

Sports, Forces, and Newton's Laws

by Jan Hughes

This module is intended for students to read provided articles and conduct limited research on a monumental sports play in either football, basketball, soccer or baseball and relate it to forces, and Newton's Laws of Motion. The final product will be an essay that examines the causes of ball movement during an isolated play and the effect it has on the success of the play. Students will have to further identify and explain all forces and Laws acting upon both the athlete and the equipment during that monumental play. It's expected to take two weeks to complete this module. Once the essay is complete, students of the same sports cluster (example: football) will share their discoveries with three other small clusters of students each representing a different sport (examples: baseball, basketball, and soccer). This closing activity will help students see the connections that tie into all sports and solidify the fact that physics relates to all their daily physical activities.



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Section 1: What Task?

Teaching Task

Task Template 16 - Informational or Explanatory

How are game-changing sport plays attributed to Newton's Laws? After reading "Why All Football Players Should Take Physics", chapters 5 and 6 in your textbook, and additional informational texts on the sport of your choosing, write an essay that relates how ball movement in an isolated play is attributed by Newton's Laws.. Support your discussion with evidence from the text(s).

Standards

Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects

CCR.R.1

Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

CCR.R.2

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

CCR.R.4

Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

CCR.R.6

Assess how point of view or purpose shapes the content and style of a text.

CCR.R.10

Read and comprehend complex literary and informational texts independently and proficiently.

CCR.W.2

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

CCR.W.4

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCR.W.5

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

CCR.W.9

Draw evidence from literary or informational texts to support analysis, reflection, and research.

CCR.W.10

Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

CCR.L.1

Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

CCR.L.2

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

CCR.L.6

Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

CCR.SL.1

Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

CCR.SL.2

Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

CCR.SL.3

Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.

CCR.SL.5

Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

RST.9-10.9

Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

WHST.9-10.2

Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

Louisiana Science Grade-Level Expectations

Differentiate between mass and weight (PS-H-E1)

Compare the characteristics and strengths of forces in nature (e.g., gravitational, electrical,

Focus

Focus

magnetic, nuclear) (PS-H-E1)

Differentiate between speed and velocity (PS-H-E2)

Calculate velocity and acceleration using equations (PS-H-E2)

Demonstrate Newton's three laws of motion (e.g., inertia, net force using F = ma, equal and opposite forces) (PS-H-E3)

Describe and demonstrate the motion of common objects in terms of the position of the observer (PS-H-E4)

Texts

- % Top 10 Super Bowl Plays of all time. (student)
- % The 50 Greatest MLB Plays of All Time. (student)
- % The Best Moves in the History of the NBA. (student)
- % Best Sports Moment in each of the 50 States. (student)
- % 76 Great Moments in Sports. (student)
- % Jeff Duncan's Top 10 New Orleans Saints plays of all time. (student)
- % 100 plays, performances and moments that define college football. (student)
- Science Videos. various videos that explain the physics behind specific sports. (student)
- Section 2015 Sports Science videos. Short video clips that illustrate experiments performed with athletes and their associated equipment to explain the science behind the plays. (student)
- Play ball -- but not before you solve that equation Christian Science Monitor (8/14/2007)—Brittain, Amy

Why Do Curveballs Curve?

Scientific American Explorations (Spring2001)—Suckow, Audrey; Discusses why curveballs thrown by pitchers curve. Techniques in throwing a curveball; Effect of spin on the curveball; Aerodynamic effect on the ball; Variations of curveball.

FORCE TO RECKON WITH

Sports Illustrated (World Series Commemo)—Segura, Melissa; The article focuses on Major League Baseball's 2006 National League Division Series in which the St. Louis Cardinals defeated the San Diego Padres. The series is chronicled game by game with certain turning points and performances, notably the pitching of Jeff Weaver and the pinch-hitting of Scott Spiezio, compared to the laws of motion formulated by Sir Isaac Newton.

