Physical Science
Grade 8
Teacher Guide for Problem: Motion, Velocity, and Acceleration

Applicable Standards:

Georgia Performance Standards: S8P3a

Problem:

Problem Handout
Problem Video

Link to Student Materials: XXXXX

Instructional Strategy:

1. All students need to be given opportunities to be silent and ponder their thoughts. They also need time to increase their attention spans, resist impulsiveness, and learn to accept delayed gratification. They need self-discipline. All of our problems require a few days to a few weeks to solve, and middle school students can develop these skills with practice. A few times each week, set aside an increasing number of minutes, starting with 1 or 2 and increasing to 10, for students to work and ponder in silence. For students who "can't" do it, find additional time apart from their groups to practice or request parental assistance.
2. There are numerous interactive websites on speed, velocity, and acceleration. Several physics applets let students set the variables and then run the program.
3. Use an open-ended inquiry about the motion of an object. If you stay indoors, you could give students a ramp, a marble, meter stick, and stopwatch. They could change the starting point on the ramp and measure varying distances and times and make a velocity graph. You could give them a tennis ball, tape measure, and stopwatch, and let them drop the tennis ball in a multi-story stairwell at varying heights. You could also have a matchbox race. Let student teams bring in a matchbox car and you could race them down a wide board ramp. Start the race by lifting a straight edge that holds them at the top. Let students time their own cars and plot their average race speed on a class poster. Trophy for the wining team and/or best inquiry report. If you go outdoors, you could race larger toy cars across a course with varying slopes. Graphs would show varying line slopes.
4. Do an inquiry where students draw graph sketches (no numbers) of demonstrated motions. Let student teams design and demonstrate one or two motion scenarios. Students could also make a video of the motion and download it to your computer so the motion can be repeatedly observed. An example would be a student stands for a few seconds, then slowly speeds up to a constant speed and holds it a few seconds, then quickly comes to a stop, then reverses direction at a lesser speed back to the origin and stops. Student teams should give you the "correct answer" graph of their demonstrated motion. You could also make video of several motions using observed cars, birds, people, falling objects, thrown objects, etc.
5. Inquiry Reports should go in student notebooks.
   Here is a possible Inquiry Report format:
   "PEDAC"
   Problem: (problem written out in form of a question)
   Experiment: (background information, identification of variables, hypothesis, procedure, and equipment diagram)
   Data Analysis: (data table, formula calculations, and/or line graph)
   Conclusion: (data analysis, error analysis, and detailed findings)
   An Inquiry Report template is included. Complete the template with desired points for each format topic and content topic you choose. Add up points and divide by the total possible for the grade.
6. After showing the EQ PowerPoints on speed, velocity, and acceleration, show students how to manipulate the formulas and solve for the other variables. Give students some practice problems using the formulas. Have them build velocity and acceleration graphs with data sets. I recommend using a word problem-solving strategy called the GUESS method. The letters stand for Given, Unknown, Equation, Solution, Sensible answer? They should use these steps in order and write down their data.

Calendar:

1 New partners? Problem Video Hand out and discuss Problem Pick team leaders Teams start PBL HW assigned	2 Thought time Share HW Team time Form. Assess. team EQ's? HW	3 Share HW Inquiry on Distance, time, and speed (indoors or outdoors) HW	4 Thought time Share HW Work on Inquiry Present EQ: Velocity? Word Problems HW	5 Inquiry Report due Grade I.R. Team time Record IR grades HW
6 Share HW EQ: Acceleration? Word Problems Team time	7 Thought time Share HW Inquiry on Graphing HW	8 Share HW Work on Inquiry Team time HW	9 Thought time Inquiry Report due Grade I.R. Team time Record Grades HW	10 Thought time Share HW Team time HW
11 Problem Due date Presentations	12 Partner evaluations Review	13	14	15

Essential Questions:

1. What is motion?
2. What is distance?
3. What is speed?
4. What is the difference between speed and velocity?
5. What is acceleration?
6. How do we measure speed, velocity, and acceleration?
7. How do we make graphs of velocity and acceleration?
8. What do the shapes and slopes of velocity and acceleration graphs mean?
9. How do we conduct our speed experiment? What data do we collect? How do we display it? How do we graph it? How do we interpret the graph?

Teacher Background Information:

The most challenging concepts in this problem are the difference between average speed and instantaneous speed and the meaning of acceleration (the rate of a rate). We generally talk about an object moving because all kinds of things move, from an ant to an elephant to the Earth. Here are answers to the essential questions.

1. Motion is the change in an object's location (called position in physics). If something moves, it goes from point A to point B.
2. Distance is a way of measuring how far an object has moved from its starting position.
3. Speed is the rate of motion, how far something moves in a particular length of time. An example of speed is 5 meters per second.
4. Velocity is also the rate of motion, but velocity also has a direction. Velocity would be 5 meters per second to the south.
5. Acceleration is the rate at which velocity changes. Speeding up and slowing down are accelerations. If an object is moving in a circle at a constant speed, it is still accelerating because its direction is changing. This distinction is important when we study force.
6. We use mathematical formulas or equations to measure velocity and acceleration. Velocity (v) equals the distance (d) an object moves in a certain length of time (t), or $v = d / t$. Acceleration (a) is the rate at which velocity changes with time, or $a = (v_f – v_i) / t$. The subscripts stand for ending or final velocity and starting or initial velocity.
7. Line graphs show speed and acceleration clearly. A speed or velocity graph has distance on the y-axis and time on the x-axis. It is also called a distance vs. time graph. An acceleration graph, also known as velocity vs. time graph, shows velocity on the y-axis and time on the x.
8. The slope of any line on a graph is $m = y / x$. Notice that in the case of a d vs. t graph, y is d, x is t, and m is v. So the slope equals the velocity. The steepness of a line on a d vs. t graph indicates the amount of speed. Steep slope = high speed. In the case of a v vs. t graph, the slope of a line is v / t which is equal to a. Steep slope = high acceleration.

The formula v = d / t gives us average velocity or speed, the total distance divided by the total time. A car's speedometer shows us instantaneous speed, how fast something is moving at an instant in time. In the acceleration formula, velocity is instantaneous velocity.

Power Point presentations for selected EQ's:

EQ: What is speed and velocity and how do we measure them?
EQ: What is acceleration and how do we measure it?

Inquiries: None

Inquiry Report Assessment Rubric

Summative Assessment:

Problem Rubric
Fair Share Partner Evaluation
Notebook Evaluation

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