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Relative frequency and frequency

Image: Veena Nair/Moment/Getty Images A natural frequency is a frequency at which an "elastic" object will naturally oscillate, without the introduction of any outside force, or at least that's how it's defined in physics. A way of demonstrating the idea is with a pendulum. If a pendulum is put into a swinging motion and left alone, it will track according to a certain number of swings per minute, which is the natural frequency of the pendulum. Simple objects and complex systems can have a natural frequency. A wine glass, for example, would also reveal its natural frequency if tapped gently to produce a ringing sound.Resonance has to do with the interaction of frequencies. A demonstration of this phenomenon is an experiment done with a wine glass and an opera singer. This effect, known as an example of acoustic resonance, involves the singer hitting a note, the pitch of which matches the natural frequency of the wine glass. Since objects are apt to absorb vibrations that match their natural frequency, if the vibrations from the opera singer's note (which are in the air) match that of the glass (which is touching the air), then the glass will absorb those vibrations until the glass cannot absorb any more, and it shatters. The shattering is due to the structural integrity of the glass being unable to store more kinetic energy, like a battery being overcharged and exploding.Does any of this remind you of your relationships with others? Take this quiz, and we'll identify your natural frequency! PERSONALITY How Witchy Are You? 5 Minute Quiz 5 Min PERSONALITY Cast Some Spells and We'll Give You a Witch Name 5 Minute Quiz 5 Min PERSONALITY Which Age Is Your Soul From? 6 Minute Quiz 6 Min PERSONALITY Am I a Vampire? 6 Minute Quiz 6 Min PERSONALITY Which Magical Element Do You Wield? 5 Minute Quiz 5 Min PERSONALITY Become a Mermaid and We'll Tell You Your Best Personality Trait 5 Minute Quiz 5 Min PERSONALITY Answer These Tarot Reading Questions and We'll Guess How Old Your Soul Is 5 Minute Quiz 5 Min PERSONALITY What Core Superpower Should You Have? 6 Minute Quiz 6 Min PERSONALITY What Kind of Ancient Magic Are You? 5 Minute Quiz 5 Min PERSONALITY What % Legendary Are You? 5 Minute Quiz 5 Min How much do you know about dinosaurs? What is an octane rating? And how do you use a proper noun? Lucky for you, HowStuffWorks Play is here to help. Our award-winning website offers reliable, easy-to-understand explanations about how the world works. From fun quizzes that bring joy to your day, to compelling photography and fascinating lists, HowStuffWorks Play offers something for everyone. Sometimes we explain how stuff works, other times, we ask you, but we're always exploring in the name of fun! Because learning is fun, so stick with us! Playing quizzes is free! We send trivia questions and personality tests every week to your inbox. By clicking "Sign Up" you are agreeing to our privacy policy and confirming that you are 13 years old or over. Copyright © 2021 InfoSpace Holdings, LLC, a System1 Company The frequency of a light wave is how many waves move past a certain point during a set amount of time -- usually one second is used. Frequency is generally measured in Hertz, which are units of cycles per second. Color is the frequency of visible light, and it ranges from 430 trillion Hertz (which is red) to 750 trillion Hertz (which is violet). Waves can also go beyond and below those frequencies, but they're not visible to the human eye. For instance, radio waves are less than one billion Hertz; gamma rays are more than three billion billion Hertz.Wave frequency is related to wave energy. Since all that waves really are is traveling energy, the more energy in a wave, the higher its frequency. The lower the frequency is, the less energy in the wave. Following the above examples, gamma rays have very high energy and radio waves are low-energy. When it comes to light waves, violet is the highest energy color and red is the lowest energy color. Related to the energy and frequency is the wavelength, or the distance between corresponding points on subsequent waves. You can measure wavelength from peak to peak or from trough to trough. Shorter waves move faster and have more energy, and longer waves travel more slowly and have less energy.Aside from the different frequencies and lengths of light waves, they also have different speeds. In a vacuum, light waves move their fastest: 186,000 miles per second (300,000 kilometers per second). This is also the fastest that anything in the universe moves. But when light waves move through air, water or glass, they slow down. That's also when they bend and refract. Once Maxwell introduced the concept of electromagnetic waves, everything clicked into place. Scientists now could develop a complete working model of light using terms and concepts, such as wavelength and frequency, based on the structure and function of waves. According to that model, light waves come in many sizes. The size of a wave is measured as its wavelength, which is the distance between any two corresponding points on successive waves, usually peak to peak or trough to trough. The wavelengths of the light we can see range from 400 to 700 nanometers (or billionths of a meter). But the full range of wavelengths included in the definition of