EDU

FOUNDING PARTNER

Chevron

DIGITAL PLAYBOOK

SCIENCE
TECHNOLOGY
ENGINEERING
ARTS
MATHEMATICS

in Football

NAME

TEACHER

SCHOOL

PROPERTY OF

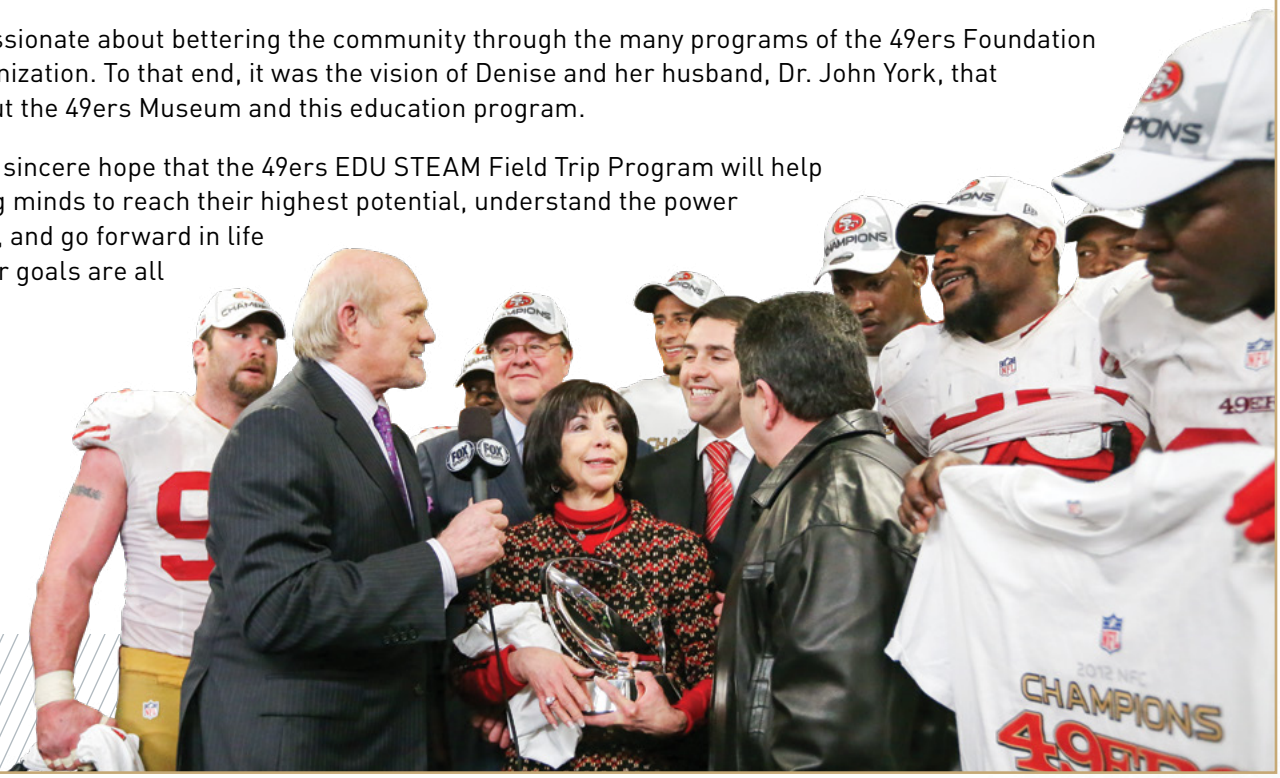
DENISE DEBARTOLO YORK

Denise DeBartolo York is one of the most influential women in the history of professional sports and has been an integral part of 49ers football for more than three decades. Earlier in her career, she served as the President of the Pittsburgh Penguins hockey team, where she helped revitalize and transform the franchise into a Stanley Cup winner. She is one of only 12 women to have her name engraved on the Cup and is one of the pillars around which the 49ers have built Super Bowl-winning teams.

The focus of her life continues to be helping at-risk and disadvantaged youth by devoting her time, guidance, and financial assistance to redirect the pathway of their lives and the course of their destinies.

Denise is passionate about bettering the community through the many programs of the 49ers Foundation and the organization. To that end, it was the vision of Denise and her husband, Dr. John York, that brought about the 49ers Museum and this education program.

It is Denise's sincere hope that the 49ers EDU STEAM Field Trip Program will help inspire young minds to reach their highest potential, understand the power of teamwork, and go forward in life knowing their goals are all within reach.



PLAYBOOK CONTENTS

WELCOME

DEAR STUDENTS, FAMILIES AND TEACHERS,

First, please let me say that we at the 49ers hope that you are well and you are finding your adjustment to distance learning to be a positive one. As the CEO of our organization, and a long time believer in the power of a good education, it is very important to me that we meet these challenging times with innovative ways to deliver our award-winning 49ers EDU programming. To that end, I hope you find this digital version of the 49ers EDU learning playbook to be engaging, educational and entertaining. This is the first in a series of efforts we will be making in the short- and long-term to increase the digital availability of our work, and we truly hope it helps reinforce the significant efforts you are making to continue learning and teaching from afar.

SINCERELY,

JED YORK
CEO, SAN FRANCISCO 49ERS

EXPLORING THE GAME: RULES OF FOOTBALL

The rules of the game are important to keep the contests fair and players safe. Below are some examples that will help you understand NFL Football. **ACTIVITY:** Before you explore the Digital Playbook, discuss with a teammate, and take notes, how you think STEAM (Science, Technology, Engineering, Arts, and Math) is related to the game of football.

THE FIELD

THE FIELD MEASURES 120 YARDS LONG AND 53 1/3 YARDS WIDE.
White markings along the field help the players, coaches, and referees keep track of where the football needs to be. The **end zone** is the scoring area; to score points, the team with possession of the ball carries the ball into the opponent's end zone.

FIRST DOWN

Yards, marked by the white lines on the field, are how progress is measured in a football game. The offense tries to get as much **yardage** as possible to gain inside its opponent's end zone to score. The offense has four downs (attempts or chances) to gain 10 yards each time it has the ball. If the team successfully moves the ball 10 or more yards, another **first down** is earned. A second attempt is called a **second down**, and so on until the team reaches **fourth down** and ordinarily gives up possession of the ball, usually with a **punt** (kick) to the defense.

THE KICKOFF

A game starts with the **kickoff**. With the ball placed on a kicking tee at the defense's 35-yard line, the kicker kicks the ball to the offense. A player on the offense, labeled a **returner**, tries to catch and advance the ball by running. If the player is stopped, the offense resumes position on the yard line where the ball was stopped.

TACKLE

The defense stops the offense from moving the football down the field by bringing the ball carrier to the ground. This is called **tackling**. If a player with the ball runs out of bounds, the play is whistled dead (or over).

MOVING THE BALL

A play starts on the **line of scrimmage**, an invisible line along which the offense lines up. The football is placed on the line by the center and is handed off to the quarterback, who may choose to throw (pass), hand off, or run with the football.

TURNOVERS

The defense can take possession of the ball in two ways: an **interception**, which is when the defense catches the ball before it hits the ground, or a **fumble**, when the defense recovers a ball that the ball carrier has dropped.

FUN FACTS

THE TOTAL SQUARE FOOTAGE OF THE SCOREBOARDS AT LEVI'S® STADIUM IS **19,200**

5-TIME SUPER BOWL CHAMPIONS

32 TEAMS IN THE NFL

THE TEAM WHO WINS IN THE SUPER BOWL RECEIVES THE VINCE LOMBARDI TROPHY. IT WEIGHS ABOUT **6.7 LBS**

42 THE NUMBER OF YEARS THAT THE 49ERS CALLED CANDLESTICK PARK THEIR HOME STADIUM

AT LEVI'S® STADIUM, GUESTS WILL NEVER BE MORE THAN **10 FEET** AWAY FROM A WI-FI SIGNAL WHILE IN THEIR SEATS

DID YOU KNOW?

THE 49ERS MUSEUM LOGO INCLUDES SILHOUETTES OF: **DWIGHT CLARK**, **JOE MONTANA**, **BILL WALSH**

MUSEUM

EXPLORING THE GAME: SCORING

POINTS

In the NFL, you can score points in three different ways during gameplay: Touchdown, Field Goal, and Safety. After scoring a Touchdown, teams have the choice of kicking an extra point, or attempting a two-point conversion.

6	3	2	2	1
TOUCHDOWN 6 POINTS	**FIELD GOAL** 3 POINTS	**TWO-POINT CONVERSION** 2 POINTS	**SAFETY** 2 POINTS	**EXTRA POINT** 1 POINT
To score a **touchdown** (TD), the ball must be carried or caught across the goal line in the opposite end zone.	The ball must be kicked in between the goalpost uprights and over the crossbar to score.	Following a touchdown, the offense can run or throw the football over the goal line into the end zone instead of kicking for an extra point.	A **safety** is made when an offensive ball carrier is tackled behind his own goal line (in the end zone).	Following a touchdown, the scoring team can successfully kick the ball through the uprights of the field goal posts.

ACTIVITY

Using the NFL point system above, determine the various ways the 49ers could have reached their final score in each Super Bowl victory.

SUPER BOWL XVI	SUPER BOWL XIX	SUPER BOWL XXIII	SUPER BOWL XXIV	SUPER BOWL XXIX
(26–21)	(38–16)	(20–16)	(55–10)	(49–26)

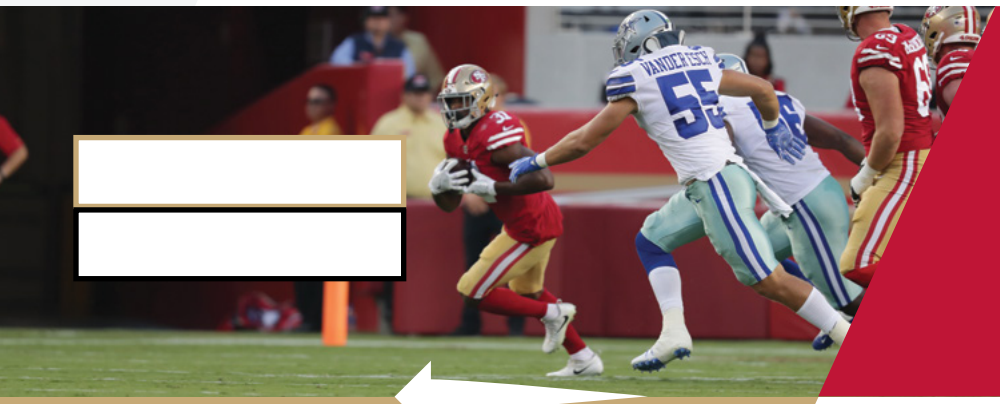
GRADES K–3

FOOTBALL PHYSICS

Physics is the science of matter and energy. Football can teach you the basic principles of physics by showing how energy is transferred by its interaction with matter. You just have to look for it in the **forces** and motion on the field.

