Granny on the Ramp

Student Information Page Activity 4B MS

Introduction:

When you are at the top of a steep hill, ready to ride down on your bicycle or skateboard, you naturally make judgments about how much fun it will be to go fast down that hill. You also think about the safety of taking this ride. You are contemplating the relationship among ***rise***, ***run***, ***slope***, ***velocity***, ***mass***, and ***acceleration***! In this activity, *"Pom-Pom Granny"* will help you explore these concepts in more detail.

Activity Background:

As you already know, a ***right triangle*** consists of a ***vertical leg***, a ***horizontal leg***, and the ***hypotenuse***. See *Figure 1 Parts of a Right Triangle*.

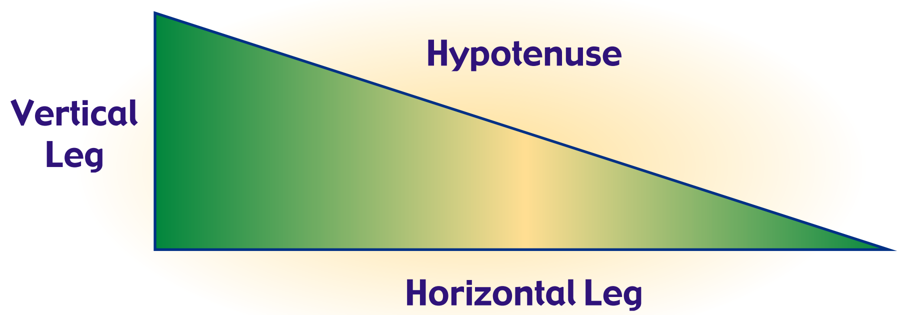


Figure 1 Parts of a Right Triangle

A ***ramp*** is an inclined surface that connects areas of different heights. The right triangle in *Figure 1* is just like a ramp, although the parts of a ramp have different names. The part of a triangle which is called the ***vertical leg*** is called the ***rise*** of a ramp. The part of a triangle which is called the ***horizontal leg*** is called the ***run*** of a ramp. The ***hypotenuse*** of a triangle is like the length of the inclined surface of a ramp. In this activity, we will call this the ***ramp length***. See *Figure 2 Parts of a Ramp*.

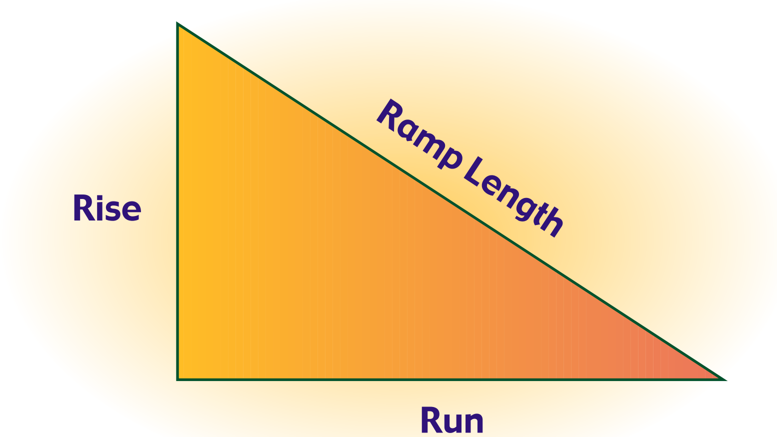


Figure 2 Parts of a Ramp

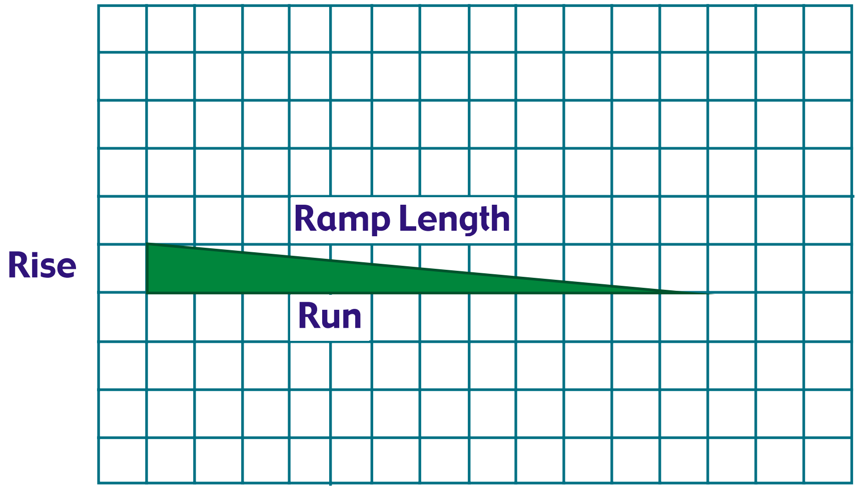


Figure 3 Slope of a Ramp

Assume a ramp, has a ***rise*** of 1 space and a ***run*** of 12 spaces. A ***ratio*** is a relation between two values in which one value is divided by the other. The ***ratio*** of the ***rise*** to the ***run*** of this ramp would be 1:12. There are several ways to express a ratio, and all of them are correct. The ratio can be expressed as 1:12; 1 *to* 12; or $^{1}/_{12}$.

