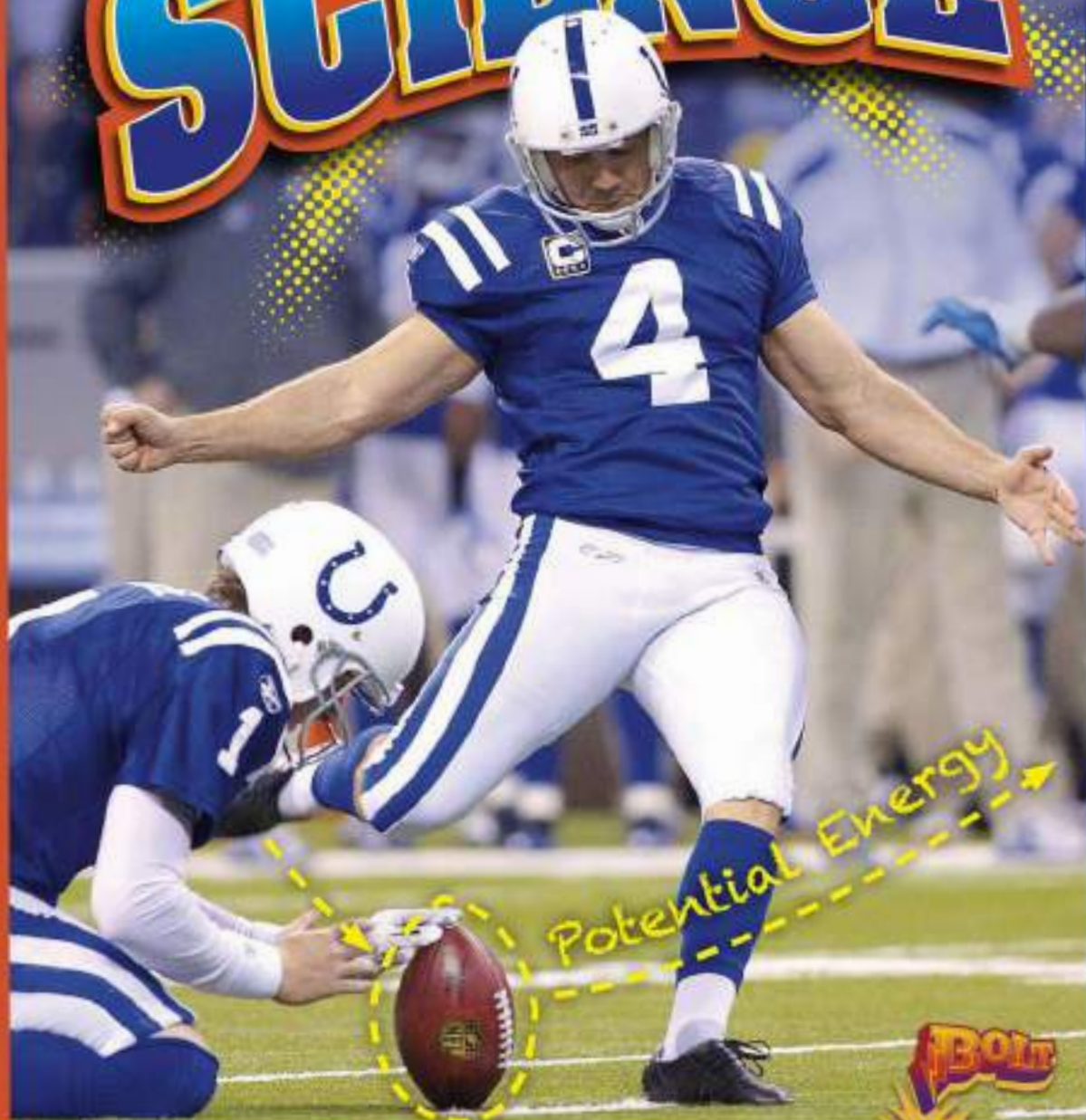


# FOOTBALL SCIENCE



**BOLT**

**Got Game**

# FOOTBALL SCIENCE

**Nicki Clausen Grace  
and Jeff Grace**



**BLACK  
RABBIT  
BOOKS**



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# Working

## for the Win

A player runs the football toward the end zone. **Defenders** clear the way. Fans cheer him on. When the game ends, the roof over the field slowly closes.

