Discovering STEM

SCIENCE, TECHNOLOGY,ENGINEERING AND MATH

AT A

2026 Milkmen BASEBALL GAME

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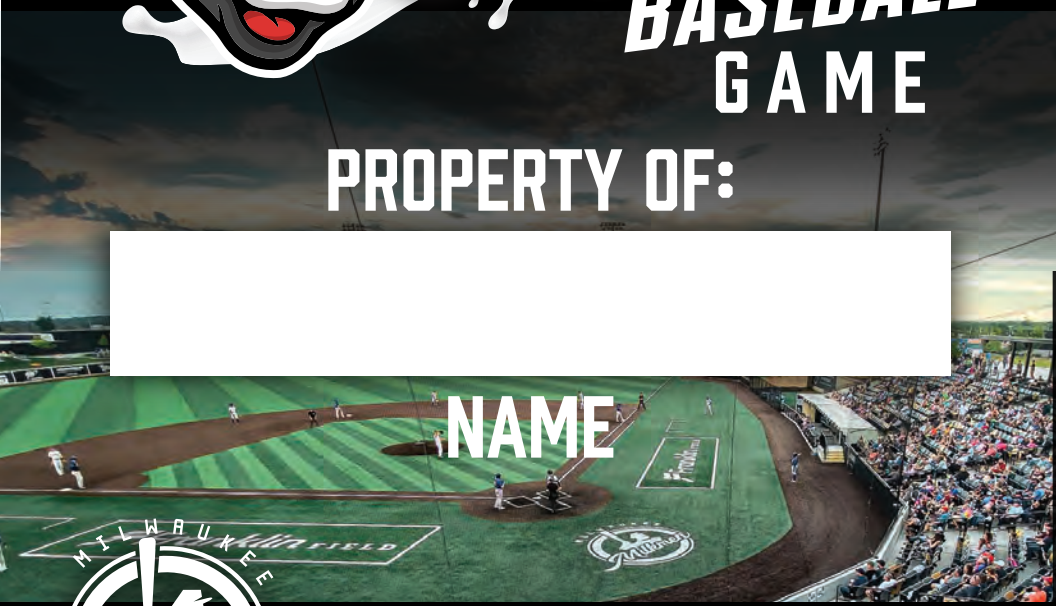

Milkmen

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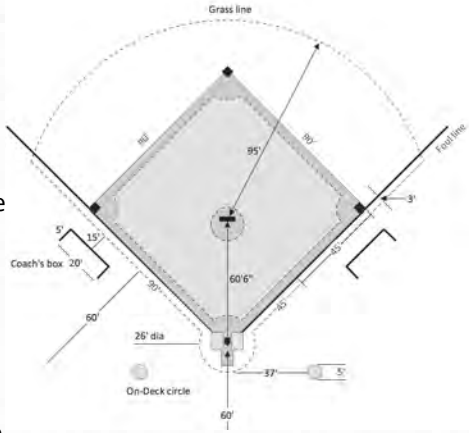
BASEBALL 101

THE GAME

Known in the United States as America's national pastime, baseball in some form has been played since the first settlers arrived. Baseball became an organized sport in the United States in the 1840s and 50s in New York City. The first all-professional baseball team was the Cincinnati Red Stockings in 1869 and they won all 60 of their games in their first season. Today, baseball is played and enjoyed by people of all ages and abilities, from a fun family pick-up game to the pros.



THE FIELD

A ballpark must have a minimum distance of 325 feet between home plate and the nearest fence, stand or other obstruction on the right- and left-field foul lines, and 400 feet between home plate and the nearest fence, stand or other obstruction in center field. The ballpark is then divided into two major parts – the infield and outfield. The infield must be a square that is 90 feet on each side and includes all the bases & pitcher's mound. The outfield is the grassy area beyond the infield dirt.

QUESTION: What is the field size of the Milkmen's home stadium, Franklin Field?

