1.0 Forces in Baseball

GRADES 6th-8th

Results will vary among students. Example data below.

	Throw 1 = 10 meters			Throw 2 = 10 meters		
Mass of ball: 0.14 kg	Time (s)	Velocity (m/s)	Kinetic Energy (Joules)	Time (s)	Velocity (m/s)	Kinetic Energy (Joules)
Student 1	2 s	5 m/s	.7 J	1.5 s	6.67 m/s	.93 J
Student 2	1.5 s	6.67 m/s	.93 J	1.5 s	6.67 m/s	.93 J
Student 3	1.5 s	6.67 m/s	.93 J	2 s	5 m/s	.7 J
Student 4	2 s	5 m/s	.7 J	1.5 s	6.67 m/s	.93 J

	Throw 3 = 10 meters			Throw 4 = 10 meters		
Mass of ball: 0.14 kg	Time (s)	Velocity (m/s)	Kinetic Energy (Joules)	Time (s)	Velocity (m/s)	Kinetic Energy (Joules)
Student 1	2 s	5 m/s	.7 J	1.5 s	6.67 m/s	.93 J
Student 2	1 s	10 m/s	1.4 J	1.5	6.67 m/s	.93 J
Student 3	1.5 s	6.67 m/s	.93 J	2	5 m/s	.7 J
Student 4	1.5 s	6.67 m/s	.93 J	1	10 m/s	1.4 J

1) What percent of the Aroldis Chapman throw (105.1 MPH) was your fastest pitch? Example: If you threw at 45 MPH/150 MPH = .3 or 30%. Your fastest throw was only 30% as fast as Aroldis Chapman's throw.

   Example data:

   My pitch speed was 22 mph.

   22 MPH/150 MPH = 14.6 or 14.6% as fast as Aroldis Chapman's throw.

Graph the kinetic energy vs your velocity for each throw from slowest to fastest.
Results will vary among students.

2) **Based on your data/graph, explain the relationship between velocity and kinetic energy by making a claim about the relationship. Support your claim with evidence and reasoning.**
   Experimental results and answers will vary among students.

   Claim: What is the relationship between velocity and kinetic energy?

   Answers will vary among students.

   Evidence: Record and reference in words any data that supports your claim.

   Answers will vary among students.

   Reasoning: Explain why your claim is supported by evidence and scientific ideas, use the kinetic energy equation to support you.

   Answers will vary among students.

2.0 Composition of a Baseball

GRADES 6th-8th

What were some of the constraints for the first baseball? Why do you think players felt they needed to make changes?

Example: One of the biggest constraints was using the same ball (or item that resembled a ball) for play, which included varying size, shape, internal and external properties. In addition, a ball that was sustainable during play and not just a portion of a game or an inning. For these reasons, please certainly felt a much needed change.

How has the anatomy of a baseball changed over time? What drove this change?

Example: The composition of the baseball has changed significantly since the 1830's, where using a rock or walnut wrapped in string or yarn and surrounded by leather was the norm. To the 1850's, where a baseball governing body was established to implement a ball with a specific weight and structure between 5.5 and 6.25 ounces. To today's ball, that consists of both natural and synthetic materials, internally and externally. This change was driven by access to materials and durability.

How have the materials of a baseball changed over time? How do you think the change from natural to synthetic cores impacted the play of the game?

Example: Based on cost and accessibility, the earliest materials used were natural. Whereas materials used today are both natural and synthetic. The natural materials are predominantly used for official play, such as at the major league, collegiate, and high school levels.

Explain the importance of the governing bodies setting clear criteria for the baseball design.

Example: By establishing a governing body between teams and its players, it created more consistent and fair play for participants and/or uniformity among teams.

How did Major League Baseball ensure that all baseball's were the same size in 2011? In 1974? Why was this important to the game?

Example: By using the same materials internally and externally, a consistent weight and durability was established, in addition to rigorously testing the composition of the ball to ensure durability and performance.

What is the author's purpose of this article? Provide text evidence to support your claim.

Example: To educate the audience on how technology and engineering has shaped and reshaped the baseball to ensure accountability and fair play for the betterment of all participants.

Using the article and classroom discussion, fill in the following criteria and constraints table.

Answers will vary among students based on inference and class discussion.

Criteria	Constraints

Results will vary among students.

