What is the Ideal Gas Law Equation? PV = nRT From what laws is this equation derived? Boyles Law relationship between pressure and volume Charles Law relationship between volume and temperature Avogadros Law relationship between moles and volume A sample of hydrogen gas has a volume of 8.56 L at a temperature of 0oC and a pressure of 1.5 atm. Calculate the moles of hydrogen present in the sample. 0.57 moles How would this answer change if the gas had been helium? There would be no difference in the answer. What equation can you use if you are given a question in which there a change in state? P1V1 = P2V2 n1T1 n2T2 A sealed balloon is filled with 1.00 L of helium at 23oC and 1.00 atm. The balloon rises to a point in the atmosphere where the pressure is 220. torr and the temperature is -31oC. What is the change in the volume of the balloon as it ascends from 1.00 atm A bicycle tire is filled with air to a pressure of 75 psi at a temperature of 19oC. Riding the bike on asphalt on a hot day increases the temperature of the tire to 58oC. The volume of the tire increases by 4.0%. What is the new pressure in the bicycle tire? 81.7 psi Assuming constant temperature and pressure what would the final volume be for the following reaction after it has run to completion? 19.3 mL An acronym that stands for Standard Temperature and Pressure. Standard Temperature = 273K Standard Pressure = 1 atm Consider What mass of NaN3 must be reacted in order to inflate an airbag to 71.4 L at STP? 138g NaN3 A compound has the empirical formula CHCl. A 256 mL flask, at 373K and 750 torr contains 0.800g of the gaseous compound. Give the molecular formula. C2H2Cl2 Consider: If this reaction is run at STP, what would the total volume be after this reaction has run to completion. 9.75 L The ideal gas law worksheet with answers provides a comprehensive set of exercises and their corresponding solutions to aid students in understanding the fundamental concepts of the ideal gas law. This worksheet covers various aspects of the ideal gas law, such as pressure-volume relationships, temperature-volume relationships, and the combined gas law. By working through these exercises, students can reinforce their understanding of the ideal gas law and its applications in real-world scenarios. The worksheet is designed to be user-friendly, with clear instructions and step-by-step solutions, making it an invaluable resource for both students and educators. Understanding the Secrets of Gas Laws: A Physics AdventureHey there, curious minds! Welcome to our thrilling expedition into the world of gas laws. These laws are the secret formulas that govern the behavior of gases, and theyre about to become as clear as crystal.State Variables: The BasicsImagine your gas as a sneaky little character with a set of vital stats: pressure (P) like the weight its pushing down on something, volume (V) like its fancy apartment size, temperature (T) like its mood, and the number of moles (n) like the number of party guests its hosting. And dont forget the ideal gas constant (R), the magical number that keeps all these stats in check.Boyles Law: The Pressure PartyPicture this: youre at a party, and the room gets packed. As more people squeeze in, the pressure goes up like crazy. But hey, the volume of the room stays the same, right? Thats Boyles Law in action: P and V are inversely related. As one goes up, the other goes down, like a seesaw.Charless Law: The Temperature TrickNow, lets turn up the heat. As the temperature rises, our gas starts to get rowdy and needs more space. Thats Charless Law: V and T are besties, always moving in the same direction.Gay-Lussacs Law: The Pressure-Temperature Dance Heres a twist: if you keep the volume constant, pressure and temperature become partners in crime. When T goes up, P also takes a leap. Its like a tango, where one step leads to the next.Avogadros Law: The Mole MysteryMolecules are like tiny soldiers, and the more soldiers you have, the more space they need. Avogadros Law says volume is directly proportional to the number of moles. Its all about the crowd size!Combined Gas Law: The Master EquationReady for the ultimate formula? The Combined Gas Law combines the secrets of Boyles, Charless, and Gay-Lussacs Laws. It tells us how P, V, and T all play together in a perfect gas world.Partial Pressure and Daltons Law: The Gas PartyImagine a party with different gases mixing it up. Partial pressure is like each gass own private space, and Daltons Law says the total pressure is just the sum of all the partial pressures. Its like a big gas cocktail!So there you have it, folks! The gas laws are like the magic spells of the gas world, and now youve got the key to unlocking their mysteries. Remember, these laws are our guides to understanding the invisible world of gases that surrounds us.Understanding Gas Laws: Key Concepts and EquationsHey there, my curious learners! Today, were diving into the fascinating world of gas laws. These laws govern how gases behave, and understanding them is like having a superpower when it comes to chemistry and physics.State Variables and Their InterrelationshipsImagine gases as tiny, bouncy balls zipping around a room. The pressure (P) of these balls is how hard theyre hitting the walls, the volume (V) is how much space they take up, and temperature (T) is how fast theyre moving. These three variables are like best friends, they love hanging out together and influencing each other. For example, if you increase the pressure, the volume will decrease, and vice versa. Its like a cosmic dance party where they take turns leading the show.Boyles Law: The Pressure-Volume TangoBoyles Law says that when the temperature stays the same, the pressure and volume of a gas are inversely proportional. Picture this: if you squeeze a balloon (increase pressure), itll get smaller (decrease volume). And if you let go and give it more space (increase volume), the pressure inside will decrease. Its like a game of tug-of-war, where pressure and volume are pulling in opposite directions.Charless Law: The Temperature-Volume WaltzCharless Law introduces temperature into the mix. It says that when the pressure stays the same, the temperature and volume of a gas are