Physics 1021

Spring 2012

ConcepTest 3.1 Cruising along

You drive at 30 mi/hr for one hour and then at 50 mi/hr for another hour. What is your average speed for the whole 2 hour trip?

1) more than 40 mi/hr
2) equal to 40 mi/hr
3) less than 40 mi/hr

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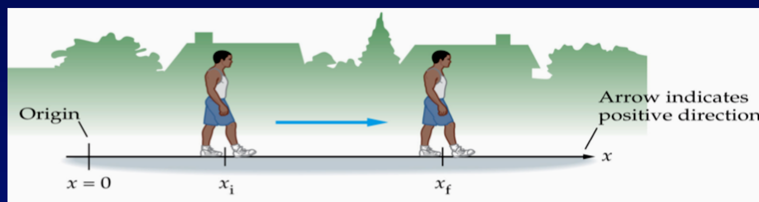
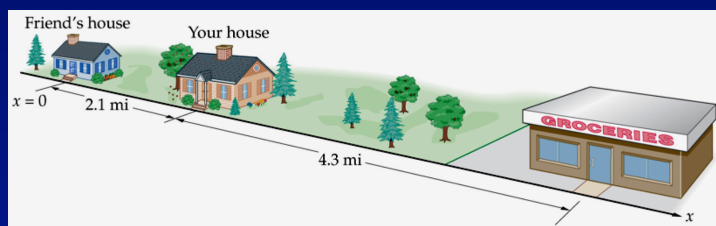
Remember that the **average speed is distance/time**. You travel 30 + 50 miles = 80 miles in two hours. Therefore, your average speed is 40 mi/hr.

Displacement and velocity

To determine your ***position***, you need a ***coordinate system***



Distance = total length of travel



Displacement = change in position
= final position – initial position

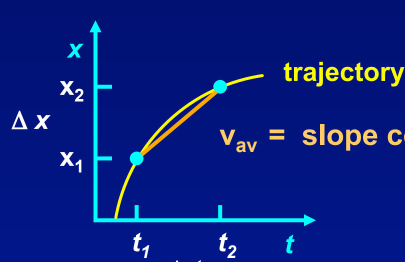
Speed and Velocity

speed and velocity measure how position *changes* with time

$$\text{average speed} = \frac{\text{total distance traveled}}{\text{total time}}$$

$$\text{average velocity} = \frac{\text{displacement}}{\text{total time}} = \frac{x_2 - x_1}{t_2 - t_1} = \frac{\Delta x}{\Delta t}$$

formula for a slope!



v_{av} = slope connecting line from t_1 to t_2

Question: Does the speedometer in a car measure speed or velocity?

ConcepTest 3.2 Cruising along

You drive 4 miles at 30 mi/hr and then another 4 miles at 50 mi/hr. What is your average speed for the whole 8 mile trip?

1) more than 40 mi/hr
2) equal to 40 mi/hr
3) less than 40 mi/hr

ConcepTest 3.2 Cruising along

You drive 4 miles at 30 mi/hr and then another 4 miles at 50 mi/hr. What is your average speed for the whole 8 mile trip?

1) more than 40 mi/hr
2) equal to 40 mi/hr
3) less than 40 mi/hr

It is not 40 mi/hr! Remember that the average speed is distance/time. Since it takes longer to cover 4 miles at the slower speed, you are actually moving at 30 mi/hr for a longer period of time! Therefore, your average speed is closer to 30 mi/hr than it is to 50 mi/hr.

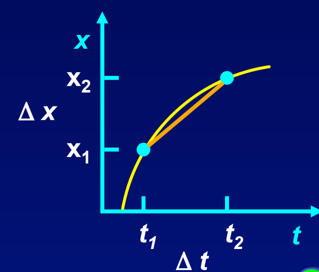
Instantaneous Velocity

The velocity at a specific instant of time

Average

Review:
Average velocity between x_1 and x_2

$$v_{av} = \frac{\Delta x}{\Delta t}$$



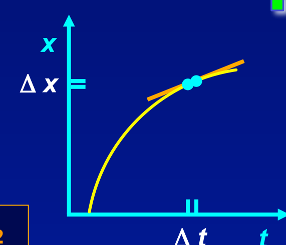
What is the velocity right at point x_2 at the instant the time is t_2 ?

