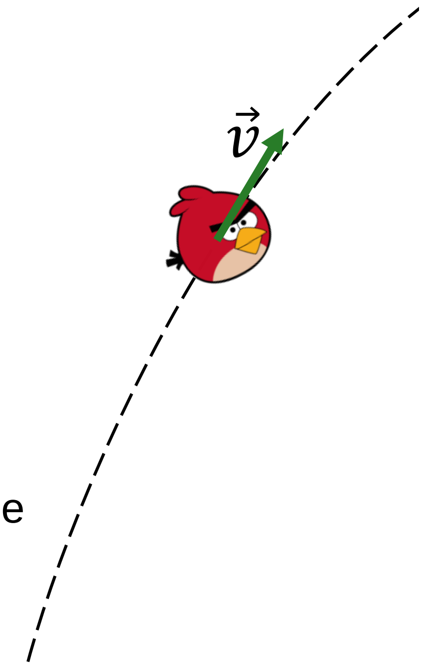
PHY131 F   Fall 2020
Class 4

Today:
- 2.7 Motion with Constant Acceleration
- 2.8 Equations of Constant Acceleration
- 2.9 Solving Kinematics Problems

Monday:
- Chapter 2 Review
- Problem Solving Examples relevant to the Synchronous Midterm Assessment



1

Speaking of which…

- Syncrhonous Midterm Assessment 1 is Tue. Sep. 29th from 8:10pm - 8:40pm on Quercus. (Toronto Time)
- Its based on Chapters 1, 2, 3 and your Practical Week 1 material.
- The Assessment is “open-book”. You are fully allowed to use the textbook, course lecture notes, Mastering, pre-recorded videos, google-searches of static web-pages, etc, as resources.
- However, the assessment must be done **individually**. You are not allowed to communicate with anyone else during the assessment.

2

Midterm Assessment 1 Sep.29

- You will need a quiet spot and a computer with good internet and no interruptions for this assessment.
- If you have an academic conflict (ie another course or research commitment), you can apply to write the alternate sitting, which will be exactly 2 hours later on the same day: 10:10pm - 10:40pm.
- April Seeley sent an announcement today with a link to a form where you can apply to write the alternate sitting.
- Non-university-related conflicts, such as work and time-zone issues will not be considered. There is no third sitting.

3

Pre-Course Diagnostic Quizzes due Today!

- This first test (FCI) is about physics, and the second (CLASS) is about your attitudes about science in general.
- The deadline for the pre-course tests tonight by 11:59pm.
- To encourage you to do the tests, you will receive 1 homework credit for doing each of the pretests, and 1 homework credit for doing each of the post-tests at the end of the semester, for a total possible of 4 homework credits.
- You get the credit for participation in the surveys; accuracy does not matter, but I encourage you to do your best.

4

Practicals begin this Friday-Thursday

- You should notice, that, on your Acorn timetable, in addition to the LEC section right now (MWF11), you are also in a 2-hour PRA section for this course.
- PRA are “Practicals”, which is the laboratory-component of this course. They were canceled for the first week so we could train all of the new Teaching Assistants (TAs).
- There are 55 TAs in this course. You will have one soon, and the student:TA ratio is about 18:1
- Practicals are on **Microsoft Teams** and begin on a Friday-Thursday cycle, starting today!

5

Practicals begin this Friday-Thursday

- To find your Microsoft Teams link, you need to check your official UTOR email, which is usually firstname.lastname@mail.utoronto.ca . You should get the link within 24 hours before your first scheduled practical.
- During your Practicals you will need to speak, so you **must have a working microphone and the ability to talk clearly, or you will be marked absent!**
- It is preferable that you have a camera as well so you can see each other.

6

Practicals begin this Friday-Thursday

- Checklist to do before your first Practical:
  - Read the "Practical Syllabus"
  - Complete your "Week 1 Pre-Practical Assignment" (due 24 hours before your Practical start time)
  - Download and install the Microsoft Teams App on your computer

7

Poll

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.

