

Forces Working Together

Trace Newton's three laws through connected motion systems.

8.7.B "investigate and describe how Newton's three laws of motion act simultaneously within systems such as in vehicle restraints, sports activities, amusement park rides, Earth's tectonic activities, and rocket launches."

NAME _____

DATE _____

1 READ AND MARK _____ Read it twice

YOUR JOB In the margin, write 1, 2, or 3 beside each sentence that shows Newton's first, second, or third law. Write more than one number beside a sentence when it shows more than one law.

Motion Systems in Action

- ① During a sudden stop, a car, its passengers, and its restraints form one system with several interacting parts. Before braking, the car and rider move forward together. When the car slows, the rider's body tends to keep moving at its earlier speed because motion does not change without a net external force. The seat belt pulls the rider back with the car, and the air bag spreads the stopping force over a larger area. The rider also pulls forward on the belt. That interaction illustrates paired forces on different objects.
- ② A soccer player changes a ball's motion by kicking it. A stronger kick produces a greater acceleration when the ball's mass stays the same, while a heavier ball needs more force for the same acceleration. At an amusement park, a roller coaster car speeds up as the track or chain exerts a net force on it. On a curve, the track pushes the car toward the center of the curve, changing its direction. The car pushes on the track at the same time, with equal force in the opposite direction.
- ③ Tectonic plates move slowly because forces act on them. A plate continues in its motion unless a net force changes it. Where plates meet, each plate pushes on the other, so contact forces are equal and opposite. If forces on a plate are unbalanced, its motion can speed up, slow down, or change direction. A launching rocket shows all three laws more quickly. Its engine pushes exhaust gas downward, and the exhaust gas pushes the rocket upward. As fuel burns, the rocket's mass decreases, so a given net force can produce greater acceleration.

2 ANSWER WITH EVIDENCE _____ Use the passage

1 During the car's sudden stop, how do the rider's continued motion, the belt's force, and the rider-belt force pair show all three laws at once?

2 How does the passage connect net force and mass to acceleration in the soccer example?

3 At a tectonic plate boundary, what happens if there is no net force, what can unbalanced forces change, and how are the contact forces related?

4 In the rocket launch, identify the objects in the force pair and the direction of each force. Then explain why the rocket can have greater acceleration as fuel burns.

3 YOUR TURN _____ Your own words

Choose a motion system not described in the passage, such as a tennis serve, a skateboard push, or a bouncing ball. Write exactly three sentences explaining how all three of Newton's laws act at the same time in that system.

PART 1 • READ AND MARK

In the margin, write 1, 2, or 3 beside each sentence that shows Newton's first, second, or third law. Write more than one number beside a sentence when it shows more than one law. Accept any marking that follows this job and points at the right text.

PART 2 • ANSWERS

#	QUESTION	ANSWER
1	During the car's sudden stop, how do the rider's continued motion, the belt's force, and the rider-belt force pair show all three laws at once?	The rider tends to keep moving forward as the car slows. The belt and air bag exert a net stopping force that changes the rider's motion. The belt pulls the rider back while the rider pulls the belt forward.
2	How does the passage connect net force and mass to acceleration in the soccer example?	A stronger kick gives greater acceleration when the ball's mass stays the same. A heavier ball needs more force to have the same acceleration.
3	At a tectonic plate boundary, what happens if there is no net force, what can unbalanced forces change, and how are the contact forces related?	A plate continues in its motion unless a net force changes it. Unbalanced forces can make its motion speed up, slow down, or change direction. Each plate pushes on the other with equal and opposite contact forces.
4	In the rocket launch, identify the objects in the force pair and the direction of each force. Then explain why the rocket can have greater acceleration as fuel burns.	The rocket's engine pushes exhaust gas downward, and the exhaust gas pushes the rocket upward. As fuel burns, the rocket's mass decreases, so the same net force can produce greater acceleration.

PART 3 • YOUR TURN (SAMPLE ANSWER)

As a tennis racket contacts a ball, the ball's motion changes only because the racket exerts a net force on it. For the same ball, a greater net force from the racket produces greater acceleration. The racket pushes the ball forward, and the ball pushes the racket backward with equal force.

Accept scientifically accurate systems and explanations that address all three laws. For the third law, students must name forces on two different objects and give equal, opposite directions.