Physics 1021

Spring 2012

Summary of Kinematics

New Topic

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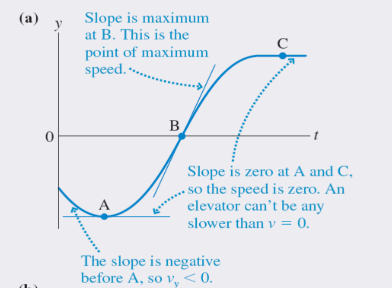
Summary for 1D motion position & velocity

- Instantaneous velocity is the slope of the position-vs-time curve

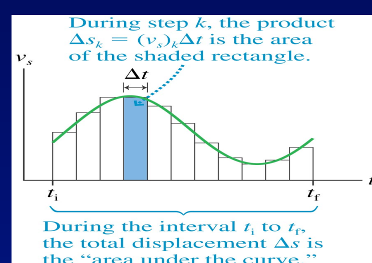
$$v_s \equiv \lim_{\Delta t \to 0} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$$

FIGURE 2.11 The velocity-versus-time graph is found from the position graph.



Summary for 1D motion position & velocity

- Displacement (not position!) is the area under the velocity-vs-time curve



$$s_f = s_i + \lim_{\Delta t \to 0} \sum_{k=1}^{N} (v_s)_k \Delta t = s_i + \int_{t_i}^{t_f} v_s \, dt$$

How would I calculate the average speed between tf and ti?

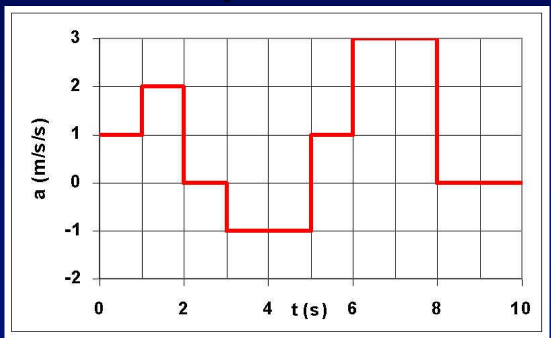
Summary

Acceleration vs velocity is similar to velocity vs position

$$a_s \equiv \lim_{\Delta t \to 0} \frac{\Delta v_s}{\Delta t} = \frac{dv_s}{dt} \qquad \text{(instantaneous acceleration)}$$

$$v_{fs} = v_{is} + \lim_{\Delta t \to 0} \sum_{k=1}^{N} (a_s)_k \Delta t = v_{is} + \int_{t_i}^{t_f} a_s \, dt$$

1D motion with Acceleration Graph Translation



- Sketch the velocity graph associated with this acceleration graph:
- Assuming that the initial velocity is zero, how far does the object travel?
- Write an equation for the position as a function of time:
- Between t = 0 and 1 s
- Between t = 1 and 2 s
- Between t = 2 and 3 s

How can we get our stuff on FB faster?

•**Upload to your page and tag with phys21bio … does this matches your FB persona?**

•**Go to phys21bio wall and upload directly … only friends of phys21bio can view your postings (unless you tag yourself on the image).**

•**Email your images to** vat461vip@m.facebook.com … fast, easy, can do this right in class, from your cellphone. Fill in the subject line (can be as long as you like) – This will be the figure caption. Nothing you put in the body will be transmitted.

