Announcements

If you're new (or weren't paying attention…):

1. Course homepage via: **physics.byu.edu → Class web pages → Physics 105 (Colton J)**
   a. See e.g. last page of class notes from Sep 2 to see what you need to do to get started and catch up.

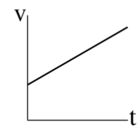
2. Homework:
   a. Second homework assignment is due Wed at 11:59 pm.
   b. All retries on the first set of homework are also due Wed at 11:59 pm.

3. Syllabus:
   a. There's some (interesting?) stuff in the syllabus that we didn't get a chance to talk about in class. Be sure to look everything over.

4. Email:
   a. There are still about 4 people whose email is bouncing. If you haven't received email from me, check your Route Y address.

Review Equations

For constant acceleration…



$$v_{ave} = \frac{v_0 + v_f}{2}$$

"Three basic kinematic equations"

velocity-time: $v = v_0 + at$

position-time: $x = x_0 + v_0 t + \frac{1}{2}at^2$ (x vs. t = parabola)

velocity-position: $v_f^{\,2} = v_0^{\,2} + 2a\Delta x$

"The Moving Man" applet:

http://phet.colorado.edu/new/simulations/sims.php?sim=The_Moving_Man

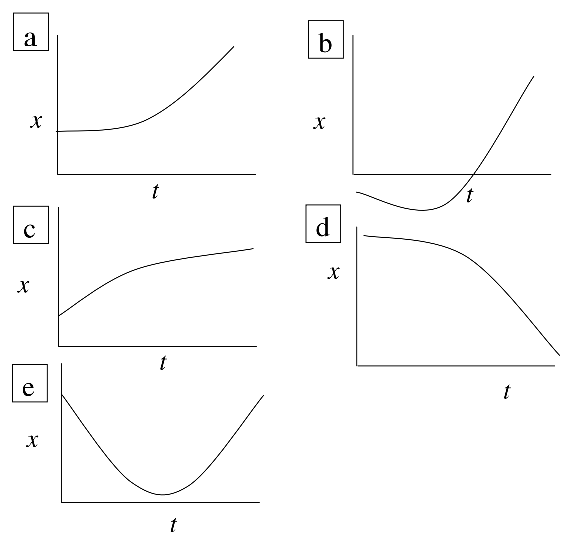
Freefall: "Milkdrop" demo

Review Questions

A sprinter runs the 50 m dash starting at rest, with a constant acceleration of 0.5 m/s^2. Find:
a) Her final velocity
b) Her average velocity
c) The time it took

Problem Solving Tip:
Always draw a **diagram**!

Problem Solving Tip:
Look for equations that contain the given information, not the variable you're looking for.



There is a lamppost at x = 0. Which x vs t curve describes:

Q1. a car **slowing down** as it moves **away** from the lamppost
Q2. a car moves **toward** the lamppost, but **slows down** and **turns around** and speeds up
Q3. a car **speeding up** as it moves **toward** the lamppost
Q4. a car that moves away from the lamppost, turns around and **passes** the lamppost

Table Tennis

http://www.photocroatia.com/eephoto/table_tennis/normal/I_DRUSANY_TABLE_TENNIS_9.jpg

Question: What is the direction of the ball's acceleration during the contact (hit) between paddle and ball?

A. right
B. left
C. zero

Question: What is the direction of acceleration of the ball while traveling to the right (and slowing down)? (same choices)

Question: What if the ball were tied to a bungee cord… What is the direction of acceleration at the instant the ball is stopped by the elastic and about to start coming back?

Q5. You drop a ball from the top of a building, and measure the time to hit the ground. You go to a second building, and find that the ball takes *twice* as long to hit the ground.

The second building is

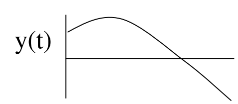
a. less than twice as tall as the first
b. twice as tall as the first
c. more than twice as tall as the first

A rock is thrown upward off a cliff 30 m high, with an initial velocity of 20 m/s.

a) How long does it take to reach the top of its path?
b) What is the velocity just before it hits the ground (30 m below the cliff)?
c) How long does it take to hit the ground?

