

Syllabus

Overview

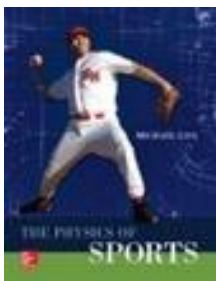
This course is a study of the motion of flying and spinning projectiles (humans too) in sports such as soccer, tennis, pickle ball, basketball, baseball, football, track and field, even ballet, etc. We will also include rolling/sliding objects along flat surfaces such as in billiards and hockey. We will 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 the optimum force you need to hit a pickle ball and hitting any harder won't help.
- 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, but a haven for a batter.

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](http://UVaBookstore) 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 10:00 – 10:55	Lecture Online (Zoom) 5-minute break
	11:00 – 11:55	Lecture Online (Zoom)
	Afternoons 1:00 – 1:55	Lecture (Zoom) 5-minute break
	2:00 – 2:30	Discussion + short break
	2:30 – 3:00	Short Quiz (Open Book)
Instructor:	Richard A Lindgren Emeritus Research Professor	ral5q@virginia.edu Department of Physics
Office Hours	TTH 7:00-8:00pm	Online (Zoom)

Teaching Assistant [Adrian Gutierrez](#) agg4hc@virginia.edu

Office Hours MTWRF [Time To be announced](#) 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 will be found on Canvas 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 it would be helpful if you had at least a high school level physics course. Non-calculus 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.

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Lecture Slides/Notes: Lectures will be on power point slides that you may download from Canvas 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 Canvas 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 Canvas.

Grading: Your grade is based on several components, so no one component makes or breaks it. Quizzes and the final exam are open book. Class power point slides or the internet are not allowed on exams. **The final exam and quizzes will be about half conceptual and half numerically oriented and both responses will be in multiple choice format with 2 attempts.**

- 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/Class participation** – 5% open book
- Total – 100%

Assignments: There are a collections homework assignments (HW) and smartbook reading assignments (SB). There will be 4 quizzes and a final exam. You will also get credit for answering poll questions and class participation.

- **Homework (HW) Worth 20% towards final grade**
Five homework Sets assigned and due every 2 days during the week and one on Sunday. Each homework set is divided into a set of 5 numerical response questions with an infinite number of attempts and a and into a set of 5 conceptual multiple-choice questions with 2 attempts.
In Canvasthe numerical response set of questions are labeled as HW01NU, HW02NU, HW03NU, HW04NU, and HW05NU. The multiple-choice set of questions are labeled as HW01MC, HW02MC, HW03MC, HW04MC, and HW05MC.

Many homework numerical problems will be selected from the end of chapter problems in the text Problem parameters are randomized and graded through the McGraw-Hill platform “Connect”. Homework is due Wed Jan 03, Fri Jan 05, Sun Jan 07, Tue Jan 9 and Thu Jan 11 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 **MTWRF** 8:00 pm – 9:00 pm. **Extra time may be spent by the instructor on selected homework problems during classes particularly in the first 30 minutes of the last hour on tuesday and thursday.**

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.

- **Quizzes (QZ) Worth 20% towards final grade**
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 6-8 questions on each quiz and approximately 50% numerical and 50% conceptual **questions in multiple choice format with 2 attempts.**

- **SmartBook Reading Assignment (SB) Worth 20% towards final grade**
Reading assignments are due every day and are graded and 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 **10:00 am**. See the class schedule for due dates.
- **Poll/Class participation (PQ) Worth 20% towards final grade**
Poll everywhere is available on Canvas during Lecture and Discussion and graded and will be worth 5% towards your final grade.
- **Final Exam: Worth 35% towards final grade**
Open book 3 hr exam at 2:00 – 5:00 pm on Friday Jan 12. Approx. 30-40 questions. 50% quantitative and 50% conceptual questions.
- **Schedule/Calendar:** A schedule of topics for class meetings, due dates for submitting **Smartbook reading assignments**, homework problems, and taking exams is available **at the end of the syllabus and also on Canvas**. This schedule will be updated from time to time. You should always refer to the schedule to meet your deadlines.

