

PHYS 1130: Physics of Sports

Syllabus

Summer Session III

Monday July 19, 2021 – Friday Aug 13, 2021 Online(Web-based)

For details on Summer Session go to the link [Registration and Academic Procedures](#)

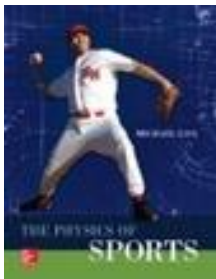
Overview

This course is a study of the physics concepts (forces, momentum, acceleration, etc.) and equations relating them behind the motion of flying and spinning projectiles (humans too) in sports such as soccer, tennis, basketball, baseball, football, track and field, etc. We will also include rolling/sliding objects along flat surfaces such as in billiards and bowling. The focus will be on how to understand motion in sports and, perhaps, gain a competitive advantage through a better knowledge of the concepts and some mathematics, but not on physics derivations.

By the end of the course you will:

- Know how to determine the hang time of a slam dunker, punted football, fly ball, and ballet dancer.
- Know how to use the center of mass concept to gain an edge in certain track & field events and give the appearance of floating in the air.
- Know why going low is the best option in tackling and blocking in football
- Know how to determine the launch angle and launch velocity for a given height release of a three pointer to optimize your chances of making nothing but net.
- Know why the stitches on a baseball or the dimples on a golf ball reduce the drag force permitting the ball to go further than if it were perfectly smooth (drag crisis).
- Know how to hit the best drop shot and why you hit with top spin in tennis.
- Know the conceptual differences between what makes a cricket ball swing and a baseball and soccer ball curve.
- Know why a four seam fast ball “rises” and a slow ball curves more than a fast ball.
- Know what a float serve in volleyball and a knuckle ball have in common.
- And why is Coor’s Field not a paradise for a pitcher since he can throw the ball faster (less drag) giving the batter less time to react to the ball’s motion and much more.

Textbook: The Physics of Sports, Michael Lisa, McGraw-Hill Education, Copywrite 2016, ISBN 978-0-07-351397-3 Softbound or digital copy is acceptable. College Level, Algebra based. You may purchase the e-version with Connect at [UVa Bookstore](#) for \$40.05. For an additional \$22.22, you can also get the printed loose-leaf version as well which I also recommend. This is a great price. These prices may change by the time the course is actually given. The cover page is shown below.



Course Organization

| | | |
|-------------------------|---|--|
| Lecture Sessions | MWF 1:00-3:15(Synchronous) | Online (Zoom) |
| Instructor: | Richard A Lindgren Research Professor of Physics | ral5q@virginia.edu Office Room 22B, Physics Bldg. |
| Office Hours | TTH 7:00-8:00pm | Online (Zoom) |

| | | |
|----------------------------|-------------------------|---|
| Discussion Sessions | TT 1:00-2:15 | Online (Zoom) |
| Teaching Assistant | TBA Graduate Student | TBA@virginia.edu TBA Physics Bldg. |
| Office Hours | M-F 8:00-9:00pm | Online (Zoom) |

About the instructor: The instructor has taught numerous introductory physics course, has many publications in nuclear physics, Directed the Master of Physics Education Program for Teachers, and spent his recreational hours trying to improve his tennis, baseball (softball), basketball, eight-ball, and table tennis skills.

Course web page: All resources can be found on Collab [21Su PHYS 1130-001](#)

Prerequisites: An good algebra-based course in mathematics at the high school or college level is required. No calculus needed. No previous physics course is required, but would be helpful if you had at least a high school level physics course. Algebra based physics courses at UVa such as PHYS2010 would be suitable and as well as any calculus physics course. If unsure about your math or physics, contact the instructor at ral5q@virginia.edu.

Required Textbook: The Physics of Sports, Michael Lisa, McGraw-Hill Education, Copywrite 2016, ISBN 978-0-07-351397-3 College Level, Algebra based. You may purchase the e-version with Connect at UVa bookstore for \$40.05. For an additional \$22.22, you can also get the printed loose-leaf version as well which I also recommend. This is a great price. [UVa Bookstore](#)
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Lecture Slides/Notes: Lectures will be on power point slides that you may download from Collab before coming to class on Zoom. However, my lecture slides will be presented to you on Zoom using Notability on my ipad. This allows me to use the stylus to solve problems during Lecture and make annotations on the slides. A copy of the annotated slides with problem solving will also be available on Collab after class. You may use any blank space to make your own class notes if you use an ipad or Tablet. If you have access to a printer, you can print out the slides and problem solutions. In addition, some demonstrations and simulations such as phets, will be shown and a whole list of YouTube sport videos will be available. All Zoom classes will be recorded and available for replay on Collab.

