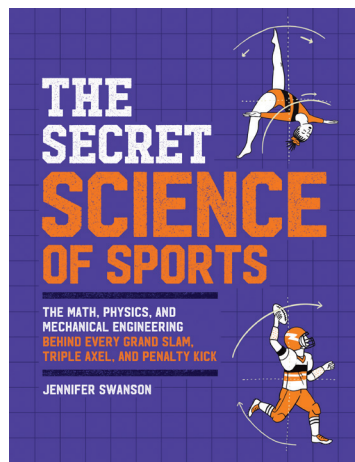




BLACK DOG  
& LEVENTHAL  
PUBLISHERS

## A Study Guide from BLACK DOG & LEVENTHAL



## THE SECRET SCIENCE OF SPORTS

*The Math, Physics, and  
Mechanical Engineering Behind  
Every Grand Slam, Triple Axel,  
and Penalty Kick*

By Jennifer Swanson

**W**hy does a football spiral? How do some athletes jump so high? The answer is science! *The Secret Science of Sports* helps kids better understand concepts of science, technology, engineering, and math through the sports they love to play and watch.

## CHAPTERS 1

### PUTTING THE SCIENCE IN SPORTS INTRODUCTION:

- Why are you reading *The Secret Science of Sports*? What are three things you want to learn about the science of sports?
- Do you play any sports? Which ones? How do you hope STEM (Science, Technology, Engineering, and Math) will help you become a better athlete?
- If you don't play sports, what do you hope to learn from reading this book?
- Write a list of personal goals you have for the sport you play. If you don't play a specific sport, what are some of your overall fitness goals? Do you hope to run longer distances or build muscle? After writing down your goals, see if there are sections of this book that will help you achieve your fitness goals. Which sections are you most curious to learn more about?

### BODY SCIENCE

- What do you know about body, brain, and fitness science? What do you think the differences (or similarities) are among them?
- Drag is "the force that acts against something when they move through a fluid, such as air or water." Sometimes, body shape plays a large role in performance. Research two athletes with different body types. How do their bodies match their sport? How does drag influence their performance?

- Can you change your body to fit the sport you want to play? What would you have to work on to be a good basketball player? What about a swimmer?
- How does body fat influence your performance in sports? Using the guide on page 17, calculate your own body fat. What did you discover?
- Research one of the positions on a football team. Can you identify any famous athletes who hold those positions? What part, if any, do you think their body type plays in their selection? Come up with some surprising examples, ie. Athletes whose bodies are uniquely designed to excel, despite what body type research says is preferred.
- What is the ultimate goal of athletic performance? I am not sure how to answer this myself? What is your idea of the ultimate goal of athletic performance? It's different for everyone.
- The average height of an NBA basketball player is 6'7" - the size of a Dromedary camel! How tall are you compared to a camel? Research other tall animals and draw a picture of them next to you to compare sizes.
- "According to many coaches, being tall isn't the only thing that can make a great basketball player" (21). What are a few other qualities that make a great basketball player?
- Using the directions on page 23, measure your wingspan. Why is a longer wingspan so important in basketball? In swimming?
- What are a few sports that involve a high vertical leap? Measure your own vertical leap using the directions on page 24. How can you increase your vertical leap?
- What does "range of motion" mean?
- What is the difference between speed and agility? Why are they important to the science of sports?
- Try this challenge: Complete the stretches in the "Loos-

OVER >>>

en Up!” section on page 31. See if you can practice these stretches every day to track your flexibility. What are some sports that require you to be flexible?

## BRAIN SCIENCE

- “\_\_\_\_\_ fitness is just as important as physical fitness (34).” Do you agree or disagree? Why?
- Using pages 34-35, write down the definitions to the parts of the brain below. Then, using a shower cap or swim cap and a marker, map out the parts of the brain with a partner on the cap. Quiz each other on which parts of the brain help with different functions of the body.
  - Frontal Lobe:
  - Parietal Lobe:
  - Temporal Lobe:
  - Occipital Lobe:
- What is focus? Find 3 examples from the book that demonstrate the importance of focus for athletes.
- Think of a time when you really needed to focus. What were you doing? Why was this moment important?
- Try this challenge:
- Using the directions on page 40, practice your focus using mental imagery. Record your observations below.
- How was your experience practicing mental imagery in silence?
- How was it when you turned your music on and tried it again? What did you notice when you were trying to focus?
- Where is your cerebellum? Find it with your fingers! What is the cerebellum’s purpose?
- Test your balance by standing on one foot with your eyes closed. How long can you stand before wobbling?
- Why is balance in sports so important? Can you think of a few other instances where balance is important?

