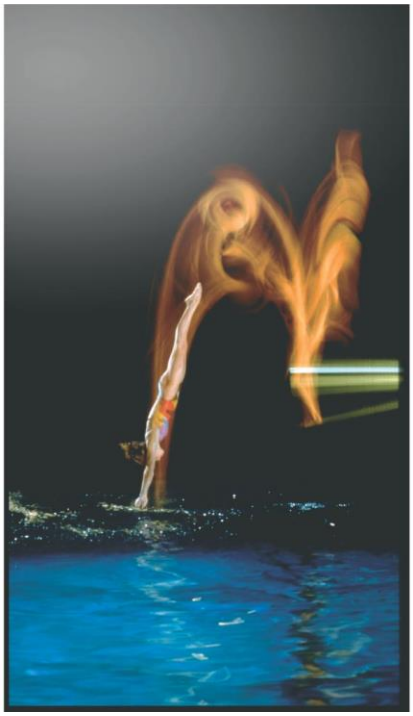
PHY131H1F - Class 7

Today, Chapter 4, sections 4.1-4.4:

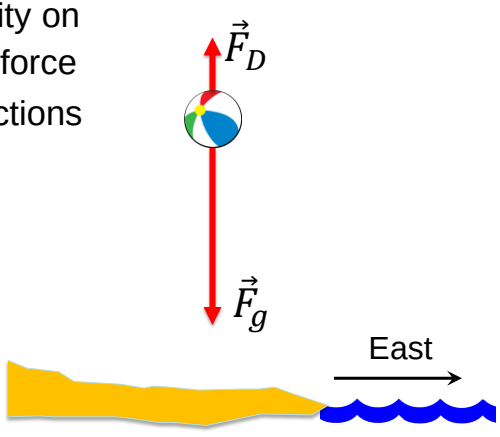
- Kinematics in One Dimension
- Kinematics in Two Dimensions
- Projectile Motion
- Relative Motion
- Test Tomorrow night at 6pm



Clicker Question

- A large, light beach ball is falling towards the beach on a windless day. The force of gravity on the ball, $\vec{F}_g$, is greater than the upward drag force from the air, $\vec{F}_D$. Which of the following directions is closest to the direction of the net force $\vec{F}_{\text{net}} = \vec{F}_g + \vec{F}_D$ on the ball?

A. North
B. East
C. South
D. West
E. The net force makes an angle of 90° with respect to all four of these directions.



Clicker Question

- A mouse digs a tunnel 1 m down, then turns and continues digging 1 m East, then turns again and digs 1 m North.
- Draw a diagram of the path of the mouse.
- How far is the mouse from his starting position?

A. 3 m

B. 2 m

C. 1 m

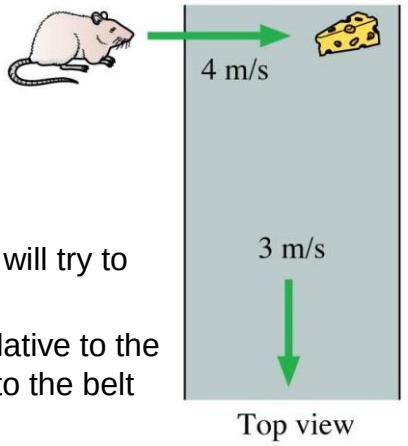
D. $\sqrt{3}$ m

E. $\sqrt{2}$ m

Last Class I asked:

- 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?
- ANSWER: They both hit the ground at exactly the same time (assuming flat ground)! The y-motion is totally independent of the x-motion.

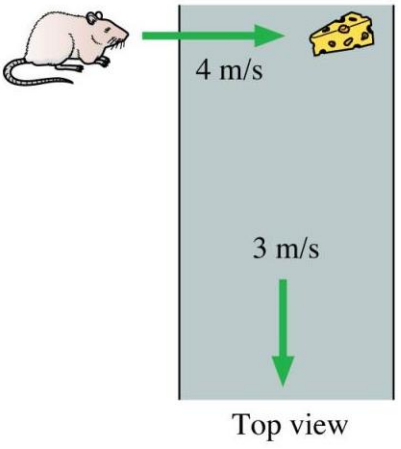
Class 7 Preclass Quiz on MasteringPhysics



- This was due this morning at 8:00am
- 986 students submitted the quiz on time
- 89% answered correctly: Both bullets hit the ground simultaneously!
- 77% answered correctly: Bullet hits the coconut (We will try to demonstrate this today)
- 79% answered correctly: The speed of the mouse relative to the floor is the **vector sum** of the mouse speed relative to the belt and the belt speed relative to the floor (5 m/s)

Class 7 Preclass Quiz on MasteringPhysics

- *"what is the mouse relative speed to the cheese? IS THAT 5m/s ?"*
- **Harlow answer:** No, it's 4 m/s.



