

Equity in Traffic Stops: A Social Justice Kinematics Lesson

Lesson Objectives:

Students will use kinematics to design a standard for police to use to make traffic stops more equitable.

- Students can represent constant and accelerated motion graphically.
- Students can use kinematic equations for constant and accelerated motion to make predictions about the motion of an object.
- Students can ask questions about and identify patterns in data.

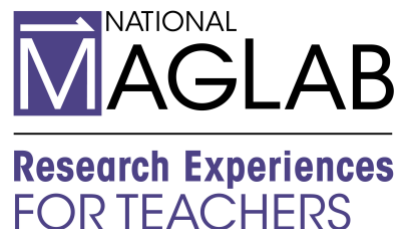
Next Generation Science Standard:

- NGSS Science and Engineering Practices: Analyzing and Interpreting Data, Using Mathematics and Computational Reasoning, Obtaining, Evaluating and Communicating Information
- NGSS Cross Cutting Concepts: Cause and Effect, Scale, Proportion, and Quantity, Patterns
- NGSS DCI: PS2.A Forces and Motion

STEM Rationale for Lesson:

This lesson is the culmination of the kinematics unit. This lesson will be used as a performance task to assess students in a more meaningful way than a traditional test. Before this lesson students will be able to create dot and motion diagrams to represent motion, create and interpret position time and velocity time graphs, use kinematic equations to make predictions about the motion of an object, and understand the difference between positive, velocity, and acceleration. After this lesson the unit will end and we will begin learning about forces and Newton's laws. Being able to understand motion conceptually, mathematically, and graphically is essential for student understanding of physics. In this lesson students will apply what they have learned about motion to propose a solution to a real-life social justice lesson.

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Culturally responsive connection:

I am teaching this lesson because it is a more authentic way to assess student understanding of kinematics than a traditional test. This will connect to students' cultural identities because it talks explicitly about how Black and Hispanic drivers are treated by the police. Students have the opportunity to share their own stories, which makes the lesson even more relevant for students. At the end of the lesson students are empowered to make their own suggestions as to what policing should look like.

When looking at the data of who gets pulled over more and what are the results of that, students may see this as a mirror to their own experience or a window into the experiences of others. Students will be able to connect their racial identity to those who are more likely to be pulled over or searched. In looking over the lesson, there are no idioms or culturally references that may confuse students. However, I will provide a translation of the article data for English Language Learners

Materials Needed:

Provided by Teacher:

1. Equity of Traffic Stops Student Worksheet. (Provided below)
 2. Calculator
 3. Kinematics Equation Sheet
 4. Ruler
 5. Graph Paper
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Activate Prior Knowledge:

1. Students should know how to create and interpret position time and velocity time graphs.
2. Students should be able to use the following equations to make predictions about the motion of an object: $x=xt+x_0$ $v=at+v_0$, $x=1/2at^2+v_0t+x_0$
3. Students should be able to create motion diagrams and dot diagrams to represent constant and accelerated motion.

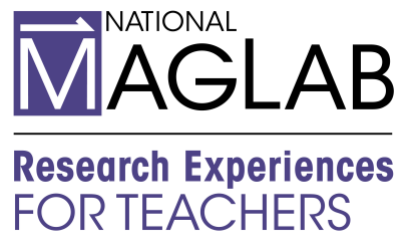
I will activate prior knowledge by first giving students examples of graphs to interpret and then asking them to create their own graphs of a given situation. I will use student backgrounds to give context to the lesson by inviting students to share their experiences with driving or policing.

Lesson Introduction:

1. I will introduce this lesson by explaining why I am using this project instead of a test to assess student learning.
2. I will then list the learning targets students are expected to meet. These learning targets will have been introduced daily as students met these goals.

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3. I will then explain why it is important for us to study issues of equity in a physics class. I will take time for myself to explicitly recognize my privileged racial identity and how my experience with policing may be different than students or their families. I will then invite students to share their own experiences with policing if they choose to.
 4. The five pieces of data will start off the lesson and catch my students' interest. I purposefully chose different types of data so there are multiple entry points for students.
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Lesson Activity:

1. In the first activity, I will show each data set projected on the board as students look at it on their paper. Students will have two minutes to silently examine the data set and write down one thing they notice and one thing they wonder about the data. After the two minutes I will invite students to share what they noticed and wonder and will facilitate a conversation about what that data set tells us. After repeating this for each data set, I will facilitate a conversation about the patterns students notice in the data. Students will notice that drivers of color, particularly Black drivers, are pulled over and penalized at a disproportionate rate. Students will then have a couple of minutes to reflect on what they saw in writing.
 2. Next I will introduce the second activity in which students will come up with a standard that police can use to determine if a driver should be pulled over. They will do this by answering several questions that require them to use kinematic equations to set a standard or represent the motion of a driver that is speeding or not speeding graphically.
 3. Finally, I will tell students that I recognize that providing this standard they developed to the police may not be a complete solution to the inequity in traffic stops. Students will then be given class time to write one to two paragraphs detailing how they think traffic policing could be improved to be more equitable.
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Lesson Assessment

1. The student worksheet will be turned in and graded according to the provided rubric. Students will be assessed on their ability to analyze and synthesize provided data, model motion with motion and dot diagrams, model motion with graphs, solve kinematic equations, and write about their possible solution to inequity in policing.