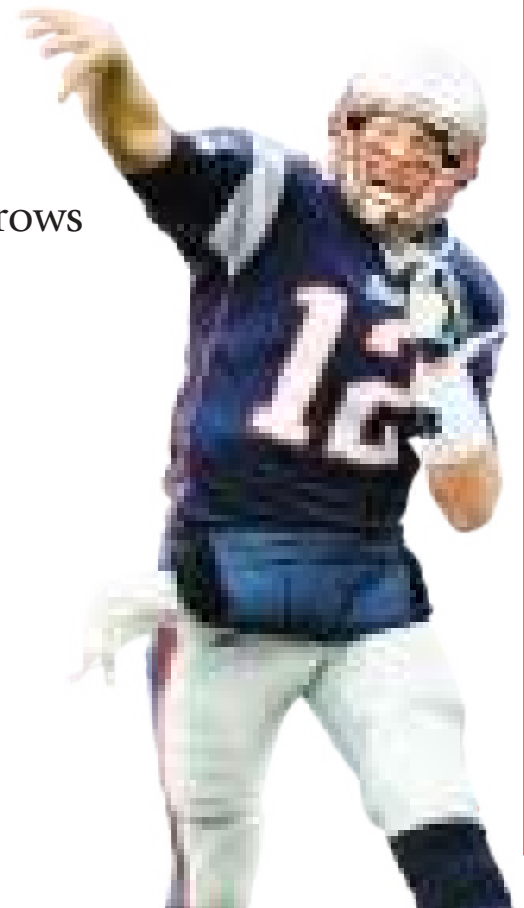
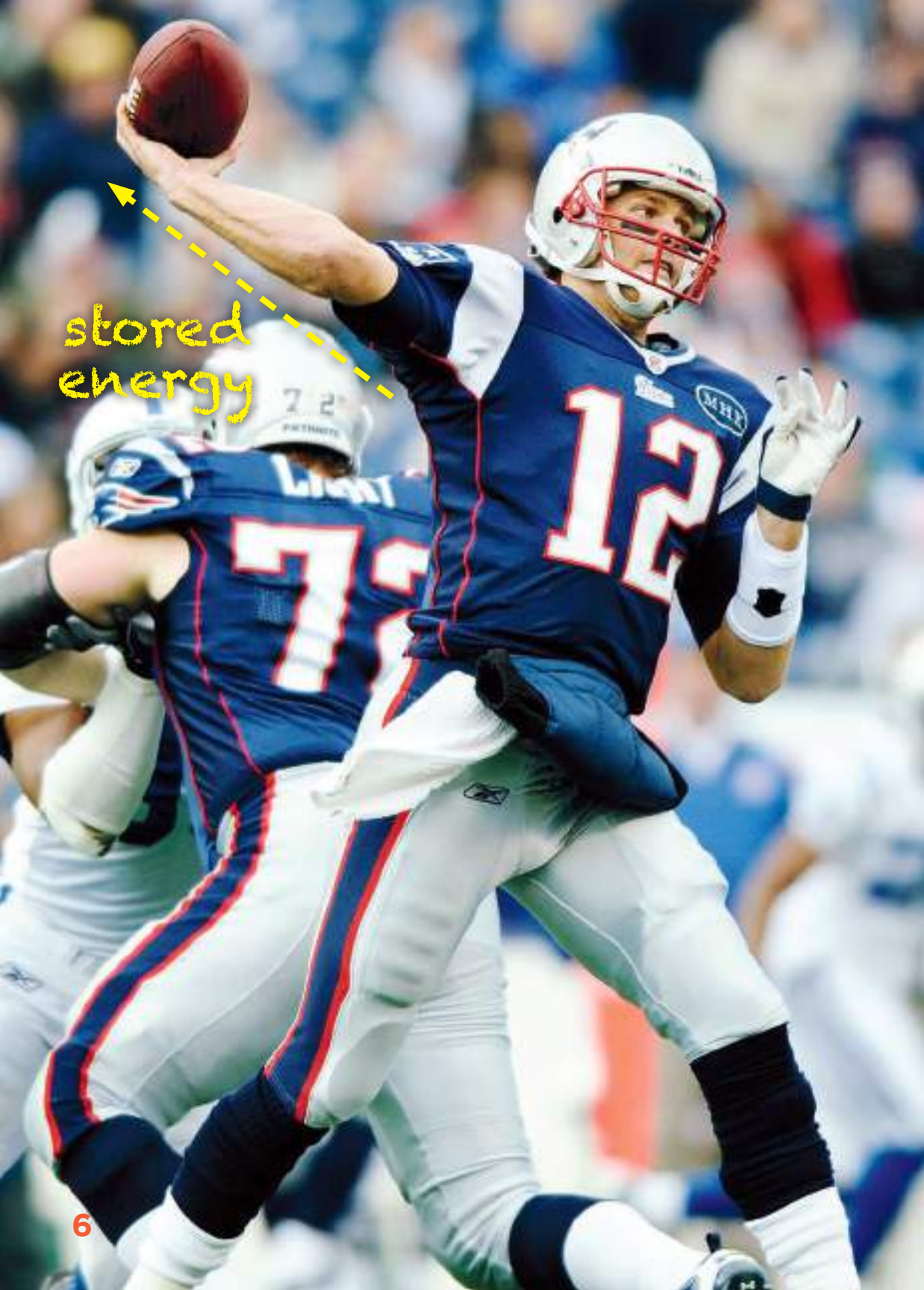
This scene is fun. It also shows how science and technology are a part of football.