A **force** is a push or a pull that acts upon an object to get it moving, or to change its motion.

ACTIVITY 1



Below are some pictures that show you different football activities that involve forces.

Write down **PUSH** or **PULL** in the first force box. Does the force cause something to start or stop moving? In the second box, write **START** or **STOP**.

ACTIVITY 2

Physicists use arrows to show size and direction of force being exerted. Examine the photos, and draw arrows on each picture to show size and direction for each force you see.

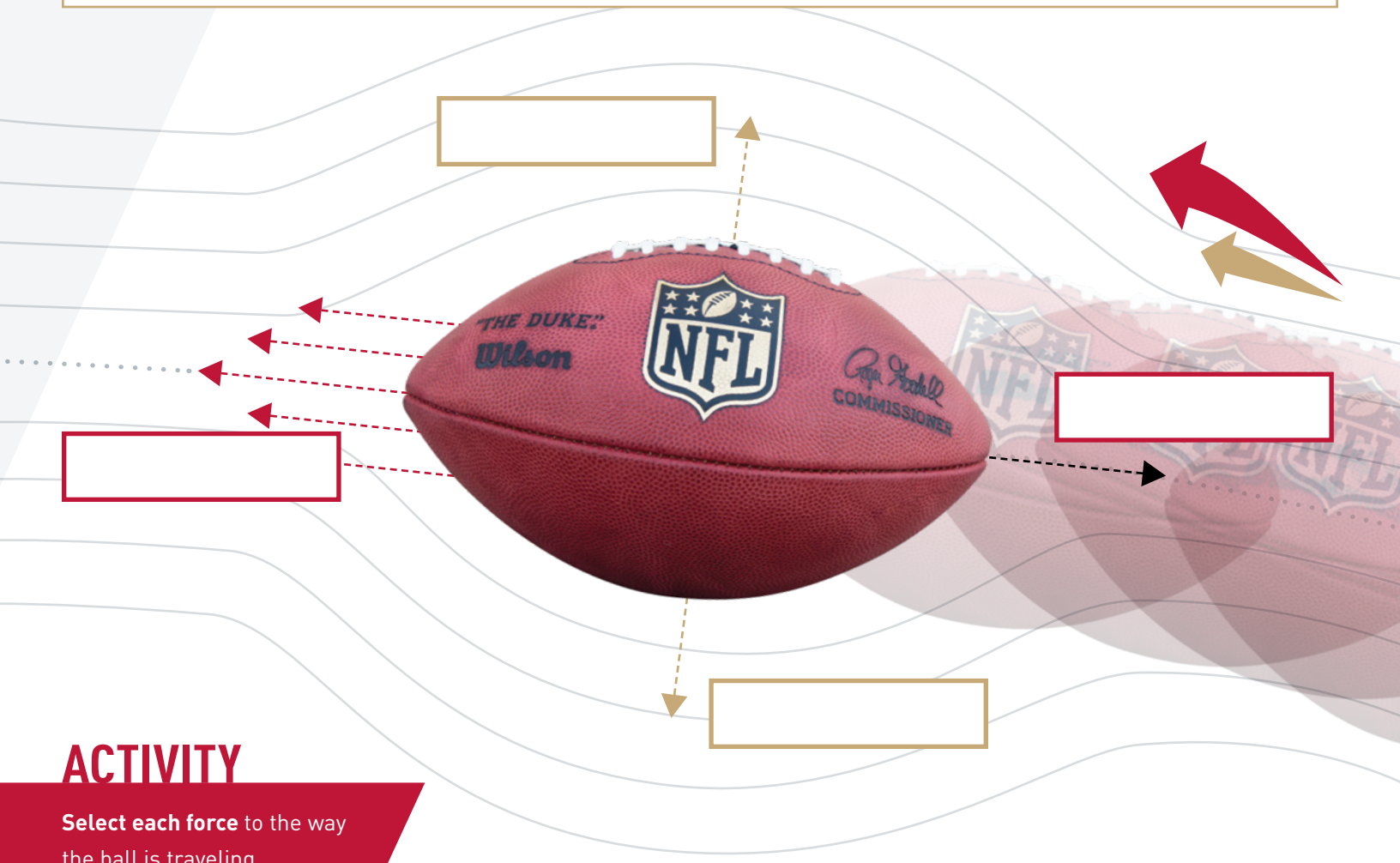
The amount of force and placement in a kickoff will determine how far and what direction the football can travel. A force acts in one direction. The direction is shown in the diagrams by using arrows.

Which arrow is showing the greater force?

GRADES K–3

FORCES OF FOOTBALL FLIGHT

Four opposing forces act on a football in flight. These forces are **lift**, **thrust**, **gravity**, and **drag**. Because of the unique shape of a football, it can move in various ways when these forces are exerted upon it.



ACTIVITY

Select each force to the way the ball is traveling.

THRUST (PUSH)

Thrust is the force that propels the football forward. The ultimate goal is to produce a lot of thrust on the football when thrown in order to make it go in the direction that the quarterback desires.

DRAG (PULL)

Drag is the force that opposes all motion through the atmosphere. Drag is created because of the football's motion through the air.

GRAVITY

Gravity is the force that makes an object fall to the ground. The magnitude of this force is dependent on the mass of the object.

LIFT

Lift is generated by air flowing over an object. The direction of the lift force will always be perpendicular to the direction that the air is flowing.

GRADES K–3

GEARING UP FOR THE BIG GAME

Football equipment is designed by engineers to protect the players bodies from harm. Each piece of equipment goes through a process of creation by first determining it's function, deciding on a design, finding proper materials to create it and testing to see if it serves the purpose it was intended to. Engineers use a process called "**The Engineering Design Process**, or **EDP**" to help stay on track and redesign or redefine if it does not function the way it was designed to.

HELMET

The helmet went from being a soft leather cap in the 19th century, to a complex, hard plastic outer shell which is heavily padded on the inside to protect the players' head from serious injury.

FOOTBALL PADS

Shoulder pads help protect vulnerable muscles and bones of the upper torso. These pads absorb the shock of impact by distributing the shock of the tackle through a larger area so there is less pressure at the point of impact.

JERSEY

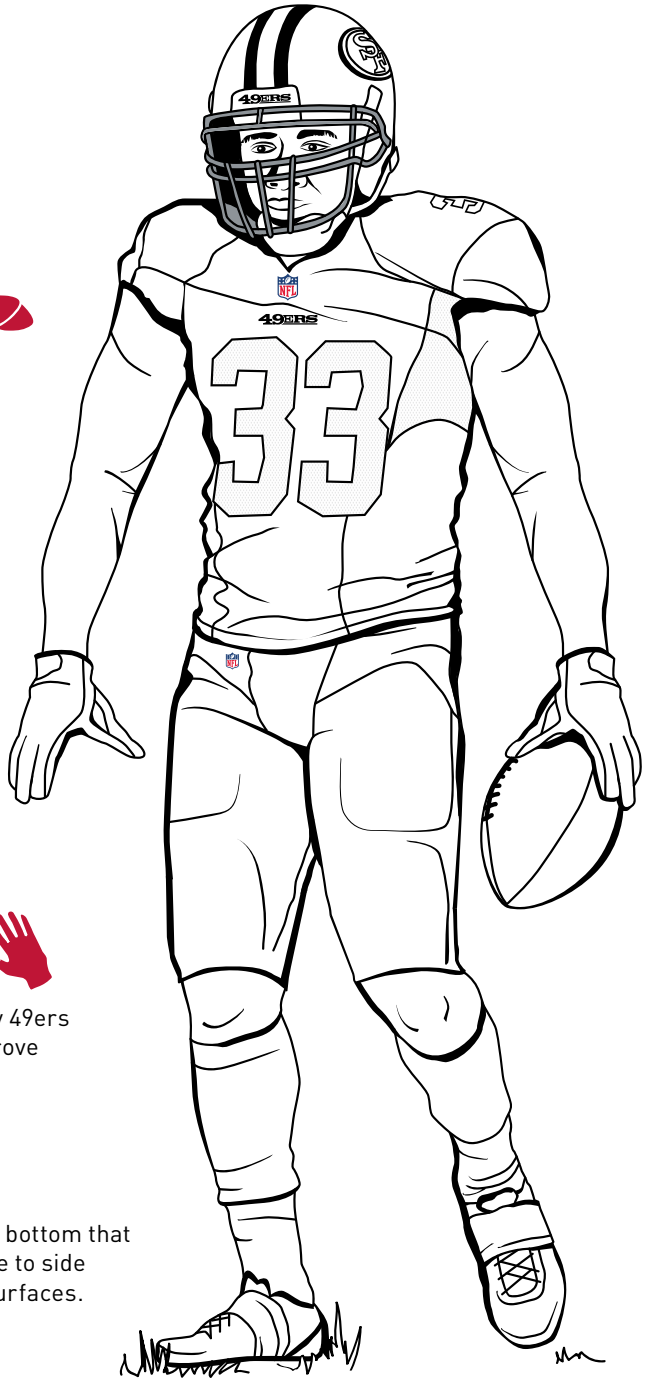
Every team has a home, away, and alternate jersey that is meant to represent the city and organization. Each player has a unique number to make them identifiable to fans, officials, teammates, and coaches.

FOOTBALL GLOVES

Although gloves aren't necessary, many 49ers choose to wear them because they improve grip on the football.

CLEATS

49ers players' shoes have spikes on the bottom that help them run, stop, and move from side to side quickly on natural or artificial playing surfaces.



1 Circle the equipment you learned about in the picture to the left.

2 Do you think football uniforms are comfortable? Why or why not?

3 What features of the uniform help the 49ers player move easier?

4 What colors will your player wear? Color the picture and share with others.

GRADES K–3

GRIDIRON ENGINEERING & DESIGN: EQUIPMENT DESIGN

Engineers are problem solvers. They are well known for solving problems like building or repairing structures. Engineers also solve design problems to improve how objects look. These solutions help make the object more interesting for people who will get to buy and use them.

DESIGN CHALLENGE

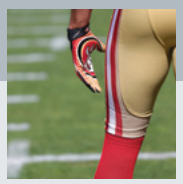
Sometimes an existing equipment model can help formulate a newer, more innovative design. **Now try your hand at creating a new design to an existing model of football equipment. What would you want to wear?**

GRADES K–3

ART IN FOOTBALL: PUNT, PASS, AND CREATE

ELEMENTS OF ART: the visual components of color, form, line, shape, texture, and symmetry. Tickets, posters, football cards, paintings, NFL pocket schedules, and a wide array of other artistic mediums are all examples of creative art integration. Below you will find actual examples of how the elements of art are found in the game of football.