	Distance of Hit 1	Distance of Hit 2	Distance of Hit 3	Distance of Hit 4	Distance of Hit 5
Baseball					
Tennis Ball					

Softball					
Golf Ball					

Based on evidence from the article and your experiment, write a claim and support it with evidence and reasoning explaining how and why a baseball behaves differently than a tennis, softball, and golf ball.

Experimental results and answers will vary among students.

1) Claim: How did the evolution of the baseball create a design that has a different function than a tennis ball, softball and golf ball?

   Answers will vary among students.

2) Evidence: Record and reference in words any data that supports your claim:

   Answers will vary among students.

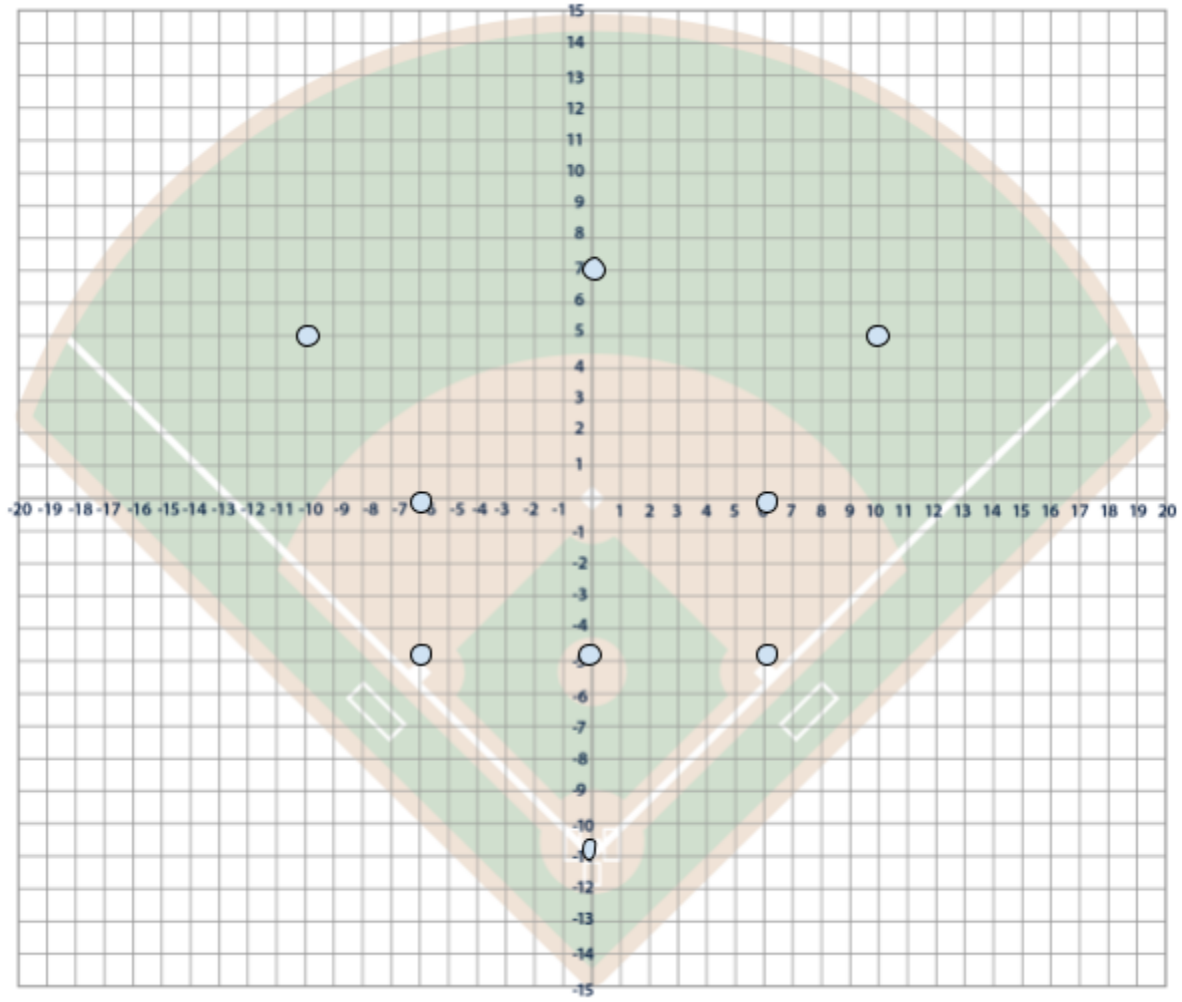
3) Reasoning: Explain why your claim is supported by evidence and scientific ideas. Use the ideas in the test and your understanding of engineering an object for a specific function.

