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Chapter 2:

Physical Science Motion and Forces

When a force (a push or a pull) is applied to an object, the object changes its motion. Gravity is a universal force that is related to the size of the masses that are being separated. Friction is a force that also acts upon objects. If a force is not acting on an object, the object will continue to move at a constant speed and in a line without stopping. The weight of an object is related to the object's mass. The mass of the object is the amount of matter in the object. Objects that have more mass also weigh more than objects that have less mass. Mass does not depend on gravity, whereas weight does. This is a large misconception among science students! Another misconception is about acceleration. In everyday (nonscientific) terms, acceleration means to speed up. The scientific definition of acceleration includes speeding up, slowing down (negative acceleration) or changing direction. Inertia is related to how difficult it is to change an object's motion. Inertia is also attributed to an object's mass.

The activities in this section will explore Newton's laws of motion.

Newton's First Law: An object at rest stays at rest unless an unbalanced force is acting upon it. If an object is already in motion, it continues to move indefinitely in a straight line unless another force acts upon it.

Newton's Second Law: In mathematical terms, force is equal to the mass times the acceleration. In other words, if an unbalanced force acts upon an object, the object will accelerate in the direction of the applied force. Force is measured in newtons (N). A newton is equivalent to the amount of force it takes to accelerate 1 kilogram of matter 1 metre per second squared.

Newton's Third Law: Forces always act in equal but opposite pairs. The most common way to state this law is that for each and every action force, there is an equal but opposite reaction force.

"Why Should You Wear a Seatbelt?" is an application-level overview of Newton's three laws of motion. Students design their own experiment and then measure how well seatbelts hold precious "cargo", which they define. The experiment also enables teachers to begin to address misconceptions about inertia, acceleration and mass versus weight.

"Newton's Laws of Motion" provides a method for teachers to clarify the differences between Newton's three laws through various memory techniques including graphic organisers, foldable notes and mnemonics. Students will also add their own creative twist by creating songs or poems, or by writing and performing a play and then presenting to the class. As a final product, students will do a self-reflection for a portion of their mark.

"Electromagnetism" is an inquiry activity in which students attempt to increase the strength of an electromagnet through scientific testing and exploration. Students carefully note the experiment in their science notebooks by recording data and drawing conclusions.

Why Should You Wear a Seatbelt?

SCIENCE TOPICS

Newton's three laws of motion, inertia, force, mass, acceleration, newton, friction, gravity, weight

Educational Goals

Students will

- relate Newton's three laws of motion to wearing a seatbelt in a vehicle for safety.
- test and gather data about the "seatbelt" by examining a clay ball, a raw egg or another student-chosen "passenger" for their vehicle.
- apply the equation $F = ma$ (where F = force, m = mass and a = acceleration) to the experiment they devise.
- differentiate between mass and weight, inertia and acceleration as defined in scientific terms.

Multiple Intelligences

logical/mathematical, verbal/linguistic, bodily/kinesthetic, visual/spatial and interpersonal

Materials

Materials will vary as determined by the students but could include rubber bands ("seatbelts"); eggs, clay balls or items that might be damaged upon impact ("passengers"); toy cars, trucks or materials to design a car; balance; metre rulers; and stopwatches.

Differentiation

Students may be designing their own cars, then deciding both the passenger of the vehicle and the seatbelt used. Students will also gather data in a manner they choose and record it in their science notebooks. The activity is tiered due to the flexibility and choice students have within its design. The teacher will provide a variety of support materials complemented by items the students may bring from home. Students will work with partners throughout this problem-based learning activity. Because the activity is tiered, the homework will be tiered as well when students experiment with Newton's laws and inertia in relation to a real-life safety example.

Why Should You Wear a Seatbelt?

One of the first things consumers want to know before they buy a car is its crash test (safety) data. Many of the new cars today have bumper bars that can be hit at a low rate of speed without damage to the passenger, driver or car. Cars are also equipped with antilock brakes, airbags (both front and side) and other safety features. Seatbelts keep passengers safe by locking in place so passengers are not ejected from a moving vehicle if an accident occurs.

Understanding all the forces involved around a moving (or quickly stopping) car require studying Newton's laws of motion. This activity will allow you to experiment with forces, acceleration, inertia, mass, weight and gravity.

Directions: Record definitions (in your own words) for the terms below.

force: _____

acceleration: _____

inertia: _____

mass: _____

weight: _____

gravity: _____

Now work with a partner to design (or attain) a model vehicle to test for safety. You and your partner should agree on a "passenger" for your model vehicle such as a ball of clay, a raw egg or a substitute of your choice. You will be designing a "seatbelt" to hold your "passenger" in place during a crash test. Be sure to record all data from your experiment in your science notebook. Suggested instruments to gather data include stopwatches, metre rulers and/or a scale. Remember Newton's second law of gravity: $F = ma$ where F = force, m = mass and a = acceleration. This law should be explored during your experiment. You may decide to vary first one variable and then another during your experiment until you fully understand how Newton's laws of motion work.