LINE

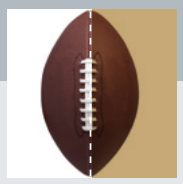


A **line** is defined by a point moving in space. Lines may be two- or three-dimensional, descriptive, implied, or abstract.

SHAPE

A **shape** is two-dimensional, flat, or limited to height and width.

SYMMETRY

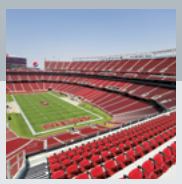


An object is **symmetrical** when one half is a mirror image of the other half.

FORM

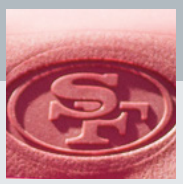
A **form** is a three-dimensional shape and encloses volume; includes height, width and depth. Cubes, spheres, pyramids, or cylinders are all examples of forms.

COLOR



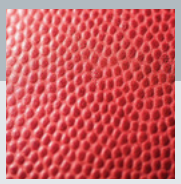
Colors are made up of three properties: hue, value, and intensity.

SPACE



Space refers to distances or areas around, between, or within components of a work of art to achieve a sense of depth.

TEXTURE



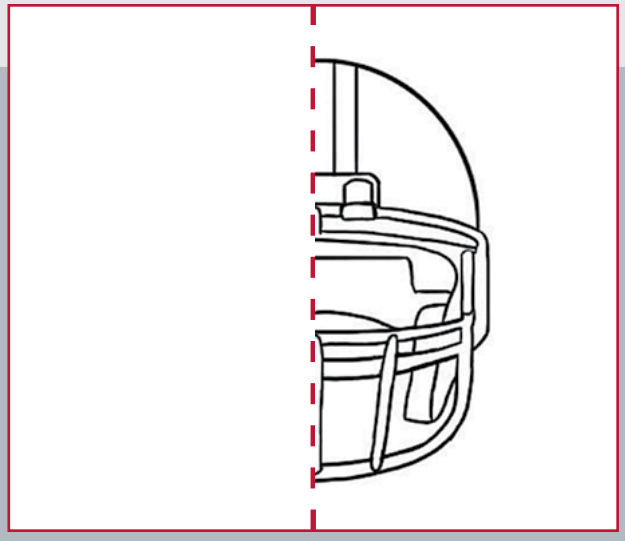
Texture refers to the way things feel or look as if they might feel if touched — like feeling the surface of a football.

If you have ever watched a 49ers football game, you cannot help but see elements of art and design in every aspect of the game. Some of the greatest inventions ever made first came from the basic design.

Design is the process of deciding how something will be made, including how it will work and what it will look like. Many designs are symmetrical, which means that both sides are mirror images of each other. For instance, if you were to fold a player's jersey or pants in half, they would be the same on both sides, making them symmetrical. Below is an example of a design, complete the design so that it is symmetrical.

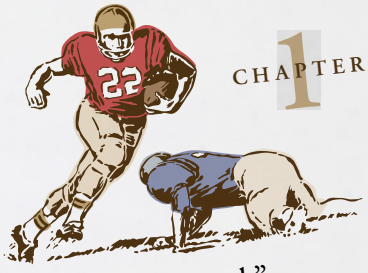
HELMET

Directions: Use the space below to draw the rest of each design: Hint: mirror the design on the completed side.



TACKLING LITERACY: READING COMPREHENSION

CHAPTER 1
PREPARING FOR THE BIG GAME



"Can I play in the game?" asked the young quarterback. "Not yet," said Coach. "You haven't practiced enough and you aren't wearing all the equipment you need."

The young quarterback really wanted to play in the big game, so they searched the locker room and found all the equipment they would need. The quarterback found a helmet, jersey, shoulder pads, gloves, and special shoes that were just the right size.

Next, the young quarterback decided they needed to practice drills, so they would be prepared. The young quarterback practiced their passing and running, and helped their fellow teammates in every way they could.

Coach noticed that the young quarterback had improved and was ready to play. Coach went up to the young quarterback right before the big game and said, "I have been watching how hard you have practiced and I noticed you are wearing all the important equipment that will keep you safe, are you ready to play?"

The young quarterback was very excited and said, "You bet, Coach!" The young quarterback went on the field and led the team to a big win.

1 What equipment did the young quarterback use? Mark the box with the picture of the first item of equipment they found in the locker room with a "1."

2 What drills did the young quarterback practice to get ready for the big game? Mark the boxes that shows the drills they completed with a "X."

3 What other equipment that was "just the right size" did the young quarterback find? Mark the box that shows the correct picture with a "V."

4 Now retell the story to someone else, in your own words.

GRADES K–3

TACKLING LITERACY: ABC SCAVENGER HUNT

STUDENT INSTRUCTIONS: Below is a box for each letter of the alphabet. Visit **49ers.com** or the **49ers app**, and find football related words or pictures and write the name of the item in the corresponding box.

A		N	
B		O	
C		P	
D		Q	
E		R	
F	Football	S	
G		T	
H		U	
I		V	
J		W	
K		X	
L		Y	
M		Z	

GRADES K–3

49ERS EDU WORD SCRAMBLE

See how many words you can spell from the words, "Forty Niners" and list them below.

HINT: Use the letter "S" to make some words plural.

1 _____

2 _____

3 _____

4 _____

5 _____

6 _____

7 _____

8 _____

9 _____

10 _____

11 _____

12 _____

13 _____

14 _____

15 _____

16 _____

17 _____

18 _____

19 _____

20 _____

GRADES K–3

49ERS EDU WORD SEARCH

DEFENSE
END ZONE
EXTRA POINT
FIELD GOAL
FOOTBALL
FUMBLE
INTERCEPTION
KICKOFF
OFFENSE
POSSESSION
PUNT
PYLON
QUARTERBACK
REFEREE
RETURN
RUNNING BACK
SACK
SCORE
SNAP
TOUCHDOWN

E	K	E	E	M	T	I	F	R	S	F	P	B	Y	E
N	N	S	P	S	H	N	S	O	M	C	Q	A	L	C
D	O	N	Y	X	N	T	I	X	O	U	O	B	N	L
Z	I	E	L	F	C	E	O	O	A	T	M	R	R	S
O	S	F	O	R	F	R	F	R	P	U	B	E	E	L
N	S	E	N	K	B	C	T	F	F	A	F	A	A	G
E	E	D	K	Y	B	E	N	D	O	E	R	O	L	S
H	S	N	A	N	R	P	T	S	R	X	G	T	R	L
C	S	L	W	B	S	T	J	E	T	D	Q	I	X	A
U	O	C	A	S	Z	I	E	O	L	C	A	G	L	E
O	P	C	H	M	S	O	R	E	T	U	R	N	X	P
F	K	C	A	B	G	N	I	N	N	U	R	D	U	X
K	C	A	S	L	F	F	O	K	C	I	K	N	P	I
Q	T	O	U	C	H	D	O	W	N	J	T	S	R	P
R	H	S	L	Q	I	A	T	J	K	H	R	N	G	X

GRADES K–3

MEASURE UP TO MATH: FOOTBALL EQUIPMENT

Measurement is used in all aspects of football. The diameter of the football, the width of the field, and the length to a first down are all standard measurements that must be followed in any football game. Knowing these measurements will help you play, and understand, the game.

49ERS MEASUREMENT CHARTS

Measure the length, width, and height of objects. Feel free to find and use any other object that is similar to the ones on this page.

FOOTBALL OBJECT	Length	Width	Height
HELMET			
FOOTBALL			
JERSEY			
CLEAT			

Measure yours and someone else's height, arm, arm span, and hand.

	Height	Arm	Span	Hand
YOU				
TEAMMATE				

Comparing objects: CIRCLE the correct answer in the parentheses.

1. The helmet's length is (GREATER THAN, LESS THAN) a football.
2. The football is (SHORTER, LONGER) than a football jersey.
3. The football jersey's width is (GREATER THAN, LESS THAN) a helmet.
4. The football cleat is (LONGER, SHORTER) than a football.

BASIC MEASUREMENT RULES

LENGTH is the distance along an object from end to end.

WIDTH is the distance from one side of an object to the other side.

HEIGHT is the distance from the lowest point to the highest point of an object or a person.

GRADES K–3

GOAL-LINE MATHEMATICS: ANGLES & GEOMETRY

ANGULAR ATTACK & GAME GEOMETRY

Geometry and **angles** are a big part of football! From a pass or kick, to the way players move, and how plays are called, mathematical principles, and geometric shapes are involved. Geometric shapes, like circles and squares, are often seen in math and in football. You can easily spot them, even if they move, rotate, or get bigger or smaller.

ACTIVITY

Can you find these geometric shapes in Levi's® Stadium below?

DRAW A LINE FROM EACH SHAPE TO ITS LOCATION.

SQUARE RECTANGLE CIRCLE TRAPEZOID ELLIPSE TRIANGLE

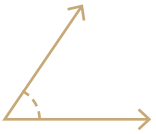
GEOMETRY is the branch of mathematics that deals with shapes, angles, sizes, positions, and properties of space. It is one of the oldest mathematical sciences and is used in constructing structures like buildings, cars, ships, and is especially utilized in the engineering and design of Levi's® Stadium.

EXTRA POINT

Shapes and angles are all around Levi's® Stadium. Many angles are right angles (90 degrees), but not all. Look at other pictures of the stadium in the playbook for these angles.

