Finding a Point of Reference - Motion

Teacher Pre-Activity Introduction and Preparation

Texas Essential Knowledge and Skills (TEKS) Alignment within this Activity

Sixth Grade

(6) Science concepts. The student knows that there is a relationship between force and motion. The student is expected to: (A) identify and describe the changes in position, direction of motion, and speed of an object when acted upon by force.

Seventh Grade

(6) Science concepts. The student knows that there is a relationship between force and motion. The student is expected to: (B) demonstrate that an object will remain at rest or move at a constant speed and in a straight line if it is not being subjected to an unbalanced force.

(8) Science concepts. The student knows that complex interactions occur between matter and energy. The student is expected to: (A) illustrate examples of potential and kinetic energy in everyday life such as objects at rest

Eighth Grade

(7) Science concepts. The student knows that there is a relationship between force and motion. The student is expected to: (A) demonstrate how unbalanced forces cause changes in the speed or direction of an object's motion.

Teacher Notes

Motion is defined as a change in position over time. The change can be in a horizontal direction, a vertical direction or in both directions. When you move on your board or your bike, such as carving, turning, grinding or going for air, you are experiencing motion. In skateboarding, you can use motion to help you go forward or backward. Going backward on a skateboard can both be referred to as "fakie" or "switch". In order to detect motion, you need to have a point of reference, in other words, something that is not moving that help relatively mark your movement. In this case, when the BMX rider begins to head toward the ramp, the point of reference is where the rider began to move toward the ramp. The cumulative change of position from the beginning to the end of a ride translates to the motion of the BMX rider

Reference point could be explored by having students build the same inclined planes, but have them race cars down the planes. In the activity, their task would be to determine which car was ahead at three times during the race using different reference points. The activity and class discussion should lead the students to identifying reference points in their own lives.

Teacher Post-Activity Materials

Answers to Questions

Once your experiment is done, answer these questions in order to draw some conclusions.

1. What is a point of reference? In order to detect motion, you need to have a point of reference, in other words, something that is not moving that help relatively mark your movement.
2. How do you determine points of reference? You determine a point of reference by making a starting line from which to assess the motion. This allows the individual the opportunity to gauge a number of variables including velocity, acceleration, and physical forces like drag and thrust. The importance of a point of reference is that it provides a baseline from which to measure and impact a change in an object's motion.
3. How does speed impact a point of reference? The faster an object is moving, the less time it will have from which to be objective within a given point of reference. For example, a NASCAR racer can hit speeds of 140 MPH on a curve, and the drivers often use various points on the track in order to determine if they need to brake or increase their speed and still maintain control of their car. In action sports, a rider going for air off a ramp often uses multiple points of reference in order to determine the speed needed to negotiate the ramp and well as at what time to effectively lift off the coping to perform an aerial.
4. How can reference points be used to calculate the distance an object travels? Reference points can be used as starting lines, finishing lines, or any other mark that stays fixed while a body is in motion.
5. How can reference points be used to calculate the speed of at which an object travels? As an object moves through one reference point to another reference point, the distance between the 2 points and the time it takes for the object to move between the points can be used to determine velocity and speed as it previous motion activities.
6. How is a reference point impacted by an inclined plane or the flat ground? Since the point of reference is a fixed point, it is not impacted by inclined planes or flat ground. It merely serves as a fixed spot from which to gauge changes in motion.

Extensions

Students can calculate velocity along with identifying points of reference. Remember that the initial velocity (Vi) is zero and the final velocity (Vf) is found using the calculation, where d=the distance covered by the car or fingerboard and the time (t) is the time in seconds that it took to go down the entire length of the ramp. You should do a minimum of 3 trials and use the data to calculate the velocity for each trial, and determine an overall average velocity for their car or fingerboard's final velocity. Also, it is vital that they keep the units correctly associated with the formula, and that velocity is a measure of how quickly an object moves or changes position.

Finding a Point of Reference - Motion

Student Laboratory Activity

Introduction

When Bill Robertson first came to the University of Texas at El Paso (UTEP) in the summer of 2004, he knew that there would be plenty of opportunities to teach and serve within the community. With a Ph.D. in science and technology education, Bill applies solid instructional principles to the courses he teaches at UTEP and, on a broader scale, to the community in outreach activities through skateboarding.

Bill performs skateboarding demonstrations with an added instructional twist on the topics of physics and mathematics. Utilizing this platform to teach the physics of skateboarding has given him the unique identity of Dr. Skateboard. Bill says, "My audiences of children and parents typically do not see the connections between skateboarding and physics. They wonder, if you have a Ph.D., why do you skateboard?" Bill says that through skateboarding he has learned patience, discipline, creativity, and the art and science of practice. His audiences include elementary, middle-school, and high-school students in El Paso and around the country.

Reference points allow someone on a bike or skateboard to determine if additional force is needed or if less force is needed. A rider utilizes a point of reference in order to adjust their center of gravity, speed, momentum or other physical factors in determining the speed or motion needed for a given maneuver or series of tricks. So, when Bill is going for tricks on his skateboard, he uses points of reference on the ground, a ramp or park in order to manage the variables associated with perfecting maneuvers and tricks.

