PHENOMENA, DRIVING QUESTIONS AND STORYLINE

FORCE AND MOTION

This unit explores the anchoring phenomenon: Some vehicles and driving behaviors result in fewer accidents and less damage than other. Examples explored include speed is a factor in the majority of accidents, and vehicles following closely behind another vehicle are less able to avoid a collision. Students generate and answer questions such as: How does the speed of a car its energy? What happens when objects collide? How can we apply an understanding of force and motion to develop solutions for improving vehicle and driving safety?

Phenomenon	Driving Questions	Guiding Questions	Activities	PE	Storyline/Flow (How an activity leads to subsequent activities)
Some vehicles and driving behaviors are safer than others.	What choices can people make to keep themselves safe while driving?	How do you decide which vehicle is safer? (Activity 1)	1	MS-PS2-1 MS-PS2-2 MS-PS3-1 MS-ETS1-1	Vehicle safety encompasses the design of the vehicle and both the condition and the driving behaviors of the driver.
Some vehicle accidents cause more damage than others.	How can we predict the amount of 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 over a certain amount of time. A motion graph can be used to quantitatively describe how an object moves.
		What is the relationship between an object's speed and its kinetic energy? (Activity 3)			Kinetic energy is motion energy and is related to the mass and speed of an object. 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.
		How does the mass of a car affect its kinetic energy? (Activity 4)			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.
		What is the mathematical relationship between kinetic energy and speed of an object, and kinetic energy and mass of an object? (Activity 5)			Whereas both speed and mass affect kinetic energy, mass has a linear relationship, and speed has a nonlinear relationship. (Kinetic energy increases with the square of speed.)

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FORCE AND MOTION (continued)

Phenomenon	Driving Questions	Guiding Questions	Activities	PE	Storyline/Flow (How an activity leads to subsequent activities)
Vehicles change motion.	What causes a vehicle's motion to change?	What causes an object to change direction? (Activity 6)	6–9	MS-PS2-2	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 it.
		What causes an object to change speed? (Activity 7)			If the forces are balanced, an 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)	10–12	MS-PS2-1	During a collision, interacting vehicles exert forces on each other. These forces are equal in size and opposite in direction.
		What additional relationship between force and motion did Newton discover? (Activity 11)			
		How can the motion of interacting objects change due to a collision? (Activity 12)			

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FORCE AND MOTION (continued)

Phenomenon	Driving Questions	Guiding Questions	Activities	PE	Storyline/Flow (How an activity leads to subsequent activities)
Engineers design vehicle features that can make vehicles safer and promote safer driving behaviors.	How can you design a successful solution to help a driver avoid a collision?	What are the effects of speed and mass on braking distance? (Activity 13) How does a vehicle's stopping distance change in different situations? (Activity 14) How can you design a device a system to help drivers keep a safe distance behind another car in different situations? (Activity 15)	13–15	MS-PS2-2 MS-ETS1-1	A vehicle's braking distance is the distance the car travels from the moment 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 affect the braking distance of a vehicle. When coming to a stop to avoid a collision where one vehicle might hit the back of another vehicle, 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 at which the driver is traveling). Therefore, the total stopping distance required for a car to come to a stop and avoid collision is different in different situations. One problem drivers face is leaving enough distance between their car and the car in front of them to ensure they can safely come to a stop in different situations. Designed solutions to this problem must address precisely defined criteria and constraints, as well as take into account scientific principles.