

PHYS 1130

Instruction mode (Online Synchronous)

Physics of Sports

J-Term 2023

**(All exams and quizzes will be 50%
conceptual and 50% problem oriented)**



Syllabus

Monday Jan 2, 2023 – Friday Jan 13, 2023

For details on J-Term 2023 go to the link [J-Term](#)

Overview

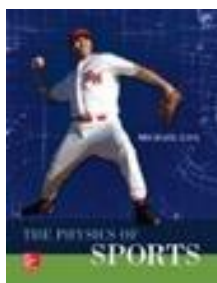
This course is a study of the motion of flying and spinning projectiles (humans too) in sports such as soccer, tennis, basketball, baseball, football, track and field, even ballet, etc. We will also include rolling/sliding objects along flat surfaces such as in billiards and hockey. We will study the physics concepts involving the gravitational force, drag and lift forces (Magnus), frictional force, momentum, acceleration, velocity, center of mass, etc. and equations relating them. 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.
- Know why Coors Field is not a paradise for a pitcher even-though 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.

Another option is Inclusive Access. You will not get a hardcopy, but you will use the digital copy online and have access to all resources online. The cost is about the same. You get to try the book as soon as you sign on to Inclusive Access (Tab on the Collab website) and you will not get charged until it is past the add/drop deadline which is probably Jan 3 or 4. If you do not want a hardcopy, this is the best option.



Course Organization

In-Person Online	MTWRF	
	Mornings 9:30 – 10:25	Lecture Online (Zoom)
	10:25 – 10:30	5 minute break
	10:30 – 11:25	Lecture Online (Zoom)
	Afternoons 1:00 – 1:55	Lecture (Zoom)
	1:55 – 2:00	5 minute break
	2:00 – 2:35	Discussion + short break
	2:35 – 3:00	Short Quiz (Open Book) or Polling/Inter.
Instructor:	Richard A Lindgren	ral5q@virginia.edu
	Research Professor of Physics	Office Room 22B, Physics Bldg.
Office Hours	TTH 7:00-8:00pm	Online (Zoom)

Teaching Assistant	Nickolaus Cabrebra	ngc6sa@virginia.edu
Office Hours	MTWRF 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 TBA

Prerequisites: A 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 PHYS 2010 would be suitable and as well as any higher-level physics or math course. If unsure about your math or physics background, 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. This price will give you access to CONNECT, the homework platform, the digital textbook, and other learning resources. Inclusive Access to Connect will be pared with Collab so you can just click on it on the class website. It is not yet available on the website, but I hope before Christmas. Your student billing account will not be charged until after the add/drop deadline. In the meantime, you get to try out the digital book and other learning resources. You can always buy

the looseleaf version for \$22.22 or hardcover textbook later. If you drop the course before the add/drop deadline on Jan 4 you are not charged. Here is the link to the bookstore if you need further information - [UVa Bookstore](#). The above prices for materials and inclusive access are from Jan 2022.

Lecture Slides/Notes: Lectures will be on power point slides that you may download from Collab before coming to class. However, my lecture slides will be presented to you in person class 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 will be shown in class and a whole list of YouTube sport videos will be available. All classes will be recorded and available for replay on Collab.

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

Quizzes and the final exam are open book only. They are not open power point slides or the internet.

(All final exam and quizzes will be 50% conceptual and 50% problem oriented)

- Final Exam (FE) – 35% open book + 1 page of notes – Lecture slides/internet forbidden
- Homework Problems – 20% open book
- Quizzes (QZ) – 20% open book + 1 page of notes – Lecture slides/internet forbidden
- SmartBook Reading (SB) – 20% open book
- Poll Everywhere (CQ) – 5% open book
- Total – 100%

- Extra credit - Sports Video with Physics Concepts Summary (see instructor for details)

Assignments:

- **Homework Problems assigned and due once a Week (HW)**

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 Jan 03, Jan 05, Jan 09, and Jan 12 at 11:59 pm 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**.

Next to reading the textbook solving problems is essential to learning the material. Students are encouraged to discuss the homework with others, but it is an honor violation to copy another students work. You must work out the final solution on your own.

Homework extensions will be accepted without penalty with a documented medical or reasonable excuse. Up to 2 of these extensions are allowed without penalty.

Homework is graded on Connect. To get full credit on numerical problems you must submit your answer with the proper units and the exact number of significant figures that are requested. Please check out the videos on how to use Connect. You will have 3 tries to get the correct answer.

- **Quizzes (QZ)**
Each week an open book 30 - minute quiz will be given on Tuesday and Thursday starting at about 2:30. Each quiz will have approximately 6 questions on each quiz and approximately 50% numerical and 50% conceptual questions in multiple choice format.
- **SmartBook Reading Assignment (SB)**
Reading assignments are posted on Connect. They are listed as SmartBook modules on Connect (SB). Each assignment has a reading comprehension goal. After you complete the reading, you answer the pop-up multiple choice questions. If you miss the answer, you may submit another answer until you get it correct. It is an easy way to increase your average if you do the reading and answer the questions. They are due at 9:00 am. See the class schedule for due dates.
- **Poll Everywhere (CQ)**
Poll everywhere is available on Collab during Lecture and Discussion and graded and will be worth 5% towards your final grade.
- **Final Exam:** Open book 3 hr exam at 2:00 - 5:00 pm on Friday Jan 14 . Approx. 30 questions. 50% quantitative and 50% conceptual questions.
- **Extra credit 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 are available on Collab. You can use this as extra credit to increase your grade up to 2 percent say from C+ to B- or B- to B or B to B+ , but not B+ to A- or A- or A.
- **Schedule/Calendar:** A schedule of topics for class meetings, due dates for submitting reading modules, homework problems, and taking exams is available and also on Collab. This schedule will be updated from time to time. You should always refer to the schedule to make your deadlines.

Important Dates:

- Online Registration opens on SIS: Nov 8 for UVa students or Nov 12 for Visiting students
- For details on Online Registration click on [Registration and Services](#)
- First Lecture: Monday Jan 2 9:30 AM Room Online Zoom
- First Quiz: Jan 3 Tue 2:30 pm See calendar for quiz dates.
- Drop deadline Jan 3 (may have changed)
- Withdrawal deadline Jan 4 (may have changed)
- Last lecture: Jan 12 9:30 am
- Final exam: Jan 13 2:00 pm – 5:00 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

Additional References

1. The Physics of Sports Science Projects (Exploring Hands-On Science Projects (Enslow))
2. The Physics of Basketball, John J. Fontanella, Published 2006, John Hopkins University Press
3. Curve Balls, Knuckle Balls and Fallacies of Baseball, Robert G Watts / A. Terry Bahill, 2000 W.H. Freeman and Company, NY
4. The Science of Pocket Billiards, Jack H. Koehler
5. The Physics of Sports, Angelo Armenti, Jr., Copywrite 1992, American Institute of Physics. This is a review that contains 259 references and 44 books.
6. The Physics of Baseball, Robert K. Adair, Copywrite 2002, Harper-Collins Publisher
7. The Physics and Technology of Tennis, Howard Brody, Rod Cross, & Crawford Lindsey, Copywrite 2002, Racquet Tech Publ. The Science of Basketball (Sports Science), Graubart, Norman D.
8. Physics of Dance, Emily Coates and Sarah Demers, Copywrite 2019, Yale University Press
9. Minnesota Fats on Pool, Seventh Printing March 1976

Final Exam Typical Questions (More will be added)

- 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.
- Know why Coors Field is not a paradise for a pitcher even-though he can throw the ball faster (less drag) giving the batter less time to react to the ball’s motion and much more.