Instantaneous

Take two times very close to each other so Δt is very small

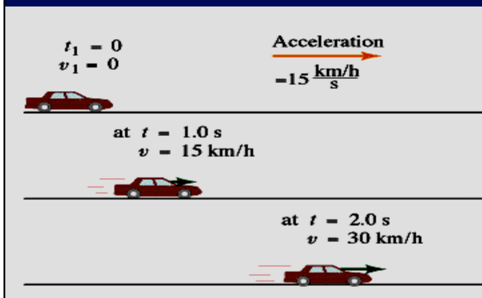
$$v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

$v(t_2)$ = slope of line tangent to path at t_2

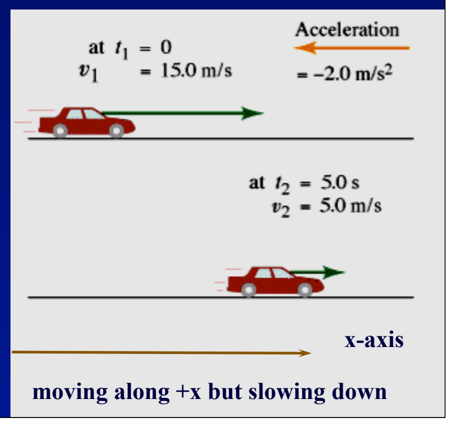


Acceleration

Acceleration measures *change* in velocity!



Note that acceleration ***a*** does ***not*** have to be in the same direction as velocity ***v!***



Acceleration

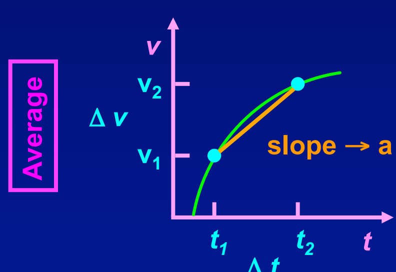
acceleration measures how the velocity ***changes*** with time

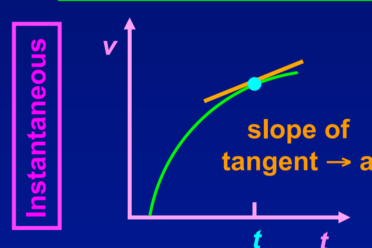
$$\text{average acceleration} = \frac{\text{change in velocity}}{\text{total time}} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t}$$

formula for a slope!

For instantaneous acceleration, the acceleration at a specific instant of time again let $\Delta t \rightarrow 0$

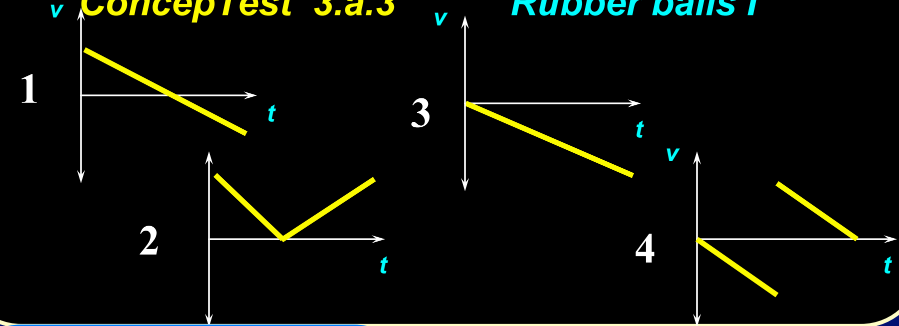
$$a = \lim_{\Delta t \rightarrow 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$$





Phys 11: chap 2, Pg 12

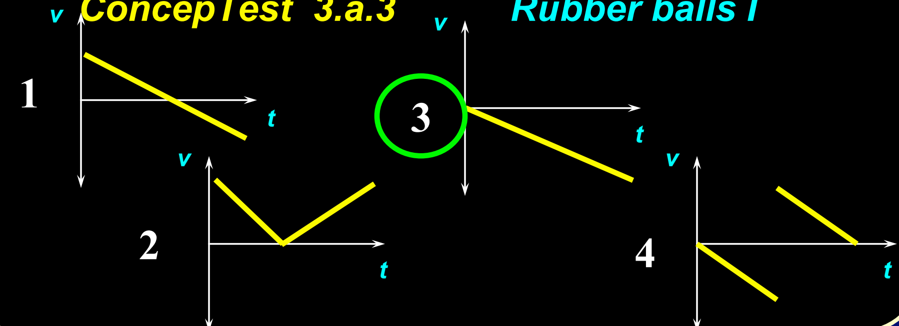
ConcepTest 3.a.3 Rubber balls I



You drop a rubber ball. Right after it leaves your hand and before it hits the floor, which of the above plots represents the *v vs. t* graph for this motion? (Assume your y-axis is pointing up).