   Answers will vary among students.

3.0 The Field of Play

GRADES 6th-8th

6th grade specific standards
Plot each player on the coordinate plane. Label their x,y coordinates.



Center field: **(0,7)**

Left Field: **(10,5)**

Right Field: **(-10,5)**

Pitcher: **(0,-5)**

First Base: **(6,-5)**

Second Base: **(4,0)**

Shortstop: **(-4,0)**

Third Base: **(-6,-5)**

Catcher: **(0,-11)**

Use the coordinate plane to determine the absolute value between players.

1. How far would the Second Base player need to throw to the Shortstop?

-8

2. How far would the Third Base player need to throw to the First Base player?

12

3. How far would the Pitcher need to throw to the Catcher?

-6

4. How far does the Center Fielder need to throw to the Pitcher?

-18

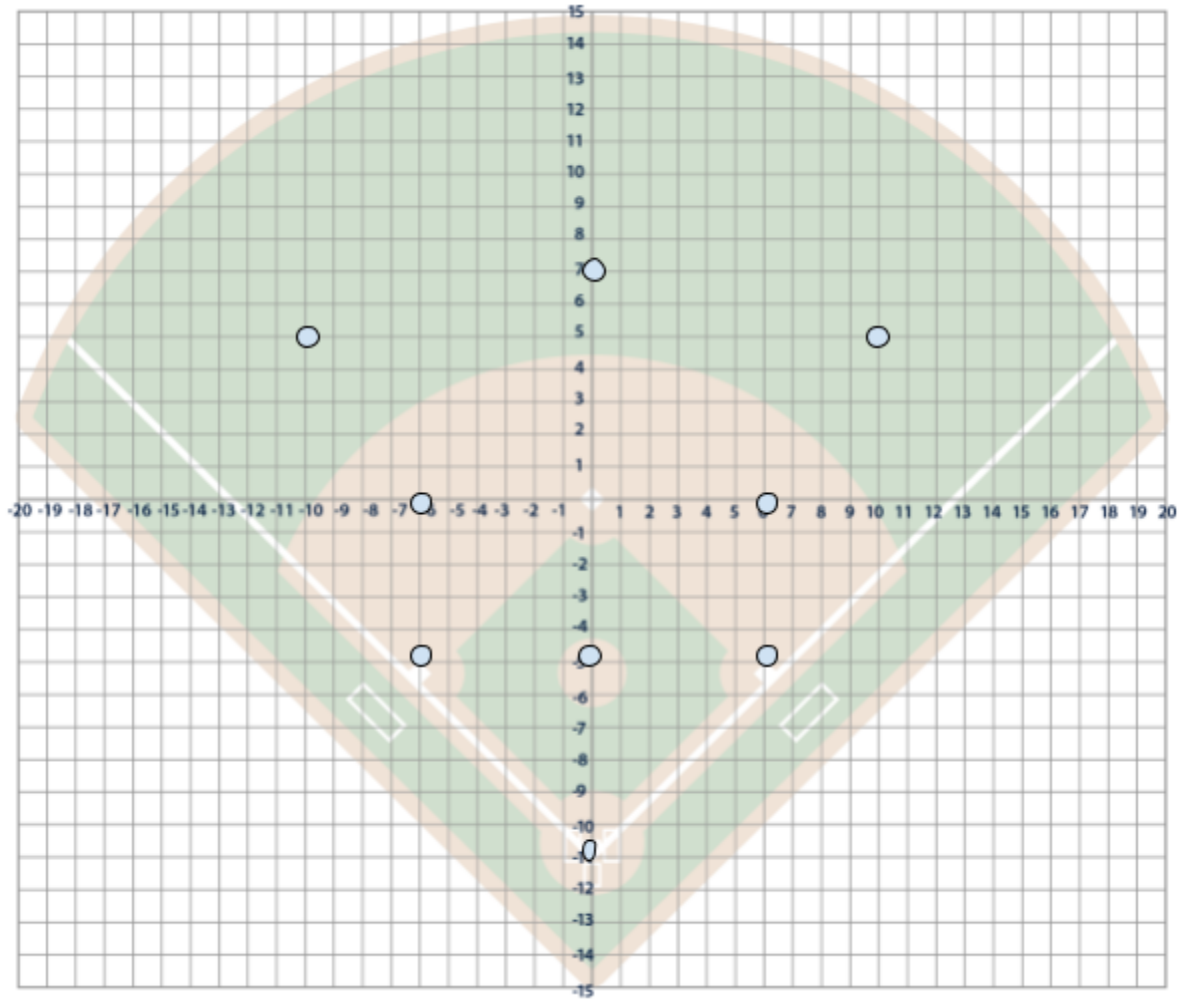
5. If the First Baseman ran to (0, 6) to catch the ball and then needed to throw to Home to make the play, how far would they throw?

