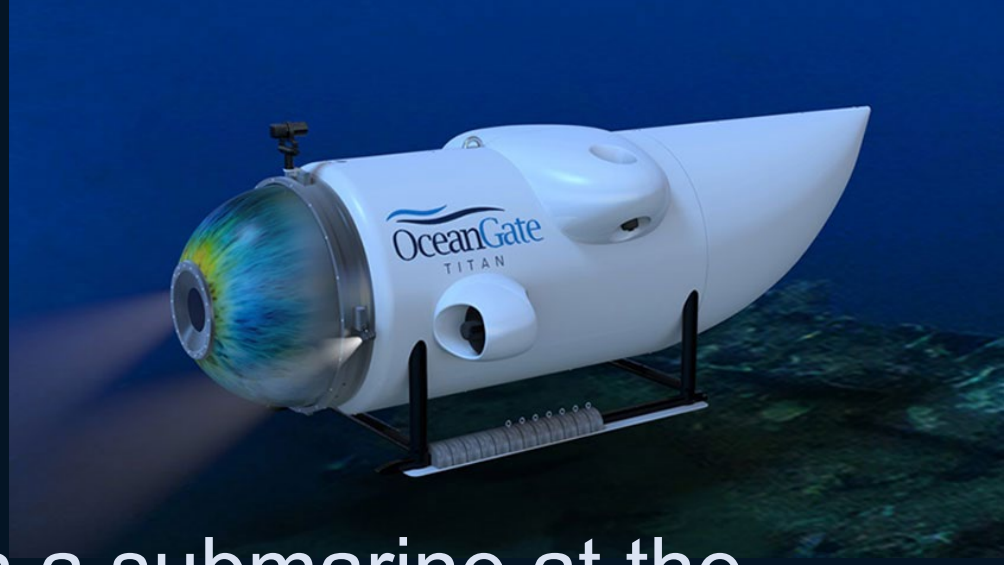
Teaching Physics Before and After 2020

Jason Harlow

UNIVERSITY OF TORONTO

Happy National Indigenous Peoples Day!
Happy Summer Solstice!
15 hours and 45 minutes of daylight in Fredericton today!

I’m happy I’m **not** at the bottom of the ocean right now…



- The wreck of the Titanic is 3800 m below the surface of the ocean.
- Every square metre of surface area on a submarine at the bottom must push outward with enough force to support the weight of 3800 cubic metres of water above it, which has a mass of 3,800,000 kg!
- That pressure force is 37 million Newtons per square meter, or the weight of about three cars per square inch.
- Also, even in the clearest ocean waters, only about 1% of the sunlight at the surface reaches down to a depth of 150 m, and it is pitch dark below about 1000 m.

Today's Outline

- I teach the first semester of our algebra-based first-year physics course for non-physics science majors (PHY131).
- We have about 1000 students in the fall, when I teach Newtonian Mechanics. Ania Harlick takes over with PHY132 in January.
- I have taught this course 14 times – this fall will be #15!
- I'll talk about my course and some of my teaching techniques that might be useful to you.
- I'll compare some teaching practices pre and post Covid, and discuss what we can learn from this big disruption.

Convocation Hall, U of T St.George Campus

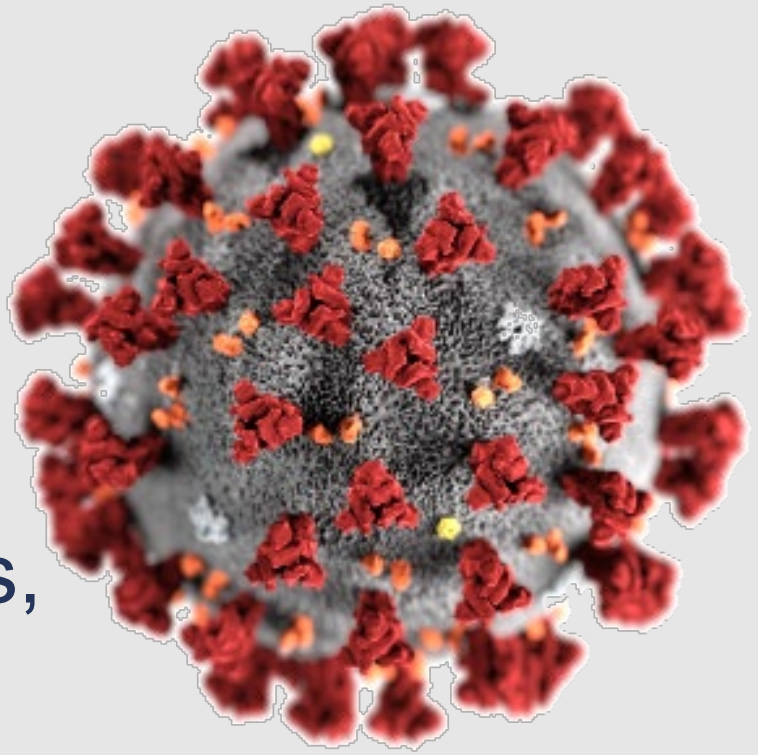
Behind me is a 50-foot screen which shows powerpoint and what I write out with a fancy tablet.