## FITNESS FUN!

- What is Isaac Newton’s Third Law of Motion? How does this apply to sports? Research the Third Law of Motion and find three other careers/hobbies where this law applies.
- Pain is part of an athlete’s life. Which part of your brain processes pain? Do you think we process physical and emotional pain the same way?
- Think of a time when you got hurt playing a sport. What happened? Where did you feel pain and what type of pain was it? What did you do when you got hurt?
- The cardiovascular system is made up of your heart and all of the blood vessels in your body. Why is this system so important for good physical health?
- Using the directions on page 48, try to find your pulse. What is your bpm (“beats per minute”)? What does this say about you in your current state? What if you find your bpm after sprinting from one end of the room to the other? What changes?
- Your lungs, airways, and blood vessels make up the \_\_\_\_\_ system. Draw a picture of this system in your body.

## FILL ‘ER UP!

- Draw a picture of your top three favorite foods. Where do they fit on the food plate on page 50?
- \_\_\_\_\_ helps you build muscle, bones, skin, and hair. Can you think of other foods that are rich in this nutrient?
- Create your own food journal using a notebook or a digital file (like Word or Google Docs). Keep note of everything you eat for one week. What did you notice? Are you eating a balanced meal or eating more of one kind of food?
- What is your body’s main source of energy? What happens you don’t eat enough of this source?
- Doctors recommend that you drink up to eight glasses of water a day. How many do you drink right now? How can you increase your daily water intake?
- “Combining \_\_\_\_\_ and \_\_\_\_\_ actually makes you a more informed and well-trained athlete” (54).

## CHAPTER 2:

### THE T IN SPORTS STANDS FOR “TECHNOLOGY” SPEED AND POWER

- Brain Buster: Set a timer for one minute. List as many sports equipment names as you can!
- Research sports equipment from different decades (and even centuries). How has technology changed over the years? Do you think you could play your favorite sport using equipment from 100 years ago?
- What is nanotechnology? List a few examples of sports equipment that is made with carbon fibers.
- Using the information about carbon nanotubes on page 60, invent a new piece of sports equipment. How would you use resin and carbon fibers to create something new?
- Bikes are a perfect example of nanotechnology in sports. Cyclists need to use bikes that are super fast and lightweight. Research the different bikes that cyclists use in the Tour de France. Don’t know what the Tour de France is? Research the history of this world-famous race. Who were some of the competitors and winners over the years?
- “The more something weighs, the more energy is required to move it” (61). Find five things in your house or classroom that vary in size and shape. How much energy does it take for you to move these things from one side of the room to the other? How much do you think each object weighs? How does your body feel after moving them?
- A swimsuit is actually a piece of sports equipment! Technology for swimsuits has changed drastically over the years. If you had every resource available to you, what would the perfect swimsuit be made of? What would it look like? Draw a picture of the perfect swimsuit.

## SAFETY FIRST

- What is a concussion? Can you get a concussion even if you are not playing a contact sport?
- Try this challenge:  
Using the directions on page 69, explore what an impact looks like. You will need a balloon to complete this challenge. Experiment with different forces of impact - are you hitting the balloon too hard? What happens? What happens when you tap the balloon instead of punching it?
- Greater impact means a higher chance of injury. Refer back to page 34, the parts of the brain. What happens to your brain when you experience a strong impact?
- What is a gyroscope? What does it look like? Can you use this in areas other than sports?

## WEARABLE TECHNOLOGY

- Try this challenge:  
Use a pedometer during a regular day. How many steps did you take? For someone your age, research the ideal amount of steps in order to maintain a healthy lifestyle.
- GPS, or Global Positioning System, uses satellites to track your movement using a fitness tracker. What else do we use GPS for? How can we use GPS in our daily lives?
- What are the two basic stages of sleep?
- Try this challenge:  
Using the “Track Your Daily Calories” section on page 74, log everything you eat in a food journal. Visit [www.myplate.gov](http://www.myplate.gov) to search for your food and find the number of calories. How many calories should a child between the ages of six-12 consume each day? Are you over or under this number?

## SENSE-IBLE SHOES

- Did you know running shoes are packed with technology?! Research a well-known shoe brand. How do they enhance their sneakers for top performance?
- How does “shoe technology” work? What are some examples of the materials used to create technology-enhanced sneakers?
- Brooks Running is one sustainable shoe company. Take to the Internet to search for more sustainable brands. What does “sustainability” mean? Why is this important?

## PREVENTING INJURY

- What do athletic trainers do? If you are in school, see if you could interview your athletic trainer. What qualifications must you have to be an athletic trainer?
- What is biometric data?

## LOOKING AHEAD

- What is graphene?

- Graphene is the same thing as your \_\_\_\_\_ sitting at your desk!
- \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ are all related. They are all made up of \_\_\_\_\_ atoms.
- Research the other uses for graphene. Can it be used for materials other than sports equipment? If you had to invent a use for graphene, what would you create?
- Is using technology in sports equipment fair? Do you believe it's fair or unfair? Take this one step further and see what you can discover about this topic online. Write a persuasive essay on this topic.