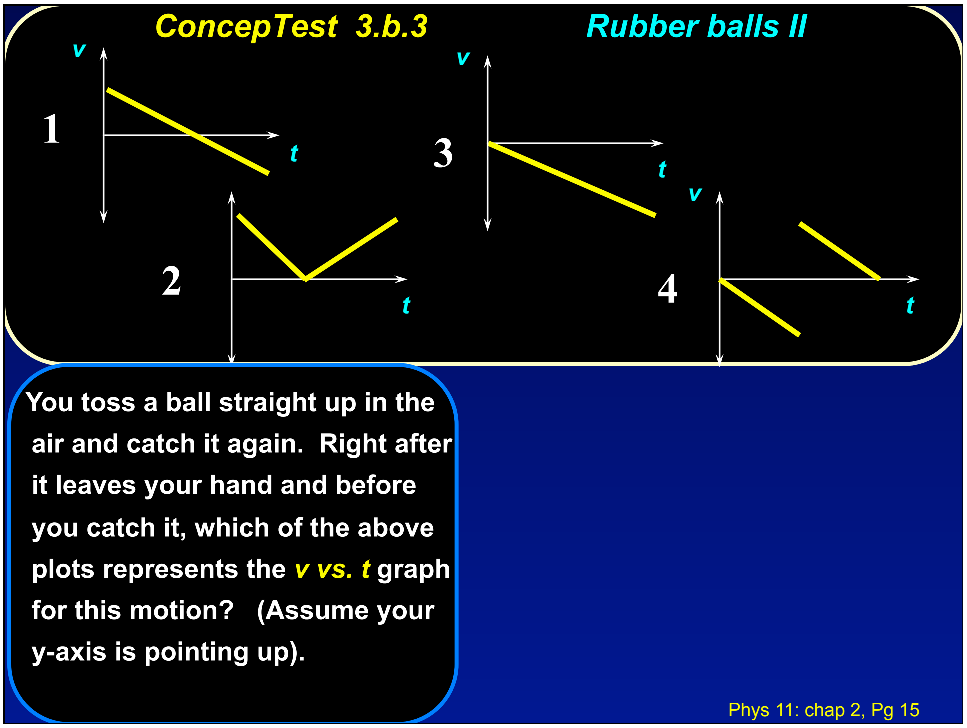
Phys 11: chap 2, Pg 13

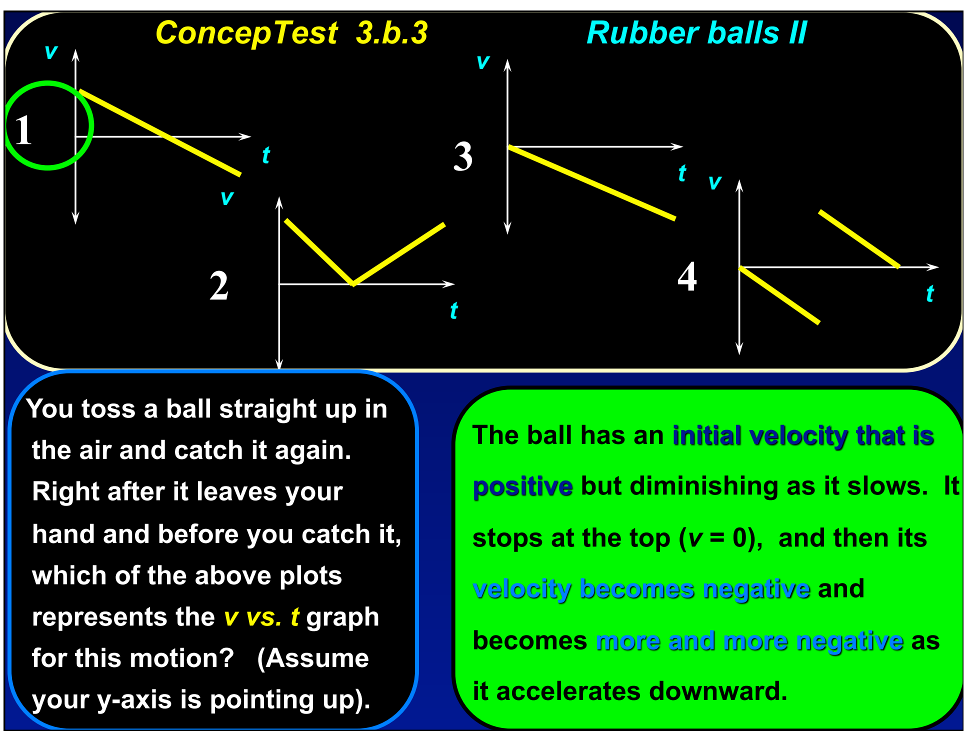
ConcepTest 3.a.3 Rubber balls I



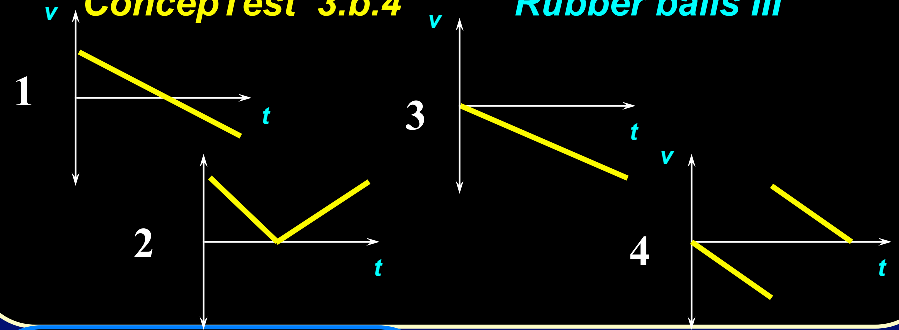
You drop a rubber ball. Right after it leaves your hand and before it hits the floor, which of the above plots represents the *v vs. t* graph for this motion? (Assume your y-axis is pointing up).

The ball is dropped from rest, so its **initial velocity is zero**. Since the y-axis is pointing upwards and the ball is falling downwards, its **velocity is negative** and becomes **more and more negative** as it accelerates downward.


ConcepTest 3.b.3
Rubber balls II
v
t
1
2
3
4
You toss a ball straight up in the air and catch it again. Right after it leaves your hand and before you catch it, which of the above plots represents the v vs. t graph for this motion? (Assume your y-axis is pointing up).
Phys 11: chap 2, Pg 15


ConcepTest 3.b.3
Rubber balls II
v
t
1
2
3
4
You toss a ball straight up in the air and catch it again. Right after it leaves your hand and before you catch it, which of the above plots represents the v vs. t graph for this motion? (Assume your y-axis is pointing up).
