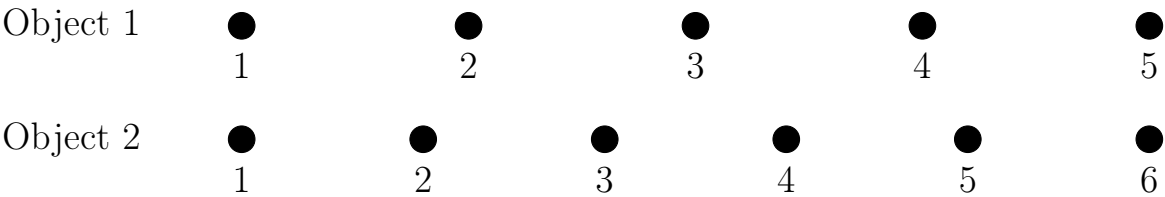
- Use the Particle Model

Motion Diagram



L2-1: Comparing Motion Diagrams

The diagrams below show the motion of two different objects. Is the average velocity of the upper object greater than, less than, or equal to the average velocity of the lower object? Explain your reasoning.



Explanations in Physics

- 1. **Principles** – what fundamental physics concepts, laws, or definitions did you start with?
- 2. **Reasoning** – explain all the reasoning steps to go from your starting point to your conclusion.
- 3. **Conclusion** – state your conclusion clearly.

L2-2: Thrown Ball

A ball is thrown straight into the air.

- Describe the motion in words (use complete sentences).
- Identify any quantities of interest with a symbol.
- Draw a motion diagram for the ball.
- Discuss any assumptions or idealizations you want to make.

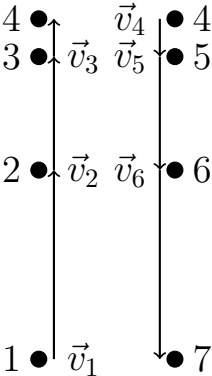


1. Analyze and Represent

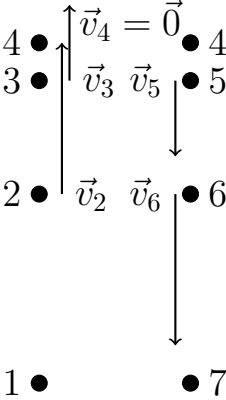
- 1a. **Understand the problem** – identify quantities by symbol and number.
- 1b. **Identify Assumptions** – identify important simplifications and assumptions.
- 1c. **Represent physically** – draw and label one or more appropriate diagrams and/or graphs that might help you solve the problem.

Motion Diagrams

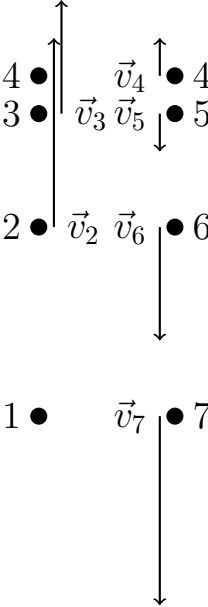
Forward



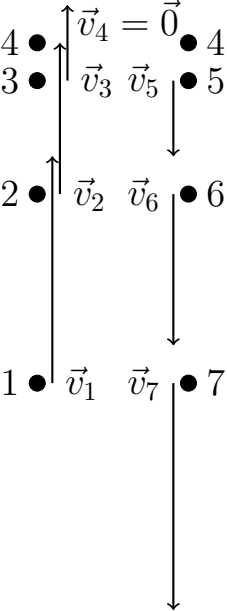
Balanced



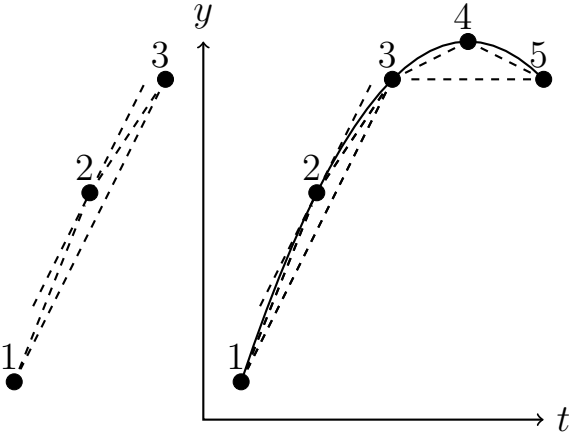
Backward



Instantaneous



Motion Graph



L2-2: Thrown Ball

A ball is thrown straight into the air.

- Estimate the average velocity of the ball:
 - During the entire motion.
 - During the first half of the motion.
 - During the second half of the motion.
- Is the velocity constant?



2. Calculate

- 2a. Represent principles** – identify relevant concepts, laws, or definitions.
- 2b. Find unknown(s) symbolically** – without numbers, find any unknown(s) in terms of symbols representing known quantities.
- 2c. Plug in numbers** – plug numbers (with units) into your symbolic answer!

Acceleration

- An object that changes in velocity is said to be accelerating.
- Acceleration is defined as the change in velocity divided by the change in time.
- Average:

$$\vec{a}_{avg} = \frac{\Delta \vec{v}}{\Delta t}$$

- Instantaneous:

$$\vec{a} = \frac{d\vec{v}}{dt}$$

Main Ideas

- The motion of an object can be characterized by quantities like position, velocity, and acceleration.
- Velocity is defined as the time rate of change of position.
- Acceleration is defined as the time rate of change of velocity.