Note on Posted Slides

- These are the slides that I intended to show in class on Wed. Jan. 9, 2013.
- They contain important ideas and questions from your reading.
- Due to time constraints, I was probably not able to show all the slides during class.
- They are all posted here for completeness.

PHY205H1S
Physics of Everyday Life
Class 2

- Motion Is Relative
- Speed : Average and Instantaneous
- Velocity
- Acceleration
- Free Fall

Chapter 3 Pre-Class Reading Question

- What does a speedometer measure?

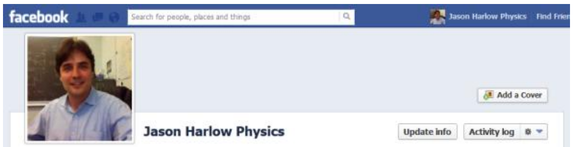
A. distance traveled
B. average speed
C. instantaneous speed
D. velocity
E. acceleration

[image downloaded Jan. 9 2013 from http://phoneky.com/applications/?p=preview&id=a1a32446&st=2]

Chapter 3 Reading Question : The Fine Print…

- Galileo's definition of speed was a breakthrough because he is acknowledged to be the first to consider _______.

A. distance covered
B. mathematics
C. direction
D. time



- If you wish to message me on facebook I have an account and would be glad to add you as a friend
- Search on “Jason Harlow Physics” or go to:
- www.facebook.com/harlowphysics
- Also, if you message me your UTORid I will add you to a facebook discussion group just for this class, so you can keep in touch with your classmates better!

Suggested End of Chapter Items

- On the course web-site under “Materials”, I have posted suggested end-of-chapter questions and problems for you to study for chapters 2, 3 and 4.

- **Chapter 2**
  Review Questions: 9, 14, 17, 21
  Ranking: 1, 2, 3, 4
  Exercises: 13, 14, 23, 24, 39, 40
  Problems: 1, 2, 3, 4

  Chapter 3
  Review Questions: 4, 7, 10, 24
  Plug and Chug:
  2, 4, 9, 12, 15, 17, 20
  Ranking: 1, 2, 3, 4
  Exercises: 1, 2, 35, 36, 39, 40
  Problems: 3, 4

- **Chapter 4**
  Review Questions: 8, 29, 34
  Plug and Chug: 4, 8
  Ranking: 1, 2, 3, 4
  Exercises:
  1, 2, 25, 26, 33, 34, 43, 44, 53, 54
  Problems: 3, 4, 5, 6

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?"

Motion Is Relative

Motion of objects is always described as *relative* to something else. For example:

- On the subway you are moving at 50 km/h North relative to the platform.
- The person sitting across from you is at rest relative to you
- The station platform is moving at 50 km/h South relative to you

Discussion 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

Caught Speeding

[Paraphrased from famous discussion in The Feynman Lectures on Physics, Vol. 1 by R.P. Feynman, R.B. Leighton and M. Sands ©1964 by Addison-Wesley]

- **Officer**: "Lady you were going 75 kilometres per hour in a 50 zone."
- **Lady**: "I'm sorry officer, but that can't be. I've only been driving for 5 minutes."
- **Officer**: "No, no. What I mean is, if you had continued driving at that speed for 1 hour, you would go 75 kilometres."
- **Lady**: "I'm sorry officer, but that's not true. If I had continued driving at that speed, I would surely have crashed into that wall at the end of the street."
- **Officer**: "Here's your ticket, explain it to the judge!"

Speed

- Defined as the distance covered per amount of travel time.
- Units are meters per second.
- In equation form:

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

Example: A girl runs 4 meters in 2 sec. Her speed is 2 m/s.

Average Speed

- The entire distance covered divided by the total travel time
  - Doesn't indicate various instantaneous speeds along the way.
- In equation form:

$$\text{Average speed} = \frac{\text{total distance covered}}{\text{time interval}}$$

Example: Drive a distance of 200 km in 2 h and your average speed is 100 km/h.

Average Speed
CHECK YOUR NEIGHBOR

The average speed of driving 30 km in 1 hour is the same as the average speed of driving

A. 30 km in 1/2 hour.
B. 30 km in 2 hours.
C. 60 km in 1/2 hour.
D. 60 km in 2 hours.

Instantaneous Speed

Instantaneous speed is the speed at any instant.

