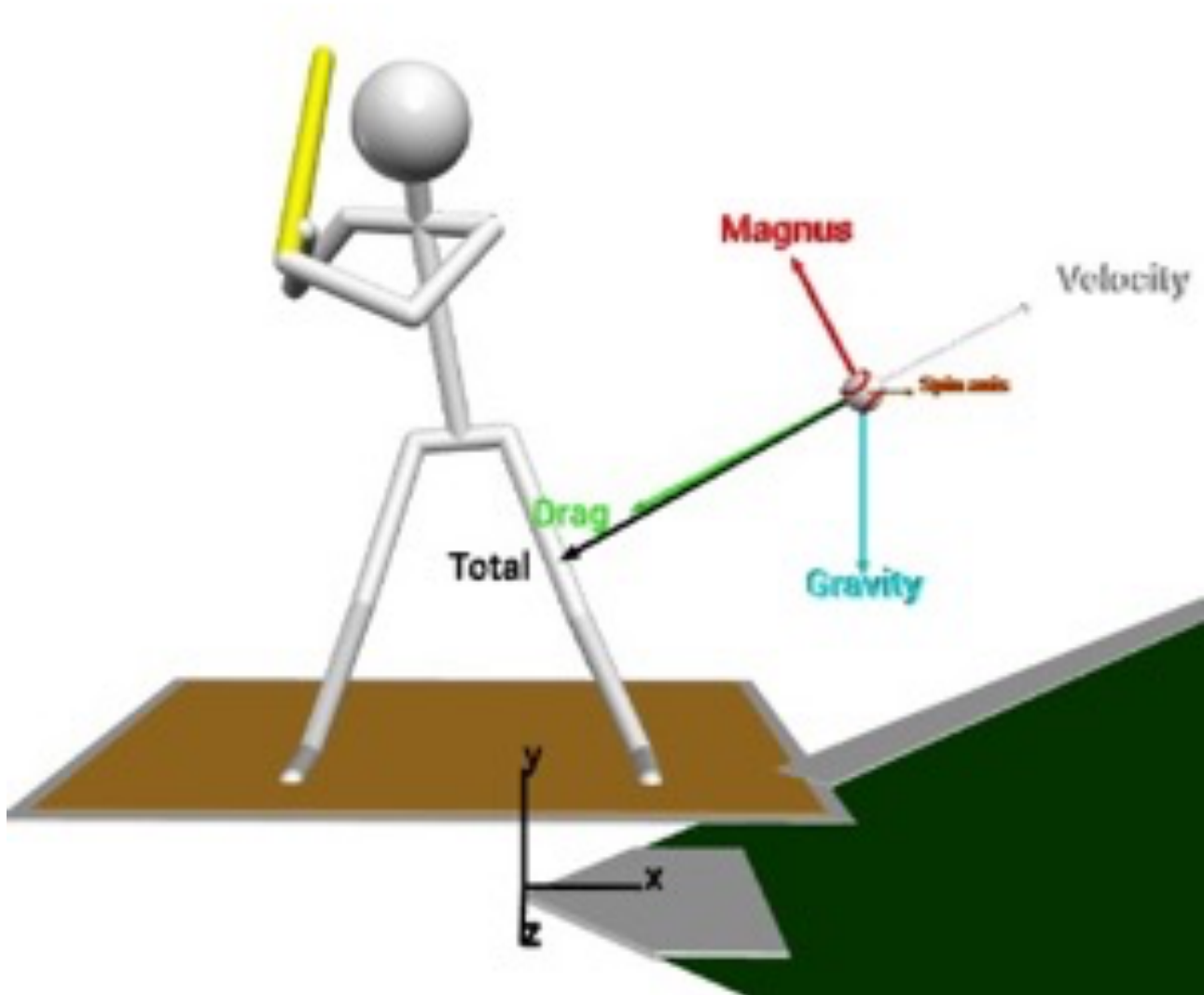


PHYS 1130 : Physics of Sports
Summer Session III In-Person
July 14 – Aug 8 2025 10:30 -12:45 MTWRF
Room 220 Physics Bldg (Jesse Beams Lab)



You will learn how the differences in motion of various projectiles moving through the air can be understood in terms of differences in speed, ball size, and surface texture, bumps, and holes.