Class 7 Preclass Quiz on MasteringPhysics

- Some common or interesting student comments/feedback:
- *"The coconut question, is the hunter looking at a coconut that's right on top of him and decided to shoot the coconut from below? or like, is the hunter looking down at a coconut on a cliff and deciding that he will shoot the coconut from a bird's eye view? or like, is the hunter shooting diagonally? horizontally? Are test questions going to be this ambiguous?"*
- **Harlow answer:** No. Hopefully the test questions will not be ambiguous at all, and will have one straightforward correct answer. Clicker and pre-class reading questions are not so carefully prepared, to tell the truth – they are meant to get you thinking, and check if you did the reading.

Class 7 Preclass Quiz on MasteringPhysics

- *"Can we ask appropriate questions during tests or exams?"*
- **Harlow answer:** Yes! There will be invigilators wandering the room who can help you interpret what the question is asking – just raise your hand.
- *"Do we get a formula sheet for the test"*
- **Harlow answer:** no, you must bring one with you.
- *"Can i use line paper as my cheat sheet? or it must be white paper?"*
- **Harlow answer:** either is fine. – but it must be handwritten! Computer printouts and photocopies will be confiscated.

Class 7 Preclass Quiz on MasteringPhysics

- *"Why would someone want to to shoot a perfectly good coconut?"*
- **Harlow answer:** Because it's cruel to shoot a monkey?
- *"Should we prepare the term test like it is the final one, or just take it easy? PLEASE tell me on Monday in the lecture!"*
- **Harlow answer:** That depends on how confident you are about this kinematics and error analysis material. The midterm tomorrow is worth 15% of your mark in the course, the final exam is worth 40%. - All in all, 70% of your mark is from these tests, so it's important to be prepared for them

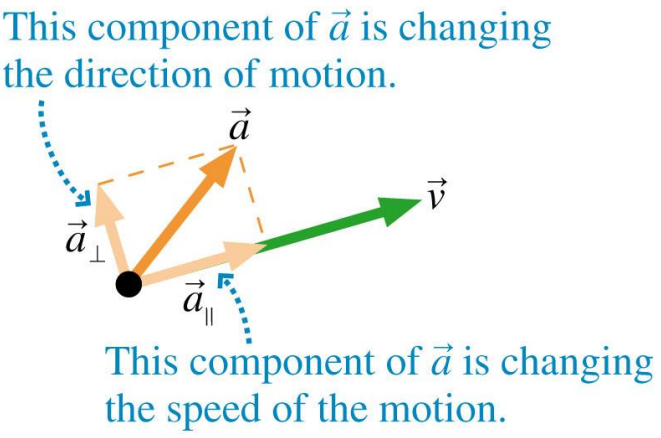
Problem Set 2 on MasteringPhysics

- This was due last night at 11:59pm
- 1009 students did the problem set by the deadline
- It took a median time of 60 minutes for students to complete the problem set
- The average for the 1009 students who submitted on time was 98%.
- The most difficult problem seemed to be the propagating errors question – you ***will*** have to do this on the test tomorrow!

Analyzing the acceleration vector

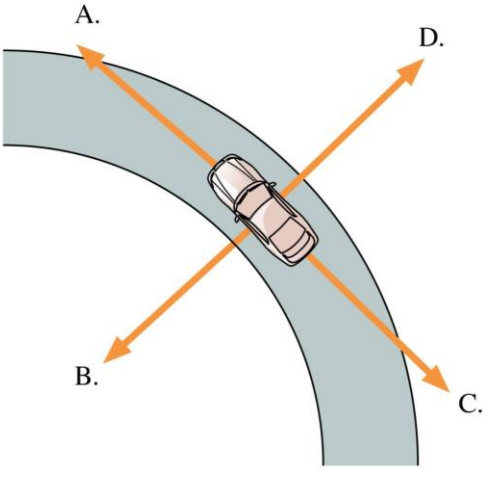
$\vec{a} = \frac{d\vec{v}}{dt}$

- An object's acceleration can be decomposed into components parallel and perpendicular to the velocity.
- parallel — $\vec{a}_{||}$ is the piece of the acceleration that causes the object to change **speed**
- perpendicular — $\vec{a}_{\perp}$ is the piece of the acceleration that causes the object to change **direction**
- An object changing direction *always* has a component of acceleration perpendicular to the direction of motion.