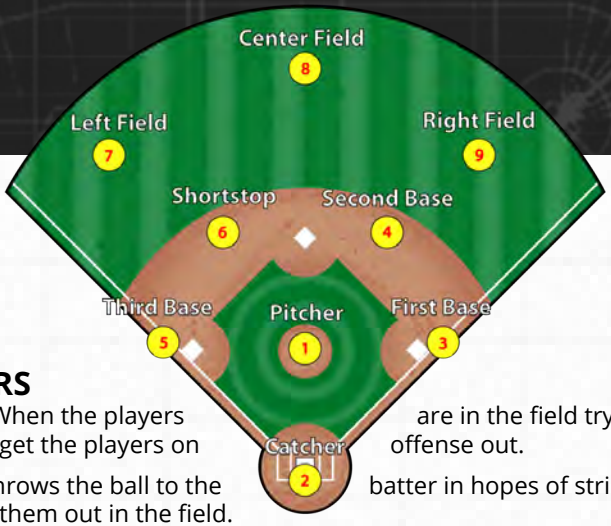
Left field: _____; Center field: _____; Right field: _____

THE GOAL

The goal in baseball is to score more points (called runs) than the other team. To score a run, the players on the team at bat attempt to score runs by touching all four bases, in order, set at the corners of the square-shaped baseball diamond.

OFFICIALS

Baseball umpires have similar duties to a referee in other sports. There are 4 umpires in a baseball game: 1 behind home plate and one stationed near each of the 3 bases. Each umpire makes the "out" or "safe" calls at their plate, the home-plate umpire also calls balls and strikes on each pitch that is thrown.



THE PLAYERS

DEFENSE – When the players are in the field trying to stop the ball and get the players on offense out.

Pitcher – throws the ball to the batter in hopes of striking them out or getting them out in the field.

Catcher – primarily responsible for catching all the throws from the pitcher; also gives pitcher hand signals on what type of pitch to throw in a situation.

First Baseman – stand on the infield by the first base and is responsible for most of the plays at that base.

Second Baseman – infield position standing, between second and first base. The second baseman often possesses quick hands and feet, needs the ability to get rid of the ball quickly, and must be able to make the pivot on a double play.

Short Stop – infield position standing between second and third base. The shortstop is considered the captain of the infield and takes charge on balls hit in the air as well as communication among infielders.

Third Baseman – infield position that defends the area around and at third base.

Left Fielder – an outfield position who makes defensive plays in the left area of the field based on standing at home base facing the pitcher's mound (area behind 3rd base); tend to be an excellent fly ball catcher.

Center Fielder - an outfield position who makes defensive plays in the center area of the field based on standing at home base facing the pitcher's mound; tend to be an excellent fly ball catcher and good communicator with other fielders.

Right Fielder - an outfield position who makes defensive plays in the right area of the field based on standing at home base facing the pitcher's mound (area behind 1st base); tend to be an excellent fly ball catcher.

OFFENSE - When the players have a chance to hit the ball and score runs. The manager will put the players in order and one player at a time will stand at home plate and try to hit the baseball. The players must stay in the order their manager submitted to the umpire unless an injury occurs. The player continues to run around the bases trying to make it home without the defense getting them out.

STEM
FIELD OF SHAPES

SHAPES

There are shapes everywhere in a baseball stadium. Shapes, lines and angles are all important math concepts. The entire field is shaped like a triangle. The bases create a diamond with each base acting as the angle points. First, second and third bases are squares. The pitcher's mound and score boards are rectangles. Home plate is a pentagon with the point facing away from the field. The baseball is a sphere and the on-deck area for batters is a circle.

Each base is 90 feet away from the next and four straight lines connect the bases. The lines between home plate and first base and home plate and third base form a 90 degree, or right, angle. Anything that happens between these two lines considered fair play. Anything outside these lines is called foul by the umpires.