Purpose

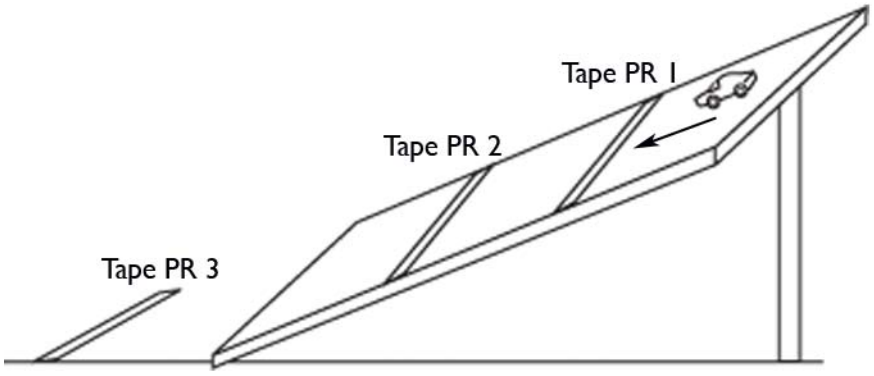
The student understands that motion cannot be determined unless a reference point is determined and that there is a relationship between force and motion. Also, the student is expected to demonstrate basic relationships between force and motion. The student is expected to identify and describe the changes in position as related to reference points, direction of motion, and speed of an object when acted upon by force.

Things You Need

- Inclined plane board (Approximately 100 cm width by 1000 cm length)
- Textbooks or wooden blocks (4-6)
- Hot Wheels cars or Fingerboards (1 for each group of 3 students)
- Stopwatches (2)
- Meter sticks
- Masking tape

What to Do

1. Take the piece of plywood and use a piece of masking tape to make a reference point approximately 15 centimeters (cm) from the top of the board.
2. Use the cinderblocks (or bricks or something else that you can use to establish the height of the ramp) in order to construct a ramp out of the cinderblocks and the plywood. The ramp is an inclined plane that can also be considered a simple machine. Be sure and secure the plywood to the cinderblocks or hold it in a secure and consistent position.
3. First, place a piece of tape on the plywood ramp at the end of the ramp. Record the measurement of the distance from the starting line (cm) on the data table. This line will be the first reference point.
4. Second, place a piece of tape on the floor 40 cm from the end of the ramp. Record the measurement of the distance from the first point of reference (cm) on the data table. This line will be the second reference point.



5. Measure the entire distance from the starting line on the plywood to the third point of reference and record the distance. This distance will be used to calculate the ratios of the distance covered by the cars or fingerboards within the points of reference.
6. Position a car or fingerboard at the first reference point at the top of the ramp and let it roll down the ramp. Using the stopwatch, time how long it takes for the vehicle to pass the reference point at the end of the ramp. Then, time how long is takes to pass the second reference point located on the floor 40 cm from the end of the ramp
7. Try this for 3 separate trials and record the times (in seconds) on the data table and different points of reference and calculate the averages of the ratios in the data table.

Student Laboratory Data Sheet

Total Distance (cm) = **Distance from Top of ramp to Second Reference Point**
Length of PR1 (cm) = **% of Course covered in PR1 = PR1/Total Distance**
Length of PR2 (cm) = **% of Course covered in PR2 = PR2/Total Distance**

Data Table

Trial	% of course covered in PR1	% of course covered in PR2	Time 1 for Reference Point 1 (seconds)	Time 2 for Reference Point 2 (seconds)
1				
2				
3				
Average				

Questions to Answer

Once your experiment is done, answer these questions in order to draw some conclusions.

1. What is a point of reference?

2. How do you determine points of reference?

3. Why do you need a reference point?

4. How does speed impact a point of reference?

5. How can reference points be used to calculate the distance an object travels?

6. How can reference points be used to calculate the speed of at which an object travels?

What Is Going On?

Motion is defined as a change in position over time. The change can be in a horizontal direction, a vertical direction or in both directions. In order to detect motion, you need to have a reference point, in other words, something that is not moving or is moving at a different speed in order to help relatively mark your movement.

When you move on your board or your bike, such as carving, turning, grinding or going for air, you are experiencing motion. In skateboarding, you can use motion to help you go forward or backward. Going backward on a skateboard can both be referred to as "fakie" or "switch". In BMX, when the rider begins to head toward the ramp, the point of reference is where the rider begins. The cumulative change of position from the beginning to the end of a ride translates to the motion of the BMX rider.

Where Does This Happen in Real Life?

A rider uses the slope of a ramp or the curve of a transition to provide an increase in the amount of force in the same direction by pumping down the incline or through the point of transition. In action sports, when a rider pushes to get up a wall or down a ramp, the push is the force over a given distance resulting in work performed. Inclined planes are also used on highways as onramps, typically an inclined plane that a car or motorcycle uses to gain speed. In contrast, the highway off-ramps are inclined planes that are designed to help a car or motorcycle slow down as they exit the highway.