Clicker Question

A car is traveling around a curve at a steady 45 mph. Which vector shows the direction of the car's acceleration?

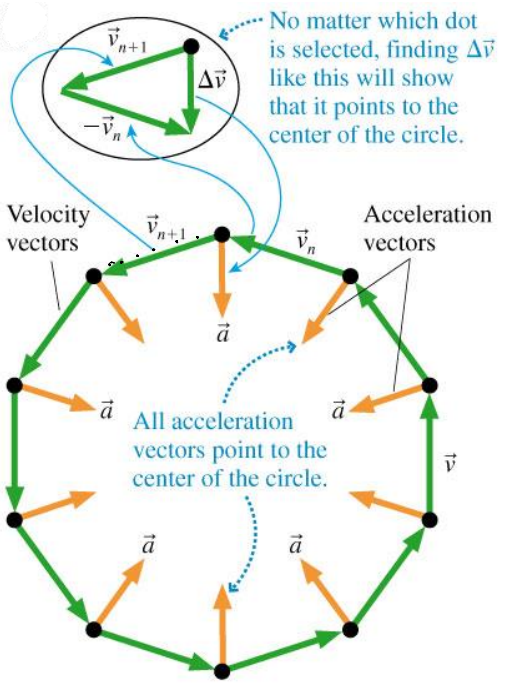


E. The acceleration is zero.

Slide 4-29

Uniform Circular Motion

Speed is constant.



$a_c = \frac{v^2}{r}$

Midterm Test 1

- Tuesday, Sep 30, from 6:00pm to 7:30pm. Tomorrow!
- The test will actually begin at 6:10pm and last for 80 minutes; please arrive 10 minutes early if you can, so you can get settled
- This test will count for 15% of your mark in the course
- **There will be no make-up** for this test. Students who miss a test for legitimate and documented reasons will have the weight of the test transferred to the other test which will then count for 30% of their course mark
- You must go to the correct room, based on your Practical Group
- Your practical group is the one that shows under the "*My PRA groups*" link on the Portal

"Which room am I in on Tuesday at 6:00pm?"

Group	Room
M2A	EX 200
M2B	HA 403
M2C	EX 300
M3A	EX 200
M3B	EX 100
M3C	EX 300

Group	Room
T1A	EX 310
T1B	EX 200
T2A	EX 310
T2B	EX 200
T3A	EX 320
T3B	EX 100

Group	Room
W2A	EX 200
W2B	EX 300
W3A	EX 100
W3B	EX 100
W4A	EX 310
W4B	EX 200

Group	Room
R1A	HA 403
R1B	EX 100
R2A	EX 100
R2B	EX 100
R3A	EX 100
R3B	EX 320

Group	Room
F1A	EX 100
F1B	HA 403
F2A	EX 320
F2B	EX 200
F3A	EX 200
F3B	EX 200

- EX = Exam Centre, 255 McCaul St.
- HA = Haultain Building, 170 College St.

Midterm Test 1

- The test will have:
  - **12** multiple-choice questions worth 5 points each (total = 60)
  - Two long-answer problems counting for a total of 40 points, which will be graded in detail; part marks may be awarded, but **only if you show your work**.
- Please bring:
  - ❑ **Your student card.**
  - ❑ A calculator without any communication capability.
  - ❑ A pencil with an eraser.
  - ❑ A single, original, handwritten 8 1/2 × 11 inch sheet of paper on which you may have written anything you wish, on both sides.

Midterm Test 1 - hints

- **Don't be late.** If you're very early, just wait outside the room.
- Spend the first 2 or 3 minutes skimming over the entire test from front to back before you begin. Look for the easy problems that you have confidence to solve first.
- Before you answer anything, read the question *very carefully*. The **most common mistake** is misreading the question!
- Manage your time; if you own a watch, bring it. 14 problems over 80 minutes means an average of 5.7 minutes per problem.
- You CANNOT HAVE YOUR PHONE with you or in your pocket at a test or exam at U of T – you must store it in your backpack at the edge of the room, or in a special bag underneath your desk

Midterm Test 1 – more rules

- You are also allowed a paper dictionary as an aid – ie it could be a translation dictionary between your first language and English – the invigilator may flip through it to make sure no extra physics-stuff is written in there
- Bags, books pencil cases and ALL notes are to be deposited in areas designated by the Chief Presiding Officer and are not to be taken to the examination desk or table. If pencil cases are found on desks, they will be searched.
- If you bring a bag (paper, transparent plastic or non-transparent plastic), the following items may be stored inside it under your chair (as long as the bag is large enough): cell phone, wallet, laptop computer.

