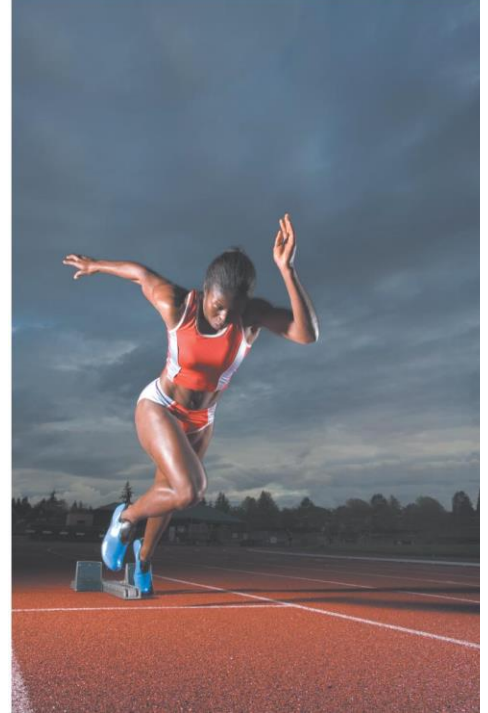


PHY131H1F

Class 4

Today, Chapter 2, Sections 2.1 to 2.4

- Uniform Motion
- Average velocity / Instantaneous Velocity
- Differentiating position to get velocity
- Integrating velocity to get position
- Equations of Constant Acceleration



Clicker Question



- If the Position versus Time graph of an object moving in 1D is a straight line, what does this mean?
 - A. The object is not moving
 - B. The object is moving with a constant velocity
 - C. The object is moving with a constant acceleration

Class 4 Preclass Quiz on MasteringPhysics

- This was due this morning at 8:00am
- students submitted the quiz on time
- % answered correctly: If the position-versus-time graph is a straight line, it means it has uniform motion. (Note: a **horizontal** straight line means it is stationary.)
- % answered correctly: Speeding up when velocity is in the negative direction means **negative** acceleration.
- % answered correctly: The area under a velocity-versus-time graph is the **displacement** of the object (it can be negative or positive, indicating direction)
- % answered correctly: The slope of a position-versus-time graph is the object's **velocity** (it can be negative or positive, indicating forward or backward direction in 1D)

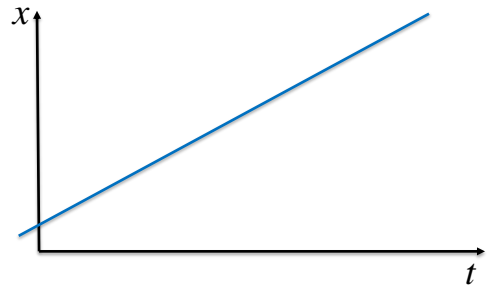
Last day I asked at the end of class:

- Does constant velocity imply constant acceleration?
- ANSWER: **YES**, and even more, it implies zero acceleration! (zero is a constant!)
- Does constant acceleration imply constant velocity?
- ANSWER: **NO!** Unless that constant happens to be zero! Constant acceleration normally means constantly *changing* velocity!

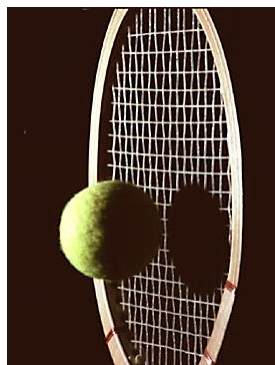
Uniform Motion = Constant Velocity

In the absence of friction, all objects tend to move with constant velocity.
This is “Newton’s First Law of Motion.”

$$x_f = x_i + v_x t$$



No force



Not squished

External
force on ball



Ball is
squished

Images from <http://people.rit.edu/andpph/exhibit-8.html> ; taken by Andrew Davidhazy

NewScientist Space

Voyager 2's view of solar system's edge will be unique

15:21 29 August 2014 by [Rebecca Boyle](#)
For similar stories, visit the [Solar System](#) and [Space flight](#) Topic Guides

Earth's second emissary to interstellar space, Voyager 2, is phoning home with new views of the solar system's ragged edge. But what it sees could be very different to what its predecessor glimpsed, revealing new details of the sun's immediate neighbourhood.

Voyager 2 has reached the heliosheath, the beginning of the end of the solar system. If the experience of its twin, Voyager 1, is anything to go by, Voyager 2 is about two-thirds of the way to the heliopause – the outer edge of the sun's influence, also considered to be where interstellar space begins. Voyager 1 [crossed this boundary](#) two years ago this week, according to NASA and most Voyager scientists. [Not everyone agrees](#), though, because readings sent back by Voyager 1 left a little room for doubt.