-17

6. If the Catcher (-11) was trying to throw out a runner stealing Third, how far would they throw?

6

8th grade specific standards
Plot each player on the coordinate plane. Label their x,y coordinates.



Center field: **(0,7)**

Left Field: **(10,5)**

Right Field: **(-10,5)**

Pitcher: **(0,-5)**

First Base: **(6,-5)**

Second Base: **(4,0)**

Shortstop: **(-4,0)**

Third Base: **(-6,-5)**

Catcher: **(0,-11)**

1. Use the distance between the Pitcher and First Base (A), and the Pitcher and Catcher (B). Use the Pythagorean Theorem to calculate the distance between First Base and Catcher. $A^2+ B^2 =C^2$

8.49

2. Use the distance between the Pitcher and Third Base (A), and the Pitcher and Catcher (B). Use the Pythagorean Theorem to calculate the distance between Third Base and Catcher. $A^2+ B^2 =C^2$

8.49

3. Use the distance between the Pitcher and Center Field (A), and the Pitcher and Third Base (B). Use the Pythagorean Theorem to calculate the distance between Third Base and Center Field. $A^2+ B^2 =C^2$

13.42

4. Use the distance between the Pitcher and Center Field (A), and the Pitcher and First Base (B). Use the Pythagorean Theorem to calculate the distance between First Base and Center Field. $A^2+ B^2 =C^2$

13.42

5. The Catcher moves to (6, -11). Use the distance between First Base and Catcher (A) and First Base and Pitcher (B). Use the Pythagorean Theorem to calculate the distance between the Pitcher and Catcher. $A^2+ B^2 =C^2$

8.4

6. The Right Fielder moves to (4, 7) in line with the Second Base player. Use the distance between the Second Base player and the Right Fielder (A) and the Second Base player and Shortstop (B). Use the Pythagorean Theorem to calculate the distance between Right Field and Shortstop. $A^2 + B^2 = C^2$

10.63

4.0 The Art of Pitching

GRADES 6th-8th

What variables do you need to control?
Results will vary. Example data below.

Pitching Motion	Speed (measured by radar) m/s	Time of travel (From video) s	Acceleration (Calculated (SI-SF)/time) m/s^2	Mass kg	Force F=MA N(newtons)
Windup	34 MPH	1.2 s	28.3 m/s^2	.14 kg	4 N
Windup	36 MPH	1.1 s	32.72 m/s^2	.14 kg	4.6 N
Stretch	32 MPH	1.3 s	24.61 m/s^2	.14 kg	3.5 N
Stretch	33 MPH	1.3 s	25.38 m/s^2	.14 kg	3.6 N

How does a change in force affect a change in motion? Support your answer with evidence from the experiment.
Example: Based on the above results, a change in force of the motions -- Wind-up and Stretch -- demonstrated a difference in higher 'Newtons' in the Wind-up motion versus the Stretch motion, as the Wind-up motion requires more force.

5.0 Engineering a Pitching Machine

GRADES 6th-8th

Identify the Problem: What is the problem you are trying to solve?

Results will vary among students.

Brainstorm multiple designs

Results will vary among students.

Select a single design (draw in detail, label materials and provide measurements)

Build, Design and Test It: Your test should be a controlled experiment; the table is provided to support your data collection. Consider ensuring the target, energy input, 'pitcher' and 'ball' are the same.

Results will vary among students.

	Test 1	Test 2	Test 3
Over the plate but low			
Over the plate but high			
Directly over the plate			

Communicate: Did it work? What evidence supports that it works? Would you make any changes?

Answers will vary among students.