The ratio of rise:run is called the ***slope***. The slope of a ramp is an indicator of the steepness of the ramp. In the ramp draw in ***Figure 3***, with its slope of 1:12, there is a rise of 1 box for every 12 boxes of run.

$$\text{Slope} = \text{Rise} : \text{Run} = \frac{\text{Rise}}{\text{Run}}$$

The ***Americans with Disabilities Act (ADA)*** is a civil rights law that was created in 1990 to provide protections against discrimination towards those in the community who have disabilities. The ADA states that **"an individual is considered to have a 'disability' if she/he has a physical or mental impairment that substantially limits one or more major life activities, has a record of such an impairment, or is regarded as having such an impairment."** Thus this law applies to persons with seeing, hearing, speaking, walking, breathing impairments, and those persons whose impairments may interfere with performing manual tasks, learning, caring for oneself, and working. The law also protects those persons who **"have a known association or relationship with an individual with a disability."**

The ADA law provides for equal opportunities in a work environment and ensures access to public facilities (such as hotels, restaurants, theaters, auditoriums, stores, services, museums, recreational areas, and schools), transportation systems, and telecommunications. Some people with disabilities may need to use a wheelchair or other devices to get around in the community and in their homes. The ADA describes guidelines to reduce architectural barriers that can prevent a disabled person from having full access to the things

they, like anyone else, may need in a community. The law contains rules for new construction and modifications to existing structures so that public facilities are as barrier-free as possible. Some of the ADA guidelines talk about removing barriers (ADA Section 36. 604) with the first priority being to install interior and/or exterior pedestrian ramps. Other portions of the ADA provide directions for building ramps or using existing space as ramps. Some of these guidelines follow:

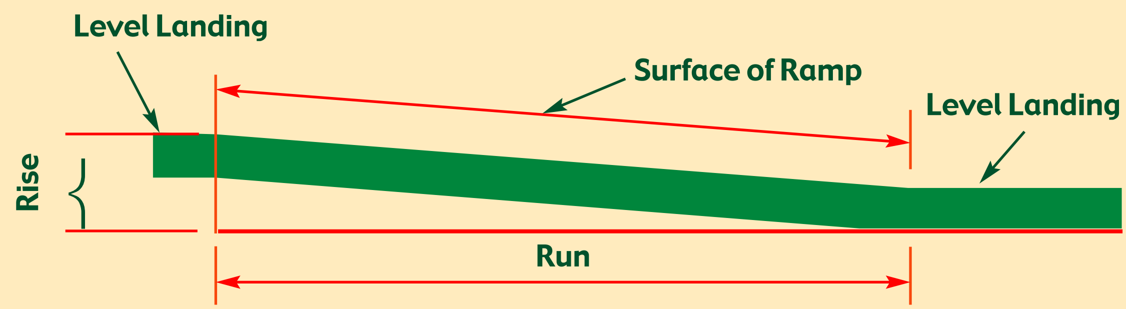


Figure 1 Components of a Single Ramp Run

Adapted from ADA guidelines

4. 8. 2 Slope and Rise. The ***least possible slope*** shall be used for every ramp. The ***maximum slope*** of a ramp in new construction shall be 1:12 . The maximum rise for any run shall be 30 in (760 mm) ***(See Fig. 1)***. **Note that 1:12 = 1 to 12 = $^{1}/_{12}$.**

4. 8. 3 Clear Width. The minimum clear width of a ramp shall be ***36 in (915 mm)***.

4. 8. 4 Landings. Ramps shall have level landings at bottom and top of each ramp and each ramp run. Landings shall have the following features:

(1) The landing shall be at least as wide as the ramp run leading to it.

(2) The landing length shall be a minimum of 60 in (1525 mm) clear.

(3) If ramps change direction at landings, the minimum landing size shall be 60 in by 60 in (1525 mm by 1525 mm).

