PHY131H1F – Introduction to Physics I
Class 2

Today: Chapter 1.

- Motion Diagrams
- Particle Model
- Vector Addition, Subtraction
- Position, velocity, and acceleration
- Position vs. time graphs

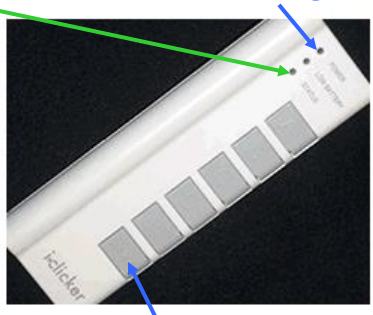
Garden-Variety Clicker Instructions

Status Light

When I start asking clicker questions:

• Status light will flash green when your response is registered on my computer.

• Status will flash red if your response is not registered.



Please turn on your clicker now

Clicker Question 1

Which car is going faster, A or B?
(Assume these are both motion diagrams.)

A B

Additional Assignment to do during this quiz:

- Learn the **name** of at least one other student in this course.

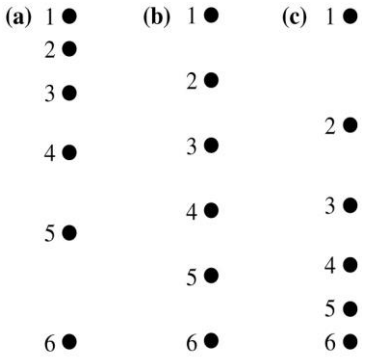
The Particle Model

- If we restrict our attention to objects undergoing translational motion, we can consider the object as if it were just a single point, without size or shape.
- We can also treat the object as if all of its mass were concentrated into this single point.
- An object that can be represented as a mass at a single point in space is called a particle.
- A particle has no size, no shape, and no distinction between top and bottom or between front and back.

Clicker Question 2

Three motion diagrams are shown. Which is:

- a dust particle settling to the floor at constant speed,
- a ball dropped from the roof of a building,
- a descending rocket slowing to make a soft landing on Mars



A. (a) is ball, (b) is dust, (c) is rocket

B. (a) is ball, (b) is rocket, (c) is dust

C. (a) is rocket, (b) is dust, (c) is ball

D. (a) is rocket, (b) is ball, (c) is dust

E. (a) is dust, (b) is ball, (c) is rocket

Scalars and Vectors

- A “scalar” is a quantity that can be represented by one number, and a unit
- A “vector” requires at least two numbers: for example, a magnitude and a direction
- Examples of scalar quantities: distance, speed, temperature, mass
- Some scalars are always non-negative, such as mass or speed
- Examples of vector quantities: displacement, velocity, acceleration, force

Distance and Displacement

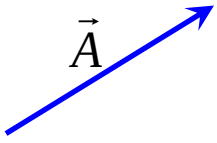
- **Distance:** how far you traveled.

- **Displacement:** final position minus initial position.

$$d \geq |\Delta \vec{s}|$$

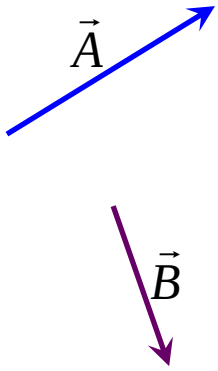
Vector Addition

$$\vec{C} = \vec{A} + \vec{B}$$



Vector Subtraction

$$\vec{D} = \vec{A} - \vec{B} = \vec{A} + (-\vec{B})$$

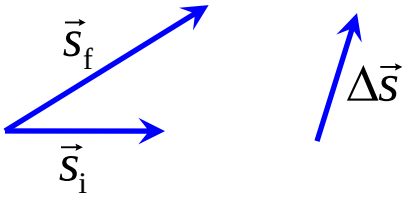


Speed and Velocity

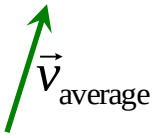
- **Average Speed:** distance traveled divided by time
- **Average Velocity:** displacement divided by time

Average Velocity

$$\vec{v}_{\text{average}} = \frac{\vec{s}_{\text{f}} - \vec{s}_{\text{i}}}{\Delta t} = \frac{\Delta \vec{s}}{\Delta t}$$



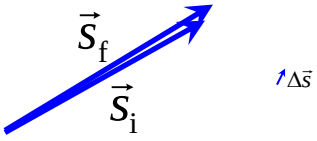
Units of $\Delta\vec{s}$ are metres.