6.0 Success at the Plate

GRADES 6th-8th

X = Hit O = No Hit

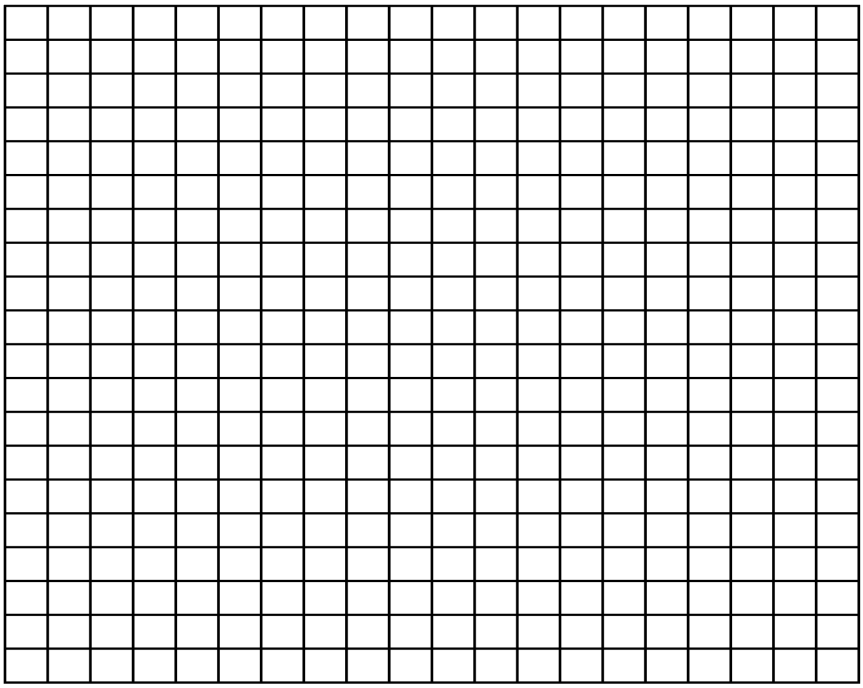
Trial 1

Swing	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Probability
Hitter	O	O	X	X	O	X	X	O	O	X	5/10

Trial 2

Swing	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Probability
Hitter	X	O	X	X	O	X	X	O	X	X	7/10

Graph the probability of each trial below: Answers will vary based on student results.



1) Based on Trial 1 probability, how many successful hits would you have out of 100 hits? **50**

2) Based on Trial 1 probability, how many successful hits would you have out of 1,000 hits? **500**

3) Based on Trial 1 probability, how many successful hits would you have out of 10,000 hits? **5,000**

4) Based on Trial 2 probability, how many successful hits would you have out of 100 hits? **70**

5) Based on Trial 2 probability, how many successful hits would you have out of 1,000 hits? **700**

6) Based on Trial 2 probability, how many successful hits would you have out of 10,000 hits? **7000**

Based on this information, were you more or less successful before or after watching the video and implementing a change to your swing mechanics? Support your answer with data.

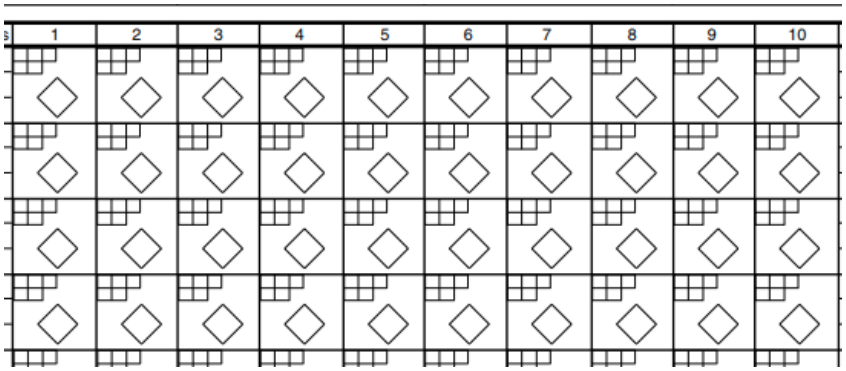
Example: I was more successful after watching the video on hitting mechanics, as I hit .50 or a batting average of .500 pre-video and hit .70 or a batting average of .700 post video.

7.0 Keeping Score

GRADES 6th-8th

Option 1: Scoring the Game

Results will vary among students.



