# History

**Explore the discoverer's biography, including general facts about his life and anecdotes regarding how he made this particular discovery. Also see other significant scientific discoveries built largely on this concept and other real-world applications in history that may not still be relevant.**

## Discoverer/Developer

Charles' Law from 1787. Jacques Charles (1746-1823) was a French-born balloonist who flew the first hydrogen balloon in 1783. Charles did an experiment filling 5 different balloons with the same volume of 5 different gases and heating them each uniformly. He noted the balloons each grew uniformly. This observation wasn't published until 1802, by Gay-Lussac, but was named for the original observer, Charles.

## Use/Application through History

Charles' Law contributed to the development of the kinetic theory of matter. Charles' Law can also be applied to osmosis, which, in turn, allows the determination of molecular weights by osmotic pressure.

# Concept Definition

**Study the primary definition of this concept, broken into general, basic, and advanced English definitions. Also see the mathematical definition and any requisite background information, such as conditions or previous definitions.**

## General Science

Volume increases as temperature increases if pressure remains constant. Volume decreases as temperature decreases if pressure remains constant.

## Basic

Volume and temperature of a gas at constant pressure are directly proportionate.

## Advanced

Volume (V) and temperature (T) are directly proportionate for a constant pressure.

## Mathematical Definition

## Background Information

**Ideal Gas**

An "ideal gas" is a gas in which:

- All collisions are totally elastic (particles always bounce off each other)
- There are no intermolecular attractions (a particle can only change direction when it collides with another particle)
- The molecule is infinitely small (particles will come all the way together before they collide)

What does this mean? An ideal gas is a collection of bouncy-balls.

# Real World Application

**Discover processes or disciplines in the natural or man-made worlds that employ the concept.**

A balloon blown up inside a warm building will shrink when it is carried to a colder area, like the outdoors.

Humans' lung capacity is reduced in colder weather; runners and other athletes may find it harder to perform in cold weather for this reason.

Charles' Law, along with a couple other gas laws, is responsible for the rising of bread and other baked goods in the oven; tiny pockets of air from yeast or other ingredients are heated and expand, causing the dough to inflate, which ultimately results in a lighter finished baked good.

Car (combustion) engines work by this principle; the heat from the combustion of the fuel causes the cylinder to expand, which pushes the piston and turns the crankshaft.

# Vocabulary

**Learn important vocabulary for this concept, including words that might appear in assessments (tests, quizzes, homework, etc.) that indicate the use of this concept.**

Important Vocabulary **Term** **Context**

Constant Pressure

- expands/compresses at a constant pressure

Isobaric

- gas in an isobaric process
- expands/compresses isobaricly

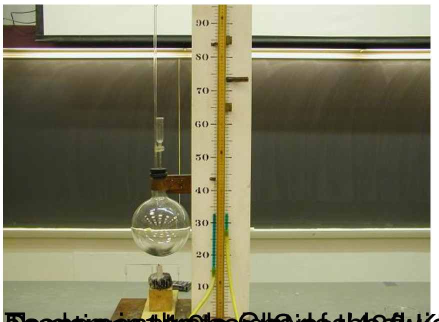
Standard Pressure

- expands/compresses at standard pressure

# Videos

**Browse relevant videos from the Journal of Chemical Education's (JCE) Chemistry Comes Alive! library and other video sources.**

## Hot Air Thermometer



To demonstrate Charles' Law, [illegible] is heated; the [illegible] indicates the increase in volume of the gas.

Duration: [illegible]

## Shrinking Balloon

To demonstrate Charles' Law, liquid nitrogen is poured over a balloon filled with air.

Duration: 11.5 s s; Size: 464 KB

## Collapsing a Metal Container

# Computer Animations

**Experience computer simulators or animations that illustrate the concept discussed here. Many simulators or animations come with worksheets for use in class.**

http://www.grc.nasa.gov/WWW/K-12/airplane/Animation/frglab2.html
http://www.walter-fendt.de/ph14e/gaslaw.htm
http://phet.colorado.edu/simulations/sims.php?sim=Gas_Properties
http://homepages.ius.edu/kforinas/physlets/thermo/piston.html
http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/gasesv6.swf
http://intro.chem.okstate.edu/1314F00/Laboratory/GLP.htm
http://preparatorychemistry.com/Bishop_animations.htm

## Classroom Demonstations

**Investigate lab procedures suitable for live classroom demonstrations or guided student exploration.**

Demos

### Soda Can

### Hard-Boiled Egg

## Summary

**Read a summary of the concept, indicating the enduring understanding students should retain after class.**

Summary

If pressure does not change, increasing the temperature of a container will increase its volume. Decreasing the temperature of the container will decrease its volume.

## Works Cited

**Review the works cited to write the researched parts of this page, such as the discover's biographical information and other areas.**

Works Cited

Frank, David V. "Gas Behavior." Physical Science. Teacher's ed. Needham, MA: Prentice Hall, 2002. 51-60.

Hutchinson, John. The Ideal Gas Law. Connexions. 16 Jan. 2005 .

HyperPhysics. Nave, C. R. 2006. Department of Physics and Astronomy, Georgia State University. 20 Jan. 2009 .

Ihde, Aaron J. The Development of Modern Chemistry. New York: Harper & Row, 1964.

Partington, J. R. A Short History of Chemistry. 2nd Ed. London: Macmillan and Co., 1948.

Wistrom, Cheryl. "The Gas Laws." Chemistry: Concepts and Applications. Teacher's wraparound ed. New York: Glencoe/McGraw-Hill, 2000. 382-392.