One clue that Voyager 1 had passed the heliopause was that its instruments measured a slowing, sparser solar wind. That's not happening yet for Voyager 2, says Rob Decker at Johns Hopkins University in Maryland.

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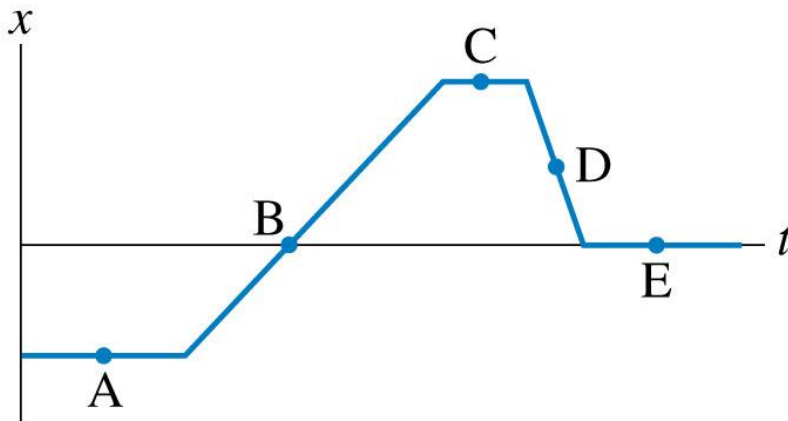


Still within the sun's grasp, but how long for? (Image: NASA)

- Currently 105 A.U. from the Sun (Earth is 1 A.U.)
- Moving at a constant velocity in a straight line of 15.428 km/s through interstellar space

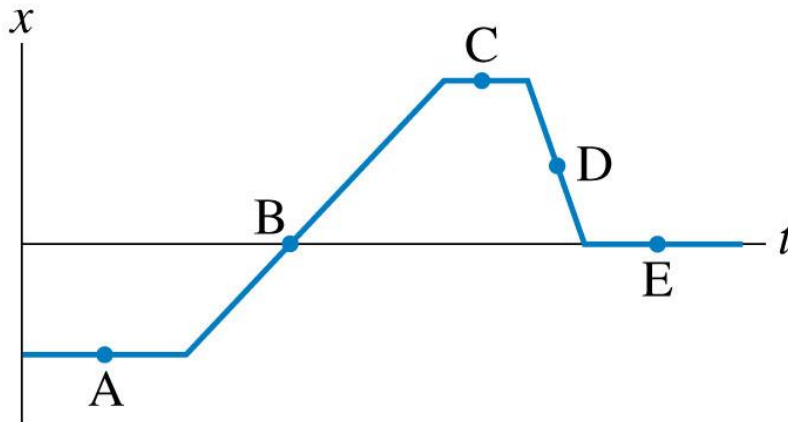
Clicker Question

- At which point is the object moving the fastest? (highest **speed**)

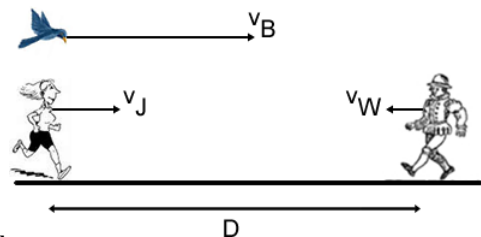


Clicker Question

- At which point is the object moving to the left?



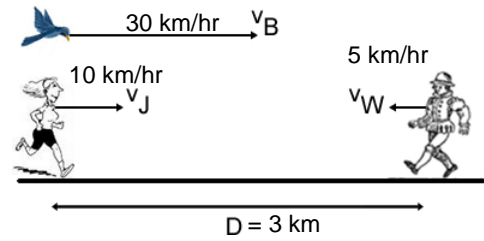
From a Past PHY131 Test:



- A jogger runs at a constant velocity $\vec{v}_J = 10 \frac{\text{km}}{\text{hr}}$ to the right.
- A walker walks at a constant velocity $\vec{v}_W = 5 \frac{\text{km}}{\text{hr}}$ to the left.
- When the jogger and the walker are $D = 3 \text{ km}$ apart, a bird flying at a constant velocity $\vec{v}_B = 30 \frac{\text{km}}{\text{hr}}$ to the right passes the jogger.
- When the bird reaches the walker, it turns around and flies back to the jogger at the same speed. When it reaches the jogger it turns around again and flies to the walker. It continues flying back and forth between the jogger and the walker.
- When the jogger and walker meet each other, how far has the bird flown?

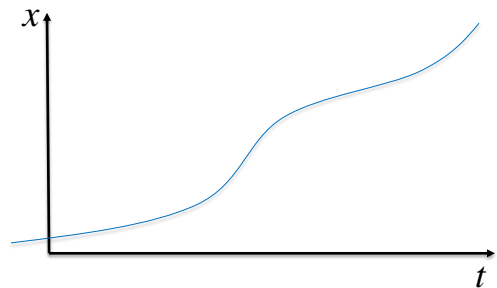
From a Past PHY131 Test:

- How far has bird flown when Jogger and Walker meet?
- Bird has constant speed, so $d_B = v_B t$
- Need to find t .



