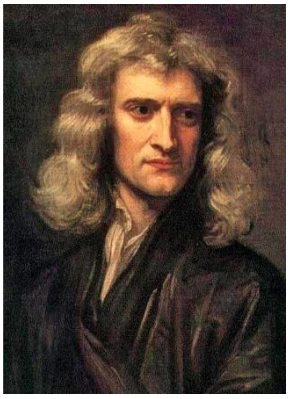
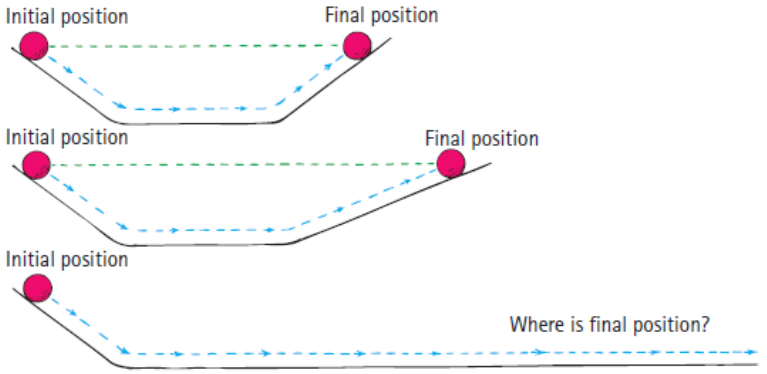
Subject Code	PHY 1	**Physics 1**
Module Code	5.0	**Newton's Laws of Motion**
Lesson Code	5.1	**Newton's 1st Law of Motion**
Time Frame		30 minutes

Components	Tasks	TA[1] (min)	ATA[2] (min)
Target 	By the end of this learning guide, the student should be able to • identify and refute misconceptions about force and change in motion	1	
Hook 	**Dynamics** is a branch of mechanics that deals with the study of motion and its causes. In the past, many scientists performed experiments in an attempt to describe the movement of objects. However, the work of an English scholar turned physicist in 1665 became the solid rock from which we describe the laws of motion. Doing this sophisticated work during his isolation in the countryside located in Woolsthorpe was his way to escape the danger of a lingering pandemic in London. His name was **Sir Isaac Newton.**  His works were compiled in a treatise known as **Principia Mathematica.** Using the experiments performed by his predecessors, especially Galileo, he deduced the three laws that describe bodies' motion. These laws are the basis of our understanding of why objects move the way they do, and its applications transcend to our knowledge of the mechanics of the vast universe where our planet belongs. One of the most celebrated experiments performed by Galileo involved careful observation of rolling balls on an inclined plane.	5	

[1] Time allocation suggested by the teacher.
[2] Actual time allocation spent by the student (for information purposes only).



Hewitt, 2006

The figure above shows Galileo's experiment. Galileo found out that when the ball rolled down on a very smooth ramp, it continued to roll up the second ramp until it reached the same level from which it was released. He performed the experiment at various steepness of the ramp. One of the interesting things that he observed in this experiment was that the ball regained its original height regardless of the steepness of the inclined plane, as shown in the figure above. Galileo then wondered what would happen to the ball if it was rolled on a perfectly horizontal surface. Up to what point will it reach?

Ignite

For centuries, the scientific community's beliefs on motion were based on Aristotle's works. For instance, Aristotle believed that force is required to keep an object moving. Galileo challenged this postulate of Aristotle on motion.

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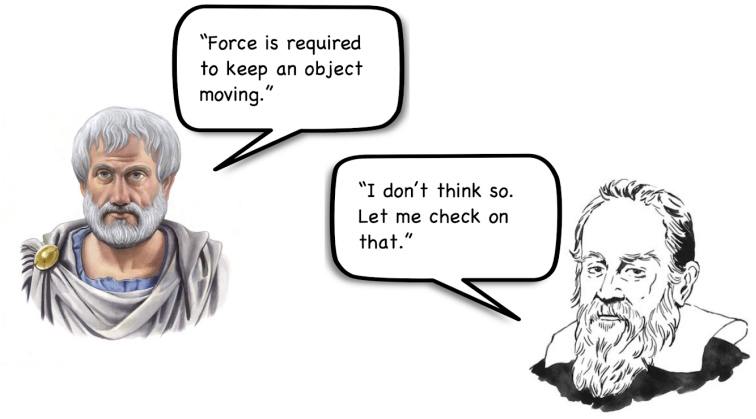
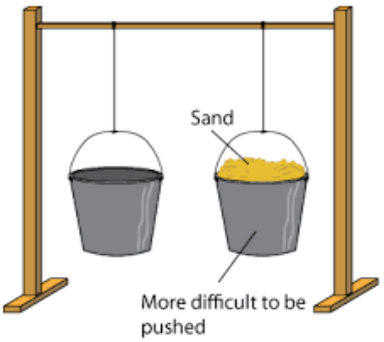


Unlike his predecessors, Galileo developed theories that are based on empirical evidence. He is considered as one of the forerunners of modern science because of his high regard and value for experimental results. From his experiment on a ball rolling down an inclined plane and into a flat surface (third setup in the first figure) Galileo realized that the ball will never reach its original

height, and so it will continue rolling on the flat surface provided there is no resistive force acting on it. He proved that force is not required to keep an object moving.