## All Kinds of

# Energy

Energy is how things change and move. Tom Brady brings his arm back to throw the ball. He has stored energy. He then uses that energy to change the ball's position. He throws a perfect spiral.



## Potential and Kinetic Energy

Kicker Adam Vinatieri prepares to kick the ball. The ball isn't moving. Just like Brady's arm, the ball has **potential** energy. Vinatieri kicks. As the ball moves, it has **kinetic** energy.



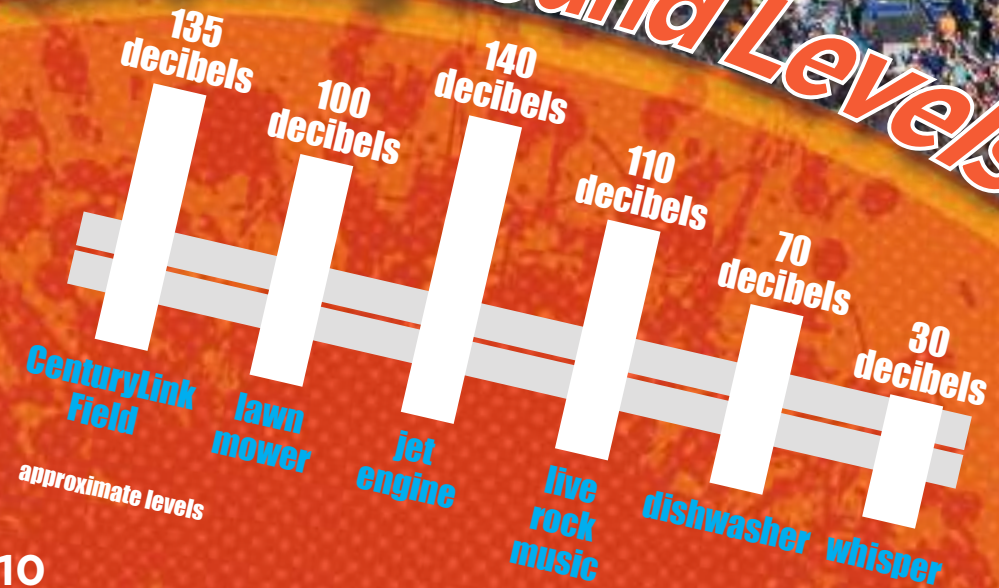


## Sound Energy

Fans produce a lot of sound energy. Vibration is when something moves back and forth. The movement makes sound energy. A fan's **vocal cords** vibrate when he or she cheers.

CenturyLink Field is home to the Seattle Seahawks. It holds and **reflects** sound. Fans' cheers bounce around the stadium.

