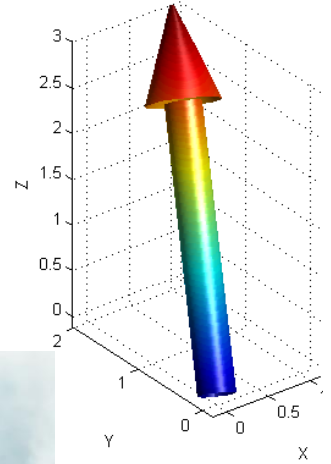


PHY131H1F - Class 6

Today:

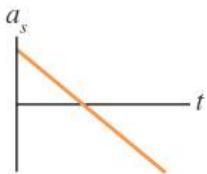
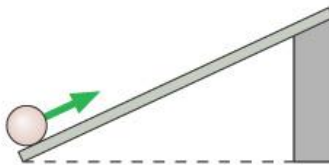
- Scalars and vectors
- Coordinate systems, Components
- Vector Algebra



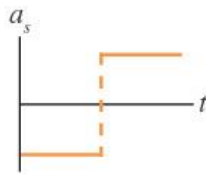
Clicker Question

The ball rolls up the ramp, then back down.
Which is the correct acceleration graph?

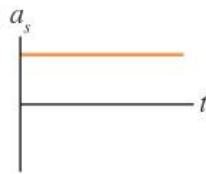
[Define positive s as up and to the right, parallel to the ramp..]



(a)



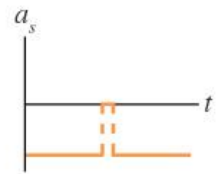
(b)



(c)

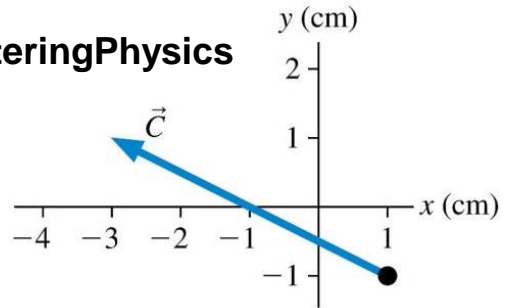


(d)



(e)

Class 6 Preclass Quiz on MasteringPhysics



- This was due this morning at 8:00am
- 996 students submitted the quiz on time
- 82% answered correctly: The (x,y) components of the vector shown are (-4,2)
- 87% answered correctly: The vector shown can be written as $-4\hat{i} + 2\hat{j}$
- 88% answered correctly: The unit-vector \hat{j} has magnitude 1, and points in the +y direction.
- 94% answered correctly: A vector is a quantity having both size and direction. It is not a number, but a set of 2 or 3 numbers.

Class 6 Preclass Quiz on MasteringPhysics

- *“Do you want us to put the little arrow on top of letters when we do a solution to show that it's a vector?????”*
- **Harlow answer:** It's generally a good idea in order to keep things clear, but you won't lose points on a test for leaving it out
- *“Someone mentioned to me that v without an arrow on top is not a vector, and v with an arrow on top is a vector. I thought velocity was always a vector, regardless. Just wondering if you could clarify?”*
- **Harlow answer:** I would say v is “speed”, \vec{v} is “velocity”

Class 5 Preclass Quiz on MasteringPhysics

- *"I was just wondering how much these quizzes/ problem sets count for towards our final marks"*
- Here is the marking scheme, from the Course Information web site:
 - Final Exam: 40%
 - Two midterm tests (Sep.30, Nov. 11): 30% *(15% each)*
 - Practicals notebooks marks: 15%
 - MasteringPhysics Problem Sets: 9%
 - MasteringPhysics Pre-class quizzes: 3%
 - In-class i-clicker questions: 2%
- Pre- and post-course diagnostic quizzes: 1%