ACUTE

Angle less than 90 degrees

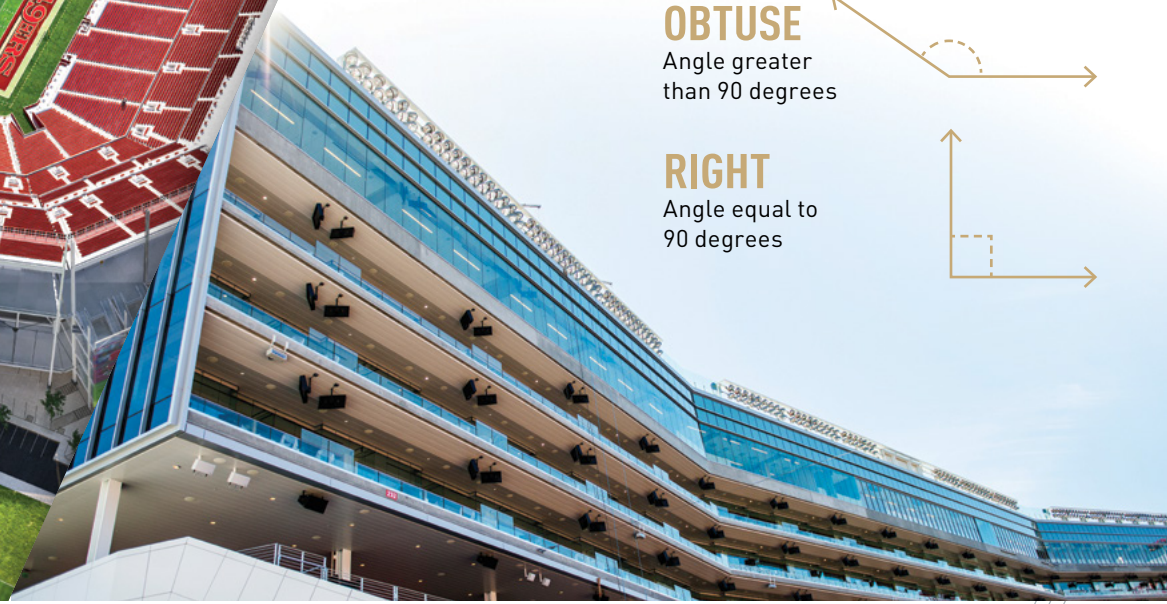


OBTUSE

Angle greater than 90 degrees

RIGHT

Angle equal to 90 degrees



FIELD GOAL FORECAST

PT. 1 / WEATHER CONDITIONS

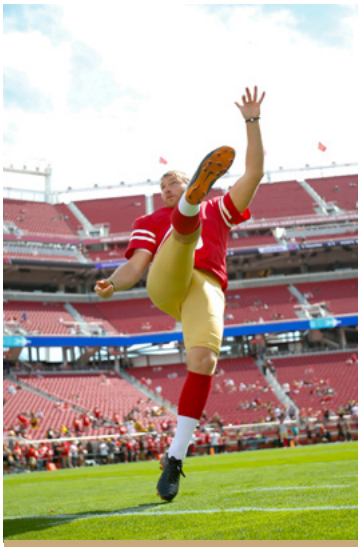
ELEMENTS THAT AFFECT FIELD GOALS

A forecast is a prediction of weather behavior based on analysis of climate in that area. Weather can change the way players prepare for a game, and how they react in certain situations. NFL teams travel across the country and play games in varying conditions. Refer to page 8 for a review on forces, because they play a massive role when weather events take place. Click below to see some of the ways nature impacts how games are won and lost.

WEATHER CONDITIONS

THE KICK

Each weather condition presents a challenge that a player must consider when they kick. In the photos below, see how these three weather conditions affect a kick.



TEMPERATURE

MOISTURE

AIR PRESSURE

ACTIVITY

Below are the **49ers away games opponents** for this year. Use **weatherspark.com**, or your own favorite website, and see what's in store for the 49ers when they play in these cities. Scroll through the weather data to find the answers to the questions on the right. Don't forget to select the team logo to reveal the location of each stadium.

Using the teams' location, find the weather data to answer the questions below for the month of December.

1. Against what team would you expect the most wind?
2. During what game is it most likely to rain?
3. In what city are the 49ers likely to play in the hottest weather?
4. In what city are the 49ers likely to play in the coldest weather?

FIELD GOAL FORECAST

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WEATHER CONDITIONS

From the snap until the end of the play, every kick has variables that must be considered to complete a successful play. Review each photo and answer the questions using the information on this page.

THE KICK

THE SNAP Kickers count on their Long Snapper to send a controlled ball to the Holder, who must then catch and place the ball perfectly. What would be more difficult about doing this in the rain or snow?

- ☐ Ball is softer
- ☐ Ball is slicker
- ☐ Ball is lighter

PLACEMENT Now the Holder must quickly get the ball in the right position in time for the Kicker to make contact around 4" above the bottom tip of the ball, the sweet spot. How do you think extreme heat would affect the Holder and Kicker in this situation?

- ☐ Wind would affect the ball
- ☐ Slowed reaction time
- ☐ Ball is slicker

MUSCLE STRENGTH Muscles around the non-kicking leg keep the Kicker stable, and muscles in the kicking leg allow for a greater force of thrust to be applied to the kick. When the ball is kicked into oncoming wind, what happens to the ball in flight?

- ☐ Increased thrust, speeding the ball forward
- ☐ Increased gravity, pulling the ball down
- ☐ Increased drag, slowing the ball down

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ENVIRONMENTAL SUSTAINABILITY

WATCH VIDEO

PT. 1 / MATH

Levi's® Stadium is the first NFL stadium to open as LEED (Leadership in Energy and Environmental Design) Gold Certified. Its use of **solar energy** helps our environment by decreasing the use of fossil fuels that pollute the earth. We can use math and science to learn more about how solar energy works, and how it can help reduce our environmental impact.

MATH

ACTIVITY In 1 year, our panels produce about 375,000 kWh (Kilowatt Hours). This is about as much energy as we use for all 10 of our home games. See if you can answer these energy questions:

1 How much energy does it take to run Levi's Stadium for one 49ers game?

- ☐ 37.5 KWH
- ☐ 375 KWH
- ☐ 37,500 KWH
- ☐ 375,000 KWH

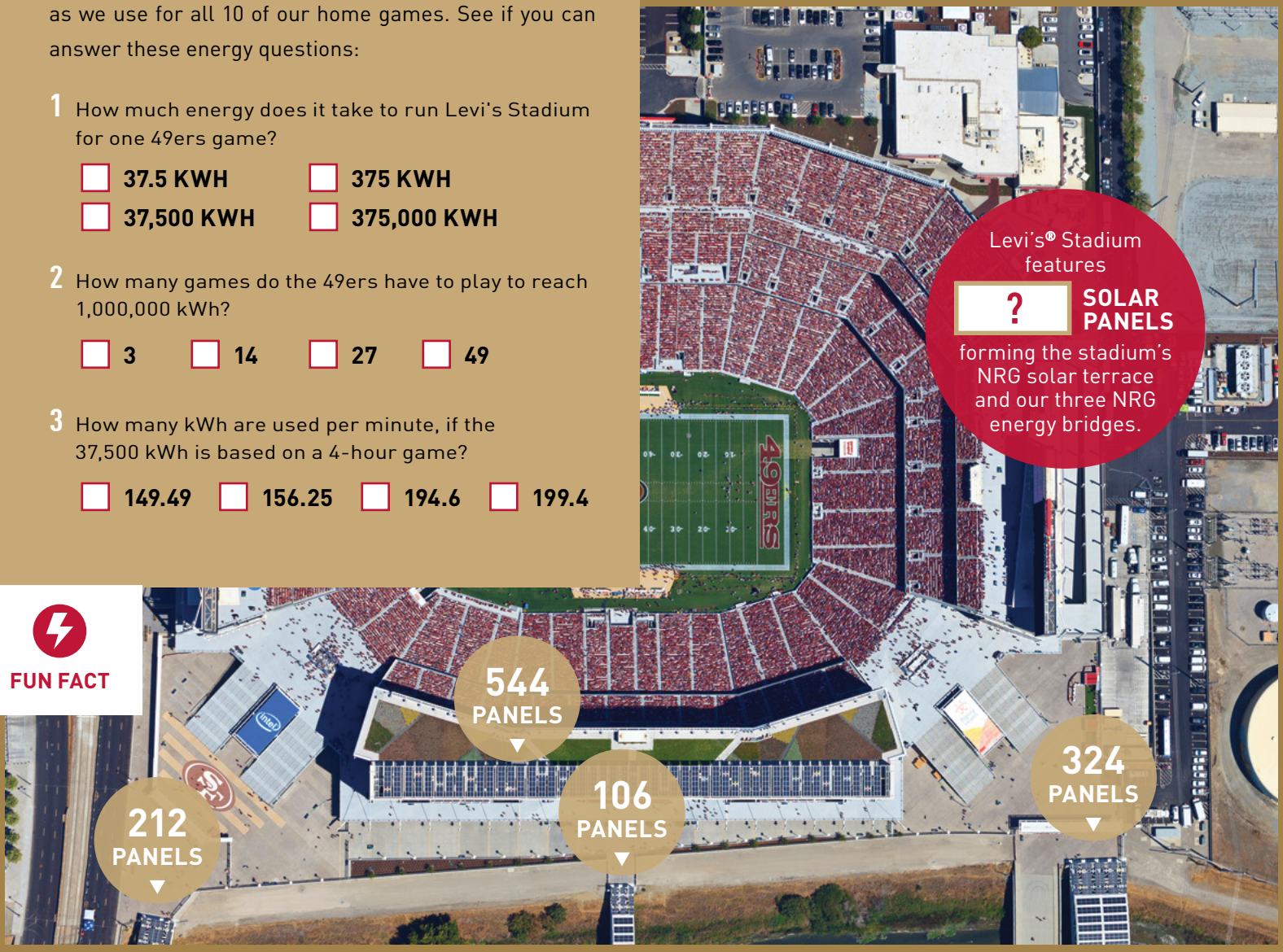
2 How many games do the 49ers have to play to reach 1,000,000 kWh?