- Use up = positive direction
- Use $a_y = -g$
- Choose origin ($y = 0$ point)

Q6. Which sketch describes **y(t)** for the rock thrown upward from a cliff? (just after the throw; y=0 is at the ground level)

A.


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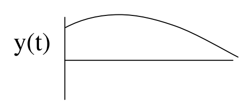

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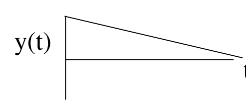

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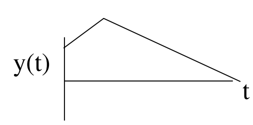
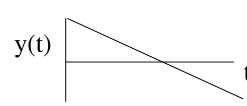
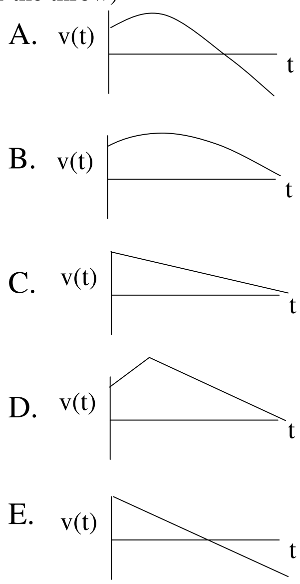
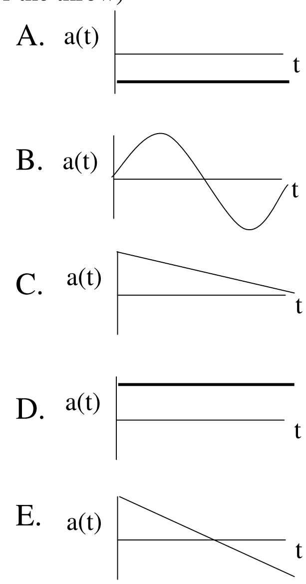


E.


Q7. Which sketch describes **v(t)** for the rock thrown upward from a cliff? (just after the throw)



Q8. Which sketch describes **a(t)** for the rock thrown upward from a cliff? (just after the throw)



Vectors: Magnitude + Direction

<u>Examples:</u>

Velocity
Acceleration

Position?
Displacement?

(later) Forces
(Physics 106) Fields

Anything else?

Represented by Arrows

Adding Vectors
The Graphical Method: "Tip to Tail"

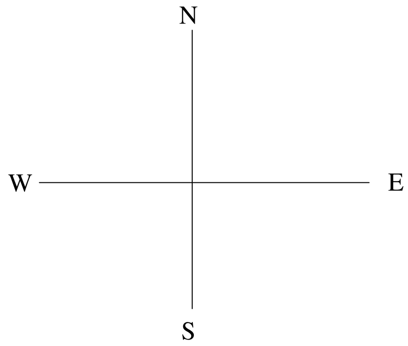
For precision, use a protractor to set the angle of the vectors, and a ruler to set the lengths (magnitudes).

- Choose an appropriate **scale** (e.g. 1 cm = 5 m/s or whatever is appropriate for your case) and **axes**.
- Draw the first vector with the proper length and angle, starting from the origin.
- **Begin the second vector with its tail at the tip of the previous vector**—hence the phrase "tip-to-tail"
- To draw in the second vector, **measure its angle from the coordinate axes**, not from the previous vector's direction.
- If you are adding more than two vectors, continue the same procedure, draw each vector's start at the previous vector's end.
- When you have drawn all of the vectors in the sum, draw a vector **from the origin to the end of the final vector** in your sum. That's the answer!
- A **negative vector** points in the opposite direction.

(Warmup question: "Briefly describe how you would go about adding two vectors together using a ruler and protractor")

Worked Problem

Adding displacements as vectors
A student runs 100 m north, then 200 m south-east, then 200 m west. What is her final displacement relative to the origin?