Class 5 Preclass Quiz on MasteringPhysics

- *"The textbook mentioned 3D vectors, and the 3rd component z. What does this mean?"*
- **Harlow answer:** In this universe there are three mutually perpendicular spatial dimensions. "north" and "up" are perpendicular to one another
- *"Why do we use degrees rather than radians? I'm not asking this because I believe one ought to be used over the other. I'm just wondering out of sheer curiosity."*
- **Harlow answer:** It is a historical convention. Actually, radians is a much better unit, and we will be using radians when we get to chapter 12.
- *"Do we have physics practical every week?"*
- **Harlow answer:** yes

Class 5 Preclass Quiz on MasteringPhysics

- *“Do you even read these?”*
- **Harlow answer:** yes
- *“By posting this on the projector screen on the date of 24 September 2014 at 11:00 a.m you will have squashed any doubts that the dubious looking gentleman with the full-rimmed glasses on the third floor balcony closest to the right has of the legitimacy that are these posts which induce laughter.”*
- *“My girlfriend is really sick and maybe if she has the support of this entire class (by this message being displayed on the screen) she will feel better.”*
- *“Tomorrow is one of my best friends Judith's birthday, she is from Mexico! Can we all say Happy Birthday to her?”*



Last day I asked at the end of class:

- Can you add a scalar to a vector?
- ANSWER: No. A 2-D vector is represented by a pair of numbers (ie x - and y - components, or magnitude and direction), and you can't add a scalar number to this.
- Can you multiply a vector by a scalar?
- ANSWER: YES! When you multiply a vector by a scalar, you can either:
 - Multiply both the x and y components by this scalar, or
 - Multiply the magnitude by the scalar, and keep the direction unchanged (but you flip direction 180° for a negative scalar)

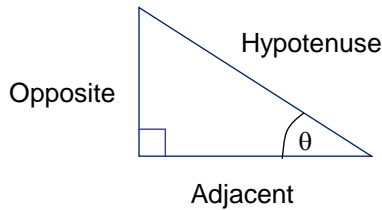
Right Triangle Trigonometry

- This is one of the most common things people are rusty with.

- $\sin(\theta) = \frac{\text{opp}}{\text{hyp}}$

- $\cos(\theta) = \frac{\text{adj}}{\text{hyp}}$

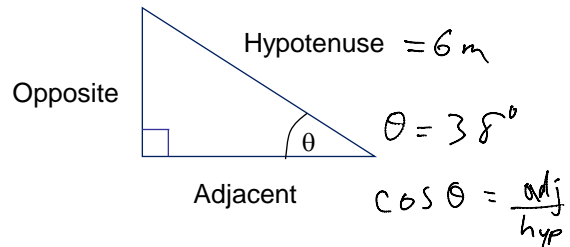
- $\tan(\theta) = \frac{\text{opp}}{\text{adj}}$



SOH CAH TOA

Clicker Question:

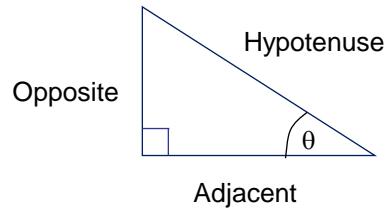
- If the hypotenuse below is 6m and the angle is 38° , what is the length of the adjacent side?



- A. $(6 \text{ m})\sin(38^\circ)$
- B. $(6 \text{ m})\tan(38^\circ)$
- C. $(6 \text{ m})\cos(52^\circ)$
- D. $(6 \text{ m})\cos(38^\circ)$
- E. Not enough information

Clicker Question:

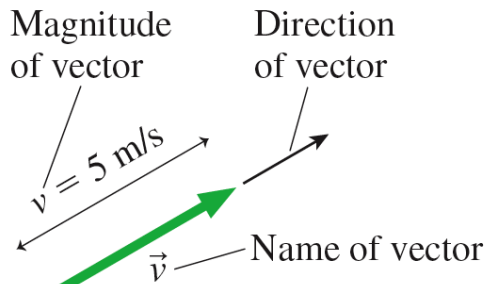
- If the adjacent side below is 6 m and the opposite side is 4 m, what is the angle θ ?