- ☐ 3
- ☐ 14
- ☐ 27
- ☐ 49

3 How many kWh are used per minute, if the 37,500 kWh is based on a 4-hour game?

- ☐ 149.49
- ☐ 156.25
- ☐ 194.6
- ☐ 199.4

SCIENCE



FUN FACT

ENVIRONMENTAL SUSTAINABILITY

WATCH VIDEO

PT. 2 / SCIENCE

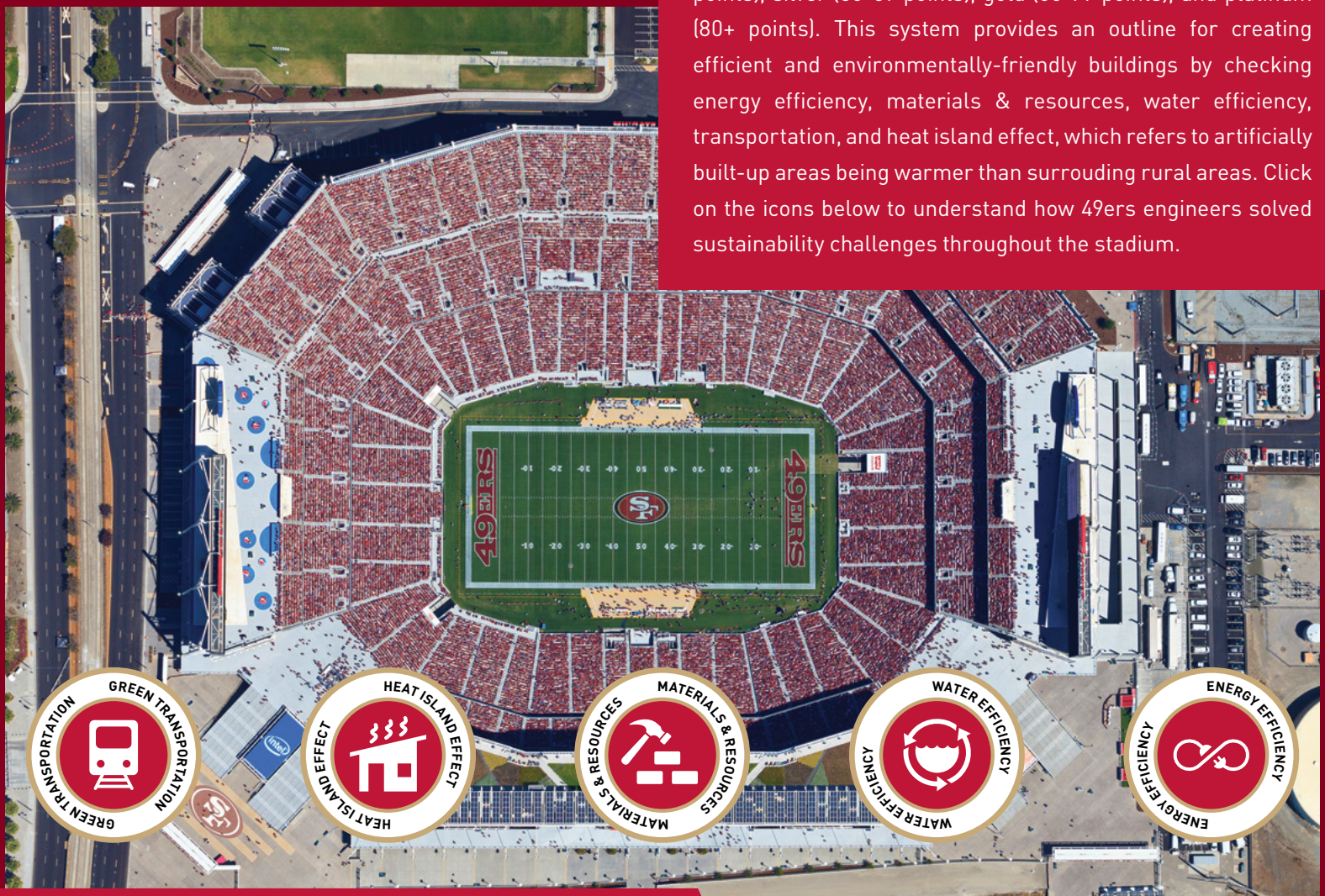
Levi's® Stadium is the first NFL stadium to open as LEED (Leadership in Energy and Environmental Design) Gold Certified. Its use of **solar energy** helps our environment by decreasing the use of fossil fuels that pollute the earth. We can use math and science to learn more about how solar energy works, and how it can help reduce our environmental impact.

MATH

SCIENCE

LEED GOLD CERTIFICATION

Leadership in Energy and Environmental Design is a sustainable rating system. Ratings include certified (40-49 points), silver (50-59 points), gold (60-79 points), and platinum (80+ points). This system provides an outline for creating efficient and environmentally-friendly buildings by checking energy efficiency, materials & resources, water efficiency, transportation, and heat island effect, which refers to artificially built-up areas being warmer than surrouding rural areas. Click on the icons below to understand how 49ers engineers solved sustainability challenges throughout the stadium.



SCIENCE ACTIVITY

ENVIRONMENTAL SUSTAINABILITY

WATCH VIDEO

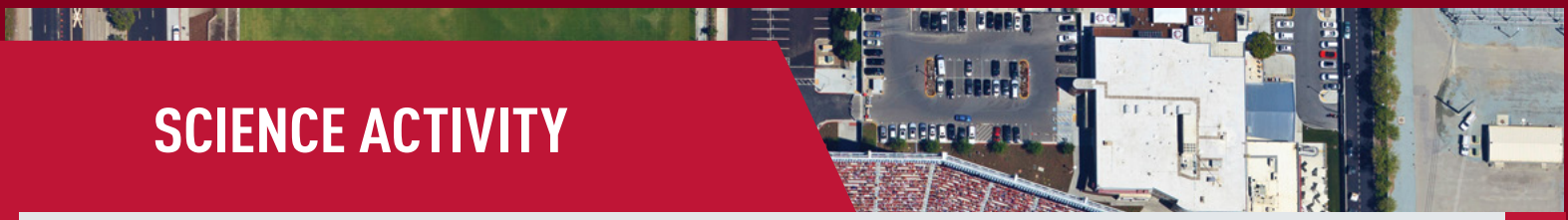
PT. 3 / SCIENCE

Levi's® Stadium is the first NFL stadium to open as LEED (Leadership in Energy and Environmental Design) Gold Certified. Its use of **solar energy** helps our environment by decreasing the use of fossil fuels that pollute the earth. We can use math and science to learn more about how solar energy works, and how it can help reduce our environmental impact.

MATH

SCIENCE

LEED GOLD CERTIFICATION



SCIENCE ACTIVITY

The United States Green Building Council has criteria for residential buildings. Using their criteria, we've made a checklist you can fill out to see how many of the practices you are currently following in your building. They may also give you ideas for what you can improve on to help support the sustainability of our environment.

- [ ] Home is located near public transportation for use instead of driving
- [ ] Family chooses alternative transportation such as walking, biking, or public transportation
- [ ] Home is insulated with energy efficient insulation
- [ ] Trees are planted strategically to provide shade for home
- [ ] Materials used for construction are natural, and do not contain harmful chemicals
- [ ] Home has been outfitted with low power usage appliances
- [ ] Widows provide sufficient daytime lighting
- [ ] Home uses energy efficient lighting
- [ ] Home has been outfitted with low water usage appliances
- [ ] Efficient irrigation to reduce need for watering
- [ ] Rainwater collection barrels to use when fresh water is not needed
- [ ] Use of renewable resources such as solar power to heat water and generate electricity
- [ ] Sorts waste in Landfill, Recycle, and Compost consistently
- [ ] Reduce disposable use - consider purchasing reusable items when available
- [ ] Consider a garden, whether private or community, to grow herbs, fruits, and vegetables

TECHNOLOGICAL ADVANCEMENTS

EQUIPMENT EVOLUTION

FROM THEN TO NOW

Technology is a word that describes the knowledge, devices, and materials used to solve problems. From the first televised game in 1939, technology has had a huge impact on professional football. The on-the-field impact of technology can be seen in every aspect of the game, from communication between players and coaches to the equipment the players use on the field. It is also important to recognize the ways technology has impacted football fans. Now more than ever, fans have more access to information about their favorite team and can experience a game in different ways thanks to technology. Below are a few examples of technology that has impacted football.





ACTIVITY

After reading the table below, select which helmet matches each description.
Click each box to enter date of helmet

	1940s	1950s	1970s	2000s	TODAY
Logo Design	Uniform leather helmets with plastic shell top	Red plastic shell (49ers introduce helmet logo in 1962)	Gold plastic shell with interlocking cherry red SF logo	Gold plastic shell with interlocking darker red SF logo	Gold plastic shell with interlocking cherry red color SF logo
Helmet Materials	Hard leather	Plastic	Plastic	Polycarbonate	Molded ploycarbonate
Interior Features	Foam and ear holes for better communication	A radio was put into the helmet for the first time	Air bladder padding for added comfort and protection	Impact absorbing foam interior; a well established radio system now standard in all helmets	Cranial scan and 3-D printed interior is used to create a customized fit
Exterior Features	The chin strap was implemented	A single face bar was added	Full face mask is added featuring several bars rather than a single bar	A more spherical design to the overall helmet shape	Chin straps contain shock-detecting sensors to measure impact; multiple companies with various shell designs

THE FAN EXPERIENCE

TECHNOLOGICAL ADVANCEMENTS

FROM THEN TO NOW

Technology is a word that describes the knowledge, d
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fans. Now more than ever, fans have more access to information about their favorite t
different ways thanks to technology. Below are a few examples of technology that has

EQUIPMENT EVOLUTION ▼

HELMETS

Technological advancements of helmets have come a long way since the original invention in 1869. New innovations have been implemented over the years to address any problems that players have experienced.

THE FAN EXPERIENCE

Technology is improving the 49er fan experience at Levi's® Stadium. One of those technologies is the 49ers app. On the app, you can access your digital tickets which is environmentally friendly, as well as access pictures, videos and articles about your favorite team. You can also find food choices within the stadium, and can even get directions to help find the best travel route to and from the game.

GET IT ON Google Play

Download on the App Store

ACTIVITY

Use the **49ers app** to access a map of Levi's® Stadium, or find one online with a compass, to answer the following questions.
Open app ☰ > MORE > EXPLORE STADIUM > GENERAL STADIUM OVERVIEW