Students also meet in groups of 36 weekly for combined tutorial and lab activities, called “Practicals”.

Every “lecture” has three assignments

- **Pre-class** material and quiz
  - A short 5 minute video
  - Reading pages from the textbook
  - Easy “Facts” Quiz done Online, based on video
  - Survey question with typed response: what are some of your questions about the reading?
- **In-class** discussion questions
  - About one per 10-15 minutes – for marks!
- **Post-class** Problem set

COVID-19



- In fall 2020 and all of 2021, University of Toronto ran all large first-year courses completely online: online lectures, Practicals, term tests, labs and final exams.
- Practicals involved students purchasing a lab-kit and performing experiments in their homes with a camera on and instructor support. Carolyn Sealfon lead the work on developing these activities.
- Synchronous Classes were held on zoom, with students often opting to watch the recordings asynchronously.

What have we kept post-COVID?

- We did **not** keep the at-home Practical option. Miranda Schmidt at McMaster has kept this for some activities.
- We have kept an **Asynchronous Lecture Section**
- Pre-2020 we had multiple in-person sections with some content posted online.
- Now there is only one in-person section.
- There is a videographer filming the lecture, the powerpoint slides are screen-captured and videos are mixed in post; silence is deleted.
- The ASYNC section (about 200 students) have access to the lecture videos 3 or 4 hours after class. In-class polling is repeated as homework questions.

The Asynchronous Lecture Section

- ASYNC sections in other courses allow us to “overbook” our rooms.
- For example, if your room holds 100 but 115 students want to take the course, at least 15 students can sign up for the ASYNC lecture section.
- Once the course starts, you can let students know the two sections are actually treated the same way.
- **Disadvantage:** Is this encouraging students to stay home and not attend class?

What else changed Post 2020?

- **Office Hours** can now be on zoom or hybrid.
- **Advantage:** I am more accessible, especially to off-campus students.
- **Disadvantages:**
  - I am more accessible, especially to off-campus students.
  - It's more difficult to communicate through zoom
  - I cannot see their work
  - It's more difficult to write on a "whiteboard"
  - I cannot read body language
  - Sometimes there are audio problems.
  - In hybrid mode the zoom students can feel a bit left out.

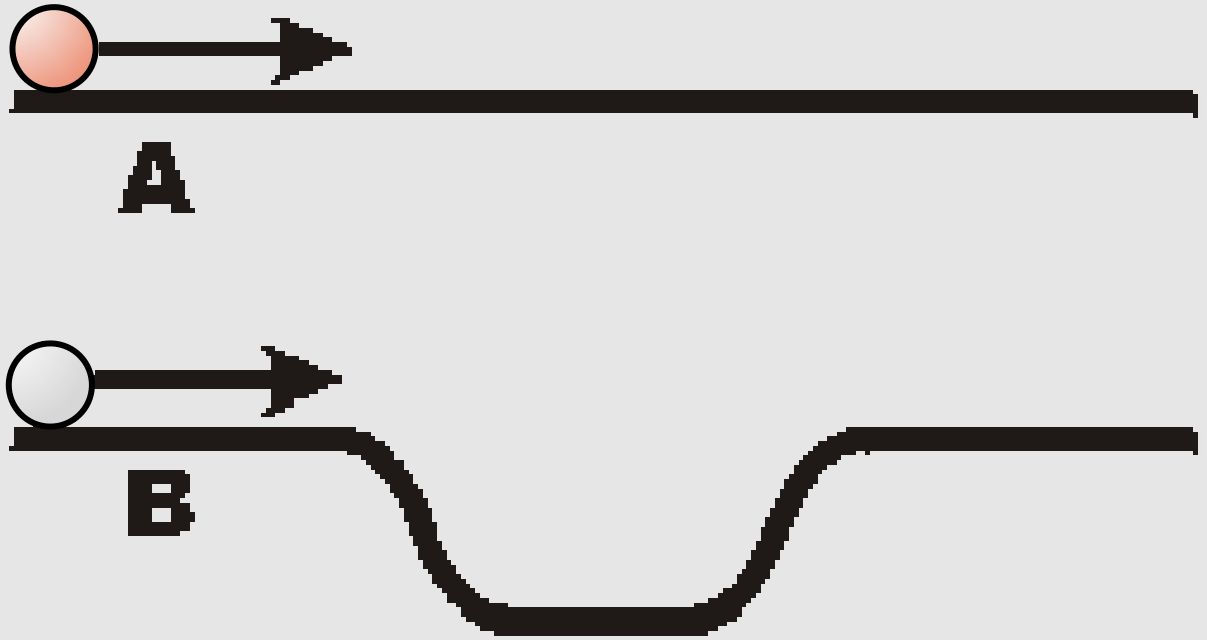
The New Normal: e-Textbooks

- Since COVID the U of T bookstore no longer stocks paper textbooks for most large courses.
- Students purchase a subscription to the e-text, sometimes with online homework options.
- Simulations like PhET, short videos / animations, and “check your understanding” quizzes can be integrated seamlessly into an e-text.
- Joanne O’Meara has recently done this with 2nd year Electricity and Magnetism, published by Top Hat.
- I have a breadth Physics of Music textbook I am preparing for January that will follow this format.