- A. $\tan^{-1}(6/4)$
- B. $\cos^{-1}(6/4)$
- C. $\cos^{-1}(4/6)$
- D. $\tan^{-1}(4/6)$
- E. $\sin^{-1}(4/6)$

Vectors

- There are two kinds of Physical quantities we will deal with:
 - Scalar (Only has a size)
 - Quantity that can be described with only one number.
 - Examples: time, speed (just a magnitude say 5 miles per hour)
 - Vector: (Has size and a direction)
 - Quantity that is described with two numbers:
 - Magnitude
 - Direction
 - Examples: Position, velocity (magnitude say “5 m/s” and direction say “north”)



The vector is drawn across the page, but it represents the particle's velocity at this one point.

Distance vs Displacement Example

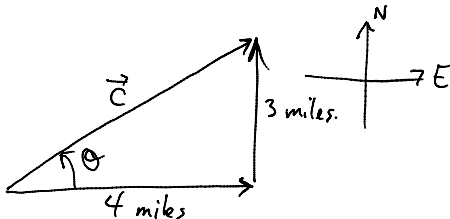
- From High Park, you ride your bike 4.0 miles East on Bloor St, then 3.0 miles North on Yonge St to the corner of Yonge and Eglinton.

- What is the distance traveled?
- What is your displacement?

(a) is odometer reading

$$d = 3 + 4 = 7 \text{ miles}$$

(b)



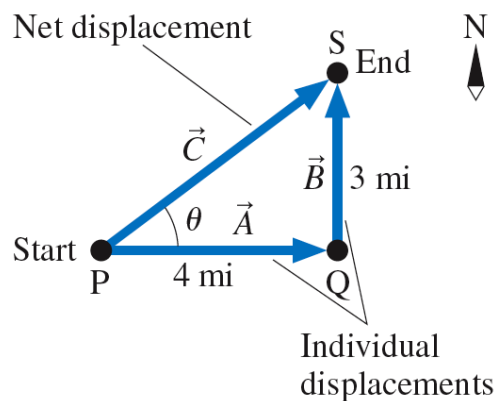
$$|\vec{C}| = \sqrt{4^2 + 3^2} = \sqrt{25} = 5 \text{ miles}$$

$$\tan \theta = \frac{3}{4} \quad \theta = \tan^{-1}(0.75) = 36.9^\circ$$

$$\vec{C} = 5.0 \text{ miles, } 37^\circ \text{ North of East}$$

Class 6 Preclass Quiz on MasteringPhysics

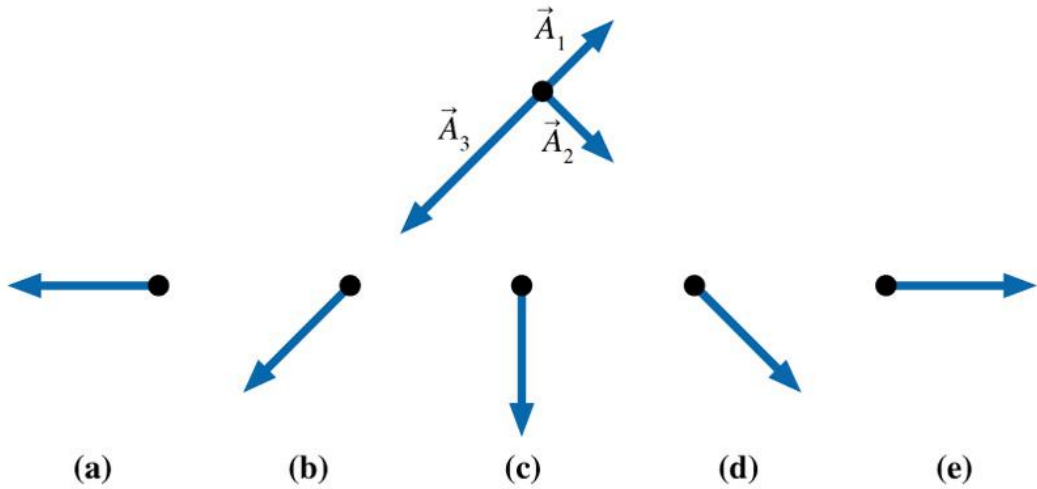
- “Does it matter to you if we denote a vector that is 37° North of East as $[E\ 37^\circ\ N]$?”
- **Harlow answer:** I would NOT recommend that you do this. I have only seen Ontario high school students do this, and it is not a world-wide accepted notation. To me it seems confusing, and it’s safer to just say “ 37° North of East”