This also led him to develop the concept of inertia or the natural tendency of an object to resist changes in its state of motion. The **mass** of an object is the **quantitative measure of inertia**. It means it is more difficult to change the state of motion of a more massive object. It is why it entails an effort to push or pull more massive objects because they possess greater inertia.



Building upon the findings of Galileo, Newton formulated his ***first law of motion***:

NEWTON'S FIRST LAW OF MOTION

A body acted on by no net force has a constant velocity (which may be zero) and zero acceleration.

(Young & Freedman, 2016)

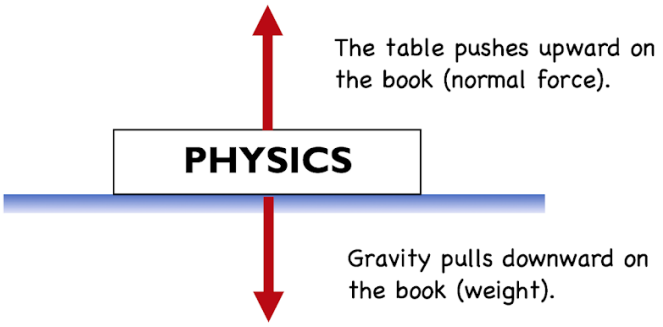
An important postulate of Newton's first law of motion is the concept of balance or equilibrium. An object may experience several forces acting on it. But if these forces balance or cancel out each other, that is there is no net force or the summation of forces is zero,

$$F_1 + F_2 + \ ... \ + \ F_n \ = \ 0 \qquad \text{[Eq. 1]}$$

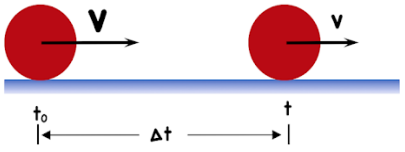
the object would have constant velocity and therefore zero acceleration.

If the object is initially at rest and there is no net force acting on it, it will remain at rest. If the object is initially moving and there is no net force acting on it, it will continue moving with the same velocity.

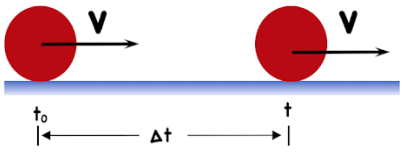
Let's examine the forces acting on an object at rest, such as a book resting on top of the table. There are two forces acting on the book – downward pull of gravity (weight) and upward push of the table (normal force). Because these forces have the same magnitude but act in opposite directions, they balance each other. Hence, the book will remain in its state of rest.



If we replicate Galileo's experiment, and the ramp is not so smooth, the ball will stop before it reaches the height of the initial position. If the ball is made to roll on a horizontal surface, it will eventually stop at some point. But this is because of the presence of a resistive force called friction. If the resistive force is reduced, the ball will roll for a longer distance before coming to stop. If there is no friction at all, we expect the ball's velocity to be sustained as it rolls indefinitely.



Rolling on a surface with friction. The ball's velocity is retarded by the presence of friction.



Rolling on a frictionless surface. No friction opposes the motion of the ball. The ball's velocity is sustained.

Navigate

Write your answers on a clean sheet of paper. Follow your teacher's instructions regarding submission.

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Write TRUE if the statement is true, otherwise write FALSE. If the statement is false, rewrite the statement to make it true.

_____ 1. Only objects that are stationary or not moving experience zero net force.

_____ 2. Force is always needed to keep an object moving.

_____ 3. All objects moving at uniform speed are not accelerating.

	_____ 4. For an object to sustain its velocity, a constant amount of force must be applied to it. _____ 5. A moving object that has experienced zero acceleration means it has stopped moving.		
Knot 	Here are some of the key takeaways after working on this learning guide. ● Newton's first law of motion describes the motion of an object when it experiences zero net force. ● An object that experiences zero net force will either remain at rest or keep moving at constant velocity.	2	

References

1. Hewitt, P. (2006). *Conceptual Physics.* Pearson Education, Inc.
2. Young, H. & Freedman, R. (2016). *Sear's and Zemansky's University Physics with Modern Physics*. Pearson Education, Inc.

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