Balanced and Unbalanced Forces

Newton's first law of motion states that:

An object at rest tends to stay at rest and an object in motion tends to stay in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

A *force* causes an object to accelerate. Remember that force equals **mass** multiplied by **acceleration** or **F = M** X **A**. Many forces exist, including gravity, friction, magnetism, chemical bonding, spring force, and others. We tend to think of a *balanced* object as being an unmoving object, such as a balanced seesaw. It requires a different way of thinking to realize that the seesaw is not moving because the forces working on it are equal and therefore the *net movement* of the seesaw is zero. If a light person sits on one end of the seesaw and there is nothing on the other end, the seesaw will move because the forces acting on it are no longer balanced. When the end of the seesaw hits the ground, the ground exerts a force on the seesaw that stops the movement. When a heavier object is placed on the other end of the seesaw, the forces are unbalanced, so the seesaw moves. It will continue moving until it hits the ground. Thus movement of an object is actually the result of an imbalance among all the forces acting upon it. See *Figure 5 Balanced and Unbalanced Forces*.

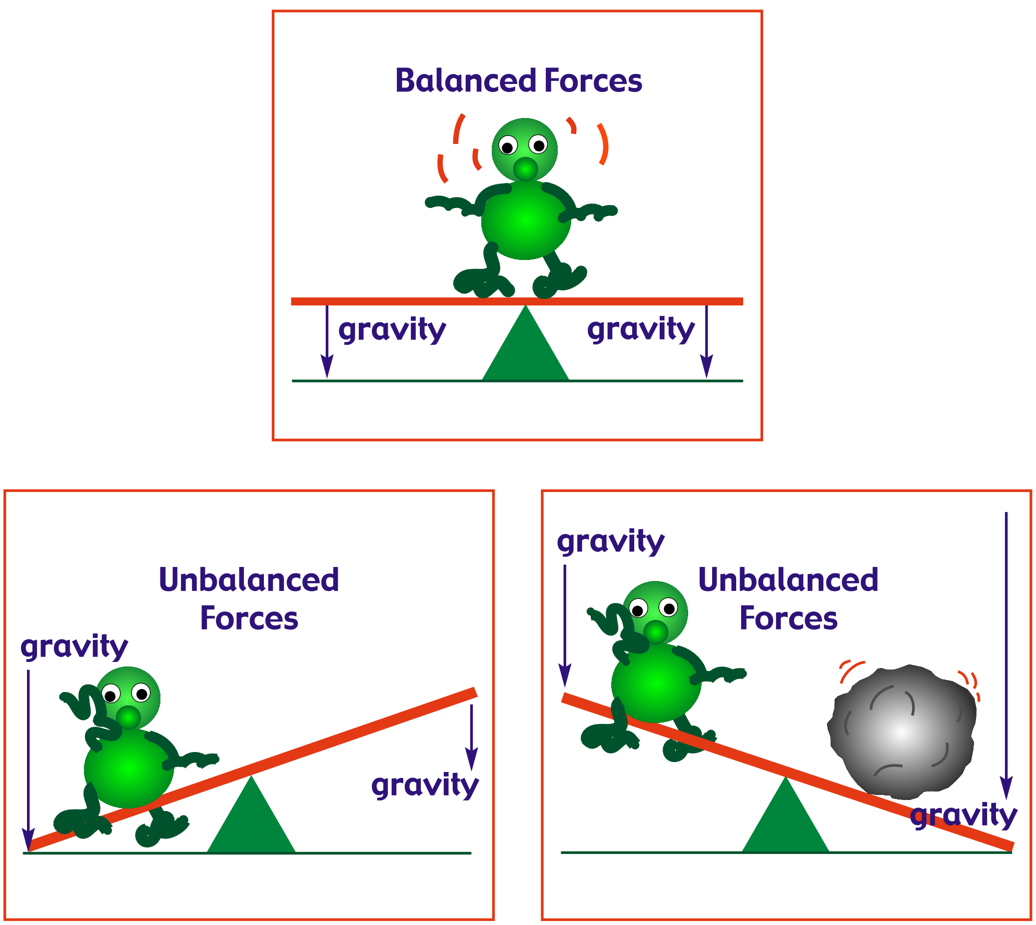


Figure 5 Balanced and Unbalanced Forces in a Seesaw

LESSON 4
ACTIVITY 4B
MIDDLE SCHOOL
MO-BILITY

Consider a book sitting on a table. It is not moving because all of the forces acting upon the book are balanced. If a new force acts upon the book or if the existing forces become unbalanced, the book will move. The book will move in the direction of the unbalanced force.