$$\vec{C} = \vec{A} + \vec{B}$$

Clicker Question:

Which figure shows $\vec{A}_1 + \vec{A}_2 + \vec{A}_3$?



<http://phet.colorado.edu/en/simulation/vector-addition>

Control Panel: $|R|$ 10.0, θ -90, R_x 0, R_y -10

Buttons: Grab one, Show Sum, Component Display (None, Style 1, Style 2, Style 3), Show Grid, Clear All

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 4:00pm.

Assu A message from the Arts and Science Student Union:

**Private companies will try to scare
you about courses.**

**Tell you its IMPOSSIBLE
to do well or not fail
without them.**

**They just want your
\$\$\$\$\$.**



Don't listen to them.

YOU CAN DO WELL WITHOUT THEM.

UofT offers free resources to help you study: check them out at uoft.me/free

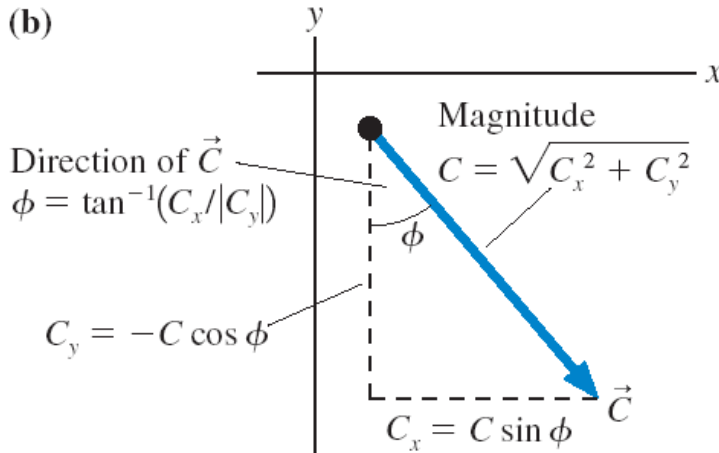
A message from ASSU.



Where to get **good** help for **free**

- **Your classmates:** form a study group
- **The course web-site:** Go to Lectures-Harlow – notice that every PHY131 midterm I've ever given is there including full solutions – all organized and for **free**
- **Your two graduate student TAs.** Learn their email address, office hours, and office location.
- **Me.** After class, office hours are T12, F10 in MP121-B, email
- **Professor Meyertholen,** office hours are M2, F12-2 in MP129-A, email
- The Physics **Drop-In Centre** in MP125, back corner MTWR 12-3, F11-2
- **Vic College Tutoring Centre** in LM204A, R10-12, F3
- **Academic Success Centre** in Koffler 1st floor, inside the Career Centre

FIGURE 3.16 Moving between the geometric representation and the component representation.



Components add and subtract like scalars!

Vector Addition By Components

- $\vec{A}_1 = 1.41 \text{ m}$, up and to the right, 45.0° above the horizontal.
- $\vec{A}_2 = 1.41 \text{ m}$, down and to the right, 45.0° below the horizontal.
- $\vec{A}_3 = 2.24 \text{ m}$, down and to the left, 26.6° below the horizontal.
- Find the sum $\vec{A}_1 + \vec{A}_2 + \vec{A}_3$.