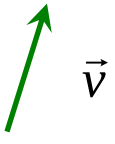
Units of $\vec{v}_{\text{average}}$ are metres per second.

Velocity (a.k.a. "instantaneous velocity")

$$\vec{v} = \lim_{\Delta t \to 0}\left(\frac{\Delta \vec{s}}{\Delta t}\right) = \frac{d\vec{s}}{dt}$$



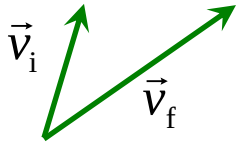
Units of $\Delta\vec{s}$ are metres.



Units of $\vec{v}$ are metres per second.

Average Acceleration

$$\vec{a}_{\text{average}} = \frac{\vec{v}_{\text{f}} - \vec{v}_{\text{i}}}{\Delta t} = \frac{\Delta \vec{v}}{\Delta t}$$

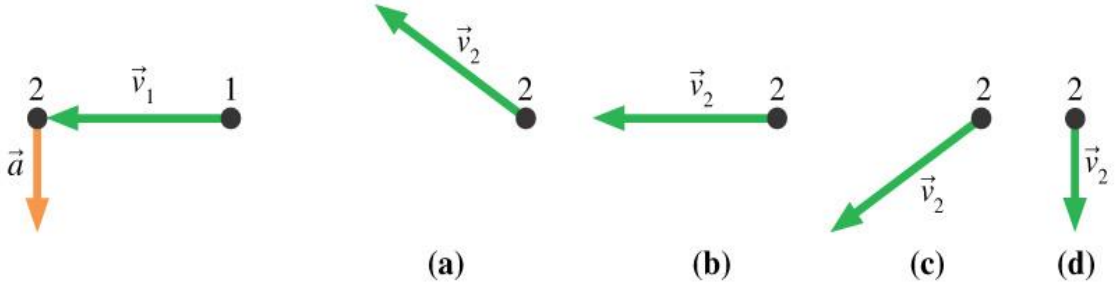


Units of $\Delta \vec{v}$ are m/s.

Units of $\vec{a}_{\text{average}}$ are m/s^2.

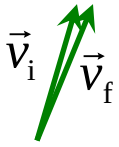
Clicker Question 3

A particle undergoes acceleration $\vec{a}$ while moving from point 1 to point 2.
Which of the choices shows the velocity vector $\vec{v}_2$ as the object moves away from point 2?

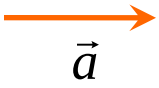


Acceleration (a.k.a. "instantaneous acceleration")

$$\vec{a} = \lim_{\Delta t \to 0}\left(\frac{\Delta \vec{v}}{\Delta t}\right) = \frac{d\vec{v}}{dt}$$



Units of $\Delta\vec{v}$ are m/s.



Units of $\vec{a}$ are m/s^2.

Tactics: Finding the acceleration vector

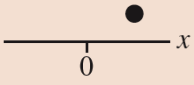
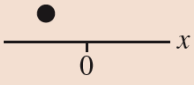
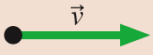
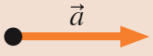
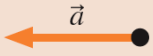
- The sign of position (x or y) tells us *where* an object is.
- The sign of velocity (v_x or v_y) tells us *which direction* the object is moving.
- The sign of acceleration (a_x or a_y) tells us which way the acceleration vector points, *not* whether the object is speeding up or slowing down.