electromagnetic radiation extends from 0.1 nanometers, as in gamma rays, to centimeters and meters, as in radio waves.Light waves also come in many frequencies. The frequency is the number of waves that pass a point in space during any time interval, usually one second. We measure it in units of cycles (waves) per second, or hertz. The frequency of visible light is referred to as color, and ranges from 430 trillion hertz, seen as red, to 750 trillion hertz, seen as violet. Again, the full range of frequencies extends beyond the visible portion, from less than 3 billion hertz, as in radio waves, to greater than 3 billion billion hertz (3 x 1019), as in gamma rays.The amount of energy in a light wave is proportionally related to its frequency: High frequency light has high energy; low frequency light has low energy. So, gamma rays have the most energy (part of what makes them so dangerous to humans), and radio waves have the least. Of visible light, violet has the most energy and red the least. The whole range of frequencies and energies, shown in the accompanying figure, is known as the electromagnetic spectrum. Note that the figure isn't drawn to scale and that visible light occupies only one-thousandth of a percent of the spectrum.This might be the end of the discussion, except that Albert Einstein couldn't let speeding light waves lie. His work in the early 20th century resurrected the old idea that light, just maybe, was a particle after all. Let's begin our dissection of the Doppler effect by considering a source that creates waves in water at a certain frequency. This source produces a series of wave fronts, with each moving outward in a sphere centered on the source. The distance between wave crests -- the wavelength -- will remain the same all the way around the sphere. An observer in front of the wave source will see the waves equally spaced as they approach. So will an observer located behind the wave source.Now let's consider a situation where the source is not stationary, but is moving to the right as it produces waves. Because the source is moving, it begins to catch up to the wave crests on one side while it moves away from the crests on the opposite side. An observer located in front of the source will see the crests all bunched up. An observer located behind the source will see the waves all stretched out. Remember, the frequency equals the number of waves that pass a specific point per second, so the observer in front actually sees a higher frequency than the observer in back of the source.The scenario above describes waves formed in water, but it also applies to sound waves and light waves. Sound waves are heard, not seen, so the observer will hear the bunched-up waves as a higher-pitched sound, the stretched-out waves as a lower-pitched sound. For example, consider a car traveling down a highway between two observers, as shown below. The roar of the engine and friction between the tires and the road surface create a noise -- vroom -- that can be heard by both observers and by the driver.To the driver, this noise will not change. But the observer located in front of the car will hear a higher-pitched noise. Why? Because the sound waves compress as the vehicle approaches the observer located in front. This increases the frequency of the wave, and the pitch of the vroom rises. The observer located behind the car will hear a lower-pitched noise because the sound waves stretch out as the car recedes. This decreases the frequency of the wave, and the pitch of the vroom falls.Light waves are perceived as color, so the observer will sense the bunched-up waves as a bluer color, the stretched-out waves as a redder color. For example, consider an astronomer observing a galaxy through a telescope. If the galaxy is rushing toward Earth, the light waves it produces will bunch up as it approaches the astronomer's telescope. This increases the frequency of the wave, which shifts the colors of its spectral output toward the blue. If the galaxy is rushing away from Earth, the light waves it produces will spread apart as it recedes from the astronomer's telescope. This decreases the frequency of the wave, which shifts the colors of its spectral output toward the red.As you can imagine, astronomers routinely take advantage of the Doppler effect to measure the speed at which planets, stars and galaxies are moving. But its usefulness isn't limited to outer space. Doppler's discovery is integral to several applications right here on Earth.The Origin of the Universe: A Shift in ThinkingIn 1929, Edwin Hubble noticed that light coming from almost every galaxy he studied was shifted, according to the Doppler effect, to the red end of the spectrum. He argued that only galaxies moving away from our galaxy could produce these "redshifts." This led to the notion that the universe was expanding and, ultimately, to the Big Bang theory. Relativity is like a triple-scoop ice cream cone; most of us just can't gobble it down in one bite, not without experiencing some serious brain freeze. So let's tackle the topic one scoop at a time. We'll start with the version of relativity that dates back more than four centuries: Galilean relativity.Yes, this scoop of cosmic gelato originates with famed Italian astronomer Galileo Galilei, and it breaks down like this: Any two observers moving at constant speed and direction will obtain the same results