QUESTION: How many shapes can you name and trace? _____

STEM
BASEBALL GEAR

BATS

All professional baseball bats are made from a single piece of wood, usually maple or ash. Wood from trees have different densities, a unit of volume of a material substance. The density of bats can affect how a baseball player bats. Bats from ash are lighter and can help players swing faster. Maple bats are heavier and may help a batter make better ball contact. Each player uses their own bat in games. Rules state that a bat can not be longer than 42" and no thicker than 2.61" in diameter at its thickest point. Aluminum bats are not allowed due to: (1) safety (they could hit even faster causing injury to fielders) and (2) maintain human skill of hitting vs. technology.

BALLS

Original baseballs were made from yarn wound around rubber with a horsehide cover sewn around it. Strict engineering guidelines go into today's baseballs made of three layers of wool wound around a cork center. A polyester and cotton yarn layer is then added before finally covering it with bleached white cowhide stitched together with red waxed thread.

- Circumference between 9 and 9.25 inches
- Weight between 5 and 5.35 ounces
- Must regain its shape within 0.08 inches when pressed
- Must bounce back at 51.4 – 57.8% of the starting speed when thrown at a solid wood surface

GLOVES

Players in the early years caught balls with their bare hands. With the speed of the ball being hit these days, think of how painful that would be! Today, gloves are made from nice soft leather, with thick padding, webbing and a nice wide pocket in which to catch the ball.

ACTIVITY: Design your bat in the box below. Would you use ash or maple?

STEM
PITCHING: VELOCITY & TORQUE

Pitching is an important part of the offense in baseball. The velocity (speed) of the pitch is measured by how fast the baseball travels over a certain distance. This measurement is part of science known as physics which uses math to answer questions. The pitcher's mound is 60 feet and 6 inches away from home plate. If a pitch gets to home plate in 1 second, it's moving about 40 miles per hour. The current average pitching speed in the pros is 92 miles per hour. According to the Guinness Book of World Records, the fastest pitch ever thrown by a man was 105 miles per hour. Today, radar gun technology behind home plate calculates the speed of each pitch.

$$\text{SPEED} = \frac{\text{DISTANCE}}{\text{TIME}}$$

The seams on a ball, although only rising about 0.03 inches above the surface, create friction where the air rushes over them. A pitcher creates movement by the way they grip the seams and spin the ball when they let it go.

Fastball pitchers use velocity to overpower the batter, so they swing and miss. They hold the ball with only two fingertips on the seams because the less of their hand holding the ball, the faster it will go.

Curveballs are pitched to start in a straight line, then curve when it gets to home plate due to the torque (spin) the pitchers give the ball when they release it.
It is also slower than a fastball because more of the pitcher's fingers are on the ball.
The pitch is known to be hard for hitters because of the ball's change in movement.

The Strike Zone is the area above home plate between the armpits and knees of the batter; the area will change based on the batter's height and build. It's the umpire's job to officially call a strike or ball.

ACTIVITY: Draw the Strike Zone over home plate for this Milkmen player.

STEM
HITTING: LAUNCH ANGLE

Hitting a ball that is moving toward you at more than 90 miles per hour, potentially spinning 20 times a second, from 60 feet away is extremely difficult. The batter makes a hitting decision in about a half of a second.

When a bat hits a ball, an angle is formed between the ground and the ball's path, called the launch angle.

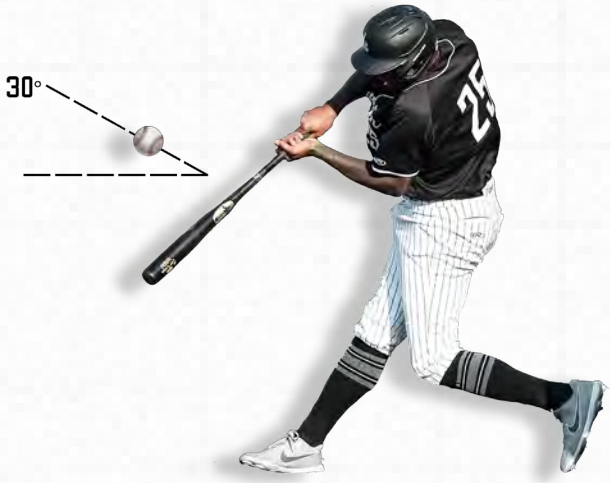
Grounder = less than 10°

Line Drive = 10° to 25°

Fly Ball = 25° to 50°

Home Run = 35° to 45°

Pop Up = more than 50°



Professional players use special cameras during batting practice to measure their hitting angles. These cameras have shown that an angle between 35° and 45° most often leads to a home run. With this information, players practice hitting within that angle range as much as they can. Batters also need to take into consideration the way the ball is pitched, wind speed and bat swing speed.