Option 2: Scoring the game

Add a tally mark, as needed.

Results will vary among students.

Inning	Runs	
	Team 1	Team 2
1		
2		
3		
4		
5		
6		
7		
8		
9		

Team 1 **Results will vary among students.**

Inning	Strikes (3)				Balls (4)			
	Hitter 1	Hitter 2	Hitter 3	Hitter 4	Hitter 1	Hitter 2	Hitter 3	Hitter 4
1								
2								
3								
4								
5								
6								
7								
8								
9								

Team 2 **Results will vary among students.**

Inning	Strikes (3)				Balls (4)			
	Hitter 1	Hitter 2	Hitter 3	Hitter 4	Hitter 1	Hitter 2	Hitter 3	Hitter 4
1								
2								
3								
4								
5								
6								
7								
8								
9								

Put your data above in ratios and simplify to unit rate in the tables below.

Strike to Pitch **Results will vary among students.**

	Ratio	Unit Rate
Inning 1:		
Inning 2:		
Inning 3:		
Inning 4:		

Strike to Ball **Results will vary among students.**

	Ratio	Unit Rate
Inning 1:		
Inning 2:		
Inning 3:		
Inning 4:		

Ball to Pitch **Results will vary among students.**

	Ratio	Unit Rate
Inning 1:		
Inning 2:		
Inning 3:		
Inning 4:		

Runs to Batters **Results will vary among students.**

	Ratio	Unit Rate
Team 1:		
Team 2:		

Inning score to total score **Results will vary among students.**

	Ratio	Unit Rate
Inning 1:		
Inning 2:		
Inning 3:		
Inning 4:		

Team 1 total score; Team 2 total score **Results will vary among students.**

	Ratio	Unit Rate
Team 1: Team 2		
Team 2: Team 1		

Team 1 inning score; Team 2 inning score **Results will vary among students.**

	Ratio	Unit Rate
Inning 1:		
Inning 2:		
Inning 3:		

Inning 4:		

Answer the questions:

1) **Based on the Run to Hitter ratios, who is a more effective pitcher? How do the ratios support your claim?**

   Based on results, answers will vary among students.

2) **Based on your inning Runs to Total Runs ratio, which inning was the best played inning? How do the ratios support your claim?**

   Based on results, answers will vary among students.

3) **If your team out scores the other team at a ratio of 2:1, what will the score be for each inning and the end of the game?**

   Based on results, answers will vary among students.

Results will vary among students.

Innings	Opponent score	Your score
1	1	
2	2	
3	4	
4	3	
5	0	
6	1	
7	2	
8	1	
9	3	
Total		

4) **If a pitcher's ratio of pitches to strikes is 5:2, how many strikes will the pitcher throw during a game of 50 pitches?**

   Based on results, answers will vary among students.

5) **If a relief pitcher strikes out a player 1/3 times, what is their ratio of strikes to pitches?**

Based on results, answers will vary among students.

8.0 Advancements in Baseball

GRADES 6th-8th

Pitching:

Rate your pitches: best to worst. Explain your reasoning.

Based on results, answers will vary among students._____

_____

Swinging:

Rate your swings/hit: best to worst. Explain your reasoning.

Based on results, answers will vary among students._____

_____

Problem: In Baseball, comprehensive skills (swinging and pitching) happen more quickly than we can see and analyze. How can coaches and players better analyze their skills?

Brainstorm a list of criteria and constraints with students and display below:

Criteria	Constraints
Example: Vision at the plate (head to contact); balanced stance; coaches identify teachable moments and correct.	**Example: Swinging and pitching happen quickly; habits are established/instilled at a young age; changes are difficult to pinpoint and correct.**

After review of Performance Technology:

Pitching:

Rate your pitches: best to worst. Explain your reasoning. What evidence did you collect from the technology?

Based on results, answers will vary among students._____

Swinging:

Rate your swings/hits: best to worst. Explain your reasoning. What evidence did you collect from the technology?

Based on results, answers will vary among students.

Which is the best solution to the problem: Coaches and players need a better way to analyze their skills, Gameplan, Performance Technology, or a redesign?

These questions will help support your writing: Which technology, GamePlan or Performance Technology, better supports a player improving their skills? What are the similarities and differences from each technology? How do both technologies meet or not meet the criteria constraints brainstormed in the *Explain* section? What improvements would you make to both technologies?

Answers will vary among students.