In-Class Discussion Questions

- Before 2006, we used hands, or coloured cards.
- I want to try this out today – do you still have your CAP bidding paddle?
- From 2006-2016 we used i-clicker remotes.
- Since 2017 we have used various smartphone / laptop apps, and are currently using **Top Hat** dynamic courseware.
- Are you ready?

Think
Pair
Share



Two balls are launched along a pair of tracks with equal velocities, as shown. Both balls reach the end of the track.

Predict: Which ball will reach the end of the track first?

A 5%

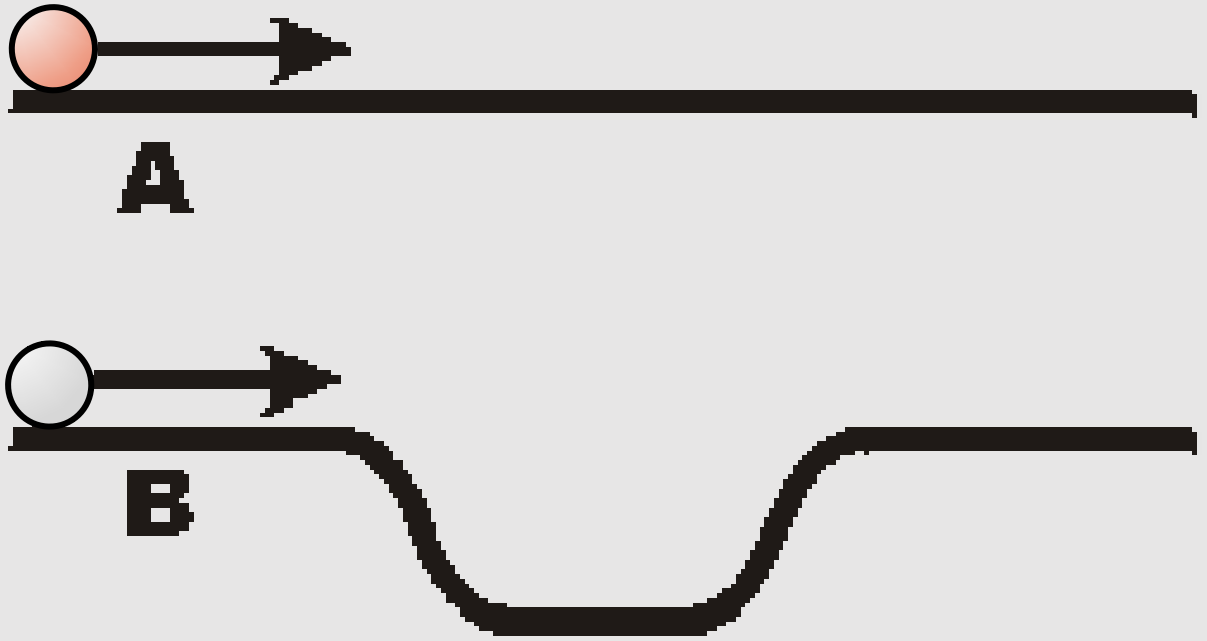
B 30%

C: They will reach the end of the track at the same time. 30%

Catchbox Microphone

- Catch and talk into the black dome on the top, and that way everyone will be able to hear you.
- Also, the Microsoft Teams participants will be able to hear you.
- Catchbox has “Automute” electronics which mutes the microphone when the box is being thrown.

Justify Your Prediction



Two balls are launched along a pair of tracks with equal velocities, as shown. Both balls reach the end of the track.