directly proportional. Think of a balloon again: as you heat it up (increase temperature), itll expand (increase volume). And if you cool it down (decrease temperature), itll shrink (decrease volume). Its like the balloon is a musical instrument, playing a beautiful symphony as temperature and volume dance together.Understanding Gas Laws: A Tale of Pressure, Volume, and TemperatureImagine gases as a bunch of tiny invisible balls bouncing around like crazy. These balls cant see each other, but they bump into each other and the walls of their container. How they behave depends on three main factors: pressure, volume, and temperature.Now, lets meet Boyles Law, our first gas-law buddy. Boyle had a flashy assistant named Robert, who kept getting distracted by the air pressure outside. One day, Boyle noticed that as Robert pumped more air into a closed container, the air inside got squished and took up less space. The pressure (the force of the air pushing) went up, while the volume (the space the air occupied) went down.Boyle realized that for a given amount of gas at a constant temperature, there was this cool inverse relationship between pressure and volume: as one goes up, the other goes down. He summed it up with this equation:**PV = constant**This means that if you double the pressure, the volume will halve and vice versa. Its like a magical see-saw of pressure and volume!Understanding Gas Laws: A Light-Hearted GuideHey there, curious minds!Today, were diving into the world of gas laws, the fascinating rules that govern the behavior of our gaseous friends. Think of them as the social etiquette that gases follow when they mingle with each other.First up, lets get acquainted with the key variables:Pressure (P): Imagine the gas molecules bouncing around in their container. The more molecules and their activity, the higher the pressure.Volume (V): This is the space that our gas buddies occupy. They like to spread out and fill up the area theyre given.Temperature (T): Think of temperature as the dance party vibes for gas molecules. Higher temperatures mean theyre moving faster and getting groovy!These variables are like the ingredients of a secret recipe for describing gases. And guess what? Theyre linked together by a cool equation: PV = constant.This magical formula tells us that as pressure increases, volume decreases (and vice versa). For example, if you squeeze a balloon (increase pressure), it gets smaller (decreased volume). Conversely, if you blow air into it (decrease pressure), it expands (increased volume).So, whats the deal with this constant? Its like the magic number that remains the same no matter how you play around with pressure and volume. Its a way for gases to keep their balance and maintain their special characteristics.So, there you have it, folks! Boyles Law in a nutshell. Understanding this relationship is like having the superpower to predict how gases will behave under different pressure and volume conditions. Stay tuned for more gas law adventures as we explore the rest of the gang!Understanding Charless Law: The Temperature-Volume DanceHey there, curious minds! Lets dive into Charless Law, a fascinating law that reveals the secret relationship between temperature and volume in the world of gases.Picture this: you have a big balloon filled with air. As you increase the temperature of the balloon, something magical happens. Just like a shy kid warming up to a new friend, the gas particles inside the balloon get excited and start moving around more vigorously. This increased movement leads to them bumping into each other more often and taking up more space. As a result, the volume of the balloon increases.So, Charless Law tells us that for a fixed amount of gas at constant pressure, the volume of the gas is directly proportional to its temperature. Increase the temperature, and the volume expands. Decrease the temperature, and it shrinks.Imagine youre a chef baking a cake. You set the oven to a specific temperature, and the cake expands as it cooks. This is because the increased temperature causes the gas bubbles in the batter to expand, giving your cake that fluffy texture.So, next time youre wondering why your bicycle tire gets harder when you ride on a hot day or why the lid of your pressure cooker starts rattling when you turn up the heat, remember Charless Law, the maestro of the temperature-volume dance in the world of gases.Understanding Gas Laws: Key Concepts and EquationsHey there, gas enthusiasts! Welcome to our journey into the fascinating world of gas laws. Today, were going to unlock the secrets of these laws and unravel their practical significance in various fields. Grab your notepads and get ready for a captivating adventure!Charless Law: Unveiling Temperature-Volume ConnectionsOne of the fundamental gas laws is Charless Law, which reveals the intimate relationship between temperature and volume. Imagine a large balloon filled with air. When you heat up the balloon, the air inside expands, causing the balloon to inflate. But when you cool it down, the air contracts, leading to a deflated balloon.This magical transformation is captured in the mathematical equation V/T = constant. This means that the volume of a gas is directly proportional to its absolute temperature (measured in Kelvin). As temperature increases, so does volume, and vice versa.Significance in Gas ExperimentsCharless Law is a crucial tool in gas experiments. For instance, when scientists want to study the temperature dependence of a chemical reaction, they often vary the temperature of the gas and measure the corresponding volume changes. By analyzing these changes, they can understand the reactions temperature sensitivity and optimize reaction conditions.So, next time you see a weather balloon soaring high in the sky, remember the power of Charless Law in action. As the balloon ascends through the atmosphere, the temperature drops, causing the balloon to expand and reach incredible heights!Gay-Lussacs Law: Unlocking the Temperature-Pressure DancePicture this: youre cooking up a delicious meal, and youre using a pressure cooker to speed things up. As you heat up the cooker, you might notice something strange: the pressure inside