[Hitting a baseball - Effects of \$g\$ +drag+Magnus](#)

Summer Session III

For details on Summer Session 2025 go to the link [Summer Session Website](#)

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 hockey. 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. Assignments and exams will be 40% quantitative based and 60% conceptual based. There will a greater emphasis on concepts and less on problem solving by the students.

By the end of the course here are some of the important points in sports you will know better.

Know why golf ball dimples and baseball stitches reduce drag allowing the ball to go further.

Know how why a pitched baseball or kicked soccer ball curves.

Know how to manipulate your center of mass to gain an edge in certain sports.

Know how to punt a football to make your gunner happy.

Know why going low is the best option in blocking/tackling in football.

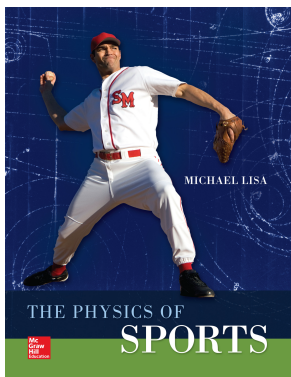
Know what is the best launch-angle and launch-velocity to make a three pointer.

Know why follow through is important in tennis or sports in general.

Know why the volley-ball motion in a float serve is similar to the knuckle-ball.

Know what factors affect your hangtime in basketball, punting, ballet dancing.

Required 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. Ask for the Inclusive Access package. All Test and Assignments will use the “Connect” platform and will be accessible from the Inclusive Access package. Instead of Collab, we will be using the new LMS system called Canvas. The link is <https://canvas.its.virginia.edu/> For an additional \$22.22, you can also get the printed loose-leaf. 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	Lecture MWF	10:30 -11:35	5 min break
	Lecture MWF	11:40 - 12:45	
	Active learning Activities.	T,R 10:30 - 12:45	and short Quiz

Instructor: Richard A Lindgren. ral5q@virginia.edu
Emeritus Research Professor Physics

Office Hours T,R 7:00-8:00pm Online (Zoom)

Teaching Assistant

Office Hours TR

About the instructor: The instructor has taught numerous introductory physics course, has published/co-published hundreds of articles in Nuclear Physics and given many professional talks in search of understanding the nuclear force; Co-Founder/First Director of the Master of Physics Education Program for Teachers, developed several physics courses for teachers, taught and organized many STEM summer workshops; and spent remaining recreational hours trying to improve his athletic skills such as tennis, basketball, etc. The instructor built up this course starting about 3 years ago and continues to make changes to meet the student needs.

Course web page: Syllabus and Schedule can be found on Lou's List; Will also be available on Canvas soon.

Prerequisites: A good algebra/Trig-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 very helpful if you had at least a high school level physics course. Algebra based physics courses at UVa such as PHYS 2010 would be very helpful and as well as any algebra-based college math course. If unsure about your math or physics background, contact the instructor at ral5q@virginia.edu.

Lectures: There will be 8 lectures each week. Two lectures on Monday, two lectures on Wednesday and two plus activity on Friday. There will be one lecture on Tuesday and one on Thursday scheduled for the first hour. Lectures will be on power point slides that you may download from Canvas before coming to class. My lecture slides will be presented to you using Notability on my I-pad. This allows me to use the stylus to sketch demonstration setups and to outline solutions to examples and homework problems on my slides during class. Lectures also include video clips of athletic activities demonstrating physics points and Newton's laws, problem solving, and conceptual explanations of how laminar/turbulent air flow around a ball is responsible for the curve in baseball, the banana curve in soccer, the swing of a cricket ball, the shank in golf, topspin in tennis, etc. and including the unpredictable knuckleball and the float serve in volley ball. A copy of the annotated slides will also be available on Canvas after class. You may take your own class notes if you use an I-pad or Tablet. All classes will be recorded and available for replay on Canvas.

Discussion: The second hour on Tuesday will be reserved totally for problem solving and questions. The second hour on Thursday will include a limited discussion and problem solving followed by a 30 minute quiz.

Assignments: All assignments are based on the McGraw-Hill platform “Connect” . Connect is part of the textbook package. The six types of assignments are: SmartBook, Homework, Quizzes, Midterm, Final exam and a *Project. The Project is optional.