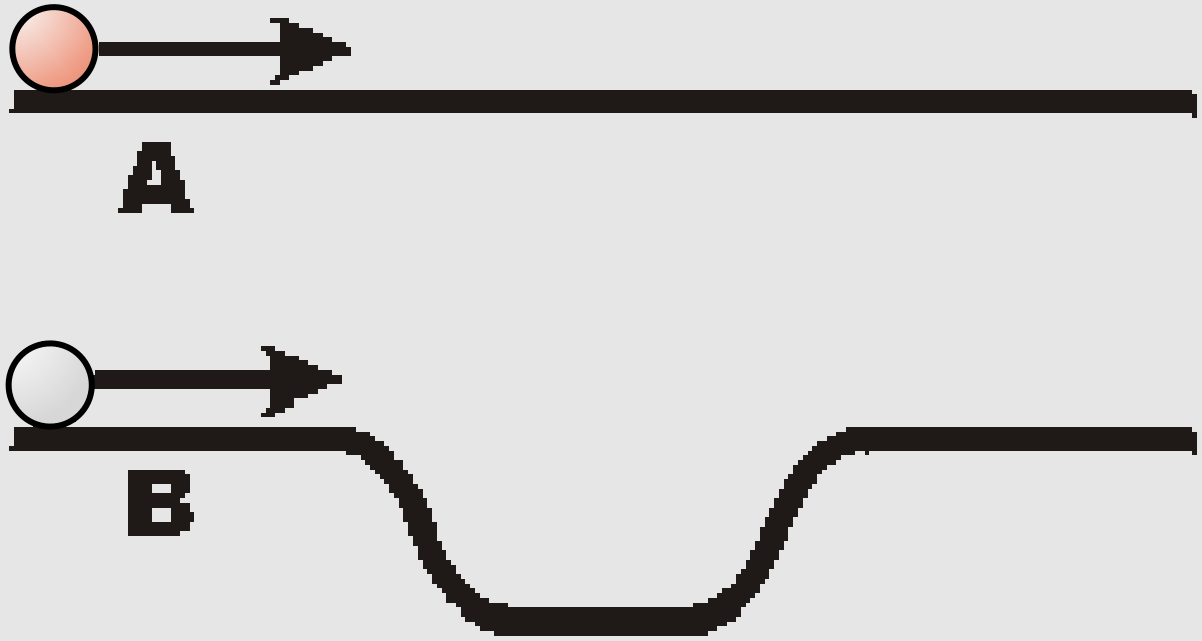
Predict: Which ball will reach the end of the track first?

A

B

C: They will reach the end of the track at the same time.

What Did **YOU** See?



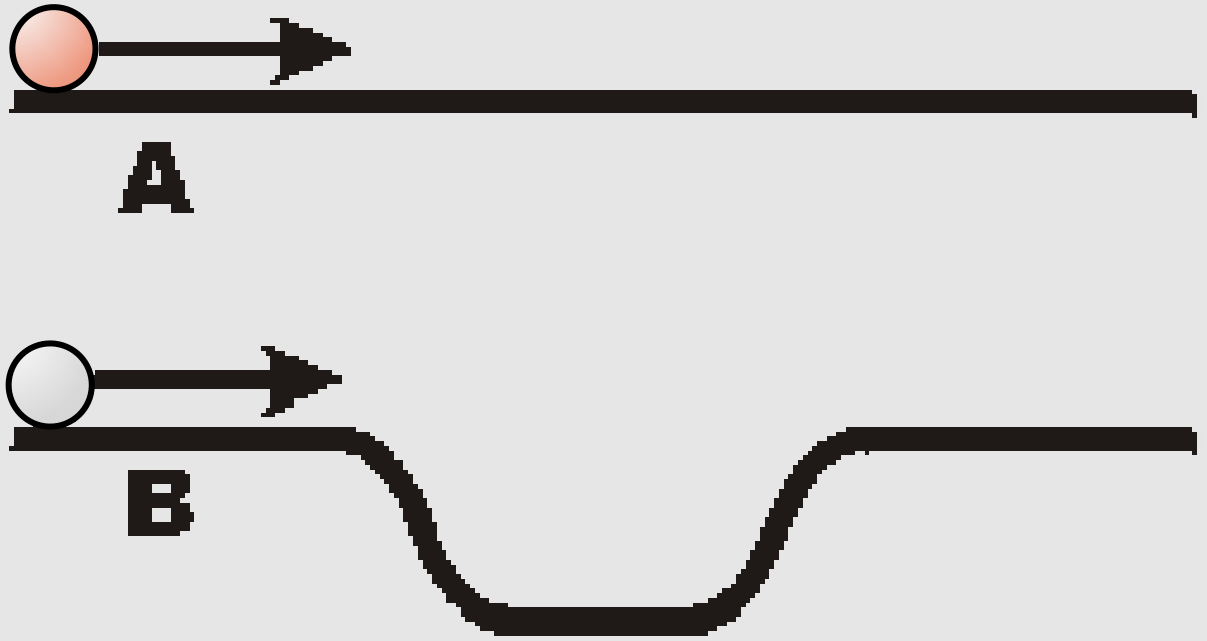
Two balls were launched along a pair of tracks with equal velocities, as shown. Both balls reached the end of the track.
Observe: Which ball reached the end of the track first?

A

B

C: They will reach the end of the track at the same time.

What Did **YOU** See?



Two balls were launched along a pair of tracks with equal velocities, as shown. Both balls reached the end of the track.

Observe: Which ball reached the end of the track first?