Example:

- When you ride in your car, you may speed up and slow down.
- Your instantaneous speed is given by your speedometer.

Velocity

- A description of
  - the instantaneous speed of the object
  - what direction the object is moving
- Velocity is a vector quantity. It has
  - magnitude: instantaneous speed
  - direction: direction of object's motion

Speed and Velocity

- Constant speed is steady speed, neither speeding up nor slowing down.
- Constant velocity is
  - constant speed and
  - constant direction (straight-line path with no acceleration).

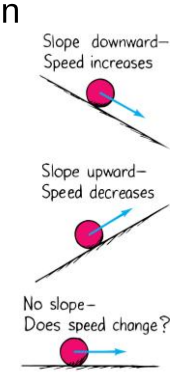
Motion is relative to Earth, unless otherwise stated.

Acceleration

Formulated by Galileo based on his experiments with inclined planes.

Rate at which velocity changes over time

Acceleration is a vector

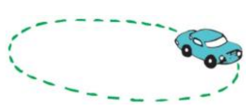


Acceleration

Because velocity is a vector, it can change in two possible ways:

1. The magnitude can change, indicating a change in speed, or
2. The direction can change, indicating that the object has changed direction.

Example: Car making a turn



Acceleration

In equation form:

$$\text{Acceleration} = \frac{\text{change in velocity}}{\text{time interval}}$$

Unit of acceleration is unit of velocity / unit of time.

Example:

- You car's speed right now is 40 km/h.
- Your car's speed 5 s later is 45 km/h.
- Your car's change in speed is 45 – 40 = 5 km/h.
- Your car's acceleration is 5 km/h/5 s = 1 km/h/s.

Acceleration CHECK YOUR NEIGHBOR

An automobile is accelerating when it is

A. slowing down to a stop.
B. rounding a curve at a steady speed.
C. Both of the above.
D. Neither of the above.

Acceleration Direction for Linear Motion

- When an object is speeding up, its velocity and acceleration are in the **same** direction.
- When an object is slowing down, its velocity and acceleration are in **opposite** directions.
- Direction can be specified with + or – signs.
- For example, something with positive velocity and negative acceleration is slowing down.
- Something with negative velocity and positive acceleration is also slowing down!

Acceleration Direction

- A car starts from rest, then drives to the right. It speeds up to a maximum speed of 30 m/s. It coasts at this speed for a while, then the driver hits the brakes, and the car slows down to a stop.
- While it is speeding up, what is the direction of the acceleration vector of the car?

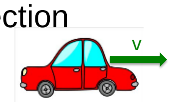
A. to the right.
B. to the left.
C. zero.

Acceleration Direction

- While the car is coasting, what is the direction of the acceleration vector of the car?

A. to the right.
B. to the left.
C. zero.

Acceleration Direction



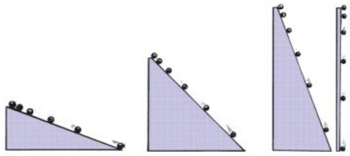
- While the car is slowing down, what is the direction of the acceleration vector of the car?

A. to the right.
B. to the left.
C. zero.

Acceleration

Galileo increased the inclination of inclined planes.

- Steeper inclines gave greater accelerations.
- When the incline was vertical, acceleration was max, same as that of the falling object.
- When air resistance was negligible, all objects fell with the same unchanging acceleration.



Free Fall

Falling under the influence of gravity only - with no air resistance

- Freely falling objects on Earth accelerate at the rate of 10 m/s/s, i.e., 10 m/s^2
- The exact value of the free fall acceleration depends on altitude and latitude on the earth.