Midterm Test 1 – *more hints!*

- Some of the multiple choice are conceptual and can be answered in less than 2 minutes.. Maybe do these ones first?
- If you start a longer problem but can't finish it within about 10 minutes, leave it, make a mark on the edge of the paper beside it, and come back to it after you have solved all the easier problems.
- When you are in a hurry and your hand is not steady, you can make little mistakes; if there is time, do the calculation twice and obtain agreement.
- Bring a snack or drink. 
- Don't leave a test early! You might spend the first half getting 95% of the marks you're going to get, and the second half getting the other 5%, but it's still worth it.

Little survey:
How are you feeling about the test tomorrow?

A. I feel confident about the test tomorrow; I believe I will get an A

B. I'm not too sure what to expect, but I'm hopeful I'll do well

C. I have no particularly positive or negative feelings about the test tomorrow..

D. I'm not too sure what to expect, but I'm worried it will be awful

E. I am very worried about the test tomorrow; I'm afraid I'm going to fail!

What will the test cover?

- Test 1 covers:
  - Knight Chapters. 1-3
  - and the ***Error Analysis in Experimental Physical Science "Mini-Version"*** 10-page document available on portal.
- If it's in the above reading, on MasteringPhysics, done in classes, or done in Practicals, it is material that is **important** and that you should know for the tests and final exam.

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

Projectile Motion

FIGURE 4.15 The parabolic trajectory of a bouncing ball.

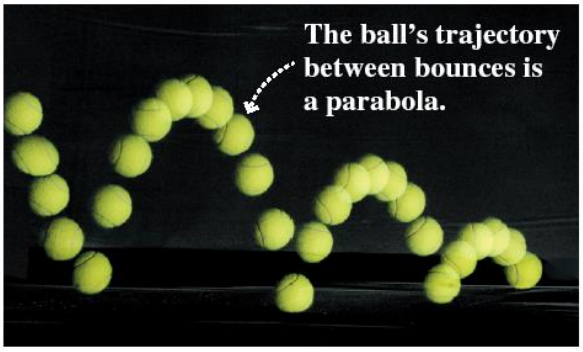
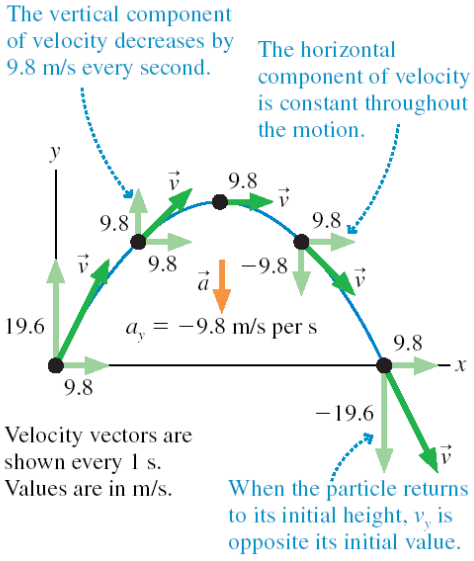
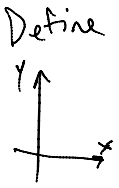


FIGURE 4.17 The velocity and acceleration vectors of a projectile moving along a parabolic trajectory.



Projectile Motion



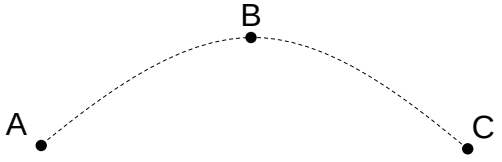
Projectile motion is made up of two **independent** motions: uniform motion at constant velocity in the horizontal direction and free-fall motion in the vertical direction. The kinematic equations that describe these two motions are

$$x_f = x_i + v_{ix}\,\Delta t \qquad y_f = y_i + v_{iy}\,\Delta t - \tfrac{1}{2}g(\Delta t)^2$$

$$v_{fx} = v_{ix} = \text{constant} \qquad v_{fy} = v_{iy} - g\,\Delta t$$

$a_x = 0$ $\quad a_y = -g$ $\quad g = 9.8\ \frac{m}{s^2}$

Clicker Question



- A tennis ball is launched at an angle, and flies through the air in a parabolic path, as shown, A→ B → C.
- At point B