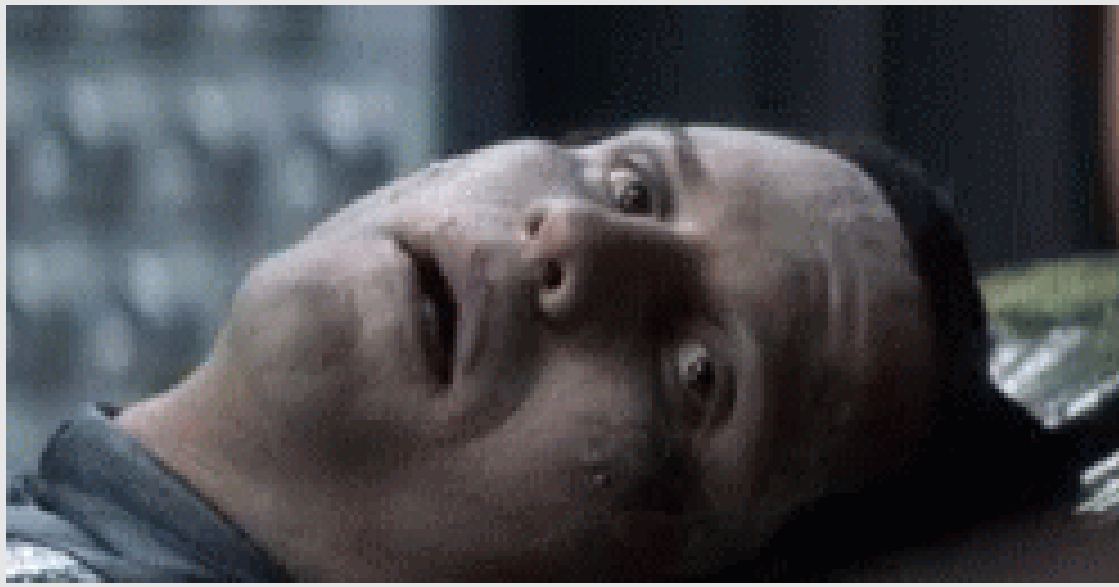
A

B

B wins every time and this does **not** depend on the details of the path shape.

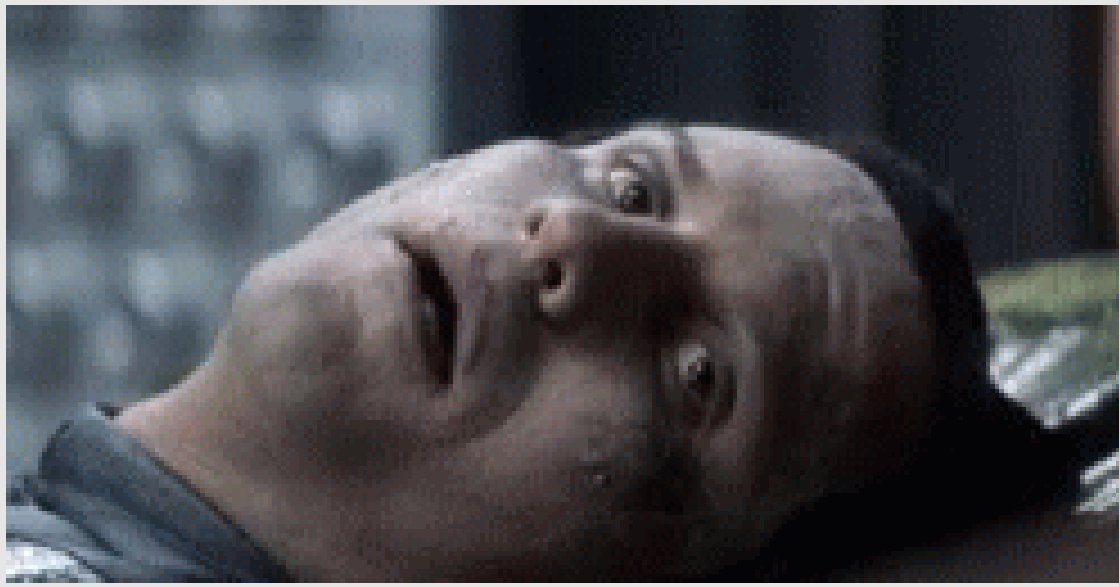
C: They will reach the end of the track at the same time.

Why does Ball B win?



A. Ball B is always traveling faster than ball A, so it reaches the end of the track first.
B. Ball B travels a shorter distance than ball A.
C. Balls A and B start and end with the same speed. But while ball B is on the lower part, it is going faster than ball A. Its *average* speed is greater, so it gets there first.
D. Ball B travels a longer distance, but is pulled faster by an extra force we cannot know about.
E. The observation is flawed – ball B should not reach the end first.

Why does Ball B win?