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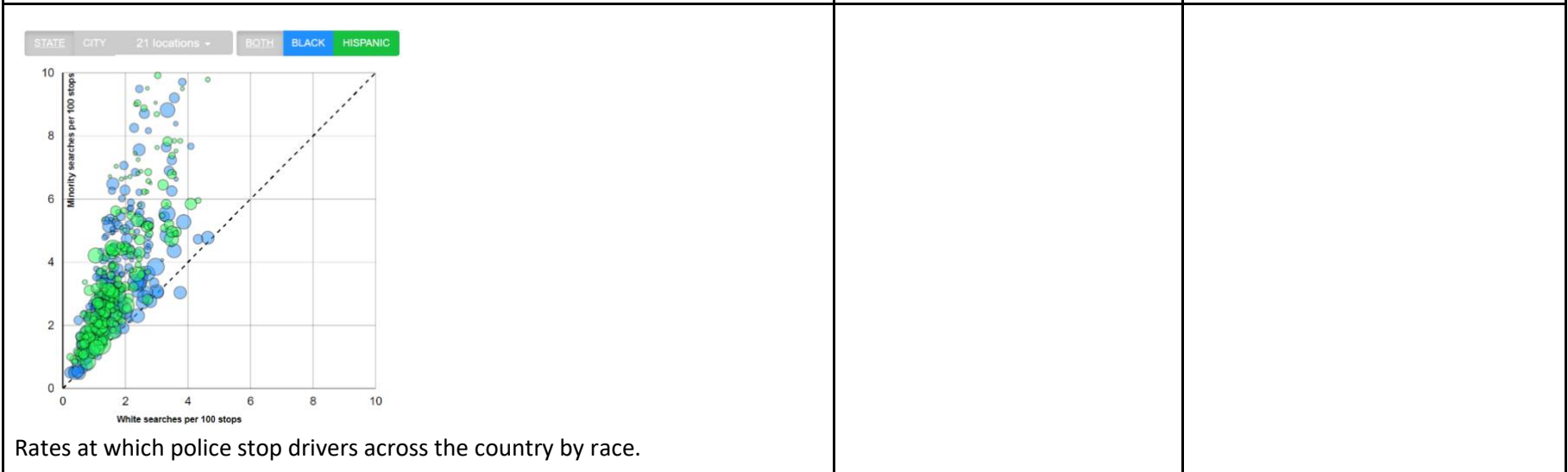
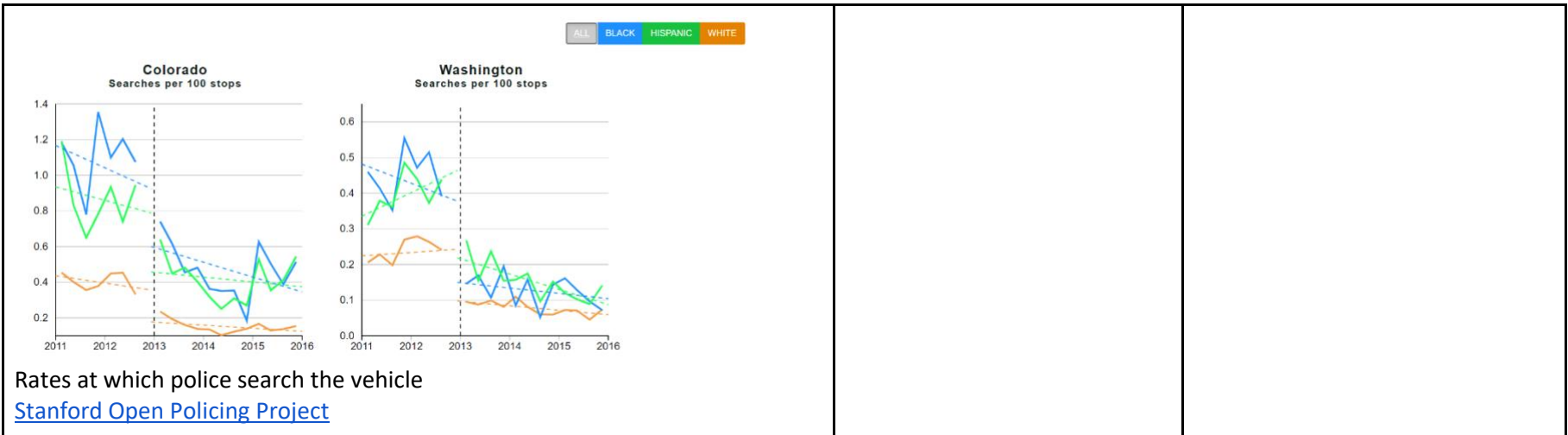
Equity in Traffic Stops A Social Justice Kinematics Lesson Student worksheet

