Lecture 3: Acceleration

Warm-Up Activity

For an object moving in one dimension (in a straight line), what does it mean if the acceleration and the velocity are in opposite directions? The object is...

(A) Slowing Down

(B) Speeding Up

(C) Staying Still

(D) Not Enough Information

Homework

- Physics homework is not (just) about getting correct answers.
- The homework format is designed to help you **communicate the depth of your physics knowledge and understanding** and **learn how to break down a problem**.
- Make sure you submit an organized and clear submission!

Late Work

- If you need an extension, ask first.
- If you miss a deadline, you should still turn it in when you are ready.
- Assignments turned in after the deadline without an approved extension may not receive feedback.
- If you need more feedback on a problem (even a problem that missed the deadline), reach out to us in the Wormhole and in office hours.

A Model for Motion

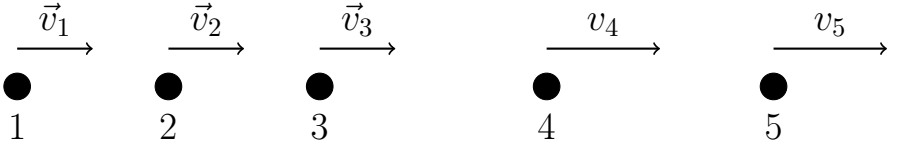
Quantities

- 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



L3-1: Direction of Velocity and Acceleration

- The motion diagram above shows a ball moving from left to right.
  - Draw velocity and acceleration vectors at each instant.
- For an object moving in one dimension (in a straight line), what does it mean if:

  (a) The acceleration is zero?

  (b) The acceleration and the velocity are in opposite directions?

  (c) The acceleration and the velocity are in the same direction?

L3-2: Vax'ildan's Acceleration

- Vax'ildan Vessar is initially located at position x_i, running to the right with initial speed v_i.
- At $t = 0$, Vax clicks his *boots of haste*, which provide an acceleration:

$$\vec{a}(t) = a_0 \left(1 - \frac{t}{T}\right) \hat{x}$$

- Our goals are:
  - Find how much time it takes for Vax to return to his initial velocity.
  - Find Vax's position at this time.

Solving an ARCS Problem

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.

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!

3. Sensemake

3a. **Units** – check that the units of your answer agree with the units you expect
3b. **Numbers** – compare your answer to other numbers in the problem or in the everyday world; if relevant, check the sign or direction.
3c. **Symbols** – use a strategy like covariation or special cases to check that your answer makes physical sense.

L3-2: Vax'ildan's Acceleration – Analyze & Represent

- Vax'ildan Vessar is initially located at position x_i, running to the right with initial speed v_i.
- At $t = 0$, Vax clicks his *boots of haste*, which provide an acceleration:

$$\vec{a}(t) = a_0 \left(1 - \frac{t}{T}\right) \hat{x}$$

- With your group:
  - What are the units of T and a_0? What do they represent physically?
  - What does $\hat{x}$ mean?
  - **Understand and Plan:** Identify quantities by symbol and number.
  - **Identify Assumptions**
  - **Represent Physically**
    - What does $\vec{a}(t)$ look like?

Main Ideas

- If we know the acceleration of an object as a function of time, we can determine the velocity as a function of time.
- If we know the velocity as a function of time, we can determine the position as a function of time.