1 Levi's Stadium is on the corner of Tasman Dr. and

2 If I'm at the Levi's 501 club, which direction is the Press Level?

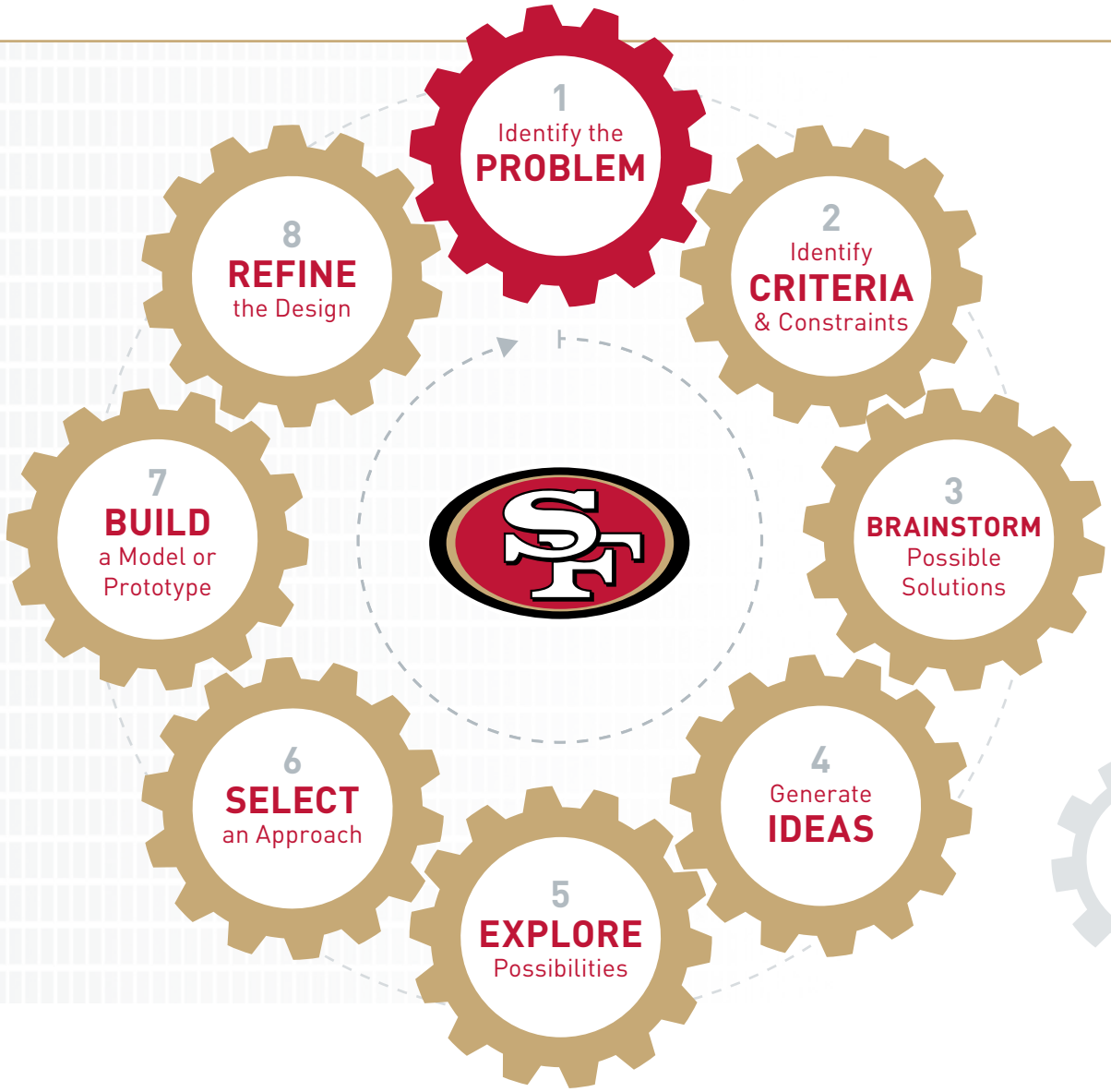
3 What is the name of the creek to the West of the stadium?

4 Discuss with a teammate, and take notes: Why are open-air NFL stadiums, like Levi's Stadium, oriented North to South?

HINT: Think about the Sun moving across the sky

THE ENGINEERING DESIGN PROCESS

The **Engineering Design Process** (EDP) is a step-by-step method which helps us create something new or improve on existing ideas. Together, engineering and design helped create all of the wonderful technology we have today. Depending on the problem that needs to be solved, you might not always start at step one and that's ok! These steps are arranged in a circle because creating is a continuous process that can be repeated to improve a design or until you get your desired result. Failure is also an important part of the process. Failure allows us to learn what pitfalls to avoid and gives us experience to grow from. Engineers learn from mistakes by going back and rethinking decisions made during previous steps or starting a completely different process altogether. Explore the steps below to see how each step can help you, then see if you can answer the questions on this page.



1 Why do you think the steps are arranged in circle and not in a line? _____

2 What is the difference between criteria and constraints? _____

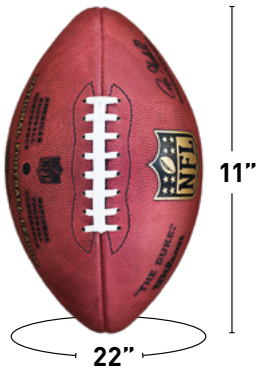
3 When do you know a design or an idea is complete? _____

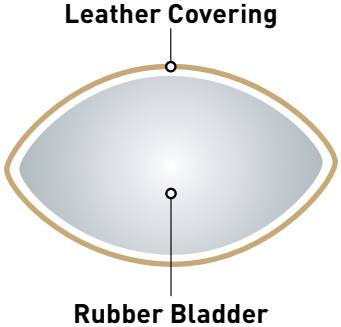
GRIDIRON ENGINEERING & DESIGN

The word "pigskin" comes from the idea that people used to play football (and other sports, like soccer) with a ball made from an inflated pig's bladder. The same *ball*, used in different sports has evolved into very distinct designs that fit the needs of each sport. The football is designed to be thrown through the air and caught. It needs to be a specific size and weight to perform the way it does.

DESIGN CHALLENGE

Use the space provided to design your own football. Be creative! Think... What would you do to make a more interesting football? A more exciting football? A football that could fly farther, or faster? Could you fill it with something besides air? Draw a diagram to show what's on the inside.





FOOTBALL

SIZE: 11 inches long and 22 inches in circumference.

WEIGHT: 14 to 15 ounces.

MATERIAL: The football is made up of four leather panels. Inside the leather panels is a 3-ply VPU rubber bladder or interior lining that holds the air.

CAREER CONNECTIONS: ALL IN A DAY'S WORK

Not everyone can play football professionally; however, people with different skill sets still work for the NFL. Below are a few examples of jobs with the 49ers organization.

STUDENT INSTRUCTIONS: Below are six scenarios that might take place during the workday of a 49ers employee. Identify which 49ers employee would best be equipped to deal with the issue. Each job will only be used once. Write the job title on the lines provided.

COMMUNITY RELATIONS SPECIALIST

The 49ers give back to the community in countless ways. During the season, the community relations specialist works with players to visit children's hospitals, participate in Make-A-Wish® events, pack boxes at food banks for families, and advocate for healthy, active lifestyles with the 49ers Foundation.

GROUNDSKEEPER

Not only does the main field at Levi's® Stadium need nurturing, the 49ers have other grass and artificial turf fields at the training facility that require consistent maintenance. All fields have to be tended to every single day. 49ers groundskeepers can be seen mowing the fields, riding a tractor, or planting new foliage around 49ers Headquarters.

EQUIPMENT MANAGER

With all of the pads, helmets, cleats, dirty laundry, and practice jerseys that can pile up, every NFL team has an equipment department to manage its gear. When the 49ers go on the road for an away game, it is the equipment manager's responsibility to make sure enough uniforms, pads, clothes, and practice gear are packed for all scenarios.

TEAM LOGISTICS MANAGER

Shuttling 53 football players and 20 coaches across the country for games every Sunday can be complicated. Thankfully, the team logistics manager oversees the travel plans for each game, including booking flights, arranging hotel rooms, transportation, and assigning security to keep the players safe.

VICE PRESIDENT OF MARKETING

Who decides what songs to play inside the stadium on game days? Who picks which outfit the 49ers Gold Rush cheerleaders wear? The vice president of marketing directs many fan-based initiatives and organizes the look and feel of game days during the season. **49ers.com**, a source for news, videos, and official updates, is also overseen by the marketing department.

COACHING STAFF

The 49ers coaching staff is made up of athletic trainers, conditioning experts, position coaches, offensive coordinator, and a defensive coordinator. At the very top is the head coach. The coaches are responsible for creating game plans and strategies and work with the football players to compete to win the Super Bowl each season.

1. There is a gopher making a hole next to the field goal posts on the 49ers practice field. Who at the 49ers should be called to help move the gopher to a safer home?

2. The 49ers would like to give out a gift to all ticket holders for the annual "Fan Appreciation" game at the end of the football season. Which person is the best option for creating and designing the coolest fan gift?

3. The 49ers just won a really big game this past week. The offensive line is excited for the upcoming week and wants to lift weights in the weight room before practice. Who is most likely to oversee the practice schedule for the players?

4. A 49ers player is really interested in literacy and teaching young students how to read. He wants to volunteer at a reading fair at a local elementary school, but wants to know the best way to contact the school. Who can help him plan the visit?

5. The 49ers are flying to Houston, Texas, to play a preseason game. The quarterback packed his suitcase, but forgot to bring an extra mouthpiece. Who can help him out?

6. The 49ers are playing a game in Florida. One of the players has to leave unexpectedly after the game to visit a family member in Indiana. Who can arrange a flight for the player?

49ERS CAREER PLAN

Using the careers on page 16, explore the **49ers website** to find who works in these positions. Use some other online resources to see if you can answer the questions below based on what you find. If you know what kind of career you want when you're older, consider searching for a career path that interests you, and fill out the SMART goal at the bottom of the page.

49ERS CAREER EXPLORATION WORKSHEET

Name of 49ers Staff:

Occupation /Job Title:

1 Where did this person go to college? What did they study?

2 What skills do they possess that helps them in their career?

3 What Volunteer Experience, Licenses, and Certifications does this person have?

4 What does this person do in their position?

S SPECIFIC ★ **M** MEASURABLE ★ **A** ATTAINABLE ★ **R** REALISTIC ★ **T** TIMELY

1 Job / Career Goal: _____

2 Education / Training Plan: _____

3 Steps I will take to achieve this goal: _____

4 What do you love to do? _____

GRADES 4–8

ART IN FOOTBALL: QUARTERBACK CURATORS

Levi's® Stadium is home to 200 pieces of original artwork and 500 pieces of photography. Many of the works were created by artists who are native to California and created these works specifically for Levi's® Stadium. Collectively these pieces tell a story about how the history of the 49ers and California are entwined. Below is an activity that will encourage you to look a little more deeply at one of these pieces so that you can begin to understand its place not just here at Levi's® Stadium, but in the world of art as a whole.

PICK A PIECE OF ARTWORK AND SKETCH IT BELOW

VIEW ARTWORK

Answer the following questions about your chosen artwork:

1 Describe the piece. What do you see? What is happening?

2 What is the main subject of this piece?

3 How does this work make you feel? Does is remind you of anything you've seen or experienced?

4 Do you think this piece is successful or a failure? Why?

CURATORS

Curators are in charge of a museum's collection. They must understand artistic movements, artists' intentions, and public perception to put together a dynamic collection of artifacts.

EXHIBITIONS

Exhibitions are displays of selected pieces from a museum collection that typically have a shared theme or tell a certain story.

HEALTH & FITNESS: TRAINING CAMP

Statistics is an area of math where numbers are collected and sorted. The way that numbers are sorted can be used to measure success, predict future results, and analyze the game and its players.

The following five drills are specific tests professionals must perform. You will be recording your results of each drill, and keeping track of your data (statistics). Use the data to analyze your group performance. Find your total time or distance, find the average for your group, and then start working to make goals for improvement.

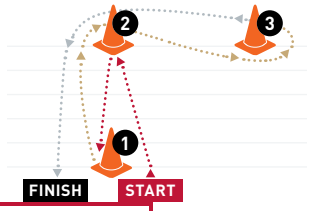
1 20-YARD DASH: TIME YOUR RUN

The 40-yard dash is the main event at the combine. It's all about speed and explosion as athletes race down the line for their best time. Athletes are timed at 10, 20, and 40-yard intervals. Today you are going to participate in the 20-yard test.

Your time:

2 3 CONE DRILL: TIME YOUR RUN

The 3 cone drill tests an athlete's ability to change directions at a high speed.