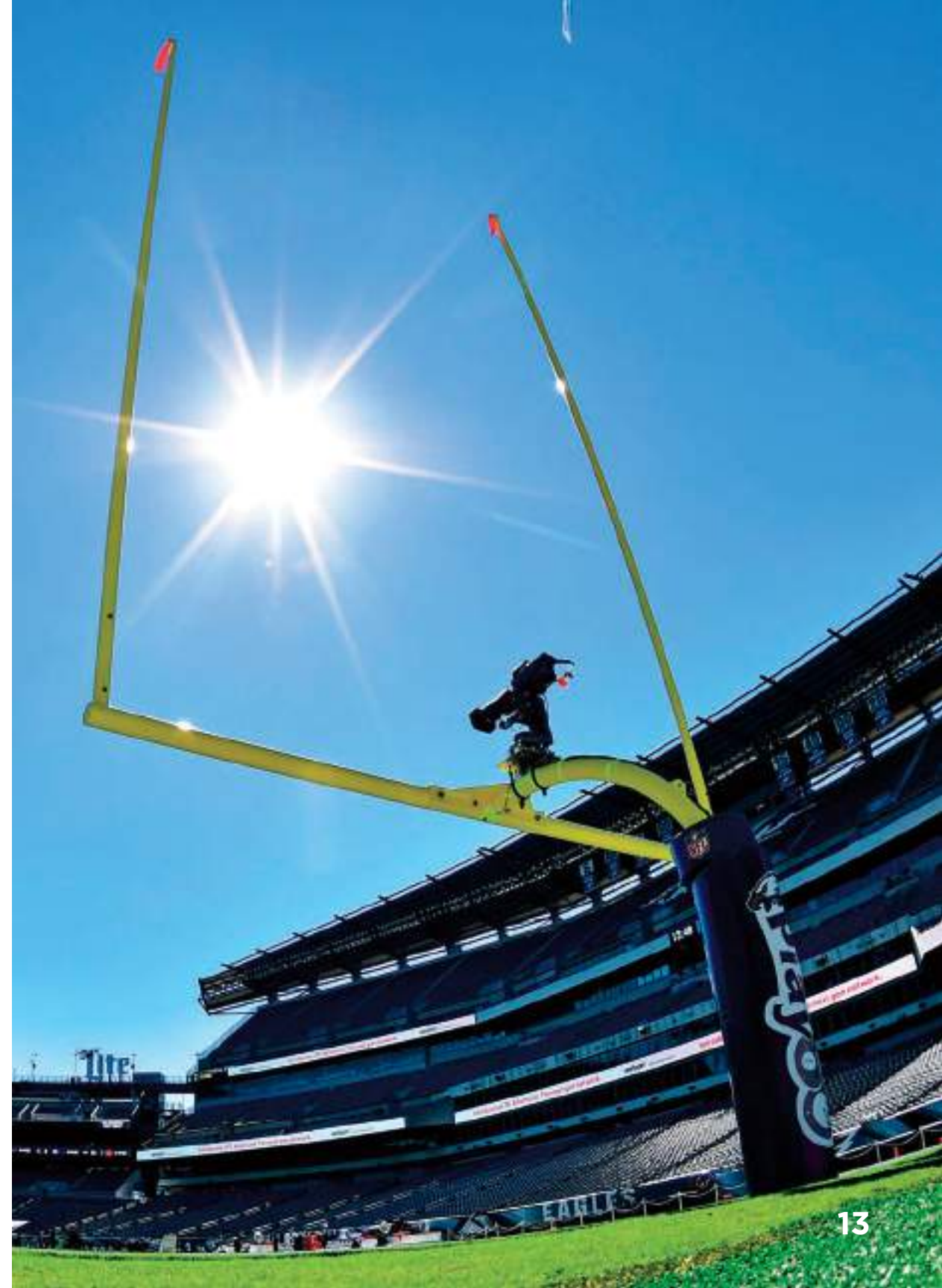
## Comparing Sound Levels



## Electrical Energy

- Loud music and bright lights are part of football fun. Stadiums use electrical energy to power those systems.

