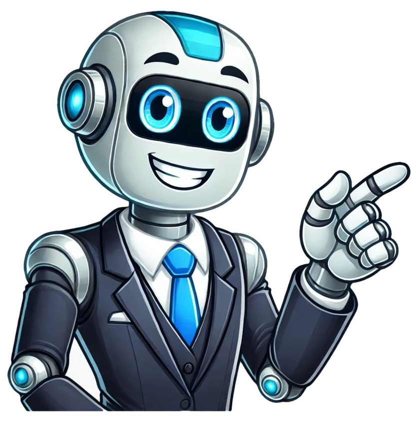

Boyle's law worksheet

Boyle’s law states that the pressure of a gas is inversely proportional to its volume, assuming constant mass and temperature.Boyle’s law or Mariotte’s law states that pressure of an ideal gas is inversely proportional to volume under conditions of constant mass and temperature. When the gas volume increases, pressure decreases. When the volume decreases, pressure increases. Boyle’s law takes its name from chemist and physicist Robert Boyle, who published the law in 1862.Boyle’s law states that the absolute pressure of an ideal gas is inversely proportional to its volume under conditions of constant mass and temperature.Boyle’s Law describes the relationship between pressure and volume of a gas when mass and temperature are held constant. (NASA)There are three common formulas for Boyle’s law:$P \propto 1/V$$PV = k$$P_1V_1 = P_2V_2$P is absolute pressure, V is volume, and k is a constant.This is a graph of Boyle’s original data, leading to the formulation of Boyle’s Law. Marc Lagrange, Wikipedia CommonsThe graph of volume versus pressure has a characteristic downward curved shape that shows the inverse relationship between pressure and volume. Boyle used the graph of experimental data to establish the relationship between the two variables.Richard Towneley and Henry Power described the relationship between the pressure and volume of a gas in the 17th century. Robert Boyle experimentally confirmed their results using a device constructed by his assistant, Robert Hooke. The apparatus consisted of a closed J-shaped tube. Boyle poured mercury into the tube, decreasing the air volume and increasing its pressure. He used different amounts of mercury, recording air pressure and volume measurements, and graphed the data. Boyle published his results in 1662. Sometimes the gas law is called the Boyle-Mariotte law or Mariotte’s law because French physicist Edme Mariotte independently discovered the law in 1670.There are examples of Boyle’s law in everyday life:The bends: A diver ascends to the water surface slowly to avoid the bends. As a diver rises to the surface, the pressure from the water decreases, which increases the volume of gases in the blood and joints. Ascending too quickly allows these gases to form bubbles, blocking blood flow and damaging joints and even teeth.Air bubbles: Similarly, air bubbles expand as they rise up a column of water. If you have a tall glass, you can watch bubble expand in volume as pressure decreases. One theory about why ships disappear in the Bermuda Triangle relates to Boyle’s law. Gases released from the seafloor rise and expand so much that they essentially become a gigantic bubble by the time they reach the surface. Small boats fall into the bubbles and are engulfed by the sea.Deep-sea fish: Deep-sea fish die if you bring them up to the surface. As outside pressure drops, the volume of gas within their swim bladder increases. Essentially, the fish blow up or pop.Syringe: Depressing the plunger on a sealed syringe decreases the air volume inside it and increases its pressure. Similarly, if you have a syringe containing a small amount of water and pull back on the plunger, the volume of air increases, but it’s pressure decreases. The pressure drop is enough to boil the water within the syringe at room temperature.Breathing: The diaphragm expands the volume of the lungs, causing a pressure drop that allows outside air to rush into the lungs (inhalation). Relaxing the diaphragm reduces the volume of the lungs, increasing the gas pressure within them. Exhaling occurs naturally to equalize pressure.For example, calculate the final volume of a balloon if it has a volume of 2.0 L and pressure of 2 atmospheres and the pressure is reduced to 1 atmosphere. Assume temperature remains constant.$P_1V_1 = P_2V_2$(2 atm)(2.0 L) = (1 atm)$V_2$$V_2$ = (2 atm)(2.0 L)/(1 atm)V_2 = 4.0 LIt’s a good idea to check your work to make sure the answer makes sense. In this example, the balloon pressure decreased by a factor of two (halved). The volume increased and doubled. This is what you expect from an inverse proportion relationship.Most of the time, homework and test questions require reasoning rather than math. For example, if volume increases by a factor of 10, what happens to pressure? You know increasing volume decreases pressure by the same amount. Pressure decreases by a factor of 10.See another Boyle’s law example problem.Fullick, P. (1994). Physics. Heinemann. ISBN 978-0-435-57078-1.Holton, Gerald James (2001). Physics, The Human Adventure: From Copernicus to Einstein and Beyond. Rutgers University Press. ISBN 978-0-8135-2908-0.Tortora, Gerald J.; Dickinson, Bryan (2006). ‘Pulmonary Ventilation’ in Principles of Anatomy and Physiology (11th ed.). Hoboken: John Wiley & Sons, Inc. pp. 863–867.Walsh, C.; Stride, E.; Cheema, U.; Ovenden, N. (2017). “A combined three-dimensional in vitro–in silico approach to modelling bubble dynamics in decompression sickness.” Journal of the Royal Society Interface. 