A. Ball B is always traveling faster than ball A, so it reaches the end of the track first.

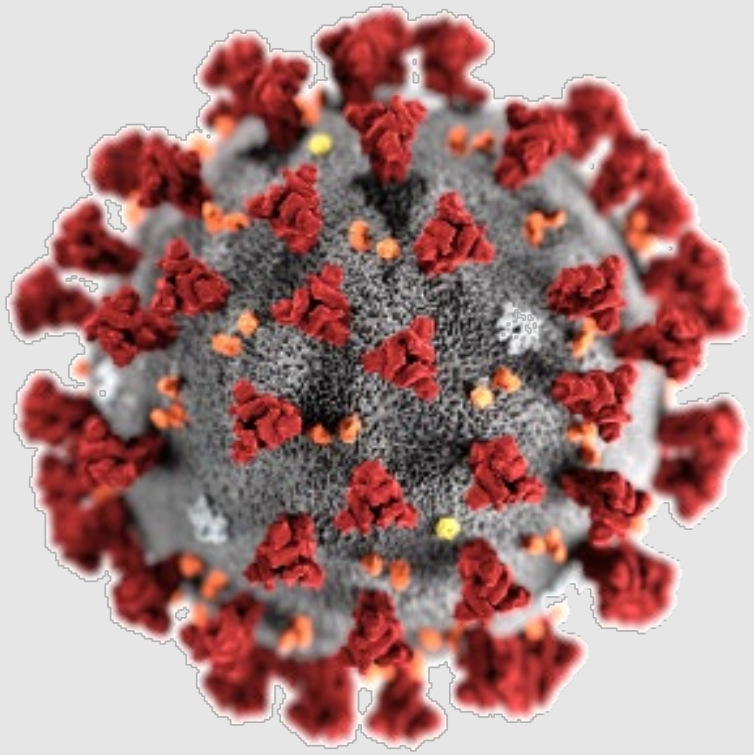
B. Ball B travels a shorter distance than ball A.

C. Balls A and B start and end with the same speed. But while ball B is on the lower part, it is going faster than ball A. Its *average* speed is greater, so it gets there first.

D. Ball B travels a longer distance, but is pulled faster by an extra force we cannot know about.

E. The observation is flawed – ball B should not reach the end first.

COVID-19



- During the pandemic, lots of methods were tried to prevent or mitigate student collaboration during these tests.
- Short, frequent, open-book, open-google, timed assessments with maximum question randomization.
- Also the final “assessment”, done online, was not weighted as heavily toward the course mark.

Gender differences in test anxiety on high-stakes summative assessments

- Chandralekha Singh at University of Pittsburgh Physics has shown that there are gender differences in Test Anxiety when taking high stakes assessments, which affect student performance.
- They did **not** find gender differences in low-stakes assessment scores.

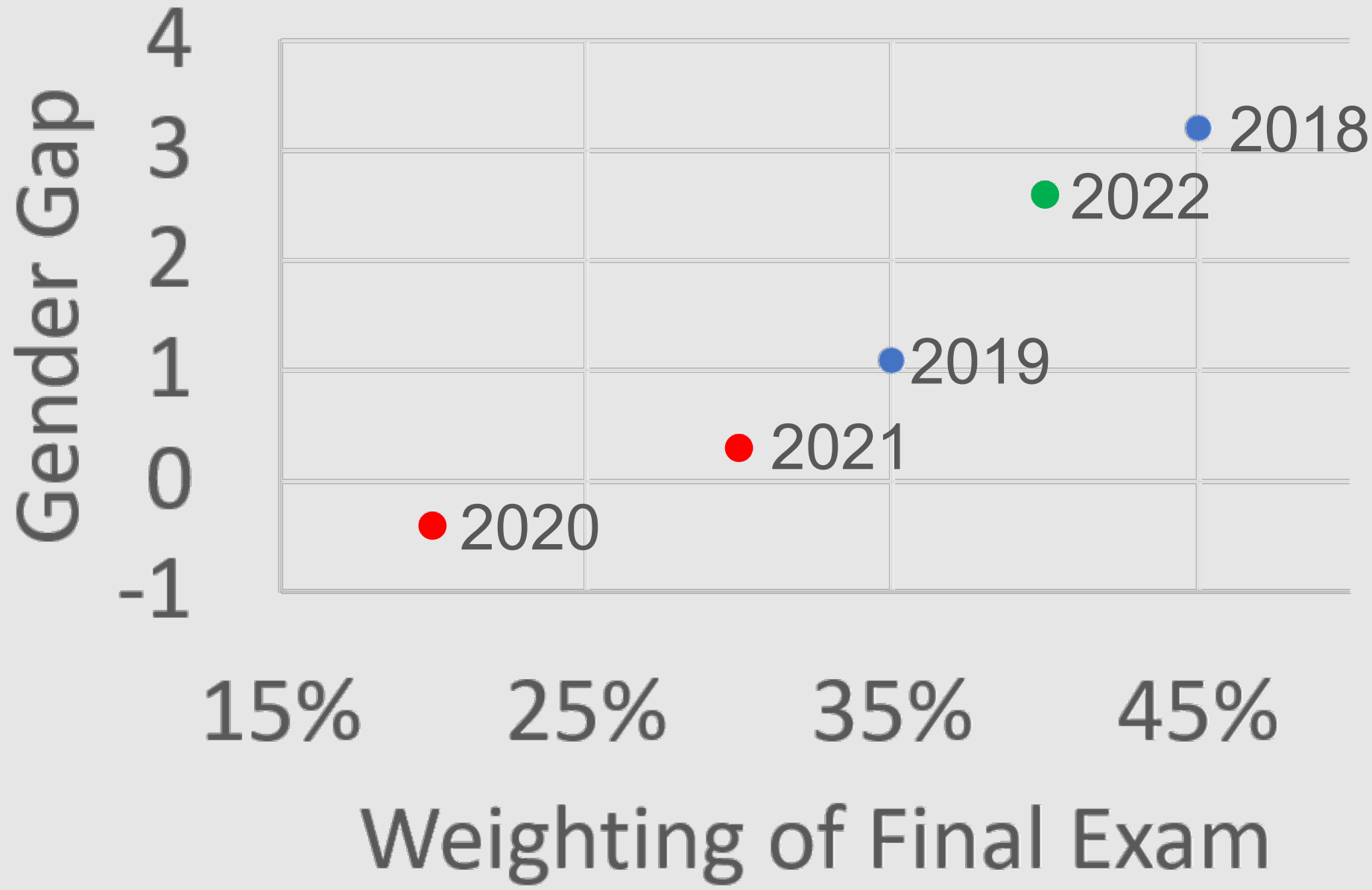
Alysa Malespina and Chandralekha Singh 2022 *Eur. J. Phys.* 43 035701

