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

Pre-Class Reading Quiz

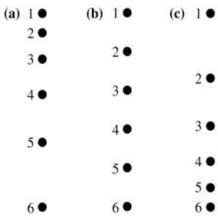
Which car is going faster, A or B?
(Assume these are both motion diagrams.)

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.

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



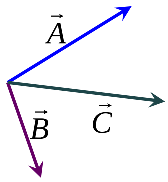
A. (a) is ball, (b) is dust, (c) is rocket
B. (a) is ball, (b) is rocket, (c) is dust
C. (a) is rocket, (b) is dust, (c) is ball
D. (a) is rocket, (b) is ball, (c) is dust
E. (a) is dust, (b) is ball, (c) is rocket

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

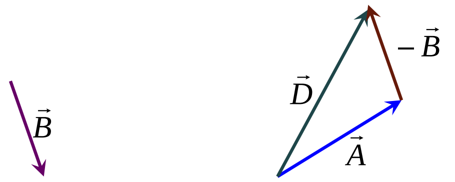
Vector Addition

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



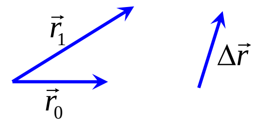
Vector Subtraction

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

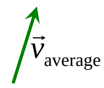


Average Velocity

$$\vec{v}_{\text{average}} = \frac{\vec{r}_1 - \vec{r}_0}{\Delta t} = \frac{\Delta \vec{r}}{\Delta t}$$



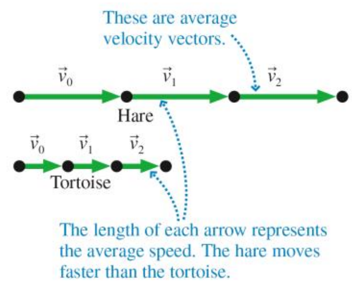
Units of $\Delta \vec{r}$ are metres.



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

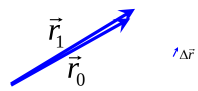
Motion Diagrams with Velocity Vectors

FIGURE 1.13 Motion diagram of the tortoise racing the hare.

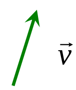


Velocity (a.k.a. "instantaneous velocity")

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



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

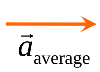


Units of $\vec{v}$ are metres per second.

Average Acceleration

$$\vec{a}_{\text{average}} = \frac{\vec{v}_1 - \vec{v}_0}{\Delta t} = \frac{\Delta \vec{v}}{\Delta t}$$

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



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

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

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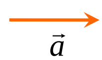
Units of $\Delta \vec{v}$ are m/s.



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

Linear Acceleration

Because velocity is a vector, it can change in two possible ways:

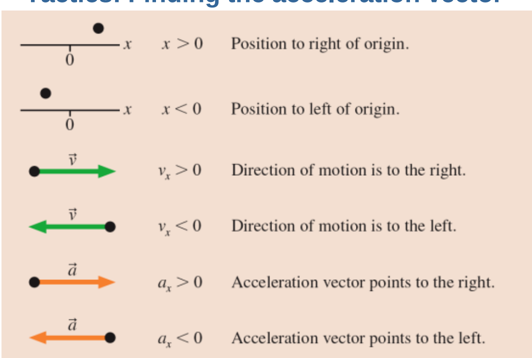
1. The magnitude can change, indicating a change in speed, or
2. The direction can change, indicating that the object has changed direction.

We will concentrate for now on the first case, a change in speed.

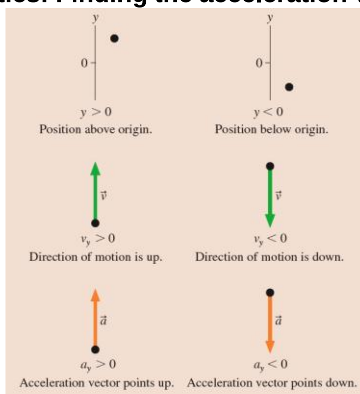
Tactics: Finding the acceleration vector

- 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.

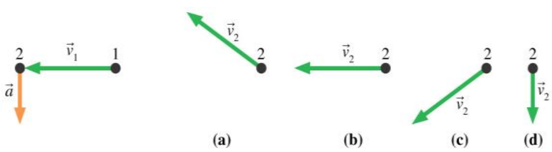
Tactics: Finding the acceleration vector



Tactics: Finding the acceleration vector



In Class Question:
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?



