

SEPUP Force and Motion 3rd Edition—Phenomena, Driving Questions, and Storyline
 How can we apply an understanding of force and motion to improve vehicle and driving safety?

Phenomenon	Driving Questions	Guiding Questions	Activities	PE	Storyline/Flow
Some vehicles and driving behaviors are safer than others.	What choices can a person to make vehicle travel safer?	What features of a vehicle and the way a person drives the vehicle make it safer? (Activity 1)	1	MS-PS	(Something about how automobile safety encompasses both the design of the vehicle and the way a person drives)
Some vehicle accidents cause more damage than others.	How can we predict the impact of a vehicle accident?	How can you measure and graph the speed of a moving object? (Activity 2)	2-5	MS-PS3-1	An object's speed can be calculated by measuring the distance an object travels in a particular direction in a certain amount of time. A motion graph can be used to quantitatively describe how an object moves.
		What is the relationship between speed and kinetic energy? (Activity 3)			Kinetic energy is motion energy, and is related to the mass and speed of an object.
		How does the mass of a car affect its kinetic energy? (Activity 4)			Kinetic energy is proportional to the object's speed. If the mass of a vehicle remains constant, a change in the vehicle's speed results in a change in kinetic energy.
		What is the mathematical relationship between kinetic energy and speed, and kinetic energy and mass? (Activity 5)			Kinetic energy is proportional to the mass of the moving object. If there are two vehicles going at the same speed but with different masses, the more massive vehicle has more kinetic energy.
		While both speed and mass affect KE, mass is a linear relationship and velocity is nonlinear (KE increases with the square of speed.)			
Vehicles change motion.	What causes a vehicle's motion to change?	What causes an object to change direction? (Activity 6)	6-9	MS PS 2-2	Inertia is the resistance of an object to changes in its motion. An object's motion is determined by the sum of forces acting on an object.

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		What causes an object to change speed? (Activity 7)			If the forces are balanced, the object's motion will not change. If the forces are unbalanced, an object's motion will change.
		What is the mathematical relationship between force, acceleration, and mass? (Activity 8)			Acceleration is a change in motion. A larger force will result in a larger acceleration.
		What relationships between force and motion did Newton discover? (Activity 9)			How an object's acceleration changes due to an unbalanced force is also dependent on the object's mass. The more mass an object has, the more inertia it has, and the greater the force it takes to change its motion.
When a vehicle accident happens, often both vehicles are damaged as a result of the collision.	What happens when vehicles collide?	What happens when objects interact? (Activity 10) What additional relationships between force and motion did Newton discover? (Activity 11) What happens when objects collide? (Activity 12)	10-12	MS-PS-2-1	During a collision, interacting vehicles exert forces on each other. These forces are equal in size and opposite in direction.
Engineers design vehicle features that can make vehicles more safe and promote safe driving behaviors.	How can you design a successful solution to help a driver avoid a collision?	What is the effect of speed and mass on braking distance? Activity 13) How does a car's stopping distance change in different situations? (Activity 14) How can you design a device to help drivers keep a safe distance behind the car in front of them in different situations? (Activity 15)	13-15	MS PS 2-2; ETS 1-1, ETS 1-2	The braking distance is the distance the car travels after the driver applies the brakes, until the car comes to a full stop. The mass of the vehicle and the speed at which it is traveling affects the braking distance of a vehicle. When coming to a stop to avoid a collision where the driver hits another vehicle in front of it, drivers need to react to the changes in road conditions and make a decision to apply the brakes. The stopping distance of a vehicle can depend on road conditions (e.g. slick vs. dry) and driving behavior (e.g. distracted drivers and the speed the driver is traveling at). Therefore, the

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					total stopping distance required for a car to come to a stop and avoid collision is different in different situations. Designed solutions are systematically evaluated to determine how well they meet the criteria and constraints.
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