Course Marks pre, during and post COVID

PHY131 has 1000 students per year; about 60% women, 39% men, 1% non-binary / other.

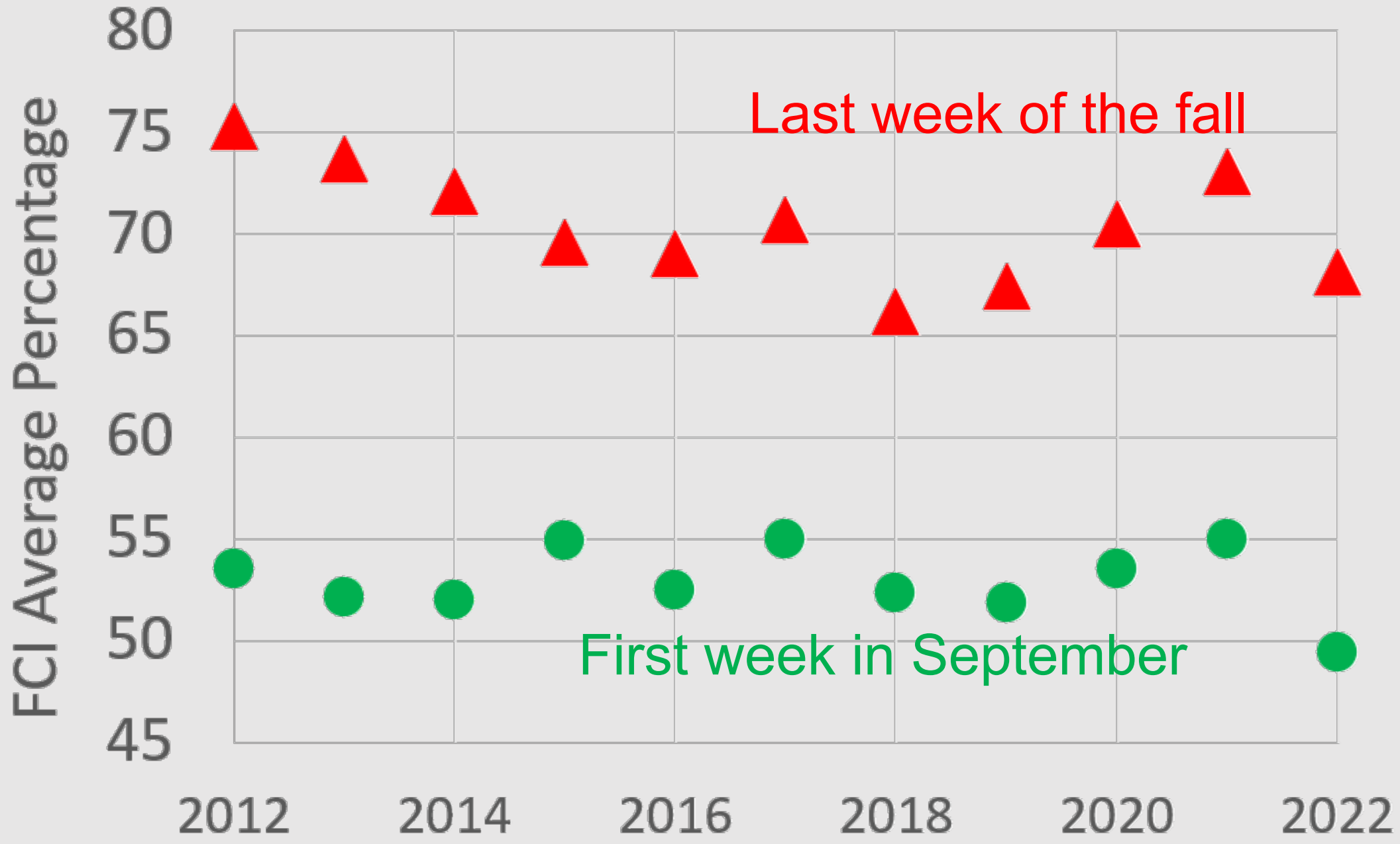
	PHY131 Final Course Mark						
Fall of	All	Men	Women	Gender Gap	# of tests	Course type	Final value
2018	76	78.1	74.9	3.2	2	in-person	45%
2019	75	75.6	74.5	1.1	2	in-person	35%
2020	84	83.6	84.0	-0.4	5	online	20%
2021	74	73.9	73.6	0.3	3	online	30%
2022	76	77.7	75.1	2.6	2	in-person	40%