the cooker starts to rise. Why is that?Well, its all thanks to a clever scientist named Joseph Louis Gay-Lussac. In the early 1800s, he discovered that theres a special relationship between the temperature and pressure of a gas. He called this relationship Gay-Lussacs Law.Gay-Lussacs Law says this: the pressure of a gas is directly proportional to its absolute temperature, when volume is constant. In other words, if you keep the volume of a gas the same and increase its temperature, the pressure will go up too.This law is like a recipe for predicting how a gas will behave when you change its temperature. Heres the mathematical equation that describes it:P/T = constantThis means that the ratio of pressure (P) to temperature (T) is always the same for a given amount of gas at constant volume.So, next time youre using a pressure cooker or even just filling up a balloon, remember the magic of Gay-Lussacs Law! Its the secret behind all sorts of cool things like cooking food faster, making balloons float, and even helping us understand the weather.Understanding Gas Laws: Key Concepts and EquationsChapter 3: Gay-Lussacs Law: Uncovering Temperature-Pressure RelationshipsHold on tight, gas enthusiasts! Were about to explore the captivating world of Gay-Lussacs Law, where temperature and pressure dance harmoniously.Imagine you have a gas sample trapped in a sealed container. As we heat it up, the molecules get all excited and start bouncing around like crazy, taking up more space. This means that the volume of the gas increases. But wait, theres more to it!The Magic Number: P/T = constantGay-Lussac discovered that the ratio of pressure (P) to temperature (T) in a gas sample remains constant, as long as the volume remains the same. Thats like a magical equation printed on the walls of the gas universe: P/T = constantWhat does this mean?Well, if you increase the temperature, the pressure will also go up proportionally. And if you decrease the temperature, the pressure will drop. Its like a see-saw: when one goes up, the other goes down.Real-Life Application:This law has some pretty cool applications. For example, scientists use it to design hot air balloons. By heating up the air inside the balloon, they can increase the pressure and make it rise. On the flip side, pressure cookers seal in the heat, raising the temperature and pressure, allowing food to cook faster.So, there you have it, the ins and outs of Gay-Lussacs Law. Remember, its all about the pressure-temperature tango. Keep this law in your back pocket, and youll be the star of your next gas law party!Understanding Gas Laws: A Whimsical Voyage into the World of GasesGreetings, my fellow curious minds! Today, we embark on a lighthearted journey into the fascinating realm of gas laws. Get ready to laugh, learn, and unravel the mysteries of gases with me as your friendly, funny guide!Imagine gases as tiny, invisible actors on a molecular stage, each with its own special traits. Well meet pressure (P), the force they exert on their surroundings; volume (V), the space they occupy; temperature (T), their level of excitement; and number of moles (n), the number of these actors on stage.Avogadros Law: When More Actors Mean More SpaceNow, lets introduce Avogadro, the master of ceremonies who governs the relationship between gas volume and the number of moles present. Avogadros Law states that under the same conditions of pressure and temperature, equal volumes of gases contain an equal number of moles.Picture this: Imagine two gas-filled balloons of the same size. One balloon contains a cast of 100 gas actors, while the other has a colossal ensemble of 200 actors. According to Avogadros Law, the balloon with more actors (moles) will occupy a larger volume. Just like a crowded theater needs more space than a sparsely populated one.So, if youre ever asked to calculate the number of moles in a gas sample, simply measure its volume, and presto! Avogadros Law will lead you to the answer.Explain the mathematical equation V/n = constant and its importance in determining gas quantities.Avogadros Law: Unraveling the Mystery of Gas Volume and MolesMy dear gas enthusiasts, lets dive into the intriguing world of Avogadros Law, where well unravel the secrets connecting gas volume to the number of moles present. Buckle up, because this is going to be a fun and informative adventure!Imagine a gas-filled balloon. As you add more moles of gas into the balloon, what do you observe? Thats right, its volume goes up! Avogadros Law mathematically expresses this relationship as V/n = constant. Here, V stands for volume, n represents the number of moles, and the constant is like a faithful chaperone that keeps the ratio between volume and moles consistent.The beauty of Avogadros Law lies in its ability to help us determine gas quantities. Lets say you have a mixture of gases and you want to figure out how many moles of each gas are present. Simply measure the volume of each gas and apply the law. The mathematical equation V/n = constant allows you to calculate the moles (n) based on the measured volume (V) and the constant (which is a known value).So, there you have it, folks! Avogadros Law is like a magic wand, helping us decipher the intricate relationship between gas volume and moles. Next time youre in a scientific predicament involving gases, dont forget the power of Avogadros Law!Understanding Gas Laws: Unraveling the Invisible ForcesGases, they fill our balloons, propel our cars, and make life possible for us. But how do they behave? Enter the realm of gas laws, the secret code that governs the invisible forces shaping gases.The Combined Gas Law: A Master EquationImagine three wise sages, Boyle, Charles, and Gay-Lussac. Each discovered their own law about gases, like pieces of a puzzle. But when we put them together, voila! The Combined Gas Law, a master equation that solves all our gas-related dilemmas.Combining the Sages WisdomBoyle showed us that pressure and volume are inversely proportional. Charles said, Hey, temperature and volume are best friends. And Gay-Lussac proved that pressure and temperature like to hang out together.The Combined Gas Law takes all three laws and smashes them into one powerful