Your time:

3 BROAD JUMP: MEASURE YOUR DISTANCE

The broad jump tests an athlete's lower-body explosion and strength. The athlete starts out with a balanced athletic stance and jumps forward as far as possible. It also tests balance, because the athlete has to land without falling over.

Your distance:

4 SHUTTLE RUN: TIME YOUR RUN

The short shuttle is the first of the cone drills and it is known as the 5-10-5. What it tests is an athlete's quickness and explosion in short distances.

Your time:

CREATE YOUR OWN STATS

You can participate in these five football drills that provide measurable statistics to log. You may then document your results and perform calculations to find your team's results. (Do your best with the materials you have. Anything can act as a cone for a drill. If you don't have a football target net, use a laundry basket or empty garbage can).

5 PASSING

See how many passes you can complete and divide that by the total number of attempts to get a completion percentage.

Complete Passes		Attempts	

COMBINE DRILLS	Player #1	Player #2	Player #3	Player #4	Player #5	Player #6	AVERAGE
	TIME / DISTANCE / SCORE						
DRILL 1: 20 YARD DASH							
DRILL 2: 3 CONE SKILL							
DRILL 3: BROAD JUMP							
DRILL 4: SHUTTLE RUN							
DRILL 5: PASSING							

HEALTH & NUTRITION

Calories are provided by nutrients in food and drinks. Your body uses calories as energy. The number of calories in a food is a measure of how much potential energy that food possesses. **Energy** is what fuels our bodies — to breathe, move, pump blood — to live. Using the examples on the page, answer the questions below. You may also compare foods you find in your refrigerator or pantry. Nutritional labels are found on all foods sold in the U.S.

Nutrition Facts
Serving Size 8 Baby Carrots (80g)
Serving Per Container

Amount Per Serving	
Calories 30	**Calories from Fat** 0
	% Daily Value*
Total Fat 0.1 g	**1%**
Saturated Fat 0 g	**0%**
Trans Fat 0 g	
Cholesterol 0 mg	**0%**
Sodium 60 mg	**3%**
Total Carbohydrate 7 mg	**2%**
Dietary Fiber 2 g	**8%**
Sugars 4 g	
Protein 1 g	

Vitamin A 120% • Vitamin C 4%
Calcium 2% • Iron 26%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less Than	65g	80g
Saturated Fat	Less Than	20g	
Cholesterol	Less Than	300mg	
Sodium	Less Than		
Total Carbohydrate			
Dietary Fiber			

Calories per gram:
Fat 9 • 4 • Protein 4

NUTRIENTS

are substances found in food that support the survival of organisms.

KEY NUTRIENTS

VITAMINS - regulate body processes

MINERALS - essential to growth and metabolism

CARBOHYDRATES - supply us with high amounts of quick energy

FATS - provide stored energy

PROTEINS - Build and strengthen muscles and bones

Nutrition Facts
Serving Size 1 Cookie (85g)
Serving Per Container

Amount Per Serving	
Calories 380	**Calories from Fat** 170
	% Daily Value*
Total Fat 19 g	**29%**
Saturated Fat 4.5 g	**23%**
Trans Fat 0 g	
Cholesterol 35 mg	**12%**
Sodium 50 mg	**2%**
Total Carbohydrate 48 mg	**16%**
Dietary Fiber 3 g	**12%**
Sugars 32 g	
Protein 7 g	

Vitamin A 0% • Vitamin C 0%
Calcium 10% • Iron 10%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories	2,000	2,500
Total Fat	Less Than	65g	80g
Saturated Fat	Less Than	20g	25g
Cholesterol	Less Than	300mg	300mg
Sodium	Less Than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Protein 4

1 How many more calories are in a cookie compared to carrots?

2 Which food do you think is better for your health?

3 Why is the food you selected better for your health?

4 Which kinds of foods do you think would be best for athletes to get some quick energy?

EXTRA POINT

= 100 YARDS

One piece of candy-coated chocolate contains 3.44 calories, including one from fat. To burn off the calories from one chocolate candy, you'd have to walk 100 yards, or the length of a football field.

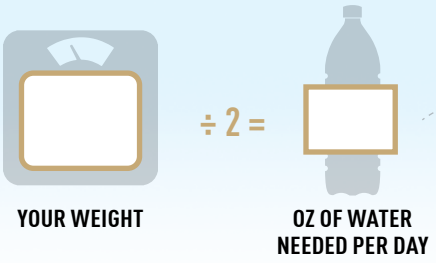
HYDRATION HEALTH

For your body to function properly, you must replenish its water supply. There are no exact rules for how much water to drink while exercising because everyone is different, however 49ers players consider factors including sweat rate, the heat and humidity in their environment, and how long and hard they are exercising.

How much water should you drink, before factoring in exercise? Your weight is one variable that changes the amount of water you should be drinking. To help you establish a baseline, you can use the following rule-of-thumb equations.

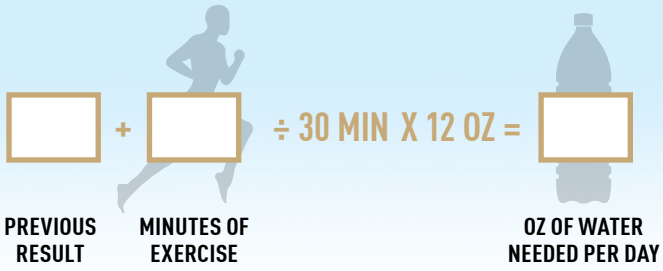
Remember your order of operation: **PEMDAS = Parentheses, Exponents, Multiply and Divide, then Add and Subtract.**

BEFORE EXERCISE



Example: 150 lbs. ÷ 2 = 75 oz. of water

AFTER EXERCISE



Example: 75 + 60 min ÷ 30 min x 12 = 99 oz. of water

Step 1: Divide 60 ÷ 30

Step 2: Multiply 2 x 12

Step 3: Add 75 + 24 to get your answer

FUNCTIONS OF WATER IN THE BODY

BENEFITS OF DRINKING PLENTY OF WATER

- Moistens tissues such as those in the eyes, mouth, and nose
- Protects your body's organs and tissues
- Regulates your body temperature
- Carries nutrients and oxygen to cells

DANGERS OF NOT DRINKING ENOUGH WATER

You will feel these effects of dehydration

- Muscle cramps
- Dry mouth
- Feeling faint or weak
- Experiencing nausea, headache, fast heartbeat, and low blood pressure

49ERS EDU SCAVENGER HUNT

Using resources such as **49ers.com**, **Wikipedia** and pages in this book to locate answers to the questions.

1 How many touchdowns did Jerry Rice score as a 49ers player? _____

2 What 2 players made "The Catch" play? _____

3 What style of offense was introduced to the 49ers in 1979? _____

4 How many Super Bowls have the 49ers won? _____

5 How many statues are in the Hall of Fame? _____

6 What does S.T.E.A.M. stand for? _____

7 What is the strongest shape in structural engineering? _____

8 Can you name 4 forces in physics? _____

9 Can you name 2 types of energy? _____

10 How long is an NFL football field? _____

11 What are the names of the stadiums the 49ers called home in the following years:

1959	1999	2019
_____	_____	_____

12 How many players are on the field playing from one team during the game? _____

13 How many points is a touchdown worth? _____

14 Can you name 2 ways Levi's® Stadium is environmentally friendly or "green?" _____

_____

15 How many stautues are in the 49ers Hall Of Fame? _____

GRIDIRON GLOSSARY

AIR PRESSURE: Force exerted onto a surface by the weight of air.

ANGLES: The space between two intersecting lines or surfaces at or close to the point where they meet. The most common angles are right angles (90 degrees), acute angles (less than 90 degrees) and obtuse angles (greater than 90 degrees).

CALORIES: The number of calories in a food is a measure of how much potential energy that food possesses. All foods have different amounts of calories, and are provided by nutrients.

CENTER: Offensive player that snaps the ball to the QB to start each play and blocks the defense.

CLEATS: Football shoes with spikes on the bottom of them to help players run and move quickly on grass and artificial surfaces.

COLOR: The way we describe the reflection or emission of light from an object. Colors are made up of three properties: hue, value, and intensity.

CURATORS: Those in charge of a museum's collection. They must understand artistic movements, artists' intentions, and public perception to put together a dynamic collection of artifacts.

DEFENSE: The team of 11 players which tries to stop the offense from scoring and get the ball back for their team.

DEFENSIVE BACKS: Defensive players that line up behind both the defensive linemen and linebackers. They primarily defend against the pass but they also support run defense.

DEFENSIVE LINE: Typically made up of defensive players called defensive ends and tackles. These players go up against the offensive linemen in a strength and agility battle across the line of scrimmage to stop the ball carrier, or try to tackle the quarterback and be rewarded with a sack.

DESIGN: The process of deciding how something will be made, including how it will work and what it will look like.

DRAG: The force that opposes all motion through the atmosphere. Drag is a type of friction, created because of the football's motion through the air.

DOWN: A period of action that starts when the ball is put into play and ends when the ball is ruled dead (play is completed). The offense gets four downs to advance the ball 10 yards. If the offense fails to do so, it must surrender the ball to the opponent, usually by punting on the fourth down.

ENERGY: Acquired by the food you eat; energy is what fuels our bodies. In physics, it is the ability to do work.

END ZONE: A 10-yard-long area at both ends of the field. You score a touchdown when you enter the end zone in control of the football.

ENGINEERING: Involves the application of creativity in partnership with math, science, social studies, language arts, and fine arts to search for quicker, more efficient, and less expensive ways to use the forces and materials of our world to meet today's challenges.

ENGINEERING & DESIGN PROCESS: A multi-step process that occurs in a certain order and are part of a larger cycle that can be repeated. This process helps to find a better way to solve problems or gives us better direction to build something.

EXHIBITIONS: Displays of selected pieces from a museum collection that typically have a shared theme or tell a certain story.

EXTRA POINT: A kick, worth one point, that's typically attempted after every touchdown. Like a field goal, the ball must sail between the uprights and above the crossbar of the goalpost.

FIELD GOAL: A kick, worth three points, that can be attempted from anywhere on the field but usually is attempted within 30-50 yards of the goalpost. The ball must sail above the crossbar and between the uprights of the goalpost to be ruled good.

FOOTBALL: A prolate spheroid made up of four leather panels. Inside the leather panels is a 3-ply VPU rubber bladder or interior lining that holds the air.

FOOTBALL FIELD: The field measures 100 yards long and 53 yards wide. White markings along the field help the players, coaches, and referees keep track of where the football needs to be.

FOOTBALL GLOVES: An optional piece of a uniform that help improve grip and protection for players' hands.