Curved Line = Not-Constant Velocity

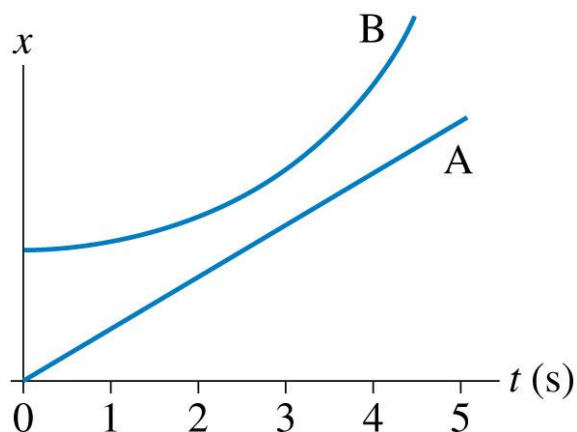
$$v_x = \frac{dx}{dt}$$



Clicker Question

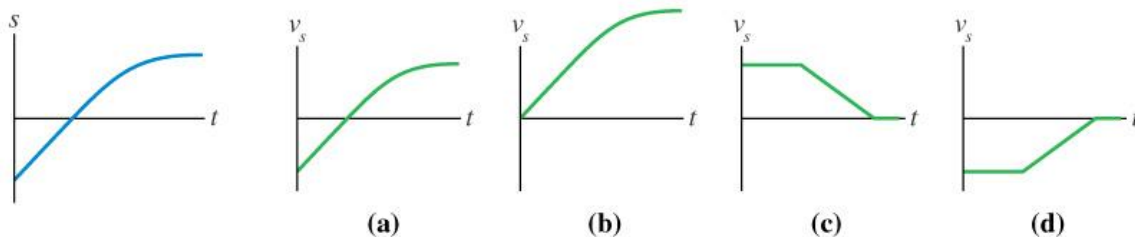
- When do objects A and B have the same velocity?

- A. $t = 0$ s
- B. $t = 1$ s
- C. $t = 3$ s
- D. $t = 5$ s
- E. Objects A and B never have the same velocity



Clicker Question

Which velocity-versus-time graph goes best with the position-versus-time graph on the left?



Announcements

- Pre-course diagnostic quiz on mechanics done during zeroth practical last week.
- Did you miss it? Still want your 0.5%? Here are two make-up times to choose from:
- Tues Sept. 23 - 11:10 am in MP125C
Wed. Sept 24 - 4:10 pm in MP125C

Announcements

- Don't change your Practical Section on ROSI – your TAs will never know, and you won't get your marks!
- You must go to portal and fill out an online form if you want to change Practical Sections.

Announcements

- The first term test will be on Tuesday, Sep 30, from 6:00pm to 7:30pm.
- Test 1 will cover chapters 1-3 plus the Error Analysis Mini-Document, plus what was done in Practicals
- You must bring a calculator and one 8.5x11' aid sheet which you prepare, double-sided
- If you have a conflict at that time with an academic activity (test, lecture, tutorial, lab), you must register to write at the alternate sitting of this test by going to portal and filling out the online form no later than Sep. 25 by 11:59pm.

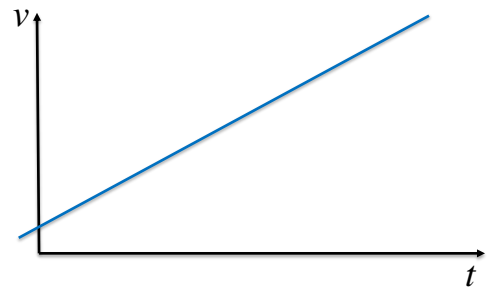
Acceleration in 1-D (along a line)

- Velocity is the time-derivative of position.
- Acceleration is the time-derivative of velocity.
- S.I. unit of acceleration is m/s ***per second***, also called m/s^2 .
- Acceleration is like the “speed of the speed”
- Acceleration is “how fast fast changes!”
- It is possible to be momentarily stopped ($v=0$) with a non-zero acceleration!