Vectors

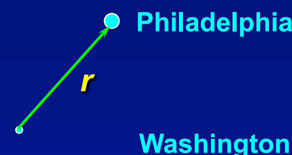
New Topic

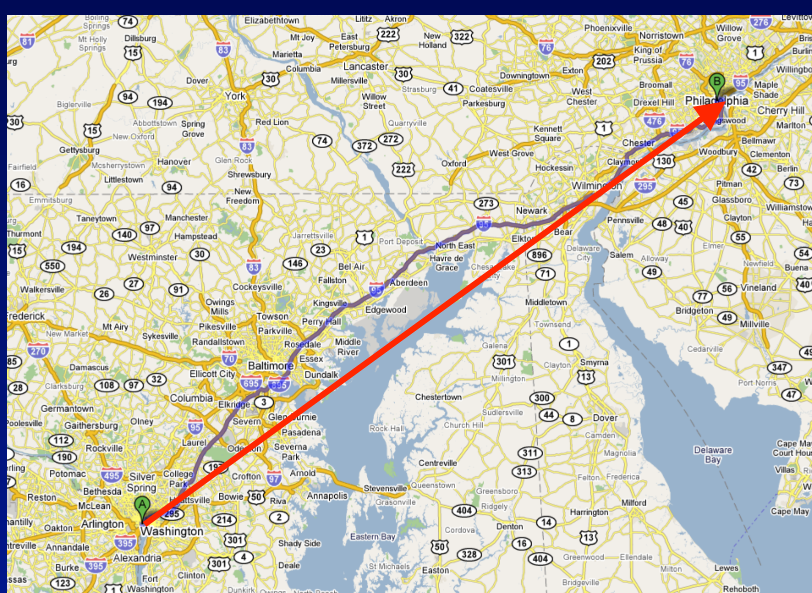
Vectors

- Scalars are numbers with units.
- Vectors have both magnitude and direction
- In 1-D, we could specify direction with a + or - sign
- In 2-D or 3-D, we need more than a sign to specify direction

- To illustrate, consider the *position vector* in 2 dimensions

Example: Where is Philadelphia?
- Choose origin at Washington
- Choose coordinates of distance (miles) and direction (N,S,E,W)
- vector *r* points 140 miles north-east

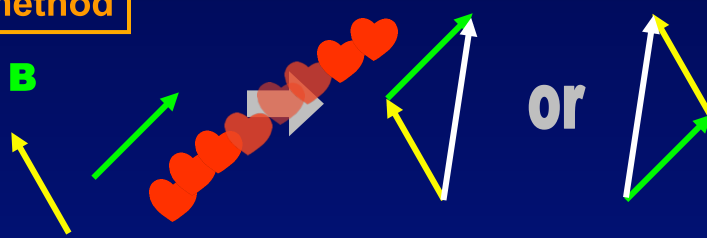




Vector Addition: Graphical method

Tip-to-tail method

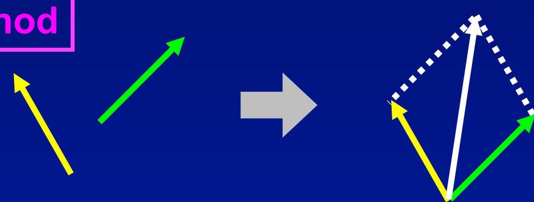
C = A + B



We can arrange the vectors any way we want, as long as we maintain their length and direction !

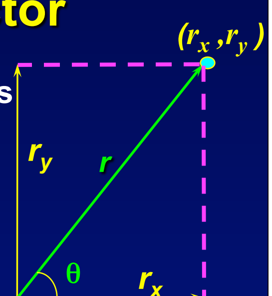
Parallelogram method

C = A + B



Components of a Vector

- Components of ***r*** are its (r_x, r_y) coordinates
  - $r = (r_x, r_y)$



- Components can be expressed as:
  - $r_x = r \cos\theta$
  - $r_y = r \sin\theta$

where $r = |\mathbf{r}|$

$\theta = \arctan(r_y / r_x)$

- Magnitude (length) of ***r*** is found by Pythagorean theorem:

$$|\mathbf{r}| = r = \sqrt{x^2 + y^2}$$

The length of a vector does **not** depend on its direction.

Using Vectors

- Components depend on the choice of the coordinate system.
- Can add vectors graphically (tip to tail)
- Can also add vectors by adding the components
- How to choose the coordinate system?
  - ➢ the right coordinate makes the problem easier.