THE SWEET SPOT

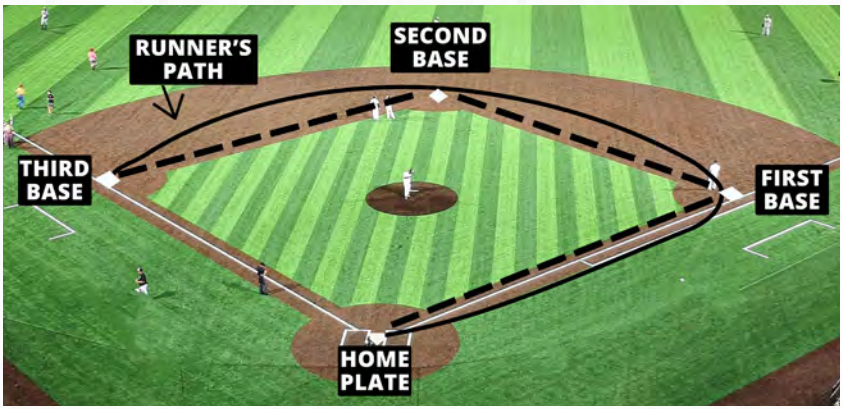
Every bat has an area that will make the ball go farther than any other places on the bat. Hitting a ball on the "sweet spot" means the hitter will have maximum momentum transferred from the bat to the ball, and the ball will fly the furthest.

ACTIVITY: How to Find The Sweet Spot

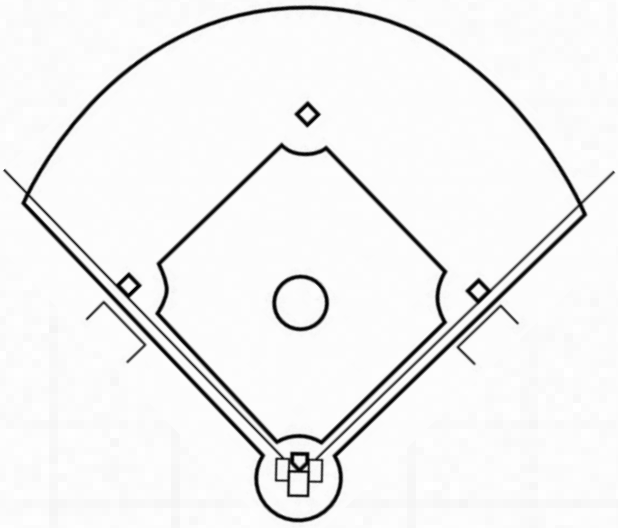
- With arm extended, hold the knob of the bat loosely between the thumb and fingers
- Have another person gently tap on the dangling bat with a hammer starting in the middle of the bat and progress downward
- As they tap, vibrations will travel up the bat and into the fingers of the person holding it
- When they no longer feel vibrations, mark that spot – that's the sweet spot!

STEM
BASE RUNNING

When is a straight line not the fastest way to get from point A to B? When running bases during a baseball game. That may sound wrong; however, if you ran as fast as you could in straight lines from home plate to first, second, third bases and then back home, you would need to slow down to touch each base and turn before heading to the next one. However, if you made a slightly wider turn (running in a small arc) while running the bases you do not need to slow down while touching the bases. Taking the optimal base running angles can reduce the time it takes to run from home to second base by nearly 2 seconds.