Define x and y axes.

	x	y
\vec{A}_1	$1.41 \cos 45^\circ$	$1.41 \sin 45^\circ$
\vec{A}_2	$1.41 \cos 45^\circ$	$-1.41 \sin 45^\circ$
\vec{A}_3	$-2.24 \cos 26.6^\circ$	$-2.24 \sin 26.6^\circ$
Sum: \vec{A}_{net}	add on calculator Sum = 0.00	add up: Sum = -1.00 m

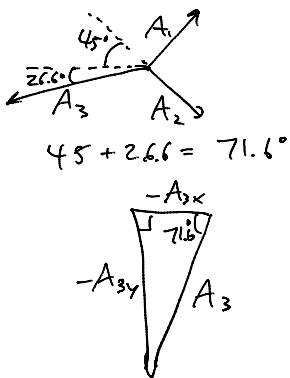
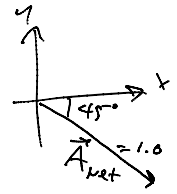
$(A_{\text{net}})_x = 0$ $(A_{\text{net}})_y = -1 \text{ m}$

$\vec{A}_{\text{net}} = 1.00 \text{ m, down}$

Additional diagrams show the decomposition of $A_3 = 2.24$ into components A_{3x} and A_{3y} using the angle 26.6° .

Vector Addition By Components (Let's tilt the axes!)

- $\vec{A}_1 = 1.41 \text{ m}$, up and to the right, 45.0° above the horizontal.
- $\vec{A}_2 = 1.41 \text{ m}$, down and to the right, 45.0° below the horizontal.
- $\vec{A}_3 = 2.24 \text{ m}$, down and to the left, 26.6° below the horizontal.
- Find the sum $\vec{A}_1 + \vec{A}_2 + \vec{A}_3$.



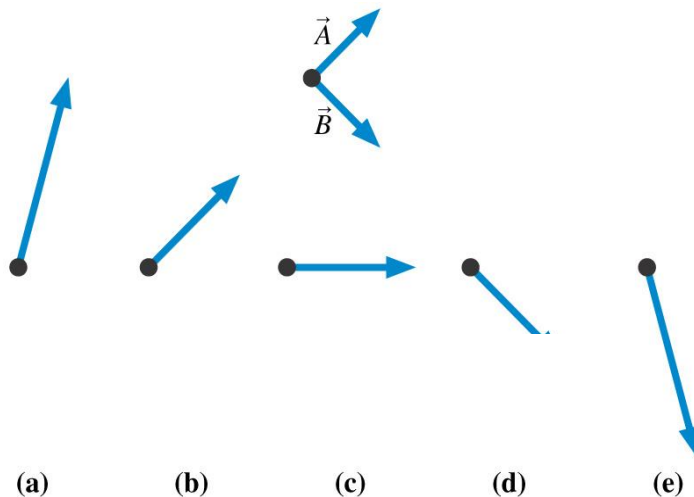
Define:

	x	y
\vec{A}_1	0	+1.41
\vec{A}_2	+1.41	0
\vec{A}_3	$-2.24 \cos 71.6^\circ$	$-2.24 \sin 71.6^\circ$
	+0.703 m	-0.715 m

$|\vec{A}_{\text{net}}| = \sqrt{0.703^2 + 0.715^2}$
 $= 1.00 \text{ m}$
 $\theta = \tan^{-1}\left(\frac{0.703}{0.715}\right) \approx 45^\circ$

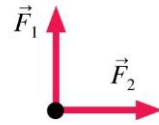
Clicker Question:

Which figure shows $2\vec{A} - \vec{B}$?

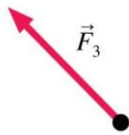


Clicker Question:

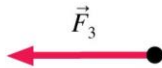
The sum $\vec{F}_1 + \vec{F}_2 + \vec{F}_3$ points to the left.
Two of three forces are shown.
Which is the missing third force?



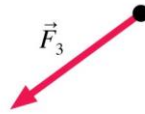
Two of the three forces exerted on an object



A.



B.



