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 Student investigates speed as an important variable regarding force of an impact. Students roll a car down a ramp and into a block of wood. The distance the car travels, the time until impact and the distance the block moves are recorded. The speed of the car is calculated. Students are asked to design and perform a study to demonstrate the effect of speed on the collision and record the data and procedure.

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| **Speed and Collisions**  |
| **Administration Procedures** |
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| Contributed by: Council of Chief State School Officers (CCSSO) **Description:**Students investigate speed as an important variable regarding force of an impact. Students roll a car down a ramp and into a block of wood. The distance the car travels, the time until impact and the distance the block moves are recorded. The speed of the car is calculated by dividing the distance by the time until impact. The experiment is performed twice and averaged for the two. Students are asked to design and perform a study to demonstrate the effect of speed on the collision and record the data and procedure. They are then asked to draw conclusions on how speed relates to impact. They are also asked to discuss whether their data gives an accurate reflection of the relationship between speed and impact and to justify their answer. This task is designed to take students approximately 40 to 50 minutes to complete. **Overall Task Content Area:**Physical Science **Specific Knowledge Areas:**Motions and forces **Performance Expertations:*** conducting investigations
* using equipment
* gathering, organizing, and representing data
* formulating conclusions from investigational data
* applying scientific principles to develop explanations and solve new problems

**National Science Education Standards:****12 B PS 4:** Motions and Forces: Grades 9-12 **4.1** Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relatio12ip F=ma, which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object. **12 A SI 1:** Ability to do scientific inquiry: Grades 9-12 **1.2** Design and conduct scientific investigations. Designing and conducting a scientific investigation requires introduction to the major concepts in the area being investigated, proper equipment, safety precautions, assistance with methodological problems, recommendations for use of technologies, clarification of ideas that guide the inquiry, and scientific knowledge obtained from sources other than the actual investigation. The investigation may also require student clarification of the question, method, controls, and variables; student organization and display of data; student revision of methods and explanations; and a public presentation of the results with a critical response from peers. Regardless of the scientific investigation performed, students must use evidence, apply logic, and construct an argument for their proposed explanations. **1.4** Formulate and revise scientific explanations and models using logic and evidence. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical. In the process of answering the questions, the students should engage in discussions and arguments that result in the revision of their explanations. These discussions should be based on scientific knowledge, the use of logic, and evidence from their investigation. (Use the "hot" link on the [PALS home page](http://pals.sri.com/pals/) to check the full text of related National Science Education Standards, if desired.) **National Council of Teachers of Mathematics:** **NO3:** Compute fluently and make reasonable estimates: **Grades 9-12 n.** develop fluency in operations with real numbers, vectors, and matrices, using mental computation or paper-and-pencil calculations for simple cases and technology for more-complicated cases**Grades 9-12 o.** judge the reasonableness of numerical computations and their results**AL3:** Use mathematical models to represent and understand quantitative relationships: **Grades 9-12 f.** draw reasonable conclusions about a situation being modeled**DAP1:** Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them: **Grades 9-12 m.** understand histograms, parallel box plots, and scatter plots and use them to display data**PS2:** Solve problems that arise in mathematics and in other contexts: **Grades 9-12** **RP3:** Develop and evaluate mathematical arguments and proofs: **Grades 9-12** **CNX3:** Recognize and apply mathematics in contexts outside of mathematics: **Grades 9-12** **General Instructions to the Teacher:**This task is designed to take students approximately 40-50 minutes to complete. Students will be working in groups of 4-6 for the experiment/activity part of this exercise. Each student must record the information in his or her own booklet (test papers). Allow from 20 to 25 minutes to complete the group work, and a similar time period for students to do their individual answers to the test questions. Students should be ready to work as soon as the period begins. Group assignments should be made in advance. The materials should be set out at each lab station, if possible. A central supply area, if needed, should be easily accessible. All supplies should be clearly labeled. **Materials:**At this station students should have: TrackToy carWooden blockRampBooksCalculatorStopwatchMeter stick or rulerScissorsMasking tapePen or pencil **Advance Preparation:**The ramps should be at least 75 cm long. Almost anything will work as a ramp as long as the material is rigid. Some suggestions for ramps would include book shelves, wood boards, and strips of rigid cardboard. What you use is up to you. Make sure that the ramps are available prior to your students beginning this experiment. If you do not have stopwatches, check with your students the day before the event to see how many of them have watches with a stopwatch function. Please ask them to bring their watches and calculators to class. **Safety:*** Be careful.
* Teachers and students should always exercise appropriate safety precautions and utilize appropriate laboratory safety procedures and equipment when working on science performance tasks.
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