→ Does the *order* matter?

Website demo: Vector addition animation
http://www.glenbrook.k12.il.us/gbssci/phys/mmedia/vectors/ao.html

(Warmup)
T/F: Vectors are commutative (that is **A** + **B** = **B** + **A**)

Relative velocities

Problem: A man on a treadmill is walking at 1.5 m/s to the left. The treadmill is going at 2 m/s to the right. If you are standing still, it looks like the man is moving…

$$v_{ac} = v_{ab} + v_{bc}$$

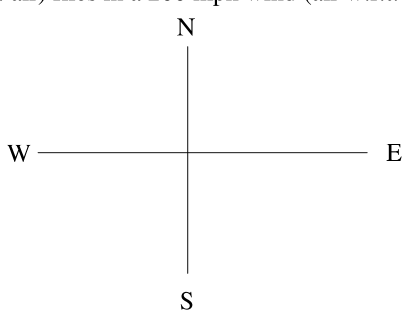
"velocity of object *a* with respect to object *c*"

$$v_{man\text{-}ground} = v_{man\text{-}treadmill} + v_{treadmill\text{-}ground}$$

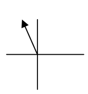
Treadmills?
http://www.youtube.com/watch?v=pv5zWaTEVkI

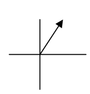
Follow-up experiment
http://www.youtube.com/watch?v=x49WZRyXGe0

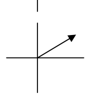
Problem: A jet pointed N at 100 mph airspeed (*v* of plane w.r.t. air) flies in a 200 mph wind (air w.r.t. ground) going NE.

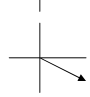


Q9. What is the jet's true bearing (velocity w.r.t. ground)?

a. 

b. 

c. 

d. 

e. none of the above

Q10. What is the magnitude of the jet's velocity (approx.)?

a. 200 mph
b. 240 mph
c. 280mph
d. 300 mph
e. none of those

Adding Vectors
The Component Method

- Use this to get an exact numerical answer
- Break the vectors into *x*- and *y*-components, and then add the components separately to get the components of the sum.
- Then, the *x*- and *y*-components you end up with can be put back together to form the final vector.

Trigonometry Reminders:
- θ measured from positive x-axis
- The *x*-component of a vector **A** is $A\cos\theta$.
- The y-component is $A\sin\theta$.
- The magnitude and direction of the resulting force vector are given by the usual polar coordinate formulas:*
  - $A = \sqrt{A_x^{\ 2} + A_y^{\ 2}}$
  - $\theta = \tan^{-1}(y/x)$

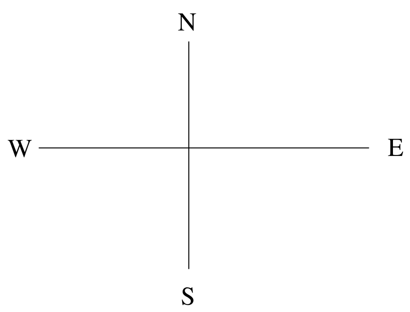
* You need to be careful with the $\tan^{-1}$ formula—as you may remember from trigonometry, 2nd and 3rd quadrant angles won't come out correctly on your calculator when you take their inverse tangent. Stay safe by always checking your answer with a picture.

Question: A boat wishes to sail exactly **E** on a map, with a speed relative to the *earth* of 10 mph. **What direction** should the captain point the boat if there is a 10 mph current to the **N**?

a. 30° north of east   b. 45° north of east
c. 30° south of east   d. 45° south of east

Hint: Start with an approximate picture

$$\mathbf{v_{bg}} = \mathbf{v_{bw}} + \mathbf{v_{wg}}$$



Q11. How fast will the boat have to go?
a. 5 mph   b. 7.1 mph   c. 10 mph   d. 14.1 mph