A. the velocity is horizontal, and the speed is maximum.

B. the velocity is horizontal, and the speed is minimum.

C. the velocity is horizontal, but the speed is neither a maximum nor a minimum.

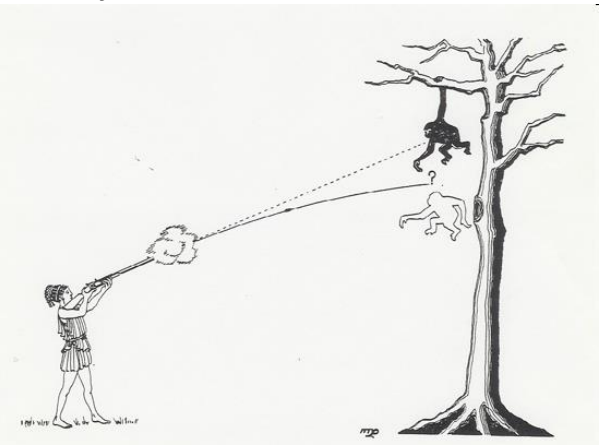
D. the velocity is not horizontal, but the speed is minimum.

E. the velocity is not horizontal, and the speed is neither a maximum or minimum.

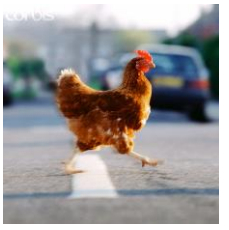
Monkey and Hunter Demonstration (and clicker question)

The classic problem: "A monkey hanging from the branch of a tree is spotted by a hunter. The monkey sees that the barrel of the gun is pointed directly at him. At the exact instant the gun is fired, the monkey lets go of the branch. Will the bullet (A) go above the monkey, (B) go below the monkey, or (C) hit the monkey?

Our demonstration uses a pressurized tennis ball launcher. The laser is aimed directly at the monkey, which is supported by an electromagnet. As the tennis ball leaves the launcher, it breaks a connection that releases the magnet.



Joke: Why Did the Chicken Cross the Road?



Aristotle (330 BC):

"Because it is the nature of chickens to cross roads."

Newton (1687):

"Because there is no external net force causing the chicken's velocity across the road to change."

Einstein (1905):

"Is the chicken crossing the road, or is the road moving under the chicken?"

[image downloaded 9/30/2013 from http://afgg.tumblr.com/post/3126636261/when-the-chicken-crossed-the-road]

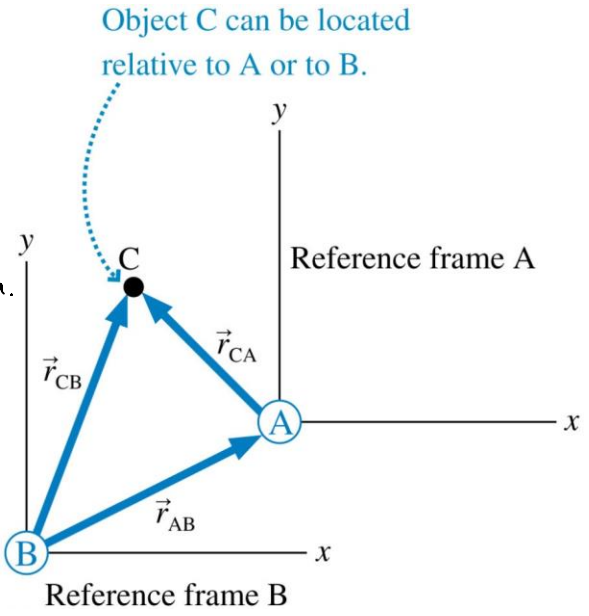
Relative Position

$$\vec{r}_{CB} = \vec{r}_{CA} + \vec{r}_{AB}$$

$\vec{r}_{CB}$ = the position vector of object C in the reference frame where B is the origin.

$\vec{r}_{CA}$ = position of C relative to A

$\vec{r}_{AB}$ = position of A relative to B



Relative Velocity

- Relative velocities are found as the time derivative of the relative positions.
- $\vec{v}_{CA}$ is the velocity of C relative to A.
- $\vec{v}_{CB}$ is the velocity of C relative to B.
- $\vec{v}_{AB}$ is the velocity of reference frame A relative to reference frame B.

$$\vec{v}_{CB} = \vec{v}_{CA} + \vec{v}_{AB}$$

- This is known as the **Galilean transformation of velocity.** (True if speeds are all much less than the speed of light.)