Part 1: Identifying a Problem

The following data, taken from several sources, illustrates who is pulled over the most by police while driving, and what the results of these interactions are. For each of the following pieces of data, write one thing you notice and one thing you wonder about the data. Then you will synthesize the data to look for patterns.

Data	Notice	Wonder																								
<div data-bbox="201 735 1129 1344"> <p>STOP RATES VARY SIGNIFICANTLY ACROSS RACIAL/ETHNIC LINES</p> <table border="1"> <caption>Approximate data from the bar chart</caption> <thead> <tr> <th>Racial/Ethnic Group</th> <th>Law enforcement stops (%)</th> <th>Population (%)</th> </tr> </thead> <tbody> <tr> <td>Latino</td> <td>~39</td> <td>~41</td> </tr> <tr> <td>White</td> <td>~33</td> <td>~34</td> </tr> <tr> <td>African American</td> <td>~15</td> <td>~6</td> </tr> <tr> <td>Asian</td> <td>~5</td> <td>~11</td> </tr> <tr> <td>Middle Eastern/South Asian</td> <td>~4</td> <td>~1</td> </tr> <tr> <td>Multiracial</td> <td>~1</td> <td>~3</td> </tr> <tr> <td>Other</td> <td>~1</td> <td>~1</td> </tr> </tbody> </table> <p>Sources: California Department of Justice, Racial and Identity Profiling Act (RIPA) Wave 1 data (July 1 to December 31, 2018). The population shares are based on weighted findings from the American Community Survey (RIPA Annual Board Report 2020). Notes: The stop data are limited to the state's eight largest law enforcement agencies (number of stops as follows): California Highway Patrol (1,033,421), Los Angeles Police Department (336,681), San Diego Police Department (89,455), San Francisco Police Department (56,409), Los Angeles Sheriff Department (136,635), San Bernardino Sheriff Department (62,433), Riverside Sheriff Department (44,505), and San Diego Sheriff Department (40,515). From: PPIC Blog, August 2020.</p> <p>Public Policy Institute of California</p> </div>	Racial/Ethnic Group	Law enforcement stops (%)	Population (%)	Latino	~39	~41	White	~33	~34	African American	~15	~6	Asian	~5	~11	Middle Eastern/South Asian	~4	~1	Multiracial	~1	~3	Other	~1	~1		
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<p>Stanford Open Policing Project</p>		
<p>The percentage of all motorists stopped who were Black over the past three years (20.3%) is larger than the percent of the state population that is Black (12.7%). But that's not a valid comparison, given some of the drivers stopped likely were from out of state and it's unknown what proportion of drivers on the highways and communities patrolled by the state police were Black.</p> <p>More valid are comparisons of what happens after a stop. According to the analysis of three years of data:</p> <ul style="list-style-type: none"> • Police wrote citations for non-moving violations in about 18% of stops of white motorists compared with almost 25% of the stops of Blacks. About 26% of whites received a moving violation, while close to 37% of Hispanics were similarly cited. • Just 2.6% of whites had a "post-stop interaction," such as being asked to get out of the vehicle, being frisked or having the vehicle searched, while 4.9% of Hispanics and 6.9% of Blacks had these interactions. • State police used force in nearly six of every 100,000 stops of whites, more than 11 of 100,000 stops of Hispanics and close to 25 of 100,000 stops of Blacks. • Black motorists make up about 20% of all those stopped by the state police, but 41% of those arrested during traffic stops were Black. About 37% of those arrested were white, while whites accounted for 57% of those stopped. <p>Thompson said more Blacks are arrested at least in part because they have more existing charges pending against them. And that's because they are stopped by police so frequently and are more likely to receive a summons when they are stopped, which may lead to a warrant being issued, she said.</p> <p>NJ Spotlight News</p>		

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NPR Podcast excerpt on the death of Philando Castile		
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Synthesize:

1. What patterns do you notice in the data?

2. What does the word **disproportionate** mean?

3. How does this data make you feel? Does something need to be done to change this?

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Part 2: Designing a Solution

Upon seeing this data, the local police department has asked your help in removing racial bias from their traffic stops. They have asked you to use physics to come up with a standard for when they should stop any driver. Complete the following questions to develop a standard.