Why All Football Players Should Take Physics

Scientific American Explorations (Winter2002)—Grout, Pam; Focuses on the application on principles of physics in football. Calculation on force of a tackle; Equation of momentum; Principles applied in a successful kick. INSET: Textbook Terms Take the Field

Football physics

Sports Illustrated (11/8/93)—Reed, William F.Walters, John; Looks at a test of the theory proposed by professor Jackie Sherrill, about helium filled footballs and lofty punts. Test by Auburn punter Terry Daniel

and physicist Stephen Knowlton; Details of the test.

Heavy Metal

Current Science (10/6/2000)—Perritano, John; Explores the materials science behind metal baseball bats.

ANATOMY OF A HIT

Popular Mechanics (Feb2007)—Higgins, MattMasamitsu, EmilyCoburn, Davin; The article focuses on new tools and methods used by researchers to study the mechanics in the game of football. According to Tony Egues, head equipment manager for the football team Miami Dolphins, shoulder-pad plastic has not changed much in 25 years, but it is now molded into designs with more right angles to deflect impacts. Football players are relying on the helmet's solid shell and face mask to redistribute the energy of a collision.

SWIFTER, HIGHER, STRONGER

Scientific American Explorations (Winter2002)—Daily, Laura; Focuses on the scientific principles of Winter Olympics in Salt Lake City, Utah. Application on principles of gravity in luge and bobsled; Role of aerodynamics; Use of angular momentum principle in skaters.

THE PERFECT PITCH

Science World (5/9/2011)—Crane, Cody; The article discusses about motion capture technology and application in performing pitches safely in baseball.

The Myth Of The Rising Fastball

Popular Mechanics (May2004)—Brancazio, Peter J.; The article focuses on the myth of the rising fastball. Years ago, baseball players and fans commonly believed that it was possible to throw a rising fastball--a pitch that would curve upward or hop as it approached the batter. This could be done, it was thought, by gripping the baseball across the seams and releasing the pitch with a wrist snap that would impart a pronounced backspin on the ball. Although they could not explain why it happened, pitchers, batters and catchers were convinced that if the pitch were thrown at high speed it would rise as it crossed the plate, causing the batter to misjudge the trajectory and swing under the ball.

Student Work Rubric - Informational or Explanatory Task - Grades 9-12

	Emerging	Approaches Expectations	Meets Expectations	Advanced
	1	2	3	4
Controlling Idea	Presents a general or unclear controlling idea.	Presents a clear controlling idea that addresses the prompt , with an uneven focus .	Presents and maintains a clear, specific controlling idea that addresses all aspects of the prompt and takes into account the complexity of the topic.	Presents and maintains a precise, substantive controlling idea that addresses all aspects of the prompt, takes into account the complexity of the topic and, where appropriate, acknowledges gaps in evidence or information.
Selection & Citation of Evidence	Includes minimal details from sources. Sources are used without citation.	Includes details, examples, and/or quotations from sources that are relevant to the controlling idea. Inconsistently cites sources.	Includes details, examples, and/or quotations from sources that support the controlling and supporting ideas . Consistently cites sources with minor formatting errors .	Includes well-chosen details, examples, and/or quotations from sources that fully support the controlling and supporting ideas. Consistently cites sources using appropriate format .
Development / Explanation of Sources	Explanation of ideas and source material is irrelevant, incomplete, or inaccurate.	Explains ideas and source material to support the controlling idea, with some incomplete reasoning or explanations.	Accurately explains ideas and source material and how they support the controlling idea.	Thoroughly and accurately explains ideas and source material to support and develop the controlling idea.
Organization	Lacks an evident structure. Makes unclear connections among ideas, concepts, and information.	Groups ideas and uses transitions to develop the controlling idea, with some lapses in coherence or organization.	Groups and sequences ideas to develop a cohesive explanation. Uses transitions to clarify the relationships among complex ideas, concepts, and information.	Groups and sequences ideas in a logical progression in which ideas build to create a unified whole. Uses varied transitions to clarify the precise relationships among complex ideas, concepts, and information.
Conventions	Major errors in standard English conventions interfere with the clarity of the writing. Language or tone is inappropriate.	Errors in standard English conventions sometimes interfere with the clarity of the writing. Uses language and tone that are sometimes inappropriate for the audience and purpose.	Consistently applies standard English conventions; minor errors, while noticeable, do not interfere with the clarity of the writing. Uses language and tone appropriate to the audience and purpose.	Consistently applies standard English conventions, with few errors. Demonstrates varied syntax and precise word choice. Consistently uses language and tone appropriate to the audience and purpose.
Content Understanding (Generic)	Attempts to include disciplinary content in explanation or argument but understanding of content is weak; content is irrelevant, inappropriate, or inaccurate.	Briefly notes disciplinary content relevant to the prompt; shows basic or uneven understanding of content; minor errors in explanation.	Accurately presents disciplinary content relevant to the prompt with sufficient explanations that demonstrate understanding.	Integrates relevant and accurate disciplinary content with thorough explanations that demonstrate in-depth understanding.

