Color and Body Style May Vary

Pull Back Car

P4-1980

BACKGROUND:

An object experiences an acceleration when its velocity changes. Since velocity entails both speed and direction, an acceleration occurs when an object's speed, direction of motion, or both change. This means that an object moving in a straight line with increasing or decreasing speed or moving in a circle with constant or variable speed is accelerating.

You would never pay good money to visit an amusement park that only offers rides that move with constant velocity. If you have your eyes closed while moving at a constant velocity, you can't even tell that you're moving. Unlike constant velocity, acceleration is something you can feel. That's why people love roller coasters, swings, and rotors. They provide a change in speed, direction, or both. For many of us, the more abrupt these changes are the better!

Acceleration results when an unbalanced force acts on an object. According to Newton's 2nd Law, the acceleration is directly proportional to the unbalanced (or net) force and inversely proportional to the mass. This is consistent with everyday experience. Two cars with the same mass will have different accelerations if one car has a more powerful engine. Likewise, a massive semi will take much longer to get up to the speed limit than a sports car, even though they both have big engines.

HOTROD TUNER NOTE:

From time to time we have had to substitute a different body style of the Pull-Back Car because of availability problems with the advertised style. If you received the Jeep body style Pull Back Car you may have noticed that the acceleration was negligible as a result of the heavy metal body. This has helped us to discover that all of our cars can deliver even better acceleration when run without their bodies. To do this, just remove the screw(s) found beneath the car. The top should now lift off easily. Minimizing the mass of an accelerating car is old-school wisdom to hotrod tuners and street racers and this real world application will captivate your students with a terrific extension to this **F=ma** lab!

ACTIVITIES:

The Pull Back Car lends itself to a number of experiments in mechanics. The net force is supplied by a spring. The spring is wound by dragging the car backward across a floor or other surface.

The inertia of the car may be increased by placing small masses in the car's roomy front seat, thus enabling students to see how acceleration and mass are related. The car accelerates predictably during the first 1.5 meters of its motion. After that, the acceleration decreases (and becomes negative) and the car may veer to the side.

The following suggestions for activities have been tested in the classroom. But be assured, you and your students will think of many more ways the Pull Back Car can be used in the study of physics.

1. You may wish to have your students explore with the cars prior to formal laboratory work. This can best be accomplished by simply placing a few cars on your desk prior to class. Upon entering the room, students will instinctively pick them up and start racing them. Student observations can later be used as a basis for a discussion of uniform and accelerated motion.

2. Have students devise an experiment to determine their car's top speed. Students may be asked whether the speed they measured represents an average or instantaneous speed. This usually prompts a lively discussion regarding the determination of the speed of an object at a given instant. You may wish to use this opportunity to introduce the concepts of limits and the derivative.

3. The Pull Back Car is a wonderful device for introducing acceleration. After discussing the definition of acceleration, students may be work in groups to devise a procedure for measuring the acceleration of their Pull Back Car. Once they have determined the acceleration of their car, they should be asked to compare it with the acceleration of other group's cars.

4. If available, a ticker tape timer may be used to study the details of the car's acceleration. Students can use the tapes to determine if the car's acceleration is constant throughout the motion or just during a portion of it.

5. As a library or Internet assignment, students may be asked to see how their car's acceleration stacks up against the acceleration of real cars. Automobile magazines generally provide amazingly detailed data on the cars they review.

6. Have students gradually add mass to their car. They will observe that the car will accelerate, regardless of its mass, but that the acceleration decreases with increased mass. You may wish to have students do a quantitative investigation by measuring the acceleration of their car as a function of mass. This may be done using ticker tape timers or photogates.

BIBLIOGRAPHY:

Conceptual Physics: The High School Physics Program. Paul G. Hewitt. Pearson Education, Inc.