Zoom Class Protocol: During class while lecturing, taking quizzes, quizzes, and exams, please have your **video unmuted**. Please dress appropriately if you are zooming from home or lounge or wher eever. Please keep your **audio muted** until you want to ask a question. This minimizes interruptions due to ringing cell phones or if some friends show up unexpectedly.

Grading: Your grade is based on several components, so no one component makes or breaks it.

- Final Exam - 30%
- 3 Quizzes – 25%
- Homework Twice Weekly (Connect Platform) – 25%
- LearnSmart Reading Modules Assignments (Connect Platform) – 15%
- Sports Video with Physics Summary (see below) – 2%
- Discussion - To be determined – 3%
- Total =100%

Assignments: LearnSmart reading modules, homework problems, quizzes, exams, etc use the McGraw-Hill platform “Connect” . Connect is part of the textbook package and must purchased along with the textbook.

Final Exam: Open book 3 hr exam. Approx. 40 questions. 30 numerical and 10 conceptual questions.

Quizzes: Each week an open book 50 minute quiz will be given on Thursdays. Approximately **10-12** questions on each quiz and approximately 70% numerical and 30% conceptual questions. Total 3 quizzes.

Homework: Homework questions and problems will be selected from the end of chapter problems in the text. Problem numbers are randomized, assigned, and graded through the McGraw-Hill platform “Connect”. Homework is due Mondays and Wednesday at 11:59pm and submitted on “Connect”. Homework help is available during office hours from the instructor 7:00 pm – 8:00 pm on TR and from the TA MWF 8:00 pm – 9:00 pm. Extra time may be spent by the instructor on selected homework problems during classes.

LearnSmart (LS) Reading Assignments: Read the sections listed on the schedule for each day and on Connect submit the LearnSmart Module LS1 as you answer the multiple choice questions. This is open book. The LearnSmart Module is part of the “Connect” platform. This is an easy way to read the material and get credit towards your grade.

Sports Video: You may submit a link to a 3-6 min sports video clip (YouTube is fine). Submit your video with 4 or 5 sentences discussing the relevance of the video to physics concepts discussed in class of your choosing. The ideas behind the sports video clip is to get you to think about the physics concepts that you see in athletics and to provide material that is interesting to you. Upload the video using features on Collab. A very large list of a variety of sports YouTube video links is available.

Discussion: How your grade for the Discussion class is yet to be determined. It may include answering clicker type questions from the Connect platform or Collab, attendance, answering and asking questions, provide leadership in any breakout room discussion, etc.

Calendar: Available is a tentative calendar of topics for class meetings, due dates for submitting reading modules, homework problems, and taking exams. This calendar will be updated by the time the class starts.

Important Dates:

- Online Registration opens on SIS: Apr 12, 2021 for UVa students or Apr 16, 2021 for Visiting students
- For details on Online Registration go to the link [Registration and Academic Procedures](#)
- First lecture: Monday July 19
- First Quiz: July 22 2:10 pm
- Last day for dropping: July 30, 2021 (No W will appear on your record)
- Withdrawal deadline: August 6, 2021 (Withdrawing from a course after July 30 and up to August 6, a W will appear on your record). No withdrawals after August
- First Quiz: July 22 2:10 pm
- Second Quiz: July 29 2:10 pm
- Third Quiz: Aug 5 2:10 pm
- Last lecture: Aug 12 1:00 pm
- Course Review: Aug 12 2:10 pm
- Final exam: July 13 2:00 pm

University Honor System: An Honor Offense is defined in the link honor.virginia.edu/overview An honor offense would be any violation of the honor pledge, “On my honor, I pledge that I have neither given nor received help on this assignment.” A pledged assignment means homework, exam, quiz, etc. or any written assignment that requires a grade unless otherwise noted. Your Professor can add to the pledge or document as he see fits. For example, an open book assignment means that you can only use your assigned textbook (digital or notebook versions). You cannot use notes compiled or summarized from other resources. I could change these rules if so desired. If I request you to take an exam with your video unmuted, then you are expected to do so. It could be considered an honor violation if you refused. If you knowingly obtain a copy of a future exam by accident or intent, I would consider that an honor violation. You should report such an incidence to your instructor. I am required to report any suspected violation of the honor code to the honor committee. If you are uncertain about any future action that you might commit, don’t hesitate to contact me to ask for advice on whether or not it is an honor violation.