Background for Students

While learning Newton's Laws of Motion, you will identify how these well-known laws plays a part in your everyday physical activities. You will also gain an understanding of related terms such as: motion, speed, velocity, acceleration, balanced and unbalanced forces, friction, and momentum. The final product will be an essay that examines the relationship between Newton's Laws and either football, basketball, soccer or baseball movement during an isolated play. Think from the perspective of a physicist who is trying to teach an athlete the science behind all his/her best sports maneuvers. Once the essay is complete, students of the same sports cluster (example: football) will share their discoveries with three other small clusters of students each representing a different sport (examples: baseball, basketball, and soccer).

Extension

Option 1: Identify a sport's play that was not successful using your understanding of Newton's Laws to explain what could have gone wrong.

Option 2: Research another sport not covered in class and apply the same knowledge as to how Newton's Laws affected that sport.

Section 2: What Skills?

Preparing for the Task

TASK ENGAGEMENT: Ability to connect the task and new content to existing knowledge, skills, experiences, interests, and concerns

TASK ANALYSIS: Ability to understand and explain the task's prompt and rubric.

RUBRIC TRANSLATION: Ability to begin linking reading results to writing task and interpret the rubric.

Reading Process

NOTE-TAKING: Ability to use note taking sheet to cite specific textual evidence to support their analysis of specific science content.

ACTIVE READING: Ability to identify the central idea and provide an accurate summary of the text. **ESSENTIAL VOCABULARY**: Ability to apply strategies for developing an understanding of text(s) by locating words and phrases that identify key concepts and facts, or information.

ACADEMIC INTEGRITY: Ability to use and credit sources appropriately.

Transition to Writing

DISCUSSION: A Socratic seminar will take place before writing the full rough draft to allow the students an opportunity to formulate connections between the intended vocabulary and real sports maneuvers.

Writing Process

PLANNING: Ability to develop a line of thought and text structure appropriate to an information/explanation task.

DEVELOPMENT: Ability to construct an initial draft with an emerging line of thought and structure.

REVISION: Ability to refine text, including line of thought, language usage, and tone as appropriate to audience and purpose.

EDITING: Ability to proofread and format a piece to make it more effective. Opening paragraphs will be peer edited and then rewritten before the body paragraphs are written. Then another round of peer/self editing will occur before typing the final draft.

COMPLETION: Ability to submit final piece that meets expectations.

Section 3: What Instruction?