Some Announcements:

Harlow and Meyertholen Office Hours this week:

- **Our normal office hours are:**
- **Jason Harlow**: W3-4 and F9-10
- **Andrew Meyertholen**: R 2-3 and F11am-12

- This week I will miss my Wednesday office hour, and Andrew will miss his Thursday and Friday hours, due to meetings in the Practicals rooms
- Starting Friday we will be keeping our regular office hours.

UTORid

- Please use your UTORid as your student ID on both MasteringPhysics and i-clicker
- This is made up of letters based on your last name, and sometimes some numbers
  - If you used your student number for MasteringPhysics, you will have to change it.
  - If you used your student number for i-clicker, you can register the same clicker ***again*** with your UTORid. Multiple IDs for the same clicker are okay.

Pre-Class Quizzes: *Why did I get a low mark???!!!!*

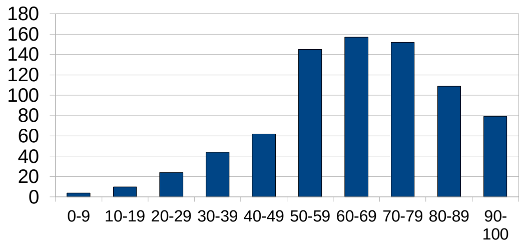
- Regarding the Pre-Class Quizzes on MasteringPhysics, on the Course Information page for PHY131 on portal it states: "Your answers will be graded on your effort and not on correctness."
- Currently MasteringPhysics displays a mark based on correctness for pre-class quizzes, which is not the mark you will receive.
- We are trying to remedy this problem in the display of marks.
- Rest assured if you try on all the pre-class quizzes and submit them on time, you will get the full 3% of the course mark.

Responding to some student comments…

- *"Is it true that the class average is generally low and that half the students drop after midterms?"*

- PHY131 fall 2011 was fairly typical; Harlow was one of the profs.
- 825 students started the course in September 2011, 645 completed it in December. So about 21% of students dropped the course, most not long after Test 1.
- In the end, 6% of the 645 students who completed the course actually failed the course (38 people).
- So in reality about 26% of the students who start this course either drop out or fail.
- In the end, the average class mark was 70% (B-), 26% of the class got an A, and 32% got a B.

Fall 2011 Test 1 results



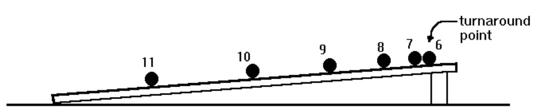
Average test mark was 65%
24% of the class got As
19% got Bs
20% got Cs
19% got Ds
18% failed

Responding to some student comments…

- On Youtube: *"lol I hear baby sounds on the back~ so cute~"*
- This was Zainab Harlow, 13 months old.
- I will try to find a quieter place in the future.

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



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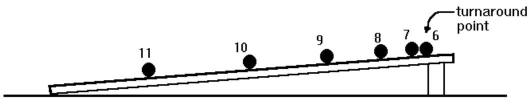
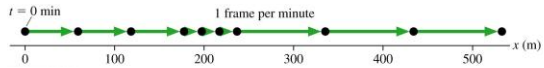
At which instant is the **acceleration** of the ball the greatest?

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

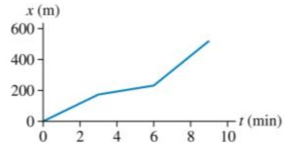


Position-versus-Time Graphs

- Below is a motion diagram, made at 1 frame per minute, of a student walking to school.



- A motion diagram is one way to represent the student's motion.
- Another way is to make a graph of x versus t for the student:



This is a graph of an object moving along a straight line. The most likely interpretation is:

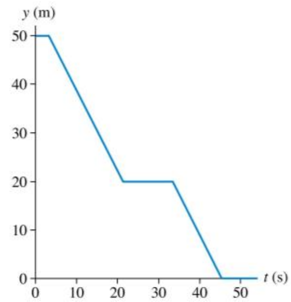
A. A person walking down a steep mountain.

B. A car that drives and stops and drives and stops.

C. An elevator descending.

D. A rock that falls, bounces, and falls some more.

E. A ball that is hit, caught, and thrown to someone else.



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%!

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 – remember you will get full credit for your honest attempt
- Problem Set 1 on MasteringPhysics is due next Friday: 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?