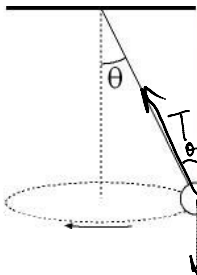
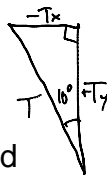
C.



D.

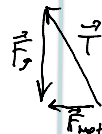
Example from a previous PHY131 Mid-Term Test

A ball is suspended on a string, and moves in a horizontal circle as shown in the figure. The string makes a constant angle $\theta = 10.0^\circ$ with the vertical. The tension in the string is 8.46 N, and the force of gravity on the ball is 8.33 N, in the negative-y direction. What is the sum of these two forces on the ball?



$\vec{T} = 8.46 \text{ N}, \theta = 10^\circ$

$F_g = 8.33 \text{ N}, \text{ down}$

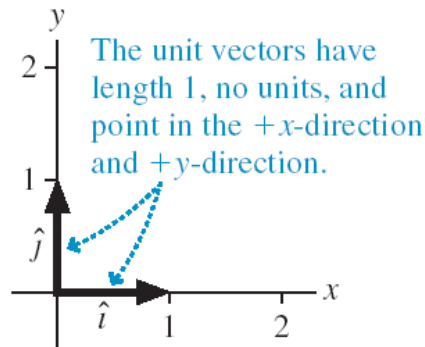


	x	y
\vec{T}	$-8.46 \sin 10^\circ$	$+8.46 \cos 10^\circ$
\vec{F}_g	0	-8.33
\vec{F}_{net}	Sum = -1.47 N	Sum = 0.00

only points toward the left.
No y-component

$\vec{F}_{net} = 1.47 \text{ N}, \text{ to the left}$

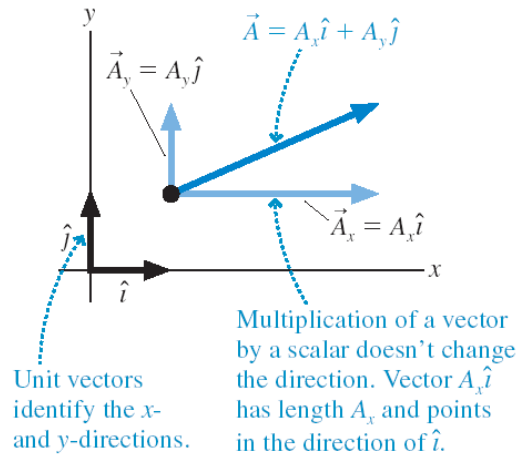
FIGURE 3.21 The unit vectors \hat{i} and \hat{j} .



Class 6 Preclass Quiz on MasteringPhysics

- “why have the circumflex accent on i ? are we doing physics in french?”
- **Harlow comment:** In physics, we call that a “hat”. It just means that it is a vector with a length of 1, and no units (dimensionless)
- “Why they have a hat above the i and j , I used the arrow above the i and the j in school, can I still use that or is that like a crime in physics?”
- **Harlow comment:** Not a crime. We like hats. You won’t lose points if you use arrows instead of hats – the marker will be able to figure it out

FIGURE 3.22 The decomposition of vector \vec{A} is $A_x\hat{i} + A_y\hat{j}$.



Clicker Question:

- $\vec{A} = -3\hat{i} + 3\hat{j}$
- $\vec{B} = 3\hat{i} + 4\hat{j}$
- What is the sum $\vec{A} + \vec{B}$?
 - A. $3\hat{j}$
 - B. $7\hat{i} + 7\hat{j}$
 - C. $-3\hat{i} + 7\hat{j}$
 - D. $7\hat{j}$
 - E. $-3\hat{i} - 3\hat{j}$

Before Class 7 on Monday

- Please read Chapter 4, sections 4.1 through 4.4
- Problem Set 2 is due Sunday by 11:59pm
- Pre-class Quiz for Class 7 is due Monday morning by 8:00am.
- Something to think about: One bullet is fired horizontally at a very high speed. The other bullet is initially at rest, but is dropped at the exact same moment the first bullet is fired. Which bullet hits the ground first?