Clicker Question 4

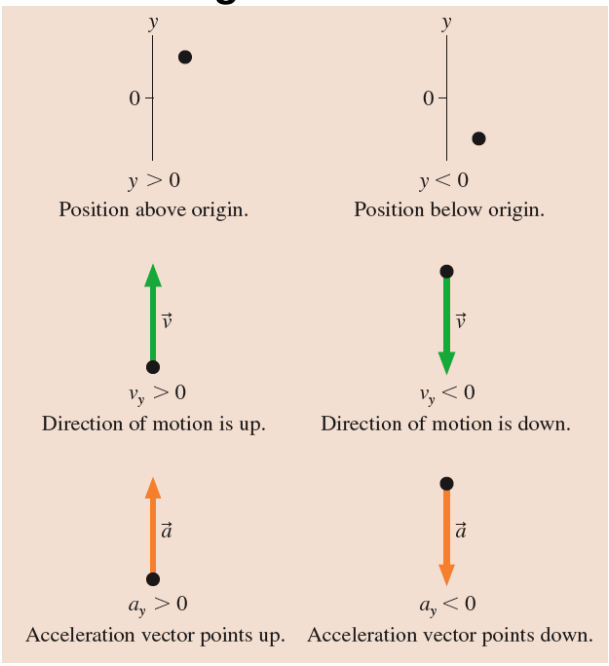
If an object is slowing down,

A. its velocity must be positive.
B. its velocity must be negative.
C. its acceleration must be positive.
D. its acceleration must be negative.
E. the acceleration and velocity vectors must be in opposite directions.

Tactics: Finding the acceleration vector

	$x > 0$	Position to right of origin.
	$x < 0$	Position to left of origin.
	$v_x > 0$	Direction of motion is to the right.
	$v_x < 0$	Direction of motion is to the left.
	$a_x > 0$	Acceleration vector points to the right.
	$a_x < 0$	Acceleration vector points to the left.

Tactics: Finding the acceleration vector



Clicker Question 5

From the PHY131H1F Past Test

Below is a motion diagram for an object with smooth motion and a constant value of acceleration. We define positive displacements as being toward the right. What can you say about the sign of the acceleration and whether the object is speeding up or slowing down?

A. The acceleration is negative, and the object is slowing down.
B. The acceleration is positive, and the object is speeding up.
C. The acceleration is positive, and the object may be speeding up or slowing down.
D. The acceleration may be positive or negative, and the object is speeding up.
E. The acceleration may be positive or negative, and the object may be speeding up or slowing down.

From the PHY131H1F Past Test

A. The acceleration is negative, and the object is slowing down.
B. The acceleration is positive, and the object is speeding up.
C. The acceleration is positive, and the object may be speeding up or slowing down.
D. The acceleration may be positive or negative, and the object is speeding up.
E. The acceleration may be positive or negative, and the object may be speeding up or slowing down.

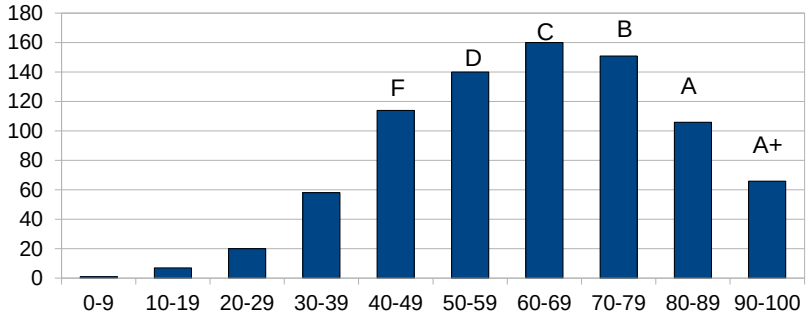
If the object is moving to the right (positive velocity):

From the PHY131H1F Past Test

A. The acceleration is negative, and the object is slowing down.
B. The acceleration is positive, and the object is speeding up.
C. The acceleration is positive, and the object may be speeding up or slowing down.
D. The acceleration may be positive or negative, and the object is speeding up.
E. The acceleration may be positive or negative, and the object may be speeding up or slowing down.