Important Dates:

- Online Registration opens on SIS: Nov 13 for UVa students or Nov 16 for Visiting students
- For details on Online Registration click on [Registration and Services](#)
- First Lecture: Tuesday Jan 2 10:00 AM Online Zoom
- First Quiz: Jan 4 Thu 2:30 pm See calendar for quiz dates.
- Drop deadline Jan 3
- Withdrawal deadline Jan 5
- Saturday class Jan 6
- Final exam: Friday Jan 12 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
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Final Exam Typical Topics. You should be able to explain any of the topics below and know how to calculate the quantities discussed in class such as hangtime, maximum height of projectiles, range of punts, peak force for triangular impacts, ground reaction force, launch velocity, baseball or soccer ball deflection, terminal velocity, etc.

- Know how to determine the hang time of a slam dunker, punted football, fly ball, and ballet dancer.
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- 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 but a haven for a batter.
- **Know about the different forces, buoyancy, gravitational, drag, Magnus, wake deflection.**

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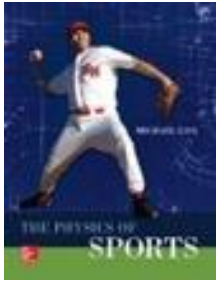
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Instructor:	Richard A Lindgren	ral5q@virginia.edu
	Emeritus Research Professor	Department of Physics
Office Hours	TTH 7:00-8:00pm	Online (Zoom)

Teaching Assistant [Adrian Gutierrez](#) agg4hc@virginia.edu

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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.

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- 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 but a haven for a batter.
- **Know about the different forces, buoyancy, gravitational, drag, Magnus, wake deflection.**