SmartBook (SB) Reading Assignments: Read the sections listed on the schedule for each day and on you submit the SmartBook Module SB01 as you answer the multiple-choice questions. This is open book. The SmartBook Module is part of the “Connect” platform. This is an easy way to read the material and get credit towards your grade. You are expected to get 100 on all SmartBook assignments. You do the assignment until you get it all right.

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 Tuesdays and Fridays 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 on a time to be announced on MTWRF. Extra time may be spent by the instructor on selected homework problems during classes and during discussion.

Quizzes: Each week an open book 10 minute quiz will be given on Thursday. Approximately 5-7 (MC) questions on each quiz. There will be 2-3 quantitative questions and 3-4 conceptual questions.

Midterm Exam: : 1 hr 15 min exam. Approx. 16-20 questions. 40% numerical and 60% conceptual questions.

Final Exam: 3 hr exam. Approx. 40 questions. 40% numerical and 60% conceptual questions.

Tuesday and Thursday will be reserved to conduct hands-on/active learning projects in groups of 2 on topics related to the sports world. Here are a few projects.

Project 1: What is your hangtime? Using the digital camera on your iphone you will take a video of your partner jumping off the floor and determine his/her hangtime and relate it to how high you can jump and with what launch speed and how it would be different if you were on the moon. All of this will be compared to simple kinematics of dropping balls from rest for verification.

Project 2: How is your release speed of a bowling ball, discuss thrower, or an underhand softball pitcher related to the angular speed and radius of the wheel - up? You will determine the radius and speed of a rotating object and the acceleration using your iphone camera. Measurements will be taken from the video to measure the period of rotation and radius of the rotating object to determine the speed and centripetal acceleration.

Project 3: Show how the Magnus force acting on a rotating cylinder or tube can cause unexpected behavior. Details to be discussed.

Project 4: Comparison of a torpedo baseball bat with a standard baseball bat. You will compare a torpedo baseball bat with standard bat to see if the torpedo bat provides more power. Simple measurements can be made by dropping a baseball on the sweet spot of the bat.

Other possible activities, Demonstrate why is it easier for a crouched football player to push over a tall football player - each being equally as strong? How does the optimum launch angle and

launch velocity change as the basketball player becomes taller when shooting a free throw to make nothing but net.

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

- Final Exam 30%
- Midterm 25%
- Quizzes 10%
- Homework 15%
- SmartBook 10%
- Active Learning Project..... 10%

- Total 100%

- If your final exam grade is not greater than the midterm, I will weigh the final at 25% and the midterm at 30%.

Calendar: A calendar of topics for class meetings, due dates for submitting reading modules, homework problems, and taking exams will be available on Canvas. This calendar will be updated from time to time.

Important Dates:

- Online Registration opens on SIS: Mar 24, 2025 for UVa Graduate students or Mar 28, 2024 for Visiting students.
- Undergraduate Enrollment Begins (4th/3rd years) Mar 25 2025
- Undergraduate Enrollment Begins (2nd/1st years) Mar 26 2025
- For details on Online Registration go to the link [Registration and Academic Procedures](#)
- First Lecture: Monday July 14
- Withdrawal with Full Refund: July 15
- First Quiz: Thursday July 17 12:15 pm. See calendar for other quiz dates.
- Midpoint: July 25
- Withdrawal No Refund: July 25
- Last lecture: Aug 8 10:45 am
- Final exam: Aug 9 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 [student health](#)

