Announcements 11 Feb 09

- **Homework**
  - Homework #2 due date postponed until Monday (both online and written homework assignments)
  - Homework #3 will be due on the following Friday though…

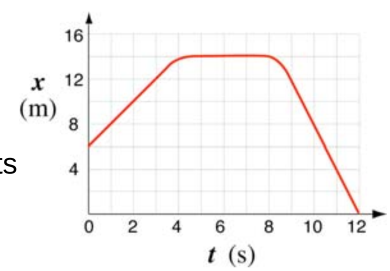
- **Exam 1 on Tuesday Feb 24 from 7 to 9 pm**
  - You need to get an "Evening Exam Conflicts" form from the Registrar's Office to be able to schedule a makeup exam
  - More info on Monday

21

Motion with Changing Velocity (Part 1)

- **Average Velocity**

Can compute ratio between displacement and time interval for *any* pair of initial and final points



$$v = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

i.e. constant velocity an object would have to travel to achieve the same displacement over the same time interval

22

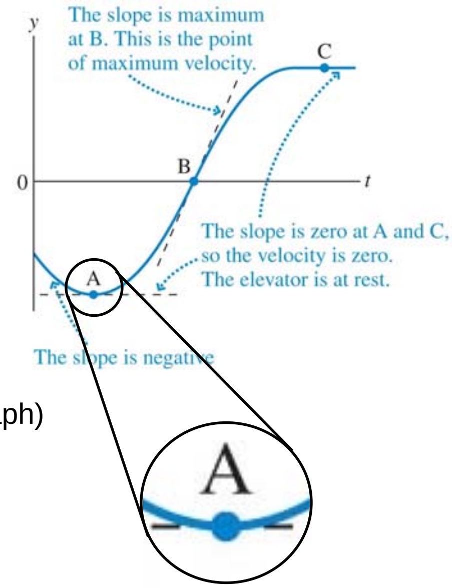
- **Instantaneous Velocity**

Same calculation as before but over a *very short* time interval

$$v = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

Instantaneous velocity at time t is the slope of the tangent line at that time (position-vs-time graph)

Motion of an elevator



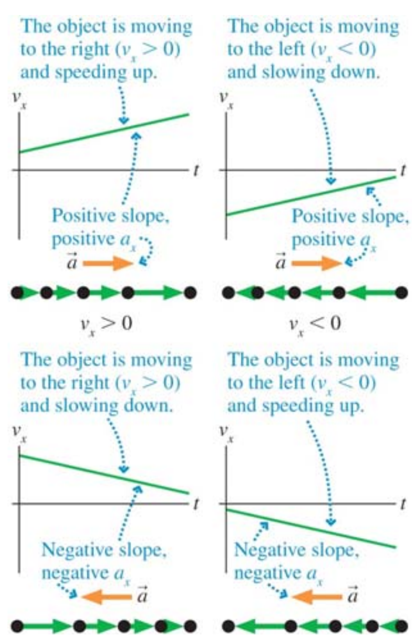
Acceleration

$$a_x = \frac{\Delta v_x}{\Delta t}$$

Acceleration is:

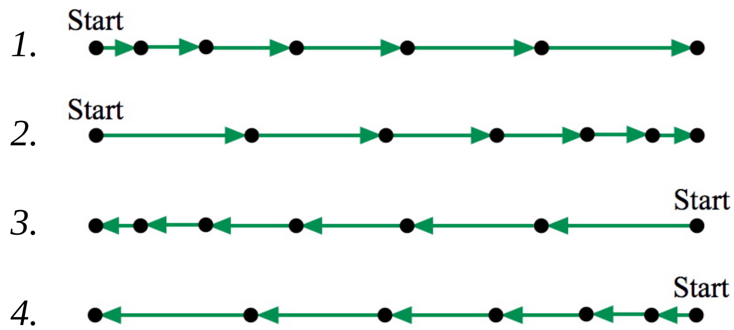
- The rate of change of velocity
- The slope of a velocity-versus-time graph

Which graph corresponds to this motion?



PRS

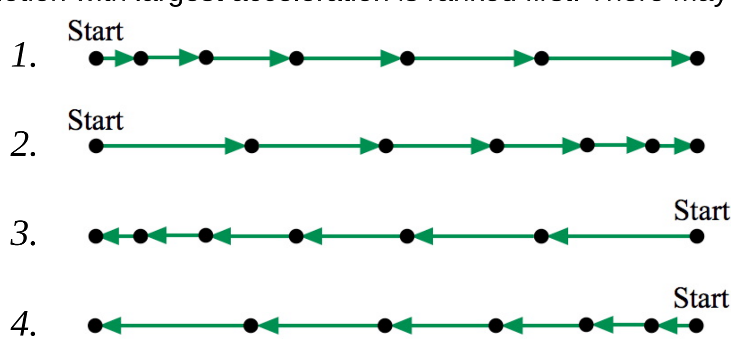
These four motion diagrams show the motion of a particle along the *x*-axis. Which motion diagrams correspond to a positive acceleration?