Satisfying General Education Requirements: Physics 1130 is an introductory-level physics course serving a broad range of students. It satisfies the requirements for courses in the [The Chemical, Mathematical & Physical Universe](#) category. It may also satisfy the requirements for disciplines Living Systems and Science and Society. The following excerpt is taken from the University General Education requirements in the Discipline category: A liberal education should develop in students a knowledge of past and present attempts to identify the material composition and mathematical structure of the physical world and universe and the forces that govern their interaction. Such knowledge is crucial to understanding the environment in which we live and inspiring the technologies we have developed to navigate and function in that environment. Courses in this category should introduce students to the concepts, facts, and theoretical principles of the mathematical and physical sciences and help students relate them to their lives as citizens and apply them to contemporary problems.

Students With Disabilities: Students needing the services provided by the Students Disability Access Center (SDAC) will need to be certified by that office. The center is located at 400 Brandon Ave. P.O. Box 800760, Charlottesville, VA 22908-0760, Phone 434-924-5362,
Email studenthealth@virginia.edu
Website studenthealth.virginia.edu/sdac

| Zoom Online | | | Calendar PHYS 1130 The Physics of Sport | Connect Assignments | | |
|-------------|------------|---------|---|---------------------------------------|-----------------|-------------------|
| | | | Topics and times are adjusted as we go | Readings | Submit Homework | Submit LearnSmart |
| Mon-Day | Time | Lecture | Topics | Textbook | Problems | Modules |
| | | | | Chapters -Sections | Due 11:59 pm | Due 1:00 pm |
| 7-19 Mon | 1:00-2:05 | 1 | Overview, Scientific Notation, Units, Conversions, C.M. | 1.1,1.3 pg. 3-11 | | LS1 |
| 7-19 Mon | 2:10-3:15 | 2 | Michael Phelps and graphs swimming, | 2.1, pg. 14-20, | | LS2 |
| 7-20 Tue | 1:00-2:05 | 3 | Usain Bolt in Berlin, 100m, velocity, accel., World Rec. | 2.2, pg. 20-26 | | |
| 7-20 Tue | 2:10-3:15 | 4 | Discussion, Review, MC Questions, Breakout, Video | | | |
| 7-21 Wed | 1:00-2:05 | 5 | Gravity, free-fall, Hang time, vertical Leap, ballerina, MJ | 2.3 pg. 27-33 | | |
| 7-21 Wed | 2:10-3:15 | 6 | Forces, Free Body, GRF, Newton's 1 st and 2 nd Law | 3.1,3.2, pg. 39-55 | HW01 | LS3 |
| 7-22 Thu | 1:00-2:05 | 7 | Jumping, Launch velocity, Landing , Force Plate | 3.2, pg. 50-54 | | |
| 7-22 Thu | 2:10-3:15 | 8 | Discussion - Quiz 1 | | | |
| 7-23 Fri | 1:00-2:05 | 9 | Sideways traction, friction, push a football sled | 3.3 p 55-58 | | |
| 7-23 Fri | 2:10-3:15 | 10 | Pushing off the floor, Crouching in football? Vectors | 3.4 pg. 63-66 | | |
| 7-26 Mon | 1:00-2:05 | 11 | "Imaginary Forces" ; Centripetal, Discuss thrower | 3.5 pg. 67-75 | HW02 | |
| 7-26 Mon | 2:10-3:15 | 12 | Math is simpler than you think, Range of a bullet, Football Punt, launch, range, hang time | 4.1 pg. 80-82 4.2,4.3 pg. 83- 90 | | LS4 |