FORCE: The cause of motion. Power or energy exerted against an object in a given direction. Also known as a push or a pull that acts upon an object to get it moving, or to change its motion.

FORM: A three-dimensional shape and encloses volume; includes height, width, and depth. Cubes, spheres, pyramids, or cylinders are all examples of forms.

FUMBLE: The act of losing possession of the ball while running or being tackled. Members of the offense and defense can recover a fumble. If the defense recovers the fumble, the fumble is called a turnover.

GEOMETRY: The branch of mathematics that deals with shapes, angles, sizes, positions, and properties of space. It is one of the oldest mathematical sciences and is used in constructing structures like buildings, cars, ships, and is especially utilized in the engineering and design of Levi's® Stadium.

GRAVITY: The force that makes an object fall to the ground. The magnitude of this force is dependent on the mass of the object.

GUNNER: A special team member who runs downfield to tackle the kick or punt returner. They are often lined up on the outside of the offensive lineman and are often double teamed by blockers.

HEAT ISLAND: An area that is significantly warmer than its surrounding rural areas due to human activities.

HEIGHT: The distance from the lowest point to the highest point of an object or a person.

HELMET: The most important part of a player's uniform. It is made up of a hard plastic outer shell and is heavily padded on the inside to protect the player's head.

HOLDER: A special team member who catches the snap from the center and places it down for the placekicker to attempt to kick it through the uprights of the goalpost. On an attempted field goal, the holder must catch the ball and put it into a good kicking position, ideally with the laces facing away from the kicker.

HYDRATION: To supply water to a person in order to restore or maintain a balance of fluids.

INTERCEPTION: A pass that is caught by a defensive player, ending the offense's possession of the ball. This is bad for the offense and good for the defense.

GLOSSARY

JERSEY: Every player has a home, away, and alternate jersey to represent the city and team. Each player has a unique jersey number to make them identifiable to fans, officials teammates, and coaches.

KICK RETURNER: A special team player who catches kickoffs and attempts to return them in the opposite direction. He is usually one of the fastest players on the team, often a wide receiver.

KICKOFF: A free kick that puts the ball into play. A kickoff is used at the start of the first and third periods and after every touchdown and successful field goal.

LENGTH: The distance along an object from end to end.

LIFT: A force that opposes gravity.

LINE: Defined by a point moving in space, lines may be two or three-dimensional, descriptive, implied, or abstract.

LINE OF SCRIMMAGE: The imaginary line separating the teams at the beginning of a play. The football is placed on the line by the center and is handed off to the quarterback.

LINEBACKERS: Defensive players that defend against passes, push forward to stop the run, and tackle the QB.

LINEMEN (2 GUARDS & 2 TACKLES): Offensive players on either side of the center to help block, in order to get the ball carrier yardage, or to protect the quarterback.

LONG SNAPPER: A special team member whose job is to make longer snaps for punts and field goal attempts. A long-snapper generally has to snap the ball 7 to 8 yards back for field goal attempts and 13 to 15 yards back for punts.

MASCOT: The character that is meant to symbolize an organization, team, or event.

OFFENSE: One 11-man team has possession of the football and tries to advance the ball down the field by running with the ball or throwing it. A team may score points by crossing the goal line and getting the ball into an area called the end zone, or by kicking the ball through the goal posts.

PHYSICS: The study of the physical world, specifically the science of matter and energy.

PLACEKICKER: A special teams member that kicks the ball on kickoffs, extra point attempts, and field goal attempts. A placekicker either kicks the ball while it's being held by a teammate or kicks it off a tee.

PUNT: A kick made when a player drops the ball and kicks it while it falls toward their foot. A punt is usually made on a fourth down when the offense must surrender possession of the ball to the defense because it could not advance the ball 10 yards.

PUNT RETURNER: A special team member who catches the ball after it has been punted and runs it back towards the punting team's end zone.

PUNTER: A special teams member who stands behind the line of scrimmage, catches the long snap from the center, and then kicks the ball after dropping it toward his foot. The punter generally comes in on fourth down to punt the ball to the other team.

QUARTERBACK (QB): Offensive player who passes, hands off, or runs with the ball.

RETURNER: A player on special teams who tries to catch and advance the ball by running. If the player is stopped short of the end zone, the offense resumes position on the yard line where the ball was stopped.

RUNNING BACKS: 1 or 2 offensive players that take the ball from the QB and run with it, or catch passes.

SACK: When a defensive player tackles the quarterback behind the line of scrimmage, resulting in lost yardage.

SAFETY: When an offensive ball carrier is tackled behind their own goal line (in the end zone).

SHAPE: An enclosed space which is two-dimensional, flat, and has length and width.

SHOULDER PADS: A piece of the uniform that protects vulnerable areas of a person's body. For example, shoulder pads help protect muscles and bones of the upper torso and back.

SOLAR ENERGY: The sun's radiant energy that reaches Earth in the form of rays of sunlight that provides the heat and light that sustains all life on Earth.

SPACE: The distances or areas around, between, or within components of a work of art to achieve a sense of depth.

SPECIAL TEAMS: The third unit enters the field during kicking situations: punts, field goals, and kickoffs. Only 11 players are on the field from each team at one time.

STATISTICS: An area of math where numbers are collected and sorted. The way that numbers are sorted can be used to measure success or predict future results.

STEAM: The integrated study of Science, Technology, Engineering, Arts, and Mathematics, and how it relates to the world.

SYMMETRICAL: When an object's one half is a mirror image of the other half.

TACKLE: When the defense stops the offense from moving the football down the field by bringing the ball carrier to the ground.

TECHNOLOGY: A word that describes the knowledge, devices, and materials used to solve problems.

TEXTURE: The way things feel, or look as if they might feel, if touched — like feeling the surface of a football.

THRUST: The force that propels the football forward. The ultimate goal is to produce a lot of thrust on the football when thrown in order to make it go in the direction that the quarterback desires and withstand the force of gravity.

TIGHT ENDS: 1 or 2 offensive players that block the defense, and can catch passes. They are a mix of a wide receiver and a lineman.

TOUCHDOWN: A score, worth six points, that occurs when a player in possession of the ball crosses the plane of the opponent's goal line, or when a player catches the ball while in the opponent's end zone, or when a defensive player recovers a loose ball in the opponent's end zone.

TURNOVERS: The defense can take possession of the ball in two ways: an interception, which is when the defense catches the ball before it hits the ground, or a fumble, when the defense recovers a ball that the call carrier has dropped.

TWO-POINT CONVERSION: An attempt by the offense to run or throw the football over the goal line into the end zone instead of kicking for an extra point. If successful, the scoring team earns two additional points after a touchdown.

WIDE RECEIVERS: Typically, 2–4 offensive players who catch the ball thrown by the QB. They are often lined up against the edges of the field, going "wide."

WIDTH: The distance from one side of an object to the other side.

YARDAGE: Yards, marked by the white lines on the field, are how progress is measured in a football game. The offense tries to get as much yardage as possible to gain inside its opponent's end zone to score.

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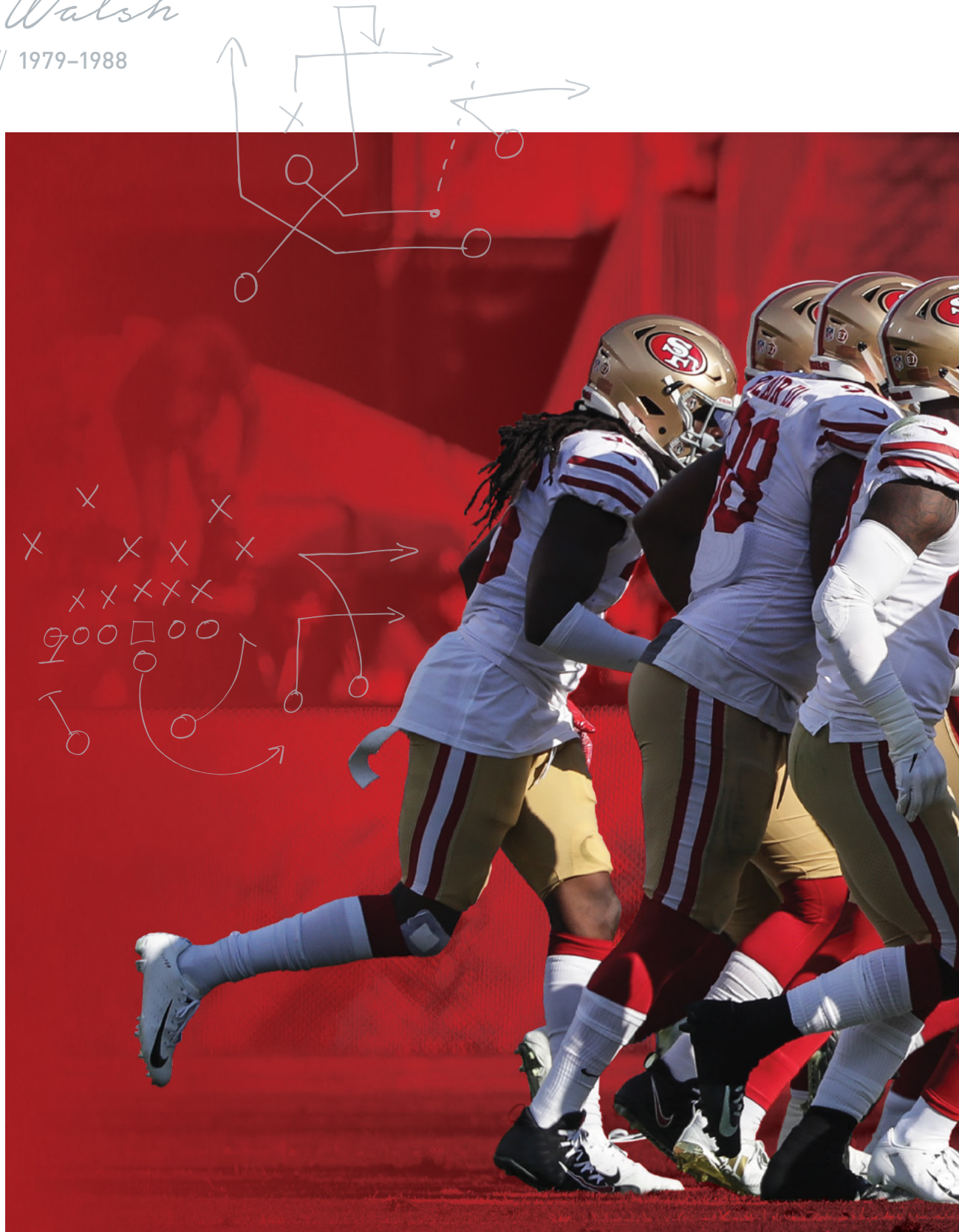

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