equation:(PV)/T = (PV)/TThis equation is like a magic wand for gas calculations. It allows us to find one variable (like pressure, volume, or temperature) when we know the other three.Real-Life Gas MagicLets say you have a balloon filled with helium on a hot summer day. The balloons volume is increasing (Charless Law), but the pressure is decreasing because the helium molecules are spreading out (Boyles Law). But wait, theres more! As the balloon heats up, the pressure also increases (Gay-Lussacs Law).The Combined Gas Law can help us predict how the balloon will behave as the temperature and pressure change. Its like having a superpower to control the invisible forces that shape our world.Understanding Gas Laws: Unveiling the Secrets of GasesYo, gas lovers! Buckle up for a wild ride as we dive into the intriguing world of gas laws. These laws govern the behavior of those pesky gas particles, and theyre like the secret code to understanding how gases get down.State Variables: The Gas GangImagine a gas gang hanging out: pressure (P), volume (V), temperature (T), and number of moles (n). Theyre like the A-team of gas properties, and theyre all connected like puzzle pieces. They cant help but affect each other.Boyles Law: The Pressure-Volume DanceThis law says that pressure (P) and volume (V) are best buds who like to play a game of inverse proportions. When you increase the pressure, the volume gets squeezed, and vice versa. Its like a game of push and pull: the stronger the pressure, the smaller the volume. And voil, we have PV = constant.Charless Law: The Temperature-Volume TangoNow, lets bring temperature (T) into the mix. Charless Law tells us that temperature and volume love to hang out together. As the temperature rises, the volume expands, and when it drops, the volume contracts. Its like a party that gets bigger and livelier as the temperature soars. V/T = constant is the mathematical groove they ride to.Gay-Lussacs Law: The Pressure-Temperature TwirlThis law pairs up pressure (P) and temperature (T) in a cozy relationship. When the temperature rises, the pressure also climbs. Theyre like two besties who love to amplify each other. The equation P/T = constant summarizes their sweet harmony.Avogadros Law: The Volume-Moles ConnectionPicture this: you have two gas gangs with the same volume (V). Avogadros Law says that if you add more of one gang, the number of moles (n), the other gang will magically increase its volume to match. Its like a gas party where more guests = more space. V/n = constant is the mathematical party planner.Combined Gas Law: The Ultimate Gas FormulaNow, lets throw all these laws into a blender and create the Combined Gas Law. Its like the ultimate gas equation that combines Boyles, Charless, and Gay-Lussacs Laws. Its the Swiss Army knife of gas calculations:[(P1V1)/T1] = [(P2V2)/T2]This equation is your gas-solving superpower. Whatever gas problems life throws your way, this equation will have your back. Pun intended!Understanding Gas Laws: A Crash Course for Science ExplorersHey there, fellow science enthusiasts! Today, were diving into the fascinating world of gas laws. Buckle up, because were going to explore the key concepts and equations that will help you understand how gases behave.State Variables: The ABCs of GasesFirst, lets meet our cast of characters: pressure (P), volume (V), temperature (T), number of moles (n), and the ideal gas constant (R). These five variables are like the building blocks of gas behavior. Theyre all related to each other, and changing one can affect the others. Its like a cosmic dance of numbers!Boyles Law: A Squeeze PlayImagine a party balloon. When you squeeze it (increase pressure), what happens? It gets smaller (decreases volume)! This is Boyles Law in action. It says that when temperature stays constant, the pressure of a gas is inversely proportional to its volume. In other words, if you double the pressure, the volume gets cut in half. Its like a magic trick!Charless Law: Heating Up the VolumeNow, lets heat up our balloon. As the temperature goes up (increase temperature), the volume also goes up (increases volume). This is Charless Law. Its like when you put a bike pump in the sun and it puffs up like a balloon. The higher the temperature, the bigger the volume. Its like the gas molecules are getting excited and dancing all over the place!Gay-Lussacs Law: Pressure and HeatTime for another party trick! Lets heat our balloon with a candle. As the temperature goes up (increase temperature), the pressure also goes up (increases pressure). This is Gay-Lussacs Law. Its like the balloon is saying, Hey, its getting hot in here, I need more space! So it expands and increases its pressure.Avogadros Law: More Molecules, More VolumeNow, lets add more balloons to the party! As the number of balloons (increase moles) increases, the volume also increases (increases volume). This is Avogadros Law. Its like when you fill a bag with marbles and the bag gets bigger. The more molecules you have, the more space they need.Combined Gas Law: The Magic FormulaAll these gas laws are great, but what if we want to change multiple variables at once? Thats where the Combined Gas Law comes in. It combines Boyles, Charless, and Gay-Lussacs Laws into one super-equation:(P1V1)/T1 = (P2V2)/T2This equation is like a magic wand for solving all kinds of gas law problems. Just plug in the values and watch the magic happen!Partial Pressure and Daltons Law: The Party MixFinally, lets talk about gas mixtures. Imagine a bag of popcorn with different flavors like caramel, cheddar, and butter. Each flavor is its own partial pressure, which is the pressure it would exert if it were the only gas in the bag. Now, the total pressure of the popcorn bag is the sum of the partial pressures of all the flavors. This is Daltons Law. Its like the popcorn bag is having a party, with each flavor contributing its own pressure to the overall atmosphere.Understanding Gas Laws: A Whirlwind Tour to Unravel the Secrets of GasesYo, my fellow science enthusiasts! Welcome to the wild and wacky world of gas laws. These laws are like the rules of the road for gases, helping us understand how these elusive substances behave under different