Newton's 1st Law

Subject Area	Physics.
Age or Grade	Elementary high school physics.
Estimated Length	One 45-minute lesson.
Prerequisite knowledge and skills	Basic knowledge of forces and free-body diagrams, as well as concepts of kinematics (displacement, velocity, and acceleration). This lesson is designed to fit before Newton's 2nd or 3rd laws.
Lesson Goals and New Content	Newton's 1st law. The goal is to guide the students through an exploration, leading to a formulation of Newton's 1st law in their own words. The students should also realize that a change in motion of an object is related to the forces acting on it. The lesson also touches upon the independence of the directions of motion, although this is not the central topic.
Materials Needed	A small ball, such as a tennis ball or lacrosse ball. Rolling chair. Worksheet for the students.
Procedure	**Opener** (~5 min.) Ask the students whether they have ever tried throwing a ball into the air while sitting in a moving car or train, and if they know why the ball doesn't just fly to the back of the vehicle when leaving your hand. In my experience, explanations from the students include that the air pushes the ball along after it leaves your hand, as well as other

	explanations involving forces pushing or pulling the ball along with you. If no one suggests that, try suggesting it yourself and see what they say. (This explanation will serve as part of a discrepant event during the development phase, and it is in my experience a common misconception among students at this point that forces are needed to maintain motion, so be sure to bring it up! If they feel stupid for suggesting this idea because they sense it might be wrong, you can tell them that it was the prevailing explanation among ancient Greek scholars for many centuries!). Play the role of the unknowing, not giving away any hints as to the correct answer just yet, and use the question to lead you into the demonstration and worksheet. **Development** (~30 min.) Distribute the worksheets and call on two volunteers. Do part 1 with the class and give them about 5 minutes to discuss the questions in groups of 3-5 before moving on to part 2. Note that they should be able to see what the acceleration is based solely on whether the ball is changing velocity or not (i.e., not by thinking of Newton's 2nd law!). Now do part 2, and let the students discuss the questions as before. This is a good point for the teacher to interject for a few minutes and check the progress of the students. Ask them as a class what they got for their free-body diagrams, and show the correct versions on the board. Ask whether anvone

	identified any forces that could push the ball along. Their free-body diagrams should contradict the idea of a force maintaining the motion of the ball. Do not elaborate more on this just yet, but continue to part 3. As before, give them 5 minutes to discuss the questions. Then do part 4, followed by another 5 minute discussion. **Closure** (~10 min.) Poll the groups to see what their explanations were for the different parts. At this point, the class should (perhaps with a little guidance) be able to dispel the explanation that a force is pushing the ball along to keep it with the chair. Hear the ideas the groups came up with. If needed, guide them towards the correct idea by asking them whether their free-body diagrams showed any force pushing the ball along. Together, you should reach the conclusion that no forces were acting on the ball to slow it down, and that forces are needed to alter its motion. At this point, ask them to formulate this idea in their own words. (See bottom of worksheet.) You might even give a suggestion of how you would formulate it to get them started, depending on how well they grasped the demonstration.
Evaluation	This brief problem set probes their basic understanding of the lesson and can be given as homework in connection with this lesson. Later in the curriculum (when all of Newton's laws has been introduced), this worksheet (two versions: version 1

	and version 2) provides good comprehensive practice for the students.
Extensions	Discussions of Newton's 2nd and 3rd laws are easily linked to this lesson. In particular, it should now be familiar to the students when seeing Newton's 2nd law that when *F* is 0, *a* is 0, and the object is either at rest or moving at a constant velocity.