1. In New Jersey the speed limit in low density business and residential areas is 35 miles per hour. Convert this speed to meters per second, given that 1 mile= 1609 meters and 1 hour= 3600 s. Show all work. This is the speed limit you will be providing a standard for.

For problems 2-4 assume the car is moving at a constant speed.

2. Given that the length of one block is about 80 m, use your kinematic equations to calculate how long it would take a driver, traveling at a constant speed at the speed limit to drive one block. Police officers can use this data to time cars and determine if they should be pulled over.

3. On a separate piece of graph paper, create and label a dot diagram. On the same diagram include dots for a car traveling constantly at the speed limit who should not be pulled over and in another color include dots for a car traveling constantly at a speed above the speed limit who should be pulled over.

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4. Now, create the following graphs on that same piece of graph paper.
 - a. A position time graph: In one color this should show the graph for a car traveling constantly at the speed limit. Then include a threshold line in a different color above which a car should be pulled over.
 - b. A velocity time graph: In one color this should show the graph for a car traveling constantly at the speed limit. Then include a threshold line in a different color above which a car should be pulled over.

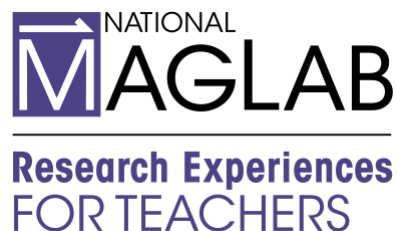
For problems 5-8 assume the car is accelerating.

5. Given that the length of one block is about 80 m, how much will a car need to accelerate to get from rest to the speed limit by the end of the block?

6. Create a motion diagram to represent the car moving as described in question 5 on your graph paper.
7. If a car starts at 10 m/s and accelerates at a rate of 1.5 m/s², after how many seconds will the car be traveling above the speed limit?

8. On your graph paper, create a velocity time graph for a car accelerating from rest. Draw a cut off line for the point where the car will be speeding.

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Part 3: Imagining Other Solutions

Despite many police stations having standards like the one you provided, police continue to pull over and search Black and Hispanic drivers at disproportionate rates. In this section, I want you to write one to two paragraphs describing how you think traffic policing could be improved to be more equitable. This might look like detailing a few specific changes police departments could make, or detailing a totally different method of policing. Whatever you think would be the best solution, describe it in detail and explain why you think this would be more equitable. Please use at least one piece of data from above as evidence to support your argument. Attach additional pages if necessary.

Rubric

Needs Improvement	Progressing	Partial Mastery	Mastery
Noticings and wonderings are provided for 1 or 2 pieces of data and are relevant to the data.	Noticings and wonderings are provided for 3 or 4 pieces of data and are relevant to the data.	Noticings and wonderings are provided for all 5 pieces of data and are somewhat relevant to the data.	Noticings and wonderings are provided for all 5 pieces of data and are relevant to the data.
Student synthesizes the data but the pattern is not related to the data.	Student synthesizes the data and finds a pattern that may be indirectly related to the data.	Student synthesizes the data to find meaningful patterns but patterns are not directly related to the data.	Student synthesizes the data to find meaningful patterns that are directly related to the data.
Motion and dot diagrams contain significant errors.	Motion and dot diagrams contain minor errors.	Motion and dot diagrams are accurate but are missing some labels.	Motion and dot diagrams are accurate and correctly labeled.
Student created graphs contain significant errors.	Student created graphs contain minor errors.	Student created graphs are accurate but are missing some labels.	Student created graphs are accurate and correctly labeled.
Mathematical representations have significant errors and do not use the appropriate equations.	Mathematical representations have errors but the appropriate equations were used.	Mathematical representations have calculation errors or are missing units.	Mathematical representations are correct, easy to read, and contain correct units.

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No solution to equitable policing is provided.	Solution to equitable policing is incomplete.	Solution to equitable policing is thoughtful but lacks detail.	Solution to equitable policing is detailed and thoughtful.
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Student Equation Sheet

Kinematics Equations

$$\bullet v = \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1}$$

$$\bullet a = \frac{\Delta v}{\Delta t} = \frac{v_2 - v_1}{t_2 - t_1}$$

$$\bullet x = vt + x_0 \text{ (for constant motion)}$$

$$\bullet v = at + v_0$$

$$\bullet x = \frac{1}{2}at^2 + v_0t + x_0$$