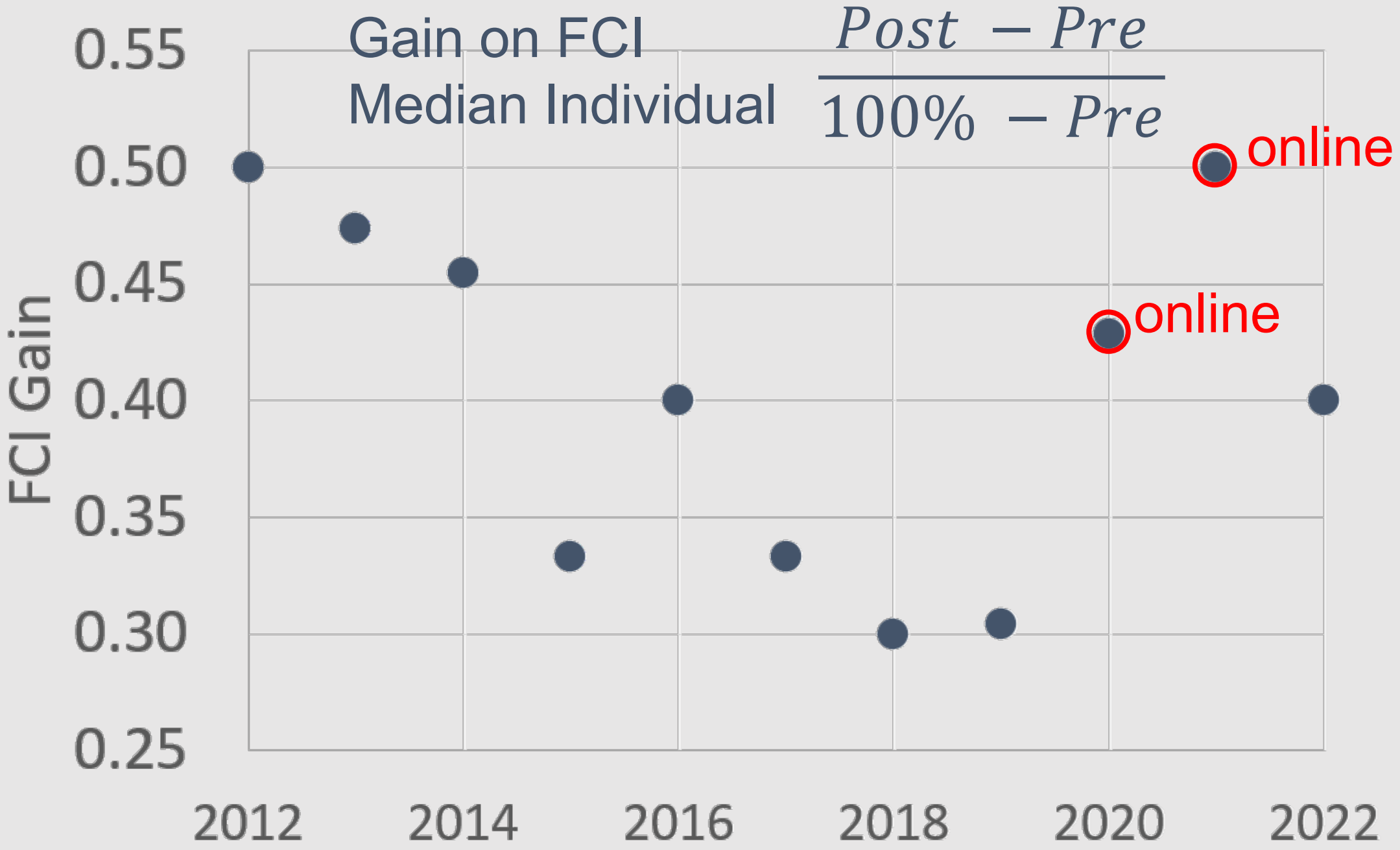
Gender Gap pre, during and post COVID



The Force-Concept Inventory (FCI)

- 30 multiple choice questions to test conceptual understanding of mechanics.
- I have 11 consecutive years of giving pre and post FCI to PHY131 students in the fall.


FCI Average Percentage
80
75
70
65
60
55
50
45
2012
2014
2016
2018
2020
2022
Last week of the fall
First week in September


Gain on FCI
Median Individual
$\frac{Post - Pre}{100\% - Pre}$
online
online
FCI Gain
0.55
0.50
0.45
0.40
0.35
0.30
0.25
2012
2014
2016
2018
2020
2022

Thank you!

Jason Harlow

UNIVERSITY OF TORONTO

Let’s talk more!

DPE/DGEP Session at 1:45pm in Kinesiology Rm.208

And don’t miss:

DGEP/DPE **Networking Reception** 3:45pm in Grad House