PHYS 1130 The Physics of Sport
J_Term 2024
Class Schedule
Updated Dec 21

			PHYS 1130 The Physics of Sport JTerm 2024	Reading	SB / HW / QZ /
			Topics and times may be adjusted as we go	Phys. of Sports	Connect
Date-Day	Time	Lecture	Topics	Chapters	Due
1-02 Tue	10:00-10:55	1	Overview, scientific notation, center of mass, speed, velocity, and acceleration	Ch 1.1-1.3,	SB01,SB02 Tue
1-02 Tue	11:00-11:55	2	Analysis of 100-meter Olympic record-breaking speed/acceleration of Usain Bolt	1.3, 2.1, 2.2	
1-02 Tue	1:00-1:55	3	How acceleration of gravity affects hangtime and height of vertically launched balls.	2.1-2.3	
1-02 Tue	2:00-2:55	PQ01	Discussion and Polling Questions	Review 1.1-2.2	
1-03 Wed	10:00-10:55	4	How does hangtime of a basketball player differ from a thrown ball or does it?	2.3	SB03 Wed
1-03 Wed	11:00-11:55	5	What launching force does a 6-ft 11" bball player need to jump 40 in. off the floor?	3.1 - 3.3	
1-03 Wed	1:00-1:55	6	What is the landing velocity of such a player? Why do you bend your knees?	3.2.4, 3.2.5	HW01NU, MC
1-03 Wed	2:00-2:55	QZ01	Discussion and Quiz QZ01	Review 2.3-3.2	QZ01 Wed
1-04 Thu	10:00-10:55	7	How lineman in football use static friction to gain an advantage on their opponent?	3.3	SB04 Thu
1-04 Thu	11:00-11:55	8	Crouching in football. Why does the low man win? All about torque and friction.	3.4-3.5	
1-04 Thu	1:00-1:55	9	Centripetal force, the rotor, car turning a corner, curling, curling, imaginary forces	3.5	
1-04 Thu	2:00-2:55	PQ02	Discussion and Polling Questions	Review 3.3-3.5	
1-05 Fri	10:00-10:55	10	Punting in football. Why is timing between the gunner and the punter important?	4.1 - 4.2	SB05 Fri
1-05 Fri	11:00-11:55	11	Humans in flight, Ballet dancer, Beamon's Long jump record. Importance of c.m.	4.3-4.4	
1-05 Fri	1:00-1:55	12	Effect of buoyancy on an object in water or air. baseballs, golf balls, basketballs	5.1 - 5.2	HW02NU, MC
1-05 Fri	2:00-2:55	QZ02	Discussion and Quiz QZ02	Review 4.1- 5.2	QZ02 Fri
1-06 Sat	10:00-10:55	13	Aerodynamics and how the Drag Force affects balls flying through the air.	5.3	SB06 Sat
1-06 Sat	11:00-11:55	14	How do the threads on baseballs and dimples on golf balls affect their flight?	5.4	
1-06 Sat	1:00-1:55	15	Drag Crisis:Reduction of the turbulent wake behind the ball reduces C_D as v increases	5.4 - 5.5.4	
1-06 Sat	2:00-2:55	PQ03	Discussion and Polling Questions	Review 5.3 -5.5	
1-07 Sun			Homework Due		HW03NU, MC
1-08 Mon	10:00-10:55	16	What is the Magnus force and how does it increase the distance a baseball travels?	5.4.2-5.5.1	SB07 Mon
1-08 Mon	11:00-11:55	17	Why is the trajectory of a spinning soccer ball part of a spiral or a banana curve?	5.5.2-5.5.5	
1-08 Mon	1:00-1:55	18	On the deflection of a curve ball across the plate; Yankee stadium vs Coors Field	5.5.3, 5.7	
1-08 Mon	2:00-2:55	QZ03	Discussion and QZ03	Review 5.4.-5.5	QZ03 Mon
1-09 Tue	10:00-10:55	19	How to shoot a basketball to maximize your field goal percentage?	5.5.5 and slides	HW04NU, MC
1-09 Tue	11:00-11:55	20	How can you explain a knuckleball to darting back and forth?	5.6.1	
1-09 Tue	1:00-1:55	21	Finding the momentum change in a total inelastic collision in football tackling.	6.1-6.2	
1-09 Tue	2:00-2:55	PQ04	Discussion and Polling Questions	Review 5.3- 5.7	
1-10 Wed	10:00-10:55	22	Why is the collision force between objects reduced when using a helmet (air bag)	6.2.2	SB08 Wed
1-10 Wed	11:00-11:55	23	Bat and ball collisions, sweet spot, COP, vibrations, triple hit and broken bats.	Slides/video	
1-10 Wed	1:00-1:55	24	Coefficient of Restitution COR; maintaining integrity of baseballs and golf balls	6.4.2	
1-10 Wed	2:00-2:55	QZ04	Discussion and QZ04	Review 6.1-6.4	QZ04 Wed
1-11 Thu	10:00-10:55	25	Using top spin and back spin to gain an edge in tennis, pickleball, and ping pong	6.5.2 and slides	SB09 Thu
1-11 Thu	11:00-11:55	26	How to improve your billiards knowing about elastic collisions and the 90 deg rule	6.3.4 and slides	
1-11 Thu	1:00-1:55	27	Summary and Review for final	Summary	
1-11 Thu	2:00-2:55	PQ05	Discussion and Polling Questions	Review 6.3-6.4	HW05NU, MC
1-12 Fri	10:00-10:55		Study for final and office hours		
1-12 Fri	11:00-11:55		Study for final and office hours		
1-12 Fri	2:00-5:00	Final	Final Exam	Ch 1 - 6.4	Final Exam
	Textbook		The Physics of Sports, Michael Lisa, McGraw-Hill Education	Copywrite	2016
			ISBN ISBN 978-0-07-351397-3		

9 Reading assignments SB in Digital Text, Ans MC questions - infinite attempts Due 10:00 am

5 Homework assignments - each assignment is divided into 5 numerical and 5 conceptual questions Due 11:59 pm

Numerical questions are labeled HW01NU, HW02NU, HW03NU, HW04NU, HW05NU- infinite attempts

Conceptual Multiple-Choice Questions are labeled HW01MC, HW02MC, HW03MC, HW04MC, HW05MC 2 attempt

4 Quizzes QZ 8-10 All MC Questions -2 attempts, half numerical and half conceptual Due 3:00 pm

Poll questions from time to time during Discussion or Lecture (I may omit the poll questions)

Final Exam 33 MC questions, half numerical half conceptual, - 2 attempts

Lowest grade of HW and lowest grade QZ will be dropped.

All homework, quizzes and final are open book.