

# Kickball Game

## 8<sup>th</sup> Grade Open Response Question

### Academic Expectations:

- 1.5 Students use mathematical ideas and procedures to communicate, reason, and solve problems.
- 2.8 Students understand various mathematical procedures and use them appropriately and accurately.
- 2.9 Students understand space and dimensionality concepts and use them appropriately and accurately.
- 2.13 Students understand and appropriately use statistics and probability.

### Kentucky Core Content:

- Students will perform the following mathematical operations and/or procedures accurately and efficiently and explain how they work in real-world and mathematical situations:
  - MA-M-2.2.5** Use formulas to find *area* and perimeter of triangles and *quadrilaterals*, area and circumference of circles, and surface area and volume of rectangular prisms.
  - MA-M-3.2.7** Represent probabilities in multiple ways such as fractions, decimals, percents, and area models
- Students will show connections and how connections are made between concepts and skills, explain why procedures work, and make generalizations about mathematics in meaningful ways for the following relationships:
  - MA-M-3.3.4** How probability and statistics are used to make predictions and/or draw conclusions

### THE PROBLEM

As a reward for good behavior, Mr. Heath's class has asked to play kickball on the blacktop playground next to the school building. Mr. Heath is worried that the strong kickers will break a window of the school, but also would like to see his students enjoy their afternoon. He's decided to look at the mathematical probability to help him make a reasonable decision. Based on the following building dimensions, determine the probability of an athletic student breaking one of the windows.

Outside wall: 55 feet high, 100 feet wide

Six windows: 10 feet high, 15 feet wide EACH

- a) Assuming that each ball hits the wall and all places on the side of the wall have an equal chance of being hit, find the probability that the ball *will* hit a window whenever it hits the side of the building. Calculate the probability as a fraction, a decimal, and a percent. Be sure to show your work.
- b) Using the probability found in part a), explain whether or not the teacher should be worried about the windows breaking. Considering the mathematics, if you were the teacher, would you allow the students to play the game?



## SCORING GUIDE

4	Student earns 4 points.
3	Student earns 3 points.
2	Student earns 2 points.
1	Student earns 1 point.
0	Student earns 0 points.

- 1 point: Student correctly calculates the areas of the wall,  $55 \times 100 = 5500$  square feet, and the windows,  $6(10 \times 15) = 900$  square feet
- 1 point: Student correctly calculates the probability in fraction form, by making the fraction window area/wall area:  
 $P(\text{hitting a window}) = 900/5500$ ;
- 0.5 points: Student correctly calculates the probability as a decimal .1636, which may be rounded to the hundredths place.
- 0.5 points: Student correctly calculates the probability as a percent 16%.
- 1 point: Student gives a reasonable argument, using mathematical justification, for his/her decision about whether or not to allow the kickball game.

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- a) Assuming that each ball hits the wall and all places on the side of the wall have an equal chance of being hit, find the probability that the ball *will* hit a window whenever it hits the side of the building. Calculate the probability as a fraction, a decimal, and a percent. Be sure to show your work.

To find the probability of the ball hitting a window, you have to first find the areas of the wall and the windows. Total wall area =  $55 \times 100 = 5500$  square feet. Total window area =  $6 (10 \times 15) = 900$  square feet. To find the probability of hitting a window, you make the fraction with window area in the numerator and total wall area in the denominator:  $900/5500$ . This fraction can also be rewritten as .1636, which is approximately 16%. The probability of a student hitting a window when playing the game of kickball is a little more than 16%.

- b) Using the probability found in part a), explain whether or not the teacher should be worried about the windows breaking. Considering the mathematics, if you were the teacher, would you allow the students to play the game?

Although the probability that the ball will hit a window is only 16%, it is still likely that a window will be hit sometime during the game. If there were 50 kicks—not unlikely during a kickball game—it is mathematically probable that 8 of those kicks ( $16/100 = 8/50$ ) will hit a window, which seems a bit too risky for breaking glass. In some situations 16% seems very unlikely, but it's just a question of whether you're willing to take even a slight risk. If I were the teacher, I think I would negotiate with my students to select a fun alternative that has an even lower probability for ending in disaster. With my professional reputation on the line, I would only be comfortable with a reward activity having a 1% chance (or less) of breaking windows.