PACING	SKILL AND DEFINITION	PRODUCT AND PROMPT	SCORING GUIDE	INSTRUCTIONAL STRATEGIES
Preparir	ng for the Task			
30 mins	TASK ENGAGEMENT: Ability to connect the task and new content to existing knowledge, skills, experiences, interests, and concerns	LIST What are some of your favorite sports moments? What do you know about Newton's Laws of Motion and forces?	Student meets expectations if he/she does the following: None	 Link this task to earlier class content. Discuss student responses. Brainstorming session
Not provided	TASK ANALYSIS: Ability to understand and explain the task's prompt and rubric.	LIST In your own words, what are the important features of a good response to this prompt?	Student meets expectations if he/she does the following: Students are comprehending what is being expected of them.	 Share examples of type of text students will produce (either from past students or from professional writers). Identify or invite students to identify key features of examples. Create a classroom list: Choose one student to share a few ideas on the board, and ask other to add to it.
Not provided	RUBRIC TRANSLATION: Ability to begin linking reading results to writing task and interpret the rubric.	LIST In a quick write, write about how physics plays a role in sports.	Not Provided	Small group discussion using question.
Reading	Process			
3 hrs		NOTES From each text,take notes using a graphic organizer highlighting the elements that look most important for answering the prompt.	 Student meets expectations if he/she does the following: Identifies relevant definitions, as well as any cause and effect relationships. Teacher will pick up pages 10-13 of the writer's notebook. Students must have: 3-4 direct quotes, correct interpretaion of the quote, and the application of the quotes to their chosen sport. 	 For the first text, teacher should model and guide students through the graphic organizer. Oversee that students are filling out their active reading worksheets in their writer's notebook. Pacing: 2-4 days of active reading and note-taking

	Standards: RST.9-10.1 : Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.				
3 hrs	ACTIVE READING: Ability to identify the central idea and provide an accurate summary of the text.	SHORT CONSTRUCTED RESPONSE Following each reading, students will determine the central idea of a text and provide an objective summary.	Student meets expectations if he/she does the following: • The summary clearly shows how physics plays a role in the sport that the text is focused on.	 Provide guiding questions for them to answer as they are reading. Invite students to share and discuss their answers for each text. After the discussion, allow them to add to their essential vocabulary. highlight & make annotations. Pacing: 2-4 days 	
	Standards: RST.9-10.2 : Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.				
3 hrs	ESSENTIAL VOCABULARY: Ability to apply strategies for developing an understanding of text(s) by locating words and phrases that identify key concepts and facts, or information.	LIST In your writer's notebook on pages 8-9, list words and phrases essential to the texts. Add definitions, and (if appropriate) notes on connotation in this context.	Student meets expectations if he/she does the following: Writer's notebook pages 8 and 9 are graded for the following: accurate definitions and application to student's chosen sport.	 After scoring, ask some students to share definition of terms that others overlooked or misunderstood. After scoring, be willing to provide direct instruction or guide a close reading if needed to work through key phrase most students missed. Pacing: 2-4 days 	
	Standards: RST.9-10.5 : Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).				
Not provided	ACADEMIC INTEGRITY: Ability to use and credit sources appropriately.	SHORT CONSTRUCTED RESPONSE Define "plagiarism" and list ways to avoid it.	 Student meets expectations if he/she does the following: all quotes are properly cited. a works cited or bibliography is present. research is paraphrased 	 Discuss respect for others' work to assemble evidence and create texts. Discuss academic penalties for stealing others thoughts and words. 	

explanations or descriptions.

10 mins	DISCUSSION: A Socratic seminar will take place before writing the full rough draft to allow the students an opportunity to formulate connections between the intended vocabulary and real sports maneuvers.	SHORT CONSTRUCTED RESPONSE Explain how Physics plays a key role in all sports.	Student meets expectations if he/she does the following: Student wrote a well thought out answer in complete sentences and cited two peer responses.	Give each student a sticky note to jot down notes or student quotes during the seminar.
				hat relate the current discussion to broader themes or , or challenge ideas and conclusions.
Writing	Process			
2 hrs	PLANNING: Ability to develop a line of thought and text structure appropriate to an information/explanation task.	OUTLINE Create an outline (pg. 14 of the writer's notebook) based on your notes and reading in which you state your thesis, develop three topic sentences, and note your supporting evidence.	Student meets expectations if he/she does the following: Teacher will check pg. 14 in the writer's notebook for the following: clear and accurate thesis, three different assertions (topic sentences)- one for each supporting body paragraph.	 Provide and teach one or more examples of outline or graphic organizers. Invite students to generate questions in pairs about how the format works, and then take and answer questions. Pacing: 2-3 days
1 hr and 30 mins	DEVELOPMENT : Ability to construct an initial draft with an emerging line of thought and structure.	LONG CONSTRUCTED RESPONSE Write an initial draft complete with opening, development, and closing; insert and cite textual evidence.	Student meets expectations if he/she does the following: N/A	 AECR (body paragraphs) Writing conferences Pacing: 1-2 days
hr and 30 mins	REVISION: Ability to refine text, including line of thought, language usage, and tone as appropriate to audience and purpose.	LONG CONSTRUCTED RESPONSE Peer edits are conducted using a checklist to ensure academic vocabulary is used and applied correctly. Use textual evidence carefully, with accurate	Student meets expectations if he/she does the following: • Provides complete draft with all parts. • Supports the	 Read students outlines or rough drafts to see if the on the right track. peer editing Pacing: 1-2 days

