



WSMC High School State Competition

Window Wiper Geometry

Team Problem

April 10, 2000

In this problem you will be asked to design the optimum windshield wiper system for a specific windshield. Wipers operate by one of two basic systems. The system you will investigate has the wiper blade that touches the windshield at a fixed angle with the wiper arm. The following are the conditions your system must perform under:



- ✓ The windshield is a 2 feet by 5 feet flat rectangle.
- ✓ The wiper arm rotates back and forth always making a 90 degree angle.
- ✓ The wiper blade (the portion that touches the window) is at a fixed angle with the arm.
- ✓ The blade must always be on the surface of the windshield.
- ✓ There will be a mirror image wiper on the left side of the windshield. Assume that the two wipers can be synchronized so that they can overlap areas of wiping.
- ✓ The arm is fastened to the center of the blade for even wiping.

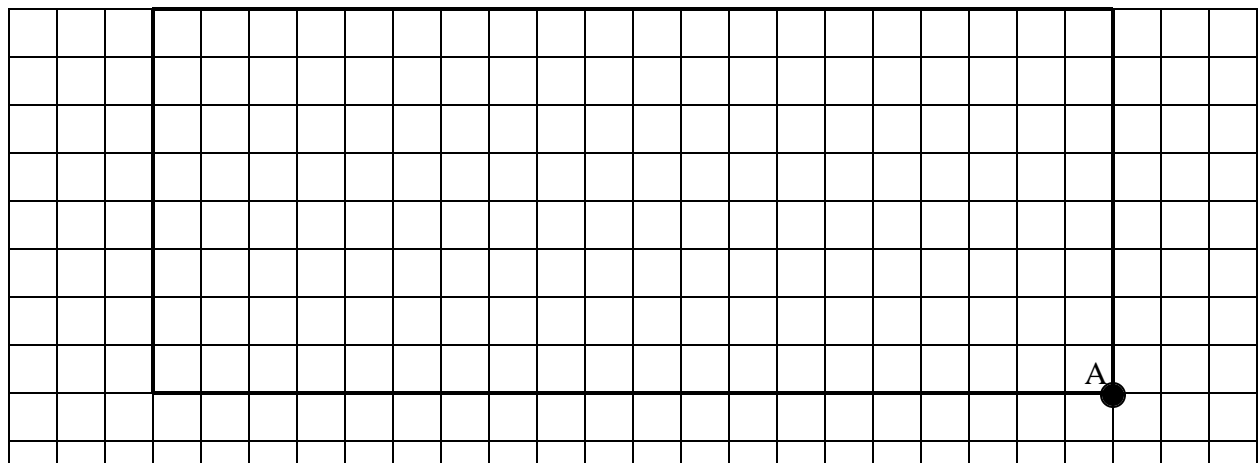
Below is a sketch of the windshield with three possible locations (A, B, and C) for the wiper to rotate about..

1. Narrow down the choices to one, A, B, or C, by the use of common sense, logic, mathematical reasoning, and mathematical analysis. Your response must show clear and convincing reasons for eliminating 2 of the 3 points.. You may want to use sketches.

With the best location selected for the wiper arm to rotate about, do the following::

2. Determine the best wiper blade length (they come only in whole inch increments) and explain your thinking.
3. Determine the best arm length.
4. Determine the acute angle between the wiper arm and wiper blade.
5. Calculate the area that one blade will wipe off.
6. Estimate the percentage of the entire windshield that will be wiped off with both of the mirror image wipers working.

Support all your work with clear and convincing information and calculations.



The grading rubric is on the back and your complete answer must be on the front of the answer sheet.

Scoring Rubric Summarized

You will be scored as follows:

Understands and Applies Mathematical Concepts and Procedures

- **Number Sense:** 2 pt - Uses appropriate number skills accurately
- **Measurement** 4 pt - Determines area appropriately
- **Geometric Sense** 5 pt - Uses geometric understanding appropriately

Solves Problems - 3 pt

- Understands the problem
- Strategies are used appropriately
- Answers for the required items are appropriate

Reasons Logically - 6 pt

- Appropriately analyzes information
- Presents a thorough and systematic verification

Communicates Understanding - 8 pt

- Presentation is clear, organized, and easy to follow; appropriate labels are included

Total Points - 28 possible

Window Wiper Geometry- Rubric for Scorers

Note: On 2-point items: 2 - meets given criteria, 1-partially meets given criteria, 0-meets none.

1. (3 points)

	Reasons	2 pt - Eliminates A because farther from windshield covers more area (1 pt)
	Logically:	and leaves large un-wiped area in center (1 pt)
		1 pt – Eliminates C because can't turn 90 degrees

2. (3 points)

	Reasons	1 pt – Explains why 24” is too much.
	Logically:	1 pt - Gives 23” as answer.
	Communication:	1 pt – Labels as “inches”

3. (4 points)

	Geometric Sense:	1 pt – Uses Pythagorean Theorem.
		1 pt – Uses legs of 6 inches and 17.9 inches (the max usable length).
		1 pt - Gives appropriate answer (18.9 inches is best, others are acceptable).
	Communication:	1 pt – Labels as “inches”

4. (4 points)

	Geometric Sense:	1 pt – Uses tangent or other appropriate procedure to determine angle.
		1 pt - Gives appropriate answer (18.9 is best, others close are acceptable).
	Communication:	1 pt – Labels as “degrees”
		1 pt – Clearly shows calculations.

5. (5 points)

	Reasons	1 pt – Justifies the area wipe is a section of a ring
	Logically:	
	Measurement:	2 pt – Uses an appropriate procedure to determine area wiped by one blade (1pt for estimation, 2 pts for calculations).
		1 pt – Gives appropriate answer (from 595 to 605 sq. in. of 4.1-4.2 sq. ft.)
	Communication:	1 pt – Labels correctly such as “square inches” or “square feet”.

6. (5 points)

	Solves Problems:	1 pt – Takes into account two wipers
		1 pt – Accounts for the overlap.
	Measurement:	1 pt – Uses correct units for squares (9 square inches).
	Number Sense:	1 pt – Uses appropriate procedure to calculate per cent.
		1 pt – Gives appropriate answer (approximately 84-85).
	Communication:	1 pt – Labels as “per cent”.

Overall. (4 points)

	Solves Problems:	2 pt – Shows understanding by using all required information appropriately
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Communication: 2 pt – Work is organized and easy to follow

Total Points 28 possible