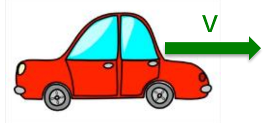
B. to the left.

C. zero.

8

Poll

Acceleration Direction



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

A. to the right.

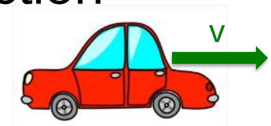
B. to the left.

C. zero.

9

Poll

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.

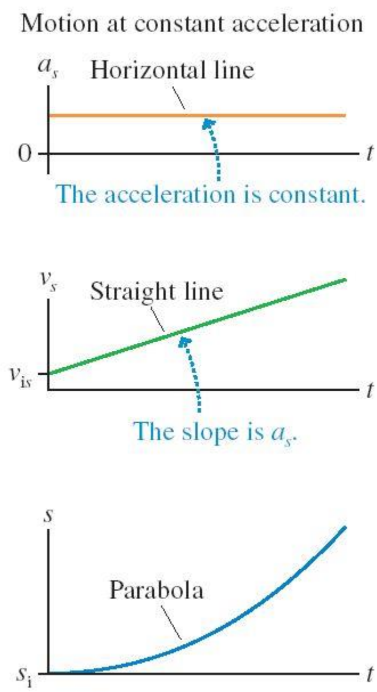
10

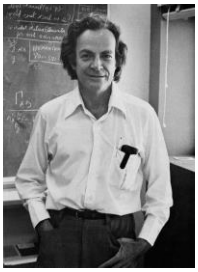
Last day I asked at the end of class:

1. Think of an example of an object with a negative acceleration which is speeding up.
2. Think of an example of an object with a positive acceleration which is slowing down.
3. Think of an example of an object with zero velocity which is accelerating!

Let's demonstrate all three of these on an inclined aluminum track with a cart.

Define $+x$ to be "to the right" parallel to the track.





Richard Feynman Joke from 1964

[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!”

13

2.7 Motion at Constant Acceleration

When velocity is not constant

- On a velocity-versus-time graph, velocity will be a straight line only if it is constant.
- **Instantaneous velocity** is the velocity of an object at a particular time. (This is called “velocity” for short.)
- **Average velocity** is the ratio of the change in position and the time interval during which this change occurred.
- For motion at constant velocity, the instantaneous and average velocities are equal; for motion with changing velocity, they are not.

14

The 3 Equations of Constant Acceleration:

2.5 $$v = v_0 + at$$ Does not contain position!

2.6 $$x = x_0 + v_0 t + \frac{1}{2}at^2$$ Does not contain final v!

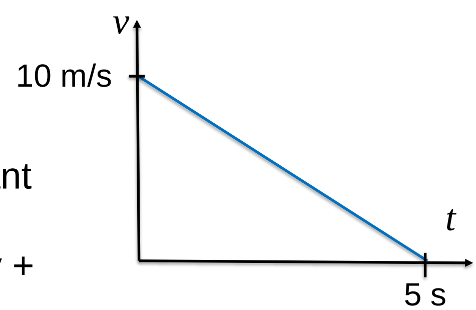
2.7 $$2a(x - x_0) = v^2 - {v_0}^2$$ Does not contain t!

Strategy: When a = constant, you can use one of these equations. Figure out which variable you don't know and don't care about, and use the equation which doesn't contain it.

15

Average Velocity

- For 1D motion with constant acceleration, the average velocity is ½(initial velocity + final velocity)



16

The 3 (+1) Equations of Constant Acceleration:

2.5 $$v = v_0 + at$$ Does not contain position!

2.6 $$x = x_0 + v_0 t + \frac{1}{2} a t^2$$ Does not contain final v!

2.7 $$2a(x - x_0) = v^2 - v_0^2$$ Does not contain t!

Extra: $$x = x_0 + \left(\frac{v_0 + v}{2} \right) t$$ Does not contain a! (but you know it's constant)

Strategy: When a = constant, you can use one of these equations. Figure out which variable you don't know and don't care about, and use the equation which doesn't contain it.