conditions. So buckle up, grab your lab coats, and lets embark on a thrilling journey through the realm of gas laws!State Variables: The Dancing Partners of GasesGases are all about these five key variables: pressure (P), volume (V), temperature (T), number of moles (n), and the ideal gas constant (R). Theyre like the best pals in the gas world, always hanging out and affecting each others lives. Just imagine a game of musical chairs, with each variable taking turns to dance around and influence the others.Boyles Law: When Pressure and Volume Do a TangoBoyles Law tells us that when we squeeze a gas (increase pressure), it shrinks in volume. And when we give it some breathing room (decrease pressure), it expands to fill the space available. Its like a rubber ball: squeeze it, and it gets smaller; release it, and it bounces back to its original size.Charless Law: Temperature Turns Up the Heat on VolumeCharless Law says that as temperature rises, the volume of a gas also increases. Think about a hot air balloon. When you heat the air inside, it expands and fills the balloon, making it rise. So if you want to fly high, just crank up the heat!Gay-Lussacs Law: Pressure and Temperatures Steamy RelationshipGay-Lussacs Law shows us how temperature affects pressure. As temperature rises, the pressure of a gas increases too. Picture a sealed container of gas on a hot summer day. The gas molecules are bouncing around like crazy, hitting the walls of the container more often and exerting more pressure.Avogadros Law: Moles and Volume, a Numbers GameAvogadros Law tells us that the volume of a gas is directly proportional to the number of moles of gas present. In other words, more moles, more gas, and more volume. Think of it like a crowded party: the more people you invite, the more space youll need.Combined Gas Law: The Swiss Army Knife of Gas CalculationsThe Combined Gas Law is the ultimate problem-solver for gas law calculations. It combines Boyles, Charless, and Gay-Lussacs Laws into one handy equation. Its like having a Swiss Army knife for gas problems: it can handle anything you throw at it.Partial Pressure and Daltons Law: Gases Share the StageIn a gas mixture, each individual gas exerts its own pressure, called partial pressure. Daltons Law tells us that the total pressure of a gas mixture is simply the sum of the partial pressures of all the individual gases. So, its like each gas has its own microphone, and the total sound you hear is the sum of all their voices.Well, folks, thats all for todays Ideal Gas Law adventure! I hope youve had as much fun exploring these concepts as I have. Whether youre a chemistry whiz or just starting to dip your toes in the world of gases, I encourage you to keep exploring. And hey, dont be a stranger! Pop back here anytime if you need a refresher or have any burning gas-related questions. Until next time, stay curious and keep your pressure on! Rohit Gupta, Akshay Yadav, July Thomas, and contributed Contents To describe an ideal gas, a set of assumptions are made. 1) Gases consist of large numbers of tiny particles that are far apart relative to their size. This implies that the gas molecules have negligible volume compared to the volume of container in which they are placed. 2) Collisions between gas particles and between particles and container walls are elastic collisions (there is no net loss of total kinetic energy). 3) Gas particles are in continuous, rapid and random motion. They therefore possess kinetic energy, which is energy of motion. 4) There are no forces of interaction between gas particles. Thus they can move independent of each other. They only interact with each other through elastic collisions. 5) The average kinetic energy of a gas particle depends only on the temperature of the gas. The last postulate of the kinetic molecular theory states that the average kinetic energy of a gas particle depends only on the temperature of the gas. Thus, the average kinetic energy of the gas particles increases as the gas becomes warmer. Because the mass of these particles is constant, their kinetic energy can only increase if the average velocity of the particles increases. The faster these particles are moving when they hit the wall, the greater the force they exert on the wall. Since the force per collision becomes larger as the temperature increases, the pressure of the gas must increase as well.\[P \propto T\] Here P is pressure and T is temperature in kelvin.In this, volume and number of moles of gas is taken constant.If temperature is represented in kelvin then the graph between pressure and temperature will be a straight line passing through origin. If temperature is represented in celsius then the graph between pressure and temperature will be a straight line but will not pass through origin. On extrapolating, the graph will hit -273.15 degrees. Gases can be compressed because most of the volume of a gas is empty space. If we compress a gas without changing its temperature, the average kinetic energy of the gas particles stays the same. There is no change in the speed with which the particles move, but the container is smaller. Thus, the particles travel from one end of the container to the other in a shorter period of time. This means that they hit the walls more often. Any increase in the frequency of collisions with the walls must lead to an increase in the pressure of the gas. Thus, the pressure of a gas becomes larger as the volume of the gas becomes smaller. If temperature and amount of gas is fixed then pressure is inversely proportional to volume occupied by the gas. \[P \propto 1/V\] Here P is pressure and V is volume. If temperature and number of moles of gas are fixed then the graph between pressure P and volume V will be a rectangular hyperbola. On increasing volume of gas pressure decrease and vice-versa. Such a process is also called as Isothermal Process The average kinetic energy of the particles in a gas is proportional to the temperature of the gas. Because the mass of these particles is constant, the particles must move faster as the gas becomes warmer. If they move faster, the particles will exert a greater force on the container each time they hit the walls, which leads to