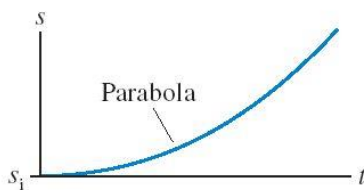
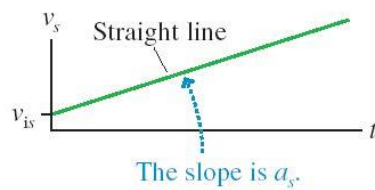
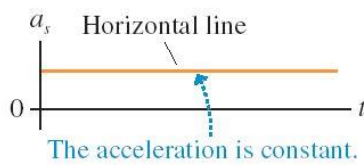
Constant Acceleration

$$x_f = x_i + \int_0^t v dt$$

$$v_f = v_i + a_x t$$

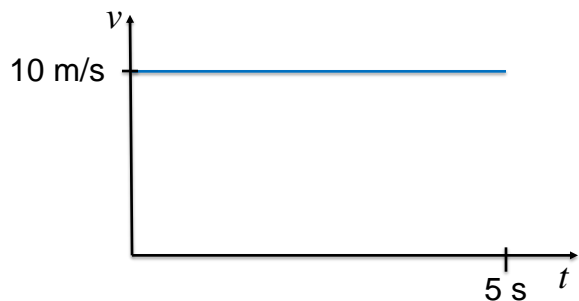


Motion at constant acceleration



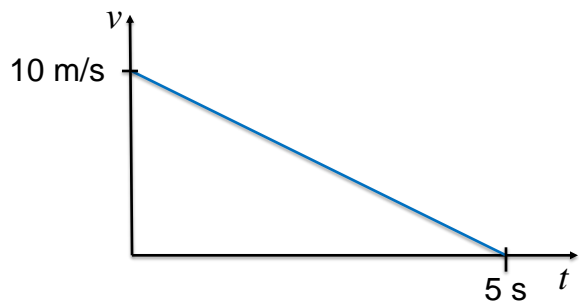
Clicker Question

- An object has a constant velocity of +10 m/s for 5 seconds.
 - How far does the object travel over these 5 seconds?
- A. 10 m
B. 25 m
C. 50 m
D. 100 m
E. 500 m



Clicker Question

- An object has an initial velocity of +10 m/s.
 - It is slowing down, with a constant value of acceleration.
 - After 5 seconds, it has stopped.
 - How far does the object travel over these 5 seconds?
- A. 10 m
B. 25 m
C. 50 m
D. 100 m
E. 500 m

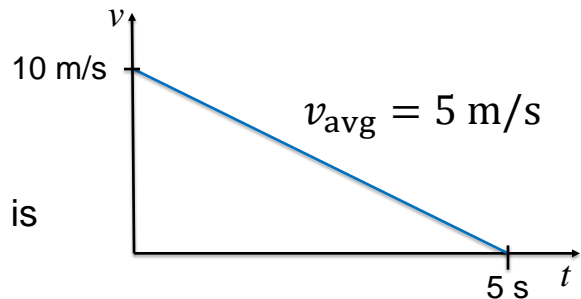


Average Velocity

- For 1D motion with constant acceleration, the average velocity is $\frac{1}{2}(\text{initial velocity} + \text{final velocity})$

$$v_{\text{avg}} = \frac{v_i + v_f}{2}$$

$$v_{\text{avg}} = \frac{d}{t}$$



The 4 Equations of Constant Acceleration:

- $v_f = v_i + a\Delta t$ Does not contain position!
- $x_f = x_i + v_i\Delta t + \frac{1}{2}a(\Delta t)^2$ Does not contain v_f !
- $v_f^2 = v_i^2 + 2a(x_f - x_i)$ Does not contain Δt !
- $x_f = x_i + \left(\frac{v_i + v_f}{2}\right)\Delta t$ Does not contain a ! (but you know it's constant)

Strategy: When $a = \text{constant}$, you can use one of these equations. Figure out which variable you don't know and don't care about, and use the equation which doesn't contain it.

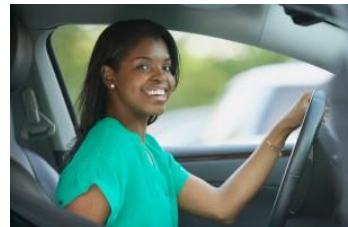
Example.

- You are traveling at 30 m/s, and suddenly hit the brakes.
- Your maximum acceleration is 10 m/s².
- What is your minimum stopping distance?

Clicker Question

- You are driving along a straight highway at a steady speed.
- A driver in the left lane passes you at a steady speed.
- At the moment when the front of her car is exactly even with the front of your car, you both turn and your eyes meet briefly.
- At this instant, do you have equal velocities?

- A. Yes
- B. No
- C. Not possible to determine with information given.



[Image downloaded Sep.17 2013 from <http://blog.famousfootwear.com/2013/03/save-your-car-and-money-with-driving-shoes/>]

Before Class 5 on Monday

- If you haven't already done it, remember there is a MasteringPhysics.com problem set due this weekend! Please submit this before 11:59pm Sunday.
- Please finish reading Chapter 2 of Knight.
- Something to think about: Which is easier to **see**: velocity or acceleration? Which is easier to **feel**: velocity or acceleration?