# CHAPTER 3:

## ENGINEERING A WIN PHYSICS IS YOUR FRIEND

- What is physics? How would you use physics outside of sports and physical fitness?
- What does an engineer do? Research two different types of engineers and explain their jobs. Do you think it would be fun to be an engineer someday?
- Using pages 89-91, make a three-column chart of Newton's Laws of Motion. Summarize what each law does and provide examples.
- Grab a tennis racket (or whatever you might have at home or at school) and go outside to an open area. Make sure there are no cars or people nearby! Practice engineering your perfect tennis shot using the example on page 93. When you're ready, using your racket and a ball, see how far you can hit the ball. How hard must you hit the ball to send it across a court? How much energy did you use?
- What other sports use the “wind-up,” or swinging method, with their arms? What does this method tell us about physics? Which law of motion is this?
- What is a lever? Which parts of your body act as levers?
- Why do you plant your feet when you swing your arms in lacrosse or tennis? Give it a shot! Choose any sport (lacrosse, baseball, tennis, Ping-Pong) and pretend to hit a ball. What do you notice about your arm placement? Your legs? (Use page 96 for help.)
- What is gravity? Write a short story about what you would do if there was no gravity on Earth. What would you do?
- What is projectile motion and why should we care about it?
- Using the chart on pages 100-101, practice throwing a ball to experiment with force and angle. With a partner, determine how far you can throw a ball. What happens when you throw the ball high into the air? What happens if you kick a ball instead?
- Try this challenge:  
Complete the “Throwing Practice” activity on page 103. Record your findings. Did you notice that changing the angle and the speed of the football affected the person trying to catch it?

- Where is the “sweet spot” on a baseball bat? Why is this important?
- Try this challenge:  
If you have a baseball bat, complete the challenge on page 110. What did you discover when trying to find the “sweet spot?”
- What is the science behind hitting a homerun? What factors do you need to keep in mind when “swinging for the fences?”
- Where does the phrase “bend it like Beckham” come from? Research this famous soccer player. What makes him so talented?
- Practice your shot! Using the directions on page 118, practice shooting a basket. (You don’t even need a hoop to do this!) What did you observe? What happens when you change the angle of your shot? What about your force?
- Mechanics: Shapes Make the Sport
- Imagine a world where all the balls in sports were a different shape. What would happen if a basketball was shaped like a triangle? What if a golf ball was a square? Why is having a rounded shape so important for this equipment?
- Set a timer for one minute. See how many sports you can name that do not use balls. How many could you name?
- Try this challenge:  
Complete the “Test it Out” challenge on page 122. Why is bounce such an important part of using different balls in sports?
- What is lift and how does it work as what does it do when a ball passes through the air?
- Smaller is Better (for some sports)
- “The average speed a major league baseball pitcher throws a baseball is between \_\_\_ and \_\_\_ miles per hour.” How fast do you think YOU could throw a baseball?
- Try this challenge:  
Complete the activity on page 124 - “Learning About Lift and Drag.” You can make a drawing of this to compare each type of ball and the way it moved.

- Scoring the Game
- What are statistics? Why are they an important part of the science of sports?
- What is probability? Have you used probability to discover the outcome of a game before? How else can you use probability in everyday life?
- What is split time? What about overall time? Find a partner and see if you can put this into practice. You will need one stopwatch. Use page 135 to help you.
- Many watches have a split button. How does it work? When the first athlete takes off, you start the time. As the first athlete reaches the point where the next athlete is ready to go, push the split button on your watch. Add up your times. If you do not have a stopwatch, count the times in your head!
- Research your favorite athlete. See if you can find their statistics - what’s their shooting average if they play basketball? What about their batting average? What do these numbers say about the athlete’s performance? (Use pages 130-149 for help!)
- Are there other ways to calculate an athlete’s statistics? What are a few other sports that would use probability and statistics to measure an athlete’s progress?

COMMON CORE STANDARDS

**ENGLISH/LANGUAGE ARTS:  
INFORMATIONAL TEXT**

CCSS.ELA-LITERACY.RI.6-8.1  
CCSS.ELA-LITERACY.RI.6-8.3  
CCSS.ELA-LITERACY.RI.6-8.4  
CCSS.ELA-LITERACY.RI.6-8.7

**ENGLISH/LANGUAGE ARTS:  
WRITING**

CCSS.ELA-LITERACY.W.6-8.1  
CCSS.ELA-LITERACY.W.6-8.3  
CCSS.ELA-LITERACY.W.6-8.7

**ENGLISH/LANGUAGE ARTS:  
SCIENCE AND TECHNICAL  
SUBJECTS**

CCSS.ELA-LITERACY.RST.6-8.2  
CCSS.ELA-LITERACY.RST.6-8.2  
CCSS.ELA-LITERACY.RST.6-8.2  
CCSS.ELA-LITERACY.RST.6-8.7

**MATHEMATICAL PRACTICE:  
STATISTICS AND PROBABILITY**

CCSS.MATH.CONTENT.6.SP.A.1  
CCSS.MATH.CONTENT.7.SP.A.1  
CCSS.MATH.CONTENT.7.SP.C.5  
CCSS.MATH.CONTENT.7.SP.C.7