Some stadiums use sun or wind energy too. The Philadelphia Eagles' stadium uses **solar** and wind power.





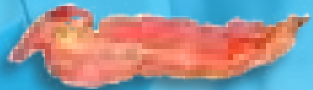
**J. J. Watt**  
needs up to  
**9,000**  
calories  
a day.

**That equals**  
about:

**20**  
chicken breasts



**50**  
strips of bacon



**12**  
avocados



## Food Energy

Football players tackle, catch, run, and pass. They need a lot of energy. When they eat, their bodies change food to chemical energy. That energy gets them up and running.



## Game-Changing

# Technology

Thanks to technology, football has become safer. In the early 1900s, players wore leather pads. Some wore soft caps.

Players now wear hard helmets and pads. Helmets have padding inside. They also have masks to protect players' faces.



HELMET

SHOULDER  
PADSTHIGH  
PADS

KNEEPADS

CLEATS

# Technology On the Field



**Speakers in players' helmets let them hear their coaches.**



**Coaches and players watch replays on tablets.**

**Sensors in pads collect data about players' bodies.**



**Referees review video. They talk about calls with officials in New York.**





## Play It Again

Instant replay allows people to see a play from different sides. Referees watch the videos. They can make more accurate calls. Instant replay can make big differences in games.

In January 2015, the Packers played the Cowboys. The Cowboys were down by five points. The Cowboys' Dez Bryant jumped up for the ball. The refs called it a catch.

But then they watched the instant replay. They decided Bryant didn't catch the ball. Many say this call was a big reason the Cowboys lost.



# Engineered

## for a Win

The Dallas Cowboys play at AT&T Stadium. It is the largest column-free room in the world. Columns help hold up roofs. Without columns, engineers had to find other ways to hold up the roof.