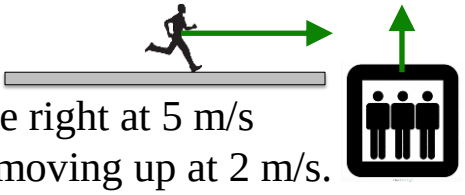
Relative Motion

- Note the “cancellation”
- $\vec{v}_{TG}$ = velocity of the **T**rain relative to the **G**round
- $\vec{v}_{PT}$ = velocity of the **P**assenger relative to the **T**rain
- $\vec{v}_{PG}$ = velocity of the **P**assenger relative to the **G**round
- Also: $v_{12} = -v_{21}$

$$\vec{v}_{PG} = \vec{v}_{PT} + \vec{v}_{TG}$$

Inner subscripts disappear

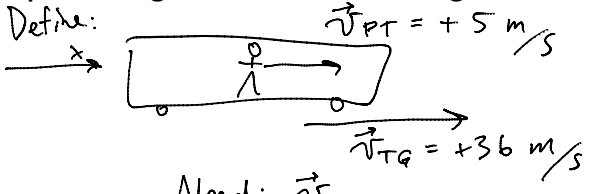
Clicker Question



You are running toward the right at 5 m/s toward an elevator that is moving up at 2 m/s. Relative to you, the direction and magnitude of the elevator’s velocity are

A. down and to the right, less than 2 m/s.
B. up and to the left, less than 2 m/s.
C. up and to the left, more than 2 m/s.
D. up and to the right, less than 2 m/s.
E. up and to the right, more than 2 m/s.

Example 1: A passenger walks toward the front of the train at 5 m/s. The train is moving at 36 m/s. What is the speed of the passenger relative to the ground?



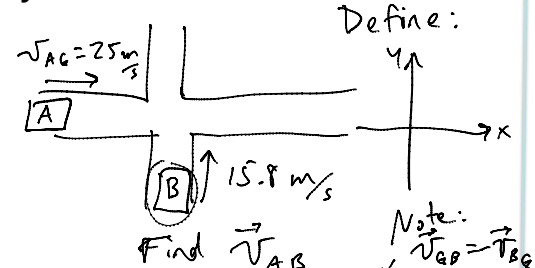
Need: $\vec{v}_{PG}$

Use: $\vec{v}_{PG} = \vec{v}_{PT} + \vec{v}_{TG}$

$= +5 + 36$

$v_{PG} = +41$ m/s

Example 2: Car A is traveling at 25.0 m/s E toward Bloor and Keele. Car B is traveling at 15.8 m/s N toward Bloor and Keele. Just before they collide, what is the velocity of car A relative to car B?

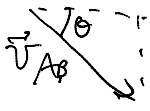


Use: $\vec{v}_{AB} = \vec{v}_{AG} + \vec{v}_{GB}$

$= \vec{v}_{AG} - \vec{v}_{BG}$

Components.

	x	y
$\vec{v}_{AG}$	+25.0	0
$-\vec{v}_{BG}$	0	−15.8
$\vec{v}_{AB}$	25	−15.8



$|\vec{v}_{AB}| = \sqrt{25^2 + 15.8^2}$

$= 29.6$ m/s

$\theta = \tan^{-1}\left(\frac{15.8}{25}\right)$

$= 32.3°$

$v_{AB} = 29.6$ m/s, 32.3° South of East

Clicker Question

- You are on an Eastbound subway train going at 20 m/s.
- You notice the Westbound train on the other track.
- Relative to the ground, that Westbound train has a speed of 20 m/s.
- What is the velocity of the Westbound train as measured by you?

A. 40 m/s, West
B. 20 m/s, West
C. zero
D. 20 m/s, East
E. 40 m/s, East

[image from http://www.cbc.ca/news/canada/toronto/ttc-closes-downtown-subway-loop-for-the-weekend-1.1347919]

Before Class 8 on Wednesday

- Please finish reading Chapter 4
- ***Note***: There is no preclass quiz due on Wednesday morning.
- Something to think about: Consider a wheel that is rotating, and speeding up. Is a point on the edge of the wheel accelerating toward the centre? Is this point accelerating in the forward direction? Or is it doing both?