If the object is moving to the left (negative velocity):

Fall 2013 Test 1 results



Average test mark was 63%
21% of the class got A
18% got B
19% got C
17% got D
24% failed

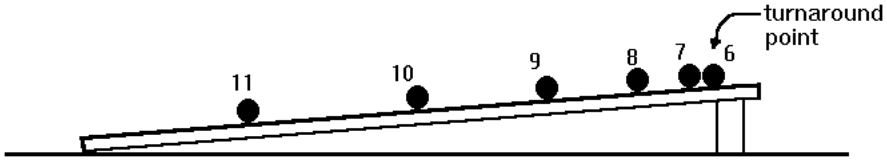
Piazza Discussion Board

- This is a fast way to get answers to your questions, sometimes from other students
- It is optional, and it is free
- Simply visit https://piazza.com/

Clicker Question 6

A ball rolls up a ramp, and then down the ramp. We keep track of the position of the ball at 6 instants as it climbs up the ramp. At instant 6, it stops momentarily as it turns around. Then it rolls back down. Shown below is the motion diagram for the final 6 instants as it rolls down the ramp.
At which instant is the **speed** of the ball the greatest?

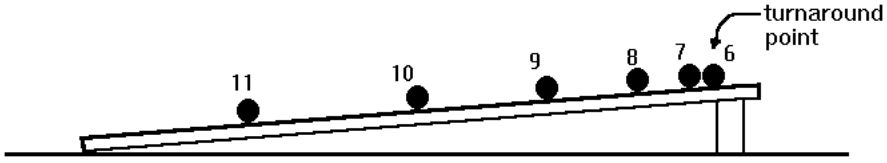
A. 6
B. 9
C. 11
D. The speed is zero at point 6, but the same at points 7 to 11
E. The speed is the same at points 6 through 11



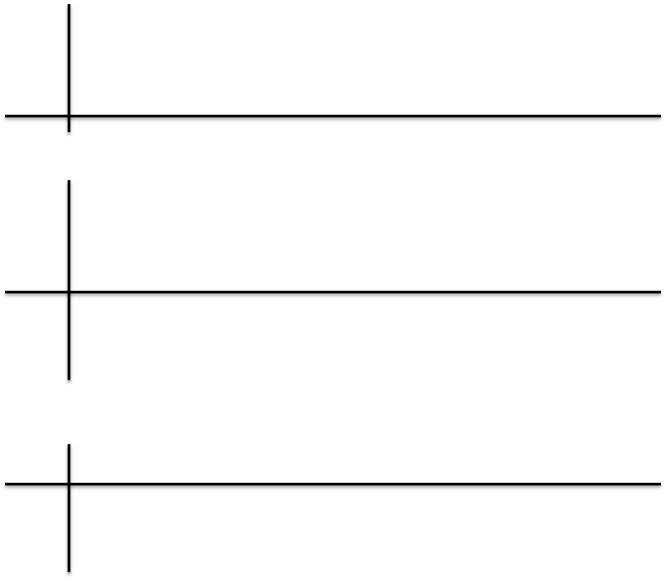
Clicker Question 7

A ball rolls up a ramp, and then down the ramp. We keep track of the position of the ball at 6 instants as it climbs up the ramp. At instant 6, it stops momentarily as it turns around. Then it rolls back down. Shown below is the motion diagram for the final 6 instants as it rolls down the ramp.
At which instant is the **acceleration** of the ball the greatest?

A. 6
B. 9
C. 11
D. The acceleration is zero at point 6, but about the same at points 7 to 11
E. The acceleration is about the same at points 6 through 11



Tennis ball thrown straight up:



Suggested Problem Solving Strategy

- MODEL — Think about and simplify the situation, guess at what the right answer might be.
- VISUALIZE — Draw a diagram. It doesn't have to be artistic: stick figures and blobs are okay!
- SOLVE — Set up the equations, solve for what you want to find. (This takes time..)
- ASSESS — Check your units, significant figures, do a "sanity check": does my answer make sense?

This is just a suggested strategy. Whatever method works for ***you*** is fine, as long as you don't make a mistake, and you show how you got to the correct answer, it's 100%!

Clicker Question 8

Significant Figures

- Which of the following has the most number of significant figures?

A. 8200

B. 0.0052

C. 0.430

D. 4×10^{-23}

E. 8000.01

Before Class 3 on Monday

- Please read the Error Analysis Mini-Document (10 page PDF) available on course web-site.
- Please do the short pre-class quiz
- Problem Set 1 on MasteringPhysics is due Sep.22: take a look at it. Don't leave problem sets until the last minute!
- Something to think about: If your height is 150 cm, is there necessarily an **error** in that number?