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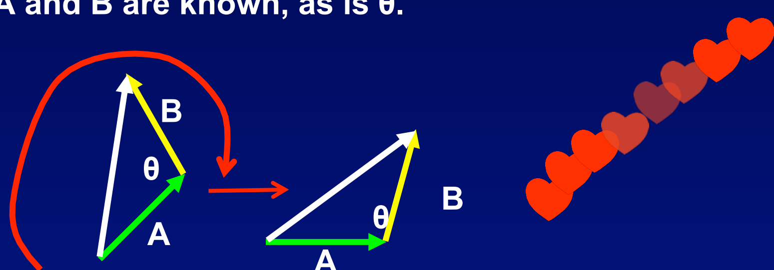
Components of added Vectors

- A and B are known, as is θ.



Using Vectors

Expressing vectors in a coordinate system is a generic method for vector manipulation. The number of component depends on spatial dimension!

Components

The component vectors are parallel to the x- and y-axes:

$$\vec{A} = \vec{A}_x + \vec{A}_y = A_x\hat{\imath} + A_y\hat{\jmath}$$

In the figure at the right, for example:

$$A_x = A\cos\theta \qquad A = \sqrt{A_x^2 + A_y^2}$$

$$A_y = A\sin\theta \qquad \theta = \tan^{-1}(A_y/A_x)$$

- Minus signs need to be included if the vector points down or left.

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ConcepTest 2.1b *Vectors III*

Given that A + B = C, and that |A| + |B| = |C| , how are vectors A and B oriented with respect to each other?

1) they are perpendicular to each other
2) they are parallel and in the same direction
3) they are parallel but in the opposite direction
4) they are at 45° to each other
5) they can be at any angle to each other

ConcepTest 2.1b Vectors III

Given that **A** + **B** = **C**, and that |A| + |B| = |C| , how are vectors **A** and **B** oriented with respect to each other?

1) they are perpendicular to each other
2) they are parallel and in the same direction
3) they are parallel but in the opposite direction
4) they are at 45° to each other
5) they can be at any angle to each other

The only time vector magnitudes will simply add together is when the direction does not have to be taken into account (i.e. the direction is the same for both vectors). In that case, there is no angle between them to worry about. So vectors A and B must be pointing in the same direction.

ConcepTest 2.2 Vector addition

You are adding vectors of length 20 and 40 units. What is the only possible resultant magnitude that you can obtain out of the following choices?

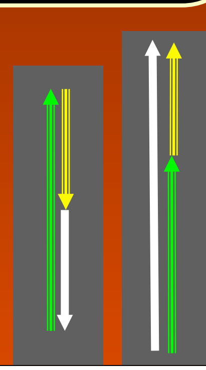
1) 0
2) 18
3) 37
4) 64
5) 100

ConcepTest 2.2 Vector addition

You are adding vectors of length 20 and 40 units. What is the only possible resultant magnitude that you can obtain out of the following choices?

1) 0
2) 18
3) 37
4) 64
5) 100

The minimum resultant occurs when the vectors are opposite, giving 20 units. The maximum resultant occurs when the vectors are aligned, giving 60 units. Anything in between is also possible, for angles between 0° and 180°.

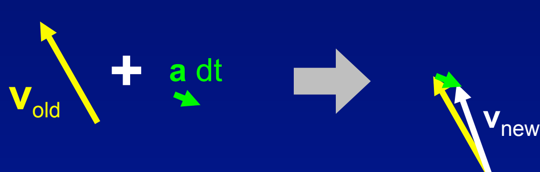


Vector Addition: What about acceleration?

$d\mathbf{v}/dt = (\mathbf{v}_{new} - \mathbf{v}_{old})/dt = \mathbf{a}$ of course, v_{new} and v_{old} are almost the same

So how does the velocity vector change ?

$\mathbf{v}_{new} = \mathbf{v}_{old} + \mathbf{a}\,dt$



Ponderable: v and Δv

For the given velocity vector, draw the appropriate Δ**v vector.**
(Assume the acceleration happens during a very short Δt.)

	Speed increases	No change in direction
	Speed decreases	No change in direction
	No change in speed	No change in direction
	No change in speed	Turns toward its left
	Speed increases	Turns toward its right
	Speed decreases	Turns toward its right