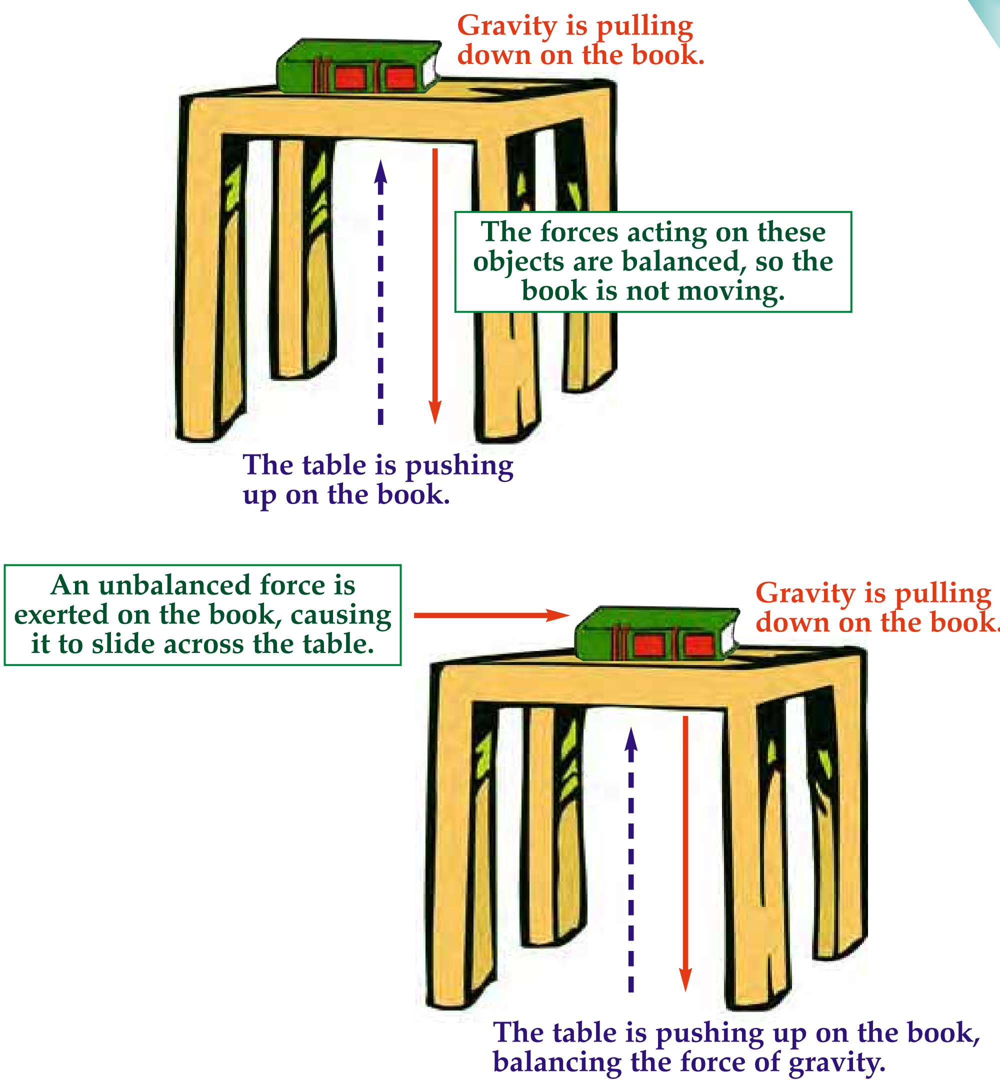
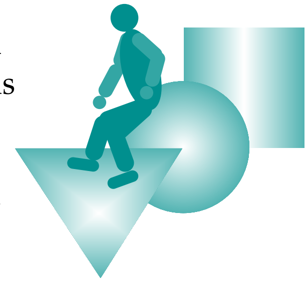


Figure 6 Balanced and Unbalanced Forces Acting on a Book

Potential and Kinetic Energy

When you are holding *Pom-Pom Granny* in her wheelchair at the top of the ramp, she is not moving; all forces acting on her are balanced. Release your hold on her and she will begin moving in the direction of the unbalanced force and she will continue moving until all forces acting upon her are again balanced. Try it – release her and watch her move down the ramp and eventually come to a stop. When *Pom-Pom Granny* was at the top of the ramp, she had *potential energy* because of her position on the ramp. When the unbalanced forces acted on her as you released your hold on her, her *potential energy* was converted to *kinetic energy*, the energy of motion. The more potential energy *Pom-Pom Granny* has at the top of the ramp, the further she will travel as potential energy is converted to kinetic energy.



The terms ***velocity*** and ***speed*** are used interchangeably but they are not synonymous. ***Velocity*** is a ***vector quantity*** that measures the rate of change in distance over a particular time period. It is direction-dependent, which means that if you take a step forward and a step backward, you have ***no*** velocity. ***Speed*** on the other hand is a ***scalar quantity***. It measures how fast an object or a person is going independent of direction. The equation used to calculate ***velocity*** is the following:

$$\text{Velocity}\left(\frac{\text{cm}}{\text{sec}}\right) = \frac{\text{Distance (cm)}}{\text{Time (sec)}}$$