14(137). doi:10.1098/rsif.2017.0653Webster, Charles (1965). “The discovery of Boyle’s law, and the concept of the elasticity of air in seventeenth century”. Archive for the History of Exact Sciences. 2(6) : 441–502.Related Posts Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. 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The inverse relationship between the pressure and volume of a container of gas held at a constant temperature is explained by Boyle's law. It was first discovered by Richard Towneley and Henry Power in the 17th century; and a few years later, Robert Boyle finally confirmed and published it. Boyle's law can be expressed mathematically as $PV=k$, where P is the pressure measurement, V is Volume, and k is a constant. It states that the pressure and volume, when multiplied together, will remain constant as long as the temperature and mass remain constant. With our Boyles Law worksheets, you will be given a chance to practice using the formula PV = constant to calculate the pressure or volume of a gas that is permitted to expand or contract at a constant temperature. It will also contain questions that require students to use their understanding of Boyle's Law to address issues with the pressure and volume of a fixed mass of gas at a fixed temperature. If you are looking for a way to re-teach and provide additional practice with this law, give our Boyles Law worksheet a try. We’re sure that these Chemistry worksheets would be a great reinforcement activity.Convert PDF to Digital Worksheets Learn about the 8 most common types of gas laws, including Boyle’s Law, Charles’ Law, and more. Explore their applications in science and engineering. Gas laws refer to a set of fundamental principles that describe the behavior of gases in various conditions. These laws form the foundation of many scientific and engineering applications, from the design of jet engines to the manufacturing of pharmaceuticals. There are many gas laws, but here we will discuss the eight most common ones. 1. Boyle’s Law Boyle’s Law, named after Irish scientist Robert Boyle, states that the pressure and volume of a gas are inversely proportional to each other when the temperature is constant. In other words, as the volume of a gas decreases, its pressure increases, and vice versa. This law finds application in many areas of science, including scuba diving, where it is crucial to understand the relationship between pressure and volume to avoid decompression sickness. 2. Charles’ Law Charles’ Law, named after French physicist Jacques Charles, states that the volume of a gas is directly proportional to its temperature at constant pressure. In other words, as the temperature of a gas increases, its volume also increases. This law is fundamental to the understanding of the behavior of gases in many everyday situations, such as in the expansion of air in hot air balloons. 3. Gay-Lussac’s Law Gay-Lussac’s Law, named after French chemist Joseph Louis Gay-Lussac, states that the pressure of a gas is directly proportional to its temperature when the volume is constant. In other words, as the temperature of a gas increases, so does its pressure, and vice versa. This law is crucial in the design of engines, where high-pressure gases are used to produce mechanical work. 4. Avogadro’s Law Avogadro’s Law, named after Italian scientist Amedeo Avogadro, states that equal volumes of gases at the same temperature and pressure contain the same number of molecules. This law forms the basis of the ideal gas law and is used to calculate the number of moles of a gas in a given sample. 5. Ideal Gas Law The Ideal Gas Law is a combination of the three laws mentioned above and relates the pressure, volume, temperature, and number of molecules of a gas. It is expressed as $PV = nRT$, where P is pressure, V is volume, n is the number of moles, R is the gas constant, and T is temperature in Kelvin. The ideal gas law finds widespread use in many areas of science, from the manufacturing of chemicals to the study of atmospheric phenomena. 6. Dalton’s Law Dalton’s Law, named after English scientist John Dalton, states that the total pressure of a gas mixture is equal to the sum of the partial pressures of each gas in the mixture. This law is fundamental to the understanding of atmospheric pressure, which is composed of a mixture of gases, including nitrogen, oxygen, and carbon dioxide. 