Acceleration Due to Gravity, g in m/s^2

Country	City	G-Constant	Country	City	G-Constant
Argentina	Buenos Aires	9.7979	Mexico	Mexico City	9.7799
Australia	Sydney	9.7979	Morocco	Rabat	9.7964
Austria	Vienna	9.8099	Netherlands	Amsterdam	9.8129
Belgium	Brussels	9.8114	New Zealand	Wellington	9.8039
Belize	Manamah	9.7904	Norway	Oslo	9.8189
Bolivia	La Paz	9.7844	Panama	Panama City	9.7814
Brazil	Brasilia	9.7889	Peru	Lima	9.7829
Canada	Montreal	9.8069	Philippines	Manila	9.7844
	Ottawa	9.8069	Poland	Swider	9.8159
	Toronto	9.8054	Portugal	Lisbon	9.8009
	Vancouver	9.8099	Rumania	Bucharest	9.8054
Czeck Republic	Prague	9.8114	Saudi Arabia	Riyad	9.7904
Chile	Santiago	9.7979	Sweden	Stockholm	9.8189
China	Hong Kong	9.8099	Singapore	Singapore	9.7814
Colombia	Bogota	9.7799	South Africa	Johannesburg	9.7919
Costa Rica	San Jose	9.7829	Spain	Madrid	9.8024
Cypress	Nicosia	9.7979	Switzerland	Bern	9.8084
Denmark	Copenhagen	9.8159	Taiwan	Taipei	9.7904
Ecuador	Quito	9.7724	Tunisia	Tunis	9.7799
Finland	Helsinki	9.8189	Turkey	Ankara	9.8024
Germany	Dusseldorf	9.8129	Uruguay	Montevideo	9.7964
Great Britain	London	9.8144	USA	Anchorage	9.8189
Greece	Athens	9.8009		Atlanta	9.7964
Guatemala	Guatemala City	9.7844		Boston	9.8039
Hungary	Budapest	9.8069		Chicago	9.8024
Indonesia	Djakarta	9.7814		Dallas	9.7949
Iraq	Baghdad	9.7964		Detroit	9.8039

- Average: 9.799 m/s^2
- For Problem Sets, Tests and the Exam in this class: let's use $g = 10\ m/s^2$

Free Fall—How Fast?

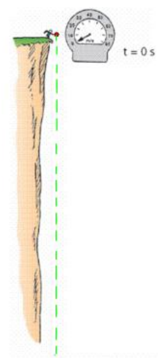
The velocity acquired by an object starting from rest is

Velocity = acceleration x time

So, under free fall, when acceleration is 10 m/s^2, the speed is

- 10 m/s after 1 s.
- 20 m/s after 2 s.
- 30 m/s after 3 s.

And so on.



Free Fall—How Far?

The distance covered by an accelerating object starting from rest is

Distance = (1/2) x acceleration x time x time

So, under free fall, when acceleration is 10 m/s^2, the distance is

- 5 m after 1 s.
- 20 m after 2 s.
- 45 m after 3 s.

And so on.

Free Fall—How Far?
CHECK YOUR NEIGHBOR

What is the distance covered of a freely falling object starting from rest after 4 s?

A. 4 m
B. 16 m
C. 40 m
D. 80 m

Three Equations of Constant Acceleration
(Good to put on your note-card)

1. $v_{f} = v_{i} + at$ — This means the change in speed is the acceleration times the time elapsed.

2. $d = v_{i}t + \frac{1}{2}at^{2}$ — This means the distance traveled is related to the initial speed times time plus half the acceleration times time squared.

3. $d = \left(\frac{v_{i} + v_{f}}{2}\right)t$ — This means the distance traveled is the average speed times time.

Example (Problem 3 from Chapter 3)

a. What is the instantaneous velocity of a freely falling object 10 s after it is released from a position of rest?
b. What is its average velocity during this 10 s interval?
c. How far will it fall during this time?

Free Fall Acceleration Direction

- An angry bird starts with an upward velocity, reaches a maximum height, then falls back down again.
- While the bird is going up (after it has left my hand), what is the direction of the acceleration vector of the bird?

A. up.
B. down.
C. zero.

Free Fall Acceleration Direction

- When the bird is momentarily stopped at the top of its path, what is the direction of the acceleration vector of the bird?

A. up.
B. down.
C. zero.

Free Fall Acceleration Direction

- While the bird is going down (but before I catch it), what is the direction of the acceleration vector of the bird?

A. up.
B. down.
C. zero.

Before Next Class

- Please read Chapter 4 on Newton's Second Law of Motion
- Note – Tutorials begin this Wednesday, Friday and Monday – go there for marks and to pick up your first problem set