an increase in the pressure of the gas. If the walls of the container are flexible, it will expand until the pressure of the gas once more balances the pressure of the atmosphere. The volume of the gas therefore becomes larger as the temperature of the gas increases. If pressure of an ideal gas is kept constant then volume of container is directly proportional to temperature (in kelvin) of the gas. \[V \propto T\] Here, V is volume of container and T is temperature of gas in Kelvin. The graph between V and T (in kelvin) depicting the Charles' law will be a straight line passing through the origin. Although, we can never reduce the volume to zero thus the graph should not be shown passing through the origin. If the temperature is taken in degrees then the graph will be instead of passing through origin will hit temperature \(-273^\circ \)C As the number of gas particles increases, the frequency of collisions with the walls of the container must increase. This, in turn, leads to an increase in the pressure of the gas. Flexible containers, such as a balloon, will expand until the pressure of the gas inside the balloon once again balances the pressure of the gas outside. Thus, the volume of the gas is proportional to the number of gas particles. If pressure and temperature of an ideal gas is kept constant then volume of container is directly proportional to the amount of gas (number of moles of gas) in the container. \[V \propto N\] Imagine what would happen, gases at different pressure but same temperature are added to a container. The total pressure would increase because there would be more collisions with the walls of the container. There is so much empty space in the container that each type of gas molecules hits the walls of the container as often in the mixture as it did when there was only one kind of gas. The total pressure will increase as more number of gas molecules hits the container walls but the pressure due to individual gas molecules remains same. The total number of collisions with the wall in this mixture is therefore equal to the sum of the collisions that would occur when each gas is present by itself. In other words, The total pressure of a mixture of gases is equal to the sum of the partial pressures of the individual gases. \[{P_t} = {P_1} + {P_2} + {P_3} + ...\] It was first stated by mile Clapeyron in 1834 as a combination of Boyle's law, Charles's law and Avogadro's Law.The ideal gas law is often written as: \(PV=nRT \) Where, \(R\) is the Gas Constant. Some values of \(R\) are given below. \(R=8.314\) \(\text{J.mol}^{-1}\text K^{-1}\) \(R=0.082\) \(\text{litre.atm.mol}^{-1}\text K^{-1}\) \(R=8.2057\) \(\text m^{3}\text{.atm.mol}^{-1}\text K^{-1}\) From ideal gas equation,\[PV = nRT \]For a closed container, number of moles remains constant, therefore \[\frac{{{T_2}}}{{{T_1}}} = \left({\frac{{{P_2}}}{{{P_1}}}} \right)\,\left({\frac{{{V_2}}}{{{V_1}}}} \right) = \left({\frac{{2{P_1}}}{{{P_1}}}} \right)\,\left({\frac{{3{V_1}}}{{{V_1}}}} \right) = 6\] \[{T_2} = 6{T_1} = 6 \times 300\] \[{T_2} = 1800\,K = 1527^\circ C.\] From Ideal gas equation,\[PV = nRT \] Since gas is trapped inside balloon therefore number of moles of gas remains unchanged.Let \({P_1}\), \({V_1}\) and \({T_1}\) are initial pressure, volume and temperature, and \({P_2}\), \({V_2}\) and \({T_2}\) are final pressure, volume and temperature then, \[\frac{{{V_2}}}{{{V_1}}} = \left({\frac{{{T_2}}}{{{T_1}}}} \right)\,\left({\frac{{{P_1}}}{{{P_2}}}} \right) = \left({\frac{{270}}{{300}}} \right)\,\left({\frac{1}{{0.5}}} \right) = \frac{9}{5}\] \[{V_2} = 500 \times \frac{9}{5} = 900\,{m^3}\] PROBLEM \(\PageIndex{1}\) What is the density of laughing gas, dinitrogen monoxide, N2O, at a temperature of 325 K and a pressure of 113.0 kPa? Answer 1.84 g/L PROBLEM \(\PageIndex{2}\) Calculate the density of Freon 12, CF2Cl2, at 30.0 C and 0.954 atm. Answer 4.64 g/L Click here to see a video of the solution PROBLEM \(\PageIndex{3}\) Which is denser at the same temperature and pressure, dry air or air saturated with water vapor? Explain. Answer air saturated with water vapor - it has a higher molar mass PROBLEM \(\PageIndex{4}\) A cylinder of O2(g) used in breathing by emphysema patients has a volume of 3.00 L at a pressure of 10.0 atm. If the temperature of the cylinder is 28.0 C, what mass of oxygen is in the cylinder? Answer 38.8 g Click here to see a video of the solution PROBLEM \(\PageIndex{5}\) What is the molar mass of a gas if 0.0494 g of the gas occupies a volume of 0.100 L at a temperature 26 C and a pressure of 307 torr? Answer 30.0 g/mol PROBLEM \(\PageIndex{6}\) What is the molar mass of a gas if 0.281 g of the gas occupies a volume of 125 mL at a temperature 126 C and a pressure of 777 torr? Answer 72.0 g/mol Click here to see a video of the solution PROBLEM \(\PageIndex{7}\) The density of a certain gaseous fluoride of phosphorus is 3.93 g/L at STP. Calculate the molar mass of this fluoride and determine its molecular formula. Answer 88.1 g mol1; PF3 PROBLEM \(\PageIndex{8}\) What is the molecular formula of a compound that contains 39% C, 45% N, and 16% H if 0.157 g of the compound occupies 125 mL with a pressure of 99.5 kPa at 22 C? Answer H5CN Click here to see a video of the solution PROBLEM \(\PageIndex{9}\) A sample of gas isolated from unrefined petroleum contains 90.0% CH4, 8.9% C2H6, and 1.1% C3H8 at a total pressure of 307.2 kPa. What is the partial pressure of each component of this gas? (The percentages given indicate the percent of the total pressure that is due to each component.) Answer CH4: 276 kPa; C2H6: 27 kPa; C3H8: 3.4 kPa PROBLEM \(\PageIndex{10}\) Automobile air bags are inflated with nitrogen gas, which is formed by the decomposition of solid sodium azide (NaN3). The other product is sodium metal. Calculate the volume of nitrogen gas at 27 C and 756 torr formed by the decomposition of 125 g of sodium azide. Answer 71.26 L Click here to see a video of the solution PROBLEM \(\PageIndex{11}\) A sample of a compound of xenon and fluorine was confined in a bulb with a pressure of 18 torr. Hydrogen was added to the bulb until the pressure was 72 torr. Passage of an electric spark through the mixture produced Xe and HF. After the HF