17

Example.

- You are traveling at 30 m/s, and suddenly hit the brakes.
- Your maximum acceleration is 10 m/s^2.
- What is your minimum stopping distance?

18

Free Fall

= Falling under the influence of gravity only, with no air resistance.

- Freely falling objects on Earth accelerate at the rate of 9.8 m/s/s, i.e., 9.8 m/s^2
- The exact value of free fall acceleration depends on altitude and latitude on the earth.
- For this course, let's use g = 9.80 m/s^2

19

Free Fall—How Fast?

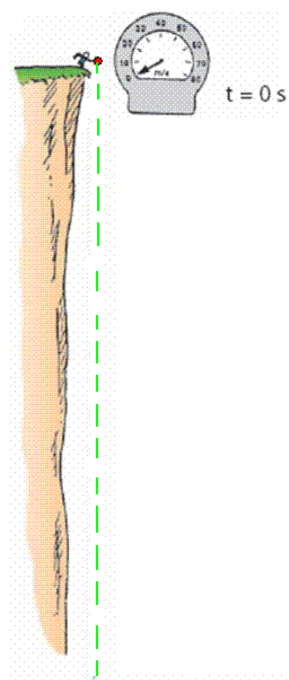
The velocity acquired by an object starting from rest is

Velocity = acceleration x time

So, under free fall, when acceleration is 9.8 m/s^2, the speed is

- 9.8 m/s after 1 s.
- 19.6 m/s after 2 s.
- 29.4 m/s after 3 s.

And so on.



20

Poll

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.

21

Poll

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.

22

Poll

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.

23

Poll Question

A 600 g basketball and a 60 g tennis ball are dropped from rest. As they fall to the ground, air resistance is negligible. Which of the following statements is true for the balls as they fall?

A. The force of gravity is 10 times greater on the basketball than on the tennis ball

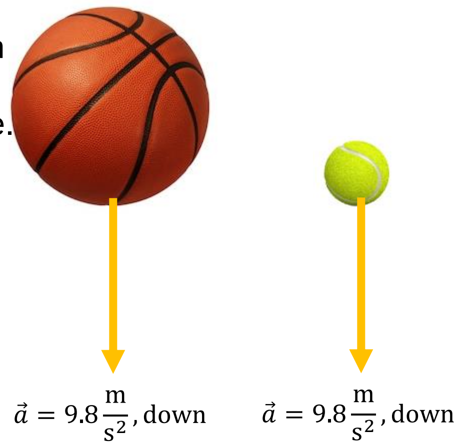
B. The force of gravity is the same on both balls

C. The force of gravity is slightly larger on the basketball than on the tennis ball

24

Free Fall

- Even though the force of gravity of the Earth on the basketball is **more** than on the tennis ball, the balls accelerate downward at the same rate.
- This was Galileo's amazing discovery.
- In 1633 the Roman Inquisition found him "gravely suspect of heresy" for his scientific findings, and sentenced him to house arrest, under which he remained until his death, 9 years later.



25

When Acceleration Changes Abruptly

- Consider an object that has a constant acceleration, a_1, from t_A until t_B
- At t_B its acceleration suddenly changes to a_2, and remains constant until t_C.
- Strategy:
  - Divide the motion into segments 1 & 2.
  - You can use the equations of constant acceleration in each segment
  - The final position and velocity of segment 1 become the initial position and velocity of segment 2.

26

Today’s Office Hour + Help Centre

- I will turn off the recording in 1 minute (after the next slide)
- I will linger in this zoom webinar for the next 20 minutes, dealing with Q&A.
- Feel free to raise your hand and I will unmute the raised hand at the top of my list
- At 12:20 I will shift over to gather.town for 10 minutes, at which point a TA from this course will be there for a PHY131 Help Centre from 12:30-1:30 today.

27

Before Class 5 on Monday

- Try to use the 4-step method to solve Chapter 2, Problem 80 from page 49. “Some people in a hotel…”
- I’ll take up this problem and others on Monday.

28