A. 1&2 **B. 3&4** **C. 1&3** **D. 2&4**

PRS

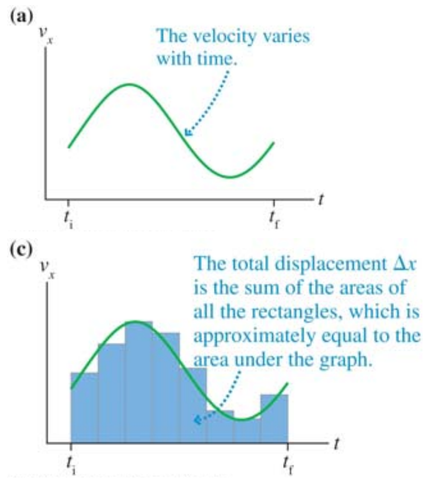
These four motion diagrams show the motion of a particle along the *x*-axis. Rank these motion diagrams such that the motion with largest acceleration is ranked first. There may be ties.

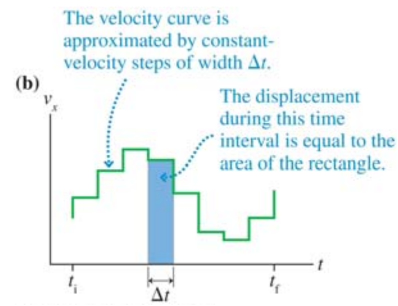


A. 1,2,3,4 **B. 1&3,2&4** **C. 1&4,2&3** **D. 1,2,4,3**

Motion with Changing Velocity (Part 2)

- **Displacement from velocity-vs-time graph**





For uniform motion :

$$\Delta x = v_x \Delta t$$

Displacement = area under the velocity-vs-time curve

27

Motion with Constant Acceleration

Straight-line motion with equal change in velocity during any successive equal-time intervals ➔ example: free fall

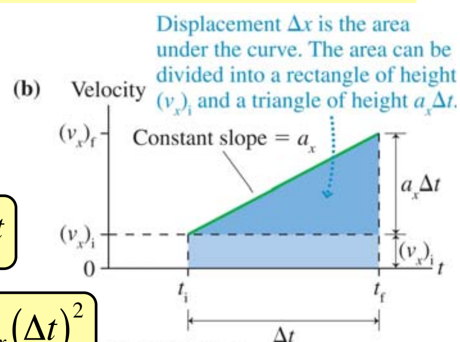
$$a_x = \frac{\Delta v_x}{\Delta t} = \frac{(v_x)_f - (v_x)_i}{t_f - t_i}$$

$$\Rightarrow \Delta v_x = a_x \Delta t$$

$$\Rightarrow \text{Eq.1}: \boxed{(v_x)_f = (v_x)_i + a_x \Delta t}$$

$$\text{Eq.2}: \boxed{x_f = x_i + (v_x)_i \Delta t + \tfrac{1}{2} a_x (\Delta t)^2}$$

$$\text{Eq.1} + \text{Eq.2} \Rightarrow \text{Eq.3}: \boxed{(v_x)_f^2 = (v_x)_i^2 + 2a_x \Delta x}$$



28

Dinner at a Distance, Part I

Chameleons catch insects with their tongues, which they can extend to great lengths at great speeds. A chameleon is aiming for an insect at a distance of 18 cm. The insect will sense the attack and move away 50 ms after it begins. In the first 50 ms, the chameleon's tongue accelerates at 250 m/s^2 for 20 ms, then travels at constant speed for the remaining 30 ms. Does its tongue reach the 18 cm extension needed to catch the insect during this time?

29

A chameleon is aiming for an insect at a distance of 18 cm. The insect will sense the attack and move away 50 ms after it begins. In the first 50 ms, the chameleon's tongue accelerates at 250 m/s^2 for 20 ms, then travels at constant speed for the remaining 30 ms. Does its tongue reach the 18 cm extension needed to catch the insect during this time?

30

Dinner at a Distance, Part II

Cheetahs can run at incredible speeds, but they can't keep up these speeds for long. Suppose a cheetah has spotted a gazelle. In five long strides, the cheetah has reached its top speed of 27 m/s. At this instant, the gazelle, at a distance of 140 m from the running cheetah, notices the danger and heads directly away. The gazelle accelerates at 7.0 m/s^2 for 3.0 s, then continues running at a constant speed that is much less than the cheetah's speed. But the cheetah can only keep running for 15 s before it must break off the chase. Does the cheetah catch the gazelle, or does the gazelle escape?

31

The cheetah has reached its top speed of 27 m/s. At this instant, the gazelle, at a distance of 140 m from the running cheetah, notices the danger and heads directly away. The gazelle accelerates at 7.0 m/s^2 for 3.0 s, then continues running at a constant speed that is much less than the cheetah's speed. But the cheetah can only keep running for 15 s before it must break off the chase. Does the cheetah catch the gazelle, or does the gazelle escape?

32

Kinematics Equations (constant acceleration)

Notation in some of the homework problems and/or different textbook is often different:

$$\left(v_x\right)_f = \left(v_x\right)_i + a_x \Delta t$$

$$\left(v_x\right)_f^2 = \left(v_x\right)_i^2 + 2a_x \Delta x$$

$$x_f = x_i + \left(v_x\right)_i \Delta t + \tfrac{1}{2} a_x \left(\Delta t\right)^2$$

equivalent to →

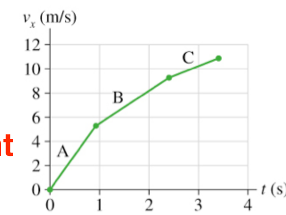
$$v = v_0 + at$$

$$v^2 = v_0^2 + 2ax$$

$$x = x_0 + v_0 t + \tfrac{1}{2} a t^2$$

These equations are valid to describe the motion of any object with *constant* acceleration

***Beware*: use only if initial and final points belong to a straight-line segment in the velocity-vs-time graph (const. a)**



33