for all mechanical experiments.Let's say the experiment in question is nothing more complicated than throwing a Ping-Pong ball down the aisle of a train. As long as the speed and direction are constant, the Ping-Pong ball would behave exactly the same whether the train's creeping along at a snail's pace or barreling down the tracks. As long as the train isn't jerking around due to speed or directional changes, there's absolutely no difference inside the train car.Outside the speeding train, however, it's a different story (or frame of reference).To the individual aboard the speeding train -- let's say it's traveling at 100 miles per hour (161 kilometers per hour) -- the ball appears to move at regular speed. To the individual standing by the tracks, the ball (assuming he or she could see it) would appear to move with the speed of the train, plus the speed with which it was thrown.How fast is that ball really traveling? Let's say you threw it at a mere 5 miles per hour (8 kilometers per hour). If we added the speed of the train to it, we'd get a total speed of 105 miles per hour (169 kilometers per hour) -- a calculation known as a Galilean transformation. Aboard the train, it wouldn't feel like 105 miles per hour if it bounced up and hit you in the chest. Relative to the outside however, that's the speed it would be traveling.Now here's where it gets tricky: What if you were to shine a flashlight up the aisle of the train? Would the light waves travel 100 miles per hour faster than the speed of light? Not so, according to physicists Albert A. Michelson and Edward Morley. In 1879, the two Americans conducted a groundbreaking experiment to measure the speed of light. As it turns out, light travels at a constant speed of 186,000 miles per second (300,000 kilometers per second). It can't travel any faster by any means, breaking the concept of Galilean relativity.Luckily, Albert Einstein stepped in to fix things in 1920 with his theory of special relativity. 1 How Long Does It Take to Develop a Vaccine? 2 Fact Check: Why Do People Think the Moon Landing Was a Hoax? 3 Form 1099 G: What Is It, and What Does It Mean for Your 2020 Tax Return? 4 Understanding SSI: Supplemental Security Income Basics for New Applicants 5 How Many U.S. Taxpayers Are There? In the construction of a histogram, there are several steps that we must undertake before we actually draw our graph. After setting up the classes that we will use, we assign each of our data values to one of these classes then count the number of data values that fall into each class and draw the heights of the bars. These heights can be determined by two different ways that are interrelated: frequency or relative frequency. The frequency of a class is the count of how many data values fall into a certain class wherein classes with greater frequencies have higher bars and classes with lesser frequencies have lower bars. On the other hand, relative frequency requires one additional step as it is the measure of what proportion or percent of the data values fall into a particular class. A straightforward calculation determines the relative frequency from the frequency by adding up all the classes' frequencies and dividing the count by each class by the sum of these frequencies. To see the difference between frequency and relative frequency we will consider the following example. Suppose we are looking at the history grades of students in 10th grade and have the classes corresponding to letter grades: A, B, C, D, F. The number of each of these grades gives us a frequency for each class: 7 students with an F 9 students with a D 18 students with a C 12 students with a B 4 students with an A To determine the relative frequency for each class we first add the total number of data points: 7 + 9 + 18 + 12 + 4 = 50. Next we, divide each frequency by this sum 50. 0.14 = 14% students with an F 0.18 = 18% students with a D 0.36 = 36% students with a C 0.24 = 24% students with a B 0.08 = 8% students with an A The initial data set above with the number of students who fall into each class (letter grade) would be indicative of the frequency while the percentage in the second data set represents the relative frequency of these grades. An easy way to define the difference between frequency and relative frequency is that frequency relies on the actual values of each class in a statistical data set while relative frequency compares these individual values to the overall totals of all classes concerned in a data set. Either frequencies or relative frequencies can be used for a histogram. Although the numbers along the vertical axis will be different, the overall shape of the histogram will remain unchanged. This is because the heights relative to each other are the same whether we are using frequencies or relative frequencies. Relative frequency histograms are important because the heights can be interpreted as probabilities. These probability histograms provide a graphical display of a probability distribution, which can be used to determine the likelihood of certain results to occur within a given population. Histograms are useful tools to quickly observe trends in populations in order for statisticians, lawmakers, and community organizers alike to be able to determine the best course of action to affect the most people in a given population.

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