was removed by reaction with solid KOH, the final pressure of xenon and unreacted hydrogen in the bulb was 36 torr. What is the empirical formula of the xenon fluoride in the original sample? (Note: Xenon fluorides contain only one xenon atom per molecule.) Answer XeF2 Contributors We're fetching your file...Please wait a moment while we retrieve your file from its home on the internet31 HEAVY METALS This test is provided to demonstrate that the content of metallic impurities that are colored by sulfide ion, under the specified test conditions, does not exceed the Heavy metals limit specified in the individual monograph in percentage (by weight) of lead in the test substance, as determined by concomitant visual comparison (see Visual Comparison in the section Procedure under Spectrophotometry and Light-Scattering 851) with a control prepared from a Standard Lead Solution. [NOTESubstances that typically will respond to this test are lead, mercury, bismuth, arsenic, antimony, tin, cadmium, silver, copper, and molybdenum.] Determine the amount of heavy metals by Method I, unless otherwise specified in the individual monograph. Method I is used for substances that yield clear, colorless preparations under the specified test conditions. Method II is used for substances that do not yield clear, colorless preparations under the test conditions specified for Method I, or for substances that, by virtue of their complex nature, interfere with the precipitation of metals by sulfide ion, or for fixed and volatile oils. Method III, a wet-digestion method, is used only in those cases where neither Method I nor Method II can be used. Lead Nitrate Stock Solution Dissolve 159.8 mg of lead nitrate in 100 mL of water to which has been added 1 mL of nitric acid, then dilute with water to 1000 mL. Prepare and store this solution in glass containers free from soluble lead salts. Standard Lead Solution On the day of use, dilute 10.0 mL of Lead Nitrate Stock Solution with water to 100.0 mL. Each mL of Standard Lead Solution contains the equivalent of 10 g of lead. A comparison solution prepared on the basis of 100 L of Standard Lead Solution per g of substance being tested contains the equivalent of 1 part of lead per million parts of substance being tested. pH 3.5 Acetate Buffer Dissolve 25.0 g of ammonium acetate in 25 mL of water, and add 38.0 mL of 6 N hydrochloric acid. Adjust, if necessary, with 6 N ammonium hydroxide or 6 N hydrochloric acid to a pH of 3.5, dilute with water to 100 mL, and mix. Standard Preparation Into a 50-mL color-comparison tube pipet 2 mL of Standard Lead Solution (20 g of Pb), and dilute with water to 25 mL. Using a pH meter or short-range pH indicator paper as external indicator, adjust with 1 N acetic acid or 6 N ammonium hydroxide to a pH between 3.0 and 4.0, dilute with water to 40 mL, and mix. Test Preparation Into a 50-mL color-comparison tube place 25 mL of the solution prepared for the test as directed in the individual monograph; or, using the designated volume of acid where specified in the individual monograph, dissolve in and dilute with water to 25 mL the quantity, in g, of the substance to be tested, as calculated by the formula: in which L is the Heavy metals limit, as a percentage. Using a pH meter or short-range pH indicator paper as external indicator, adjust with 1 N acetic acid or 6 N ammonium hydroxide to a pH between 3.0 and 4.0, dilute with water to 40 mL, and mix. Monitor Preparation Into a third 50-mL color-comparison tube place 25 mL of a solution prepared as directed for Test Preparation, and add 2.0 mL of Standard Lead Solution. Using a pH meter or short-range pH indicator paper as external indicator, adjust with 1 N acetic acid or 6 N ammonium hydroxide to a pH between 3.0 and 4.0, dilute with water to 40 mL, and mix. Procedure To each of the three tubes containing the Standard Preparation, the Test Preparation, and the Monitor Preparation, add 2 mL of pH 3.5 Acetate Buffer, then add 1.2 mL of thioacetamideglycerin base TS, dilute with water to 50 mL, mix, allow to stand for 2 minutes, and view downward over a white surface *: the color of the solution from the Test Preparation is not darker than that of the solution from the Standard Preparation, and the color of the solution from the Monitor Preparation is equal to or darker than that of the solution from the Standard Preparation. [NOTEIf the color of the Monitor Preparation is lighter than that of the Standard Preparation, use Method II instead of Method I for the substance being tested.] NOTEThis method does not recover mercury. pH 3.5 Acetate Buffer Prepare as directed under Method I. Standard Preparation Pipet 4 mL of the Standard Lead Solution into a suitable test tube, and add 10 mL of 6 N hydrochloric acid. Test Preparation Use a quantity, in g, of the substance to be tested as calculated by the formula: in which L is the Heavy metals limit, as a percentage. Transfer the weighed quantity of the substance to a suitable crucible, add sufficient sulfuric acid to wet the substance, and carefully ignite at a low temperature until thoroughly charred. (The crucible may be loosely covered with a suitable lid during the charring.) Add to the carbonized mass 2 mL of nitric acid and 5 drops of sulfuric acid, and heat cautiously until white fumes no longer are evolved. Ignite, preferably in a muffle furnace, at 500 to 600, until the carbon is completely burned off (no longer than 2 hours). If carbon remains, allow the residue to cool, add a few drops of sulfuric acid, evaporate, and ignite again. Cool, add 5 mL of 6 N hydrochloric acid, cover, and digest on a steam bath for 10 minutes. Cool, and quantitatively transfer the solution to a test tube. Rinse the crucible with a second 5-mL portion of 6 N hydrochloric acid, and transfer the rinsing to the test tube. Monitor Preparation Pipet 4 mL of the Standard Lead Solution into a crucible identical to that used for the Test Preparation and containing a quantity of the substance under test that is equal to 10% of the amount required for the Test Preparation. Evaporate on a steam bath to dryness. Ignite at the same time, in the same muffle furnace, and under the same conditions used for the Test