ACTIVITY: Draw the fastest running path from second base to home below:



STEM
BATTING STATISTICS

No other sport relies on numbers and math like baseball. Coaches use them to set line-ups, change pitchers, and trade players. The game itself is based on numbers – 9 innings, 3 outs per team per inning, pitch count, speed of the pitch, 3 strikes per out or 4 balls per base on balls, 4 bases to touch in sequence to score a run, etc. Bottom line: Numbers and math are everywhere in baseball!

Batting is so challenging that getting a hit just 3 or 4 times out of every 10 times at bat makes you a great hitter. A player's batting average (BA) will show you how good of a hitter he is. Batting average is calculated by taking the number of hits divided by the number of times he was up to bat. Most pro players get 1 hit for every 4 times at bat or an average of .250 (1 divided by 4). The best hitters have averages above .300. The higher the BA, the better the hitter.

$$\text{BA} = \frac{\text{\# HITS}}{\text{\# OF TIMES AT BAT}}$$

ACTIVITY: Milkmen Player Jose Sermo had 107 hits and 370 at bats in the 2023 season. Calculate his BA:

On-base percentage (OBP) tells you based on how often they go up to hit, they end up on base. OBP is a truer indicator of how good of an offensive player is because it incorporates both hits and walks. An average OBP is around .320. Again, the higher the number, the better the player.

$$\text{OBP} = \frac{\text{(\# HITS + \# WALKS + \# HIT BY PITCH)}}{\text{\# OF TIMES AT BAT}}$$

ACTIVITY: Milkmen Player Reggie Pruitt Jr. ended the 2023 season with 92 hits and 50 walks. He was at bat a total of 325 times during the season. Calculate his OBP:

STEM
PITCHING STATISTICS

Many pitching statistics are the opposite of hitting, the lower the number the better the pitcher. Pitchers have their performance measured by earned run average (ERA). ERA is a number to show how many runs a pitcher gives up to the other team if they had pitched a 9-inning game (according to math and statistics it's recommended to make pitching changes more regularly). Under 3.00 is a good pitching ERA. ERA is a whole-game statistic.

$$\text{ERA} = \frac{\text{(NUMBER OF EARNED RUNS X 9 INNINGS PER GAME)}}{\text{BY THE NUMBER OF INNINGS PITCHED}}$$

ACTIVITY: Circle the picture of the best Milkmen pitcher.

Milkmen Pitcher Shane Barringer has an ERA of 4.75

Milkmen Pitcher Juan Echevarria has an ERA of 2.84

Milkmen Pitcher Victor Vargas has an ERA of 4.80

Another statistic is Walks plus Hits per Inning Pitched (WHIP), which is a per-inning statistic. Again, the lower this number, the better the pitcher.

$$\text{WHIP} = \frac{\text{(WALKS + HITS)}}{\text{TOTAL NUMBER OF INNINGS PITCHED}}$$

QUESTION: Which pitcher has the lower WHIP?

	Hits	Walks	Innings Pitched
John	145	41	184
Bill	187	66	217

STEM
STADIUMS

Stadiums are where all the components of STEM design come together. Engineers and architects understand the location of the ballpark before building it – is it in a city, country, suburb, near water, mountains or woodlands. They use math to measure the space they have for building it, then model the design on the computer.

Engineers work to get as many seats into the stadium as possible allowing all fans to have a good view, stay safe and have a great experience. Notice how seats in a stadium raise higher as they go away from the field for better sight-lines. Strong materials such as steel and concrete are used to hold up the massive stadium structure. Not only does it need to be safe and strong but look good too! It's always a better experience when the ballpark looks exciting to be at.

Weather impacts the building of a stadium as well. Water drainage is key for moving water away from the field. This system includes the use of pipes, sand and crushed rock under the grass so water can pass through the grass quickly and drain away under the field.

Technology plays an important part of creating an enjoyable experience at the ballpark as well. Scoreboards that are large and easy to read, along with a sound system that is loud and clear keeps fans engaged.