| 7-27 Tue | 1:00-2:05 | 13 | Human projectiles, Bob Beamon's Long Jump | 4.4.pg. 91-99 | | |
| 7-27 Tue | 2:10-3:15 | 14 | Discussion, Review, MC Questions, Breakout, Video | | | |
| 7-28 Wed | 1:00-2:05 | 15 | Buoyancy in water/air, Effects of air in sports, | 5.1,5.2 pg. 105-110 | HW03 | LS5 |
| 7-28 Wed | 2:10-3:15 | 16 | Air drag coefficient C_D , speed dependence, aerodynamics | 5.3.pg. 110-112 | | |
| 7-29 Thu | 1:00-2:05 | 17 | Surface roughness, drag crisis, tripping the boundary layer golf ball dimples, baseball threads, small/big turbulent wake | 5.4 pg. 112-114 | | |
| 7-29 Thu | 2:10-3:15 | 18 | Discussion - Quiz 2 | | | |
| 7-30 Fri | 1:00-2:05 | 19 | Sideward force due to asym. in surface roughness (seams) (C_D) causes cricket ball to swing, wake deflection | 5.4.1 pg. 115-117 | | |
| 7-30 Fri | 2:10-3:15 | 20 | Sideward force due to asym. in surface speed due to spin (Magnus Force) causes baseball to curve ,etc. | 5.4.2 pg. 117-118 | | |
| 8-2 Mon | 1:00-2:05 | 21 | Deflection of a slow curve in baseball due to Magnus Force | 5.5 .1 pg. 119-122 | HW04 | |
| 8-2 Mon | 2:10-3:15 | 22 | Deflection of a soccer ball (free kick) due to Magnus Force | 5.5.4 pg. 124-125 | | |
| 8-3 Tue | 1:00 -2:05 | 23 | Basketball launch angle, launch velocity, and arc, that maximizes chances of making a basket: least energy principle | 5.5.5 pg. 127-128 Notes and Slides | | |
| 8-3 Tue | 2:10-3:15 | 24 | Discussion, Review, MC Questions, Breakout, Video | | | |
| 8-4 Wed | 1:00-2:05 | 25 | Knuckleball, volleyball float serve, wing, wake deflection | 5.6-5.7 pg. 129-134 | | |
| 8-4 Wed | 2:10-3:15 | 26 | Is Coors Field a pitching paradise or hitters delight? | 5.7 pg. 135-139 | HW05 | |
| 8-5 Thu | 1:00 -2:05 | 27 | Collisions. Impulse, momentum, simple collision force eqn. | 6.1 pg. 145-147 | | LS6 |
| 8-5 Thu | 2:10 -3:15 | 28 | Discussion - Quiz 3 | | | |
| 8-6 Fri | 1:00-2:05 | 29 | Inelastic collisions football/tackling, kinetic energy/mv | 6.2 pg. 147-151 | | |
| 8-6 Fri | 2:10-3:15 | 30 | How does a football helmet protect you or an air bag in a car? | 6.2.2 pg. 151-154 | | |
| 8-9 Mon | 1:00-2:05 | 31 | Head-on and off center elastic collisions, bowling/billiards | 6.3 pg.156-167 | | |
| 8-9 Mon | 2:10-3:15 | 32 | More on Billiards, 90° and 30° rules, stun, swerve, throw | Notes, Slides, Video | HW06 | |
| 8-10 Tue | 1:00-2:05 | 33 | Categories of collisions, (COR), KE transfer in golfing | 6.4 pg. 167-177 | | |
| 8-10 Tue | 2:10-3:15 | 34 | Discussion, Review, MC Questions, Breakout, Video | | | |
| 8-11 Wed | 1:00-2:05 | 35 | Off-center collisions, spin effects, bounce pass, golf, ping pong | 6.5 pg. 177-181 | | |
| 8-11 Wed | 2:10-3:15 | 36 | Racquet sweet spot, COR, more spin, drop shot, lob, & serve | Notes, Slides, Video | HW07 | |
| 8-12 Thu | 1:00-2:05 | 37 | Energy transfer, energy efficiency, thermal energy, heat death | 7.1-7.2.3 | | LS7 |
| 8-12 Thu | 2:10-3:15 | 38 | Discussion, Review, MC Questions, Breakout | | | |
| 8-13 Fri | TBA | | Final Exam | | | |
| 8-13 Fri | TBA | | Final exam | | | |