The ball has an initial velocity that is positive but diminishing as it slows. It stops at the top (v = 0), and then its velocity becomes negative and becomes more and more negative as it accelerates downward.

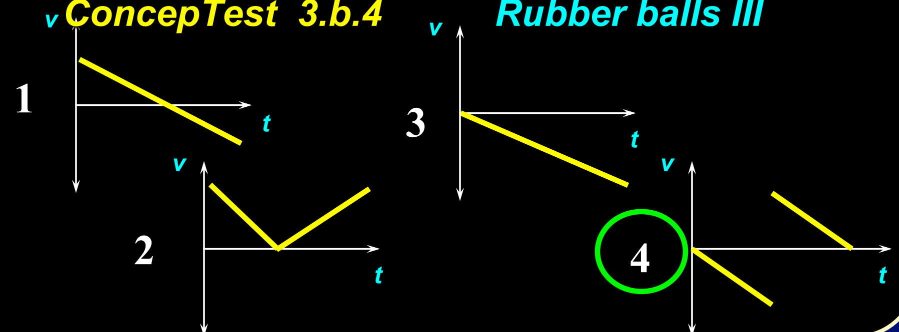
ConcepTest 3.b.4 Rubber balls III



You drop a very bouncy rubber ball. It falls, and then it hits the floor and bounces right back up to you. Which of the following represents the *v vs. t* graph for this motion?

Phys 11: chap 2, Pg 17

ConcepTest 3.b.4 Rubber balls III



You drop a very bouncy rubber ball. It falls, and then it hits the floor and bounces right back up to you. Which of the following represents the *v vs. t* graph for this motion?

Initially, the ball is falling down, so its velocity must be ***negative*** (if UP is positive). Its velocity is also ***increasing*** in magnitude as it falls. Once it bounces, it changes direction and then has a ***positive*** velocity, which is also ***decreasing*** as the ball moves upward.