Preparation. Cool, add 5 mL of 6 N hydrochloric acid, cover, and digest on a steam bath for 10 minutes. Cool, and quantitatively transfer to a test tube. Rinse the crucible with a second 5-mL portion of 6 N hydrochloric acid, and transfer the rinsing to the test tube. Procedure Adjust the solution in each of the tubes containing the Standard Preparation, the Test Preparation, and the Monitor Preparation with ammonium hydroxide, added cautiously and dropwise, to a pH of 9. Cool, and adjust with glacial acetic acid, added dropwise, to a pH of 8, then add 0.5 mL in excess. Using a pH meter or short-range pH indicator paper as external indicator, check the pH, and adjust, if necessary, with 1 N acetic acid or 6 N ammonium hydroxide to a pH between 3.0 and 4.0. Filter, if necessary, washing the filter with a few mL of water, into a 50-mL color-comparison tube, and then dilute with water to 40 mL. Add 2 mL of pH 3.5 Acetate Buffer, then add 1.2 mL of thioacetamideglycerin base TS, dilute with water to 50 mL, mix, allow to stand for 2 minutes, and view downward over a white surface*: the color of the solution from the Test Preparation is not darker than that of the solution from the Standard Preparation, and the color of the solution from the Monitor Preparation is equal to or darker than that of the solution from the Standard Preparation. [NOTEIf the color of the solution from the Monitor Preparation is lighter than that of the solution from the Standard Preparation, proceed as directed for Method III for the substance being tested.] pH 3.5 Acetate Buffer Prepare as directed under Method I. Standard Preparation Transfer a mixture of 8 mL of sulfuric acid and 10 mL of nitric acid to a clean, dry, 100-mL Kjeldahl flask, and add a further volume of nitric acid equal to the incremental volume of nitric acid added to the Test Preparation. Heat the solution to the production of dense, white fumes; cool; cautiously add 10 mL of water; and, if hydrogen peroxide was used in treating the Test Preparation, add a volume of 30 percent hydrogen peroxide equal to that used for the substance being tested. Boil gently to the production of dense, white fumes. Again cool, cautiously add 5 mL of water, mix, and boil gently to the production of dense, white fumes and to a volume of 2 to 3 mL. Cool, dilute cautiously with a few mL of water, add 2.0 mL of Standard Lead Solution (20 g of Pb), and mix. Transfer to a 50-mL color-comparison tube, rinse the flask with water, adding the rinsing to the tube until the volume is 25 mL, and mix. Test Preparation Unless otherwise indicated in the individual monograph, use a quantity, in g, of the substance to be tested as calculated by the formula: in which L is the Heavy metals limit, as a percentage. If the substance is a solid Transfer the weighed quantity of the test substance to a clean, dry, 100-mL Kjeldahl flask. [NOTEA 300-mL flask may be used if the reaction foams excessively.] Clamp the flask at an angle of 45, and add a sufficient quantity of a mixture of 8 mL of sulfuric acid and 10 mL of nitric acid to moisten the substance thoroughly. Warm gently until the reaction commences, allow the reaction to subside, and add portions of the same acid mixture, heating after each addition, until a total of 18 mL of the acid mixture has been added. Increase the amount of heat, and boil gently until the solution darkens. Cool, add 2 mL of nitric acid, and heat again until the solution darkens. Continue the heating, followed by addition of nitric acid until no further darkening occurs, then heat strongly to the production of dense, white fumes. Cool, cautiously add 5 mL of water, boil gently to the production of dense, white fumes, and continue heating until the volume is reduced to a few mL. Cool, cautiously add 5 mL of water, and examine the color of the solution. If the color is yellow, cautiously add 1 mL of 30 percent hydrogen peroxide, and again evaporate to the production of dense, white fumes and a volume of 2 to 3 mL. If the solution is still yellow, repeat the addition of 5 mL of water and the peroxide treatment. Cool, dilute cautiously with a few mL of water, and rinse into a 50-mL color-comparison tube, taking care that the combined volume does not exceed 25 mL. If the substance is a liquid Transfer the weighed quantity of the test substance to a clean, dry, 100-mL Kjeldahl flask. [NOTEA 300-mL flask may be used if the reaction foams excessively.] Clamp the flask at an angle of 45, and cautiously add a few mL of a mixture of 8 mL of sulfuric acid and 10 mL of nitric acid. Warm gently until the reaction commences, allow the reaction to subside, and proceed as directed for If the substance is a solid, beginning with add portions of the same acid mixture. Monitor Preparation Proceed with the digestion, using the same amount of sample and the same procedure as directed in the subsection If the substance is a solid in the section Test Preparation, until the step Cool, dilute cautiously with a few mL of water. Add 2.0 mL of Lead Standard Solution (20 g of lead), and mix. Transfer to a 50-mL color comparison tube, rinse the flask with water, adding the rinsing to the tube until the volume is 25 mL, and mix. Procedure Treat the Test Preparation, the Standard Preparation, and the Monitor Preparation as follows. Using a pH meter or short-range pH indicator paper as external indicator, adjust the solution to a pH between 3.0 and 4.0 with ammonium hydroxide (a dilute ammonia solution may be used, if desired, as the specified range is approached), dilute with water to 40 mL, and mix. To each tube add 2 mL of pH 3.5 Acetate Buffer, then add 1.2 mL of thioacetamideglycerin base TS, dilute with water to 50 mL, mix, allow to stand for 2 minutes, and view downward over a white surface*: the color of the Test Preparation is not darker than that of the Standard Preparation, and the color of the Monitor Preparation is equal to or darker than that of the Standard Preparation. * In those countries or jurisdictions where thioacetamide cannot be used, add 10 mL of freshly prepared hydrogen sulfide TS to each of the tubes, mix, allow to stand for 5 minutes, and view downward over a white surface. 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