7. Graham’s Law Graham’s Law, named after Scottish chemist Thomas Graham, states that the rate of diffusion of a gas is inversely proportional to the square root of its molecular weight. This law is crucial in the understanding of gas transport in living organisms, such as the exchange of oxygen and carbon dioxide in the lungs. 8. Combined Gas Law The Combined Gas Law is a combination of Boyle’s Law, Charles’ Law, and Gay-Lussac Problem #1: A gas occupies 12.3 liters at a pressure of 40.0 mmHg. What is the volume when the pressure is increased to 60.0 mmHg? (40.0 mmHg) (12.3 liters) = (60.0 mmHg) (x) x = 8.20 L Note three significant figures. Problem #2: If a gas at 25.0 °C occupies 3.60 liters at a pressure of 1.00 atm, what will be its volume at a pressure of 2.50 atm? (1.00 atm) (3.60 liters) = (2.50 atm) (x) x = 1.44 L Problem #3: To what pressure must a gas be compressed in order to get into a 3.00 cubic foot tank the entire weight of a gas that occupies 400.0 cu. ft. at standard pressure? (400.0 cu. ft) (1.00 atm) = (x) (3.00 cubic foot) x = 133 atm It doesn't matter what the volume units are. It just matters that they be the same on each side. Problem #4: A gas occupies 1.56 L at 1.00 atm. What will be the volume of this gas if the pressure becomes 3.00 atm? (1.56 L) (1.00 atm) = (3.00 atm) (x) 0.520 L Problem #5: A gas occupies 11.2 liters at 0.860 atm. What is the pressure if the volume becomes 15.0 L? (11.2 liters) (0.860 atm) = (x) (15.0 L) x = 0.642 atm Problem #6: 500.0 mL of a gas is collected at 745.0 mmHg. What will the volume be at standard pressure? (745.0 mmHg) (500.0 mL) = (760.0 mmHg) (x) x = 490.1 mL Problem #7: Convert 350.0 mL at 740.0 mmHg to its new volume at standard pressure. (740.0 mmHg) (350.0 mL) = (760.0 mmHg) (x) Problem #8: Convert 338 L at 63.0 atm to its new volume at standard pressure. (63.0 atm) (338 L) = (1.00 atm) (x) Problem #9: Convert 273.15 mL at 166.0 kPa to its new volume at standard pressure. (166.0 kPa) (273.15 mL) = (101.325 kPa) (x) Problem #10: Convert 77.0 L at 18.0 mmHg to its new volume at standard pressure. (18.0 mmHg) (77.0 L) = (760.0 mmHg) (x) Problem #11: When the pressure on a gas increases, will the volume increase or decrease? Volume will decrease. Problem #12: If the pressure on a gas is decreased by one-half, how large will the volume change be? It will double in size. Problem #13: A gas occupies 4.31 liters at a pressure of 0.755 atm. Determine the volume if the pressure is increased to 1.25 atm. (0.755 atm) (4.31 liters) = (1.25 atm) (x) Problem #14: 600.0 mL of a gas is at a pressure of 8.00 atm. What is the volume of the gas at 2.00 atm? (8.00 atm) (600.0 mL) = (2.00 atm) (x) Problem #15: 400.0 mL of a gas are under a pressure of 800.0 torr. What would the volume of the gas be at a pressure of 1000.0 torr? (800.0 torr) (400.0 mL) = (1000.0 torr) (x) Bonus Example #1: A particular balloon is designed by its manufacturer to be inflated to a volume of no more than 2.5 liters. If the balloon is filled with 2.0 liters of helium at sea level (101.3 kPa), and rises to an altitude at which the boiling temperature of water is only 88 degrees Celsius, will the balloon burst? Solution: Comment: These is no way of determining the starting temperature of the gas. However, we know something not in the problem: at sea level, the boiling point of water is 100 °C. So: 1) Let us use a ratio and proportion to estimate the pressure required for water to boil at 88 °C: 100 °C is to 101.3 kPa as 88 °C is to x x = 89.144 kPa 2) Now, we can solve the problem using Boyle's Law: $P_1V_1 = P_2V_2$ (101.3) (2.0) = (88.144) (x) x = 2.27 L The balloon will not burst. Comment: Boyle's Law assumes that the temperature and amount of gas are constant. Since we never knew the starting temperature, we will assume it never changed as the balloon rose. If the temperature actually did change, but by some unknown value, then we cannot solve the problem. Bonus Example #2: Two bulbs of different volumes are separated by a valve. The valve between the 2.00 L bulb, in which the gas pressure is 1.00 atm, and the 3.00 L bulb, in which the gas pressure is 1.50 atm, is opened. What is the final pressure in the two bulbs, the temperature being constant and the same in both bulbs? Solution using Boyle's Law: 1) $P_1V_1 = P_2V_2$ twice (1.00 atm) (2.00 L) = (x) (5.00 L) x = 0.400 atm (1.50 atm) (3.00 L) = (y) (5.00 L) y = 0.900 atm 2) Add 'em up! 0.400 atm + 0.900 atm = 1.30 atm Solution using the Ideal Gas Law: 1) $PV = nRT$ twice: (1.00) (2.00) = n_1RT in the first bulb moles gas = n_1 = 2.00/RT (1.50) (3.00) = n_2RT in the second bulb moles gas = n_2 = 4.50/RT 2) $PV = nRT$ for a third time total volume = 2.00 + 3.00 = 5.00 (P_3) (5.00) = (n_1 + n_2)RT (P_3) (5.00) = (2.00/RT + 4.50/RT)RT (P_3) (5.00) = 6.50 P_3 = 6.50 / 5.00 = 1.30 atm