## Room For Fans

Giants' and  
Jets' MetLife  
Stadium

**82,500**  
seats

Cowboys'  
AT&T  
Stadium

**80,000**  
seats

Panthers'  
Bank of America  
Stadium

**75,419**  
seats

Seahawks'  
CenturyLink  
Field

**68,000**  
seats

Steelers'  
Heinz Field

**65,500**  
seats

# University of Phoenix Stadium

## BY THE NUMBERS

**19 million pounds**  
(8,618,255 kilograms)  
**weight of the field**

**234 feet**  
(71 meters)

**WIDTH OF THE FIELD**

**403 feet**  
(123 m)  
**LENGTH OF THE FIELD**

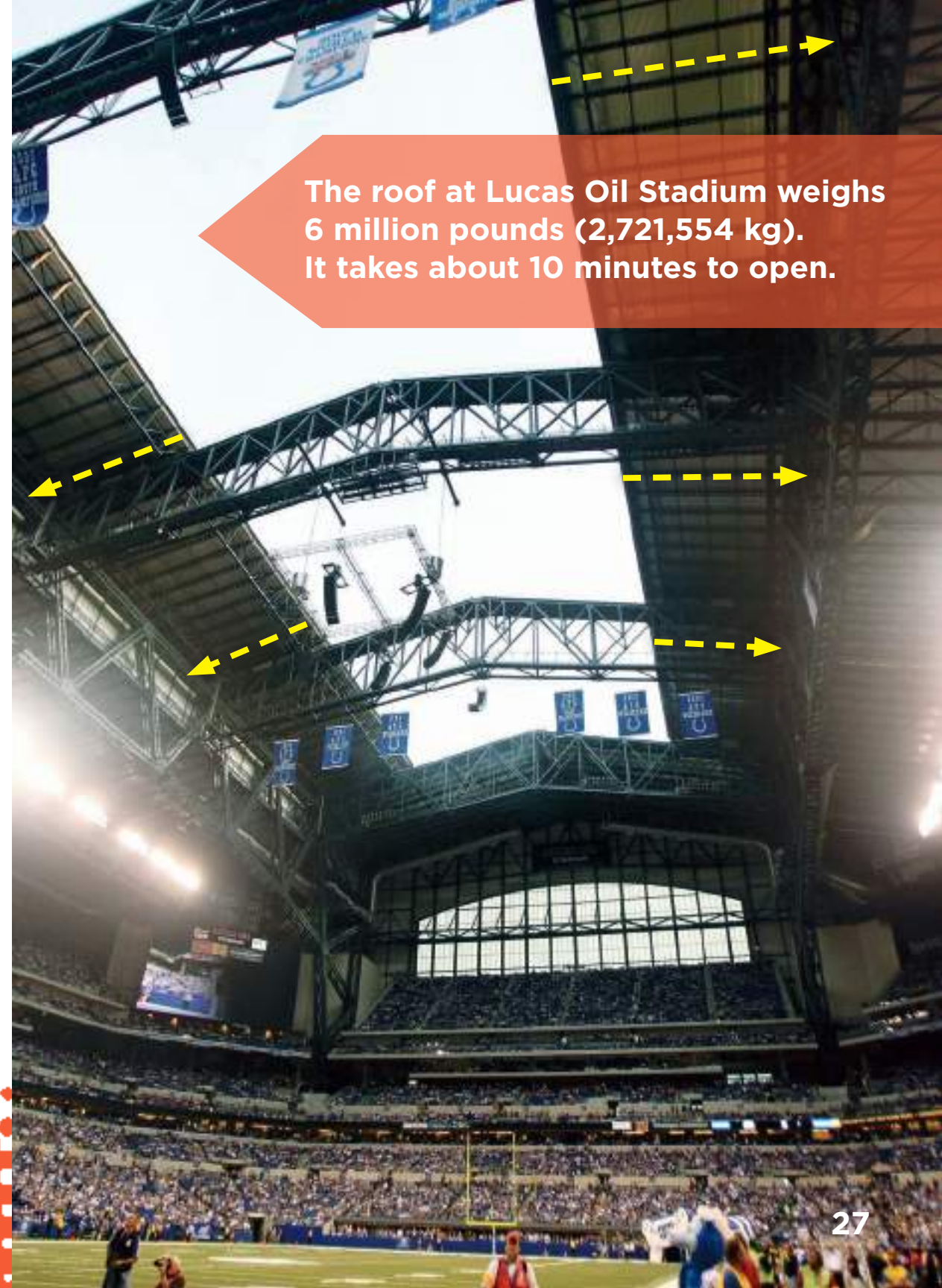
## Grass Tech

The Cardinals play at the University of Phoenix Stadium. The roof there doesn't let in enough sunlight to grow grass. Engineers came up with a solution. The stadium uses grass grown on a large tray. Workers roll it outside between games.

**75 MINUTES**  
time it takes to roll the field into place

## Rolling Roof

Sometimes the weather is just right for football. Sometimes it is not. Engineers made roofs that open and close. Lucas Oil Stadium has the NFL's largest **retractable** roof.



The roof at Lucas Oil Stadium weighs 6 million pounds (2,721,554 kg). It takes about 10 minutes to open.



## Science in Football

Football has changed a lot over the years. Players and scientists have created today's exciting game. Technology will continue to change football. But one thing won't change. Science and math are always at work on the field.



**calorie** (KAH-luh-ree)—a unit used to indicate the amount of energy foods will produce in the body

**defender** (de-FEN-dur)—a player who works to stop the other team from scoring

**kinetic** (ki-NEH-tik)—relating to the movement of objects

**potential** (po-TEN-shul)—capable of becoming real

**reflect** (ree-FLEKT)—when light or sound hits a surface and quickly bounces off in another direction

**retractable** (ree-TRAKT-uh-buhl)—able to be pulled back

**sensor** (SEN-sor)—a device that detects heat, light, sound, motion, or other things

**solar** (SO-lur)—relating to the sun

**vocal cords** (VO-kul KORDZ)—the thin pieces of tissue in a person's throat that make sounds

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Football: STEM in Sports

[www.connectamillionminds.com/campaigns/stem-in-sports/football](http://www.connectamillionminds.com/campaigns/stem-in-sports/football)

The Physics of Football

[scienceofeverydaylife.discoveryeducation.com/teachers/blog/index.cfm/2010/12/27/The-Physics-of-Football](http://scienceofeverydaylife.discoveryeducation.com/teachers/blog/index.cfm/2010/12/27/The-Physics-of-Football)

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