			 and citations. Improves earlier edition. has another student read and provide suggestions to improve their work. Peer editor can find 3-4 direct quotes and parenthetical citations. 	
Not provided	EDITING : Ability to proofread and format a piece to make it more effective. Opening paragraphs will be peer edited and then rewritten before the body paragraphs are written. Then another round of peer/self editing will occur before typing the final draft.	LONG CONSTRUCTED RESPONSE Revise draft to have sound spelling, capitalization, punctuation, and grammar. Adjust formatting as needed to provide clear, appealing text.	 Student meets expectations if he/she does the following: Provides draft free from distracting surface errors. Uses format that supports purpose. 	 Briefly review selected skills that many students need to improve. Teach a short list of proofreading marks. Assign students to proofread each other's texts a second time.
Not provided	COMPLETION: Ability to submit final piece that meets expectations.	LONG CONSTRUCTED RESPONSE Turn in your complete set of drafts, plus the final version of your piece	 Student meets expectations if he/she does the following: Fits the "Meets Expectations" category in the rubric for the teaching task. 	Not Provided

Instructional Resources

Student Handout

Writer's Notebook

Section 4: What Results?

Student Work Samples

Not Yet

Newton's Laws

Teacher Reflection

Not provided

All Attachments

% Top 10 Super Bowl Plays of all time. (student) : https://s.ldc.org/u/c8ed57v0or2ra57lffphg7l04

% The 50 Greatest MLB Plays of All Time. (student) : https://s.ldc.org/u/1svjield23q1tlt9o9r2dbwu1

 $\boldsymbol{\diamondsuit}$ The Best Moves in the History of the NBA. (student) :

https://s.ldc.org/u/78irv5stxf286atp66cmw8hoc

[∞] Best Sports Moment in each of the 50 States. (student) : https://s.ldc.org/u/805bwsc5k9gby2xa1lf8evrgt

% 76 Great Moments in Sports. (student) : https://s.ldc.org/u/8t2iqdkcj75i1at6mufaod3r2

⊗ Jeff Duncan's Top 10 New Orleans Saints plays of all time. (student) : https://s.ldc.org/u/792fk7r63cblqbnie03ytxa9r

𝗞 100 plays, performances and moments that define college football. (student) : https://s.ldc.org/u/7thah86yyltns63jrhbq6sdwl

[∞] Science Videos. various videos that explain the physics behind specific sports. (student) : https://s.ldc.org/u/ddwbbo948i68519lvpsl073c0

[∞] ESPN's Sports Science videos. Short video clips that illustrate experiments performed with athletes and their associated equipment to explain the science behind the plays. (student) : https://s.ldc.org/u/et6upskbpmaiwidtgx2oviir6

Newton's Laws : https://s.ldc.org/u/6ipmut5hxx31unpcrdhqifh5c

Lce Skating : https://s.ldc.org/u/8j7cvw6dqhornkkzpd6snuybc

Writer's Notebook : https://s.ldc.org/u/386bxk27u15tnvbcm6p2o8r9i