			PHYS 1130 The Physics of Sport	Reading	SB / HW
			Topics and times may be adjusted as we go	CONNECT	CONNECT
Date	Time-Day	Lecture	Topics	Chapters	Due
7-14	10:30 -Mon	1	Overview, motion of balls, and projects	Ch 1.1-1.3,	
7-14	11:40-Mon	2	Learn how to get the speed and acceleration of runners and projectiles	1.3, 2.1, 2.2	
7-15	10:30-Tue	3	How acceleration of gravity affects hangtime and height of vertically launched balls.	2.1-2.3	SB1.1, SB2.1
7-15	11:40-Tue	Project 1	Project 1 What's your hangtime?		
7-16	10:30-Wed	4	How does hangtime of a basketball player differ from a ball thrown in the air?	2.3	SB3.1
7-16	11:40-Wed	5	How much launching force do you need to jump 40 in. off the floor?	3.1 - 3.3	HW01
7-17	10:30-Thu	6	What is the landing velocity of such a player? Why bend your knees when landing?	3.2.4, 3.2.5	
7-17	11:40-Thu	Project 1	Complete Project 1 and QZ01 12:35 – 12:45	1.1-3.2	
7-18	10:30-Fri	7	How lineman in football use static friction to gain an advantage on their opponent?	3.3	SB3.4
7-18	11:40-Fri	8	Crouching in football. Why does the low man win? All about torque and friction.	3.4-3.5	
7-21	10:30 -Mon	9	Centripetal force, the rotor, car turning a corner, curling, imaginary forces	3.5	SB4.1
7-21	11:40-Mon	10/11	Punting in football and timing between gunner and football. Humans in flight	4.1 – 4.4	
7-22	10:30-Tue	Project 2	Project 2 What's your release speed?		
7-22	11:15-Tue	Project 2	Complete Project 2 and QZ02 12:35 – 12:45	3.3-4.4	
7-23	10:30-Wed	12	Effect of buoyancy on an object in water or air. baseballs, golf balls, basketballs	5.1 - 5.2	SB5.1
7-23	11:40-Wed	13	Aerodynamics and how the Drag Force affects balls flying through the air.	5.3	HW02NUMC
7-24	10:30-Thu	14	How do the threads on baseballs and dimples on golf balls affect their flight?	5.4	
7-24	11:25-Thu	Midterm	Midterm Exam 11:30 -12:45	Ch 1 – Ch 4	
7-25	10:30-Fri	15	Drag Crisis:Reduction of the turbulent wake behind the ball reduces C_D as v increases	5.4 - 5.5.4	SB5.4
7-25	11:40-Fri	16	What is the Magnus force and how does it increase the distance a baseball travels?	5.4.2-5.5.1	HW03NUMC
7-28	10:30 -Mon	17	Why is the trajectory of a spinning soccer ball part of a spiral or a banana curve?	5.5.2-5.5.5	
7-28	11:40-Mon	18	On the deflection of a curve ball across the plate; Yankee stadium vs Coors Field	5.5.3, 5.7	HW04NUMC
7-29	10:30-Tue	19	How to shoot a basketball to maximize your field goal percentage?	5.5.5 and notes	
7-29	11:15-Tue	Project 3	Project 3	5.4-5.5	
7-30	10:30-Wed	20	How can you explain a knuckleball to darting back and forth?	5.6.1	SB6.1
7-30	11:40-Wed	21	Finding the momentum change in a total inelastic collision in football tackling.	6.1-6.2	HW05NUMC
7-31	10:30-Thu	22	Why is the collision force between objects reduced when using a helmet (or air bag)	5.6.1	
7-31	11:40-Thu	Project 3	Compete Project 3 and QZ03 12:35 – 12:45	5.6-6.2	
8-01	10:30-Fri	23	Bat and ball collisions, sweet spot, COP, vibrations, triple hit and broken bats.	6.1-6.2	
8-01	11:40-Fri	24	Coefficient of Restitution COR; maintaining integrity of baseballs and golf balls	6.4.2	
8-04	10:30 -Mon	25	Using top spin and back spin to gain an edge in tennis.	6.1-6.2	SB6.4
8-04	11:40-Mon	26	How to improve your billiards knowing about elastic collisions and the 90 deg rule.	6.4.2	HW06NUMC
8-05	10:30-Tue	27	The law of diminishing returns in Golf	6.5.3	
8-05	10:30-Tue	Project 4	Project 4 Torpedo bat comparison with standard baseball bat	Slides and notes	
8-06	10:30-Wed	Project 4	Complete Project 4 and QZ04 12:35 – 12:45	6.1-6.4	
8-06	11:40-Wed	28	The Physics of Pickleball	Notes	
8-07	10:30-Thu	30	Study on your own		HW07NUMC
8-07	11:35-Thu	31	Study on your own and available for Office hours		6:00 pm
8-08	10:30-1300 Fri	Final	Final Exam		
	Textbook		The Physics of Sports, Michael Lisa, McGraw-Hill Education	2016	
			ISBN ISBN 978-0-07-351397-3		

HW due 11:59 PM

SB due at 9:00 am

QZ due at 12:45 pm

Midterm due at 12:45 pm

Final Exam TBA