ACTIVITY: List two (2) important things engineers and architects need to consider or use when building a baseball stadium:

1. _____ 2. _____

ANSWER KEY

PAGE 3

Field size:
Left field: 330 ft
Center field: 408 ft
Right field: 330 ft

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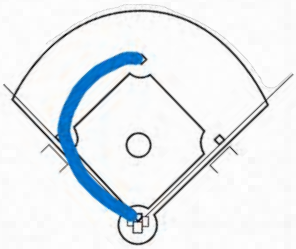
PAGE 7

PAGE 9



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107 / 370 = .289
Yes, he is a good hitter because he's close to .300

(92+50) / 325 = .437
Yes, he is a good offensive player

PAGE 11

1. Juan Echevarria

2. John
John = (145+41) / 184 = 1.01
Bill = (187+66) / 217 = 1.17

PAGE 12

Any of the following: location, steel, cement, sound system, seat arrangement, lighting, design, field drainage

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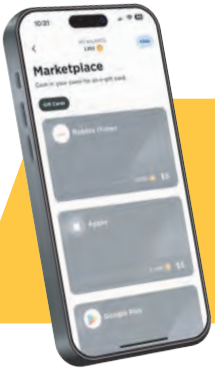

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SUN	MON	TUE	WED	THU	FRI	SAT
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	6:30PM WPG 15	6:00PM WPG 16
1:00PM WPG 17	6:30PM GAR 18	10:30AM GAR 19	10:30AM GAR 20	21	AT WPG 22	AT WPG 23
AT WPG 24	AT SCE 25	AT SCE 26	AT SCE 27	AT SCE 28	AT LCD 29	AT LCD 30
AT LCD 31						

JUN

SUN	MON	TUE	WED	THU	FRI	SAT
	1	6:30PM CHI 2	6:30PM CHI 3	6:30PM CHI 4	6:30PM FAR 5	6:00PM FAR 6
1:00PM FAR 7	8	AT GAR 9	AT GAR 10	AT GAR 11	AT CHI 12	AT CHI 13
AT CHI 14	15	6:30PM KCO 16	6:30PM KCO 17	6:30PM KCO 18	AT KAN 19	AT KAN 20
AT KAN 21	AT LCD 22	AT LCD 23	AT LCD 24	AT LCD 25	6:30PM CLE 26	6:00PM CLE 27
1:00PM CLE 28	29	TBD CHI 30				

JUL

SUN	MON	TUE	WED	THU	FRI	SAT
			AT CHI 1	AT CHI 2	AT KCO 3	AT KCO 4
AT KCO 5	6:30PM WPG 6	6:30PM WPG 7	6:30PM WPG 8	9	6:30PM LCD 10	6:00PM LCD 11
1:00PM LCD 12	13	14	15	16	AT GAR 17	AT GAR 18
AT GAR 19	20	6:30PM LCD 21	6:30PM LCD 22	6:30PM LCD 23	6:30PM KCO 24	6:00PM KCO 25
1:00PM KCO 26	27	AT CLE 28	AT CLE 29	AT CLE 30	AT CLE 31	

AUG

SUN	MON	TUE	WED	THU	FRI	SAT
						AT CLE 1
AT CLE 2	3	6:30PM GAR 4	6:30PM GAR 5	12:00PM GAR 6	AT SFC 7	AT SFC 8
TBD SFC 9	10	6:30PM CHI 11	6:30PM CHI 12	6:30PM CHI 13	6:30PM KAN 14	6:00PM KAN 15
1:00PM KAN 16	17	AT KCO 18	AT KCO 19	AT KCO 20	6:30PM CLE 21	6:00PM CLE 22
1:00PM CLE 23	6:30PM LIN 24	6:30PM LIN 25	6:30PM LIN 26	12:00PM LIN 27	AT FAR 28	AT FAR 29
AT FAR 30	31					

SEP

SUN	MON	TUE	WED	THU	FRI	SAT
		AT LIN 1	AT LIN 2	AT LIN 3	6:30PM FAR 4	6:00PM FAR 5
1:00PM FAR 6	1:00PM FAR 7	8	9	10	11	12

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