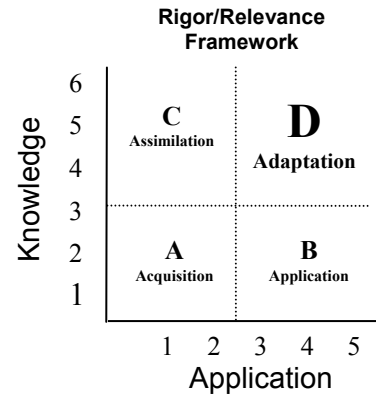




Gold Seal Lesson

HIGHWAY SAFETY DESIGN



Subject

SCIENCE

Grades 9-12

Instructional Focus

Science as Inquiry: Students demonstrate knowledge and skills necessary to perform scientific inquiry.

Science in Personal and Social Perspectives: Students apply scientific principles to personal and social issues.

Algebraic Concepts and Relationships: Students use algebraic methods to investigate, model, and interpret patterns and functions involving numbers, shapes, data, and graphs in a problem-solving situation. Students evaluate and communicate the reasoning used in solving these problems.

Writing: Students write for a variety of purposes and audiences with sophistication and complexity appropriate to the grade level.

Performance Task

In this science/technology task, students apply Newton's Second Law to the issue of safe vehicle design. They calculate the stopping time of vehicles traveling at various speeds, then consider the effectiveness of various safety devices. The final challenge is to design their own highway safety devices.

Begin with a review of Newton's Second Law which can be stated as $F=ma$. (F = Force; m = mass; a = acceleration)

Acceleration is the change in velocity over time and can be stated as $(\text{initial velocity} - \text{final velocity})/\text{time}$.

Resulting formula: $F = m(v_i - v_f)/t$

Ask the students to use this formula to calculate the average force of different cars with different weights and different stopping times.

Through this activity, students should arrive at the understanding that one way to minimize the force of an accident is to increase the time over which the vehicle goes from its highway speed to a complete stop.

Performance Task continued

Ask students to identify several highway or automobile design features that increase stopping time. Answers should include: air bags, bumpers, breakaway light poles and signs, crush zones, impact attenuators. Have them read about the comparative effectiveness of these options.

Then challenge students to design other devices that they think would help increase stop time. Students should submit a drawing or model along with an explanation of their design. The report must include reference to Newton's Law and how it impacts the design.

Scoring Guide

see attached rubric

Essential Skills

- Understand and apply statics (i.e., the relation between forces acting on an object at rest) and dynamics (i.e., the relation between the forces acting on an object and the resulting motion). (s84)
- Know and apply the principles of scientific inquiry. (Implicit in this statement are the processes of prediction, estimation, developing hypotheses, drawing conclusions, evaluation, and following ethical principles and professional procedures.) (s114)
- Understand the impact upon society and the environment of scientific and technological discoveries and the contributions of scientists. Understand how society may accept or reject scientific discoveries based upon need or refusal to change. (s116)
- Understand basic algebraic properties (i.e., commutative: $ab = ba$; associative: $ab(c) = a(bc)$; and distributive: $a(b+c) = (ab)+(ac)$). (m3)
- Understand the use of variables in expressions such as $4x$, $x+2$, and $2x-1$, solve for the variable, and know how to represent expressions such as "twice the number" or "four more than the number" using variables. (m7)
- Use addition and multiplication to simplify an algebraic expression by identifying the order of operations and techniques necessary to carry out the operations (e.g., $5-3(x-2) = 5-3x+6 = 11-3x$). (m11)
- Present information in well-organized fashion that will be clear to the target audience. (ela 11)

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Highway Safety Design Scoring Rubric

Score each of the following characteristics on a scale of 4 to 0,
 4 = surpasses expectations
 3 = high quality performance
 2= satisfactory quality performance
 1 = minimum quality performance
 0 = does not meet expectations.

Characteristic	Criteria	Score
Apply algebraic operations and mathematical computations	<ul style="list-style-type: none"> Accurately calculates force as it relates to automobile impacts 	
Transfer information to highways	<ul style="list-style-type: none"> Identifies at least two highway safety features whose effectiveness is related to Newton's 2nd Law 	
Engineering design	<ul style="list-style-type: none"> Proposes a potential design feature that is plausible The design is explained in the context of Newton's Second Law of Physics. 	
Written explanation and defense	<ul style="list-style-type: none"> The written explanation is technically correct in grammar and spelling. The written defense effectively explains and defends the design. 	
Drawings/Models	<ul style="list-style-type: none"> The drawings/models effectively describe the proposed design features. 	
	Total Points	