Is a continuous function always differentiable

We will start with the simplest type of differential, called an open differential. First we'll need to explore some terminology: The image below labels the components of an open differential.When a car is driving straight down the road, both drive wheels are spinning at the same speed. The input pinion is turning the ring gear and cage, and none of the pinions within the cage are rotating -- both side gears are effectively locked to the cage.Animation courtesy Geebee's Vector AnimationsNote that the input pinion is a smaller gear than the ring gear; this is the last gear reduction in the car. You may have heard terms like rear axle ratio or final drive ratio. These refer to the gear ratio in the differential. If the final drive ratio is 4.10, then the ring gear has 4.10 times as many teeth as the input pinion gear. See How Gears Work for more information on gear ratios.When a car makes a turn, the wheels must spin at different speeds.Animation courtesy Geebee's Vector AnimationsIn the figure above, you can see that the pinions in the cage start to spin as the car begins to turn, allowing the wheels to move at different speeds. The inside wheel spins slower than the cage, while the outside wheel spins faster.Open Differential - Straight (600KB)Open Differential - Turning (1.1MB) VerifiedHint: We will first write the fact that every differentiable function is continuous and then see if the converse is true or not. We will then just try to disprove the statement using any example which doesn't follow the given rule.Complete step by step answer:We have the statement which is given to us in the question that: Every continuous function is differentiable.Since, we know that "every differentiable function is always continuous".We just now need to check if the converse is also true or not.Let us take the example of $f(x) = |x|$.If forms a pointed edge at x = 0.We will check its differentiability at 0 only.We know that a function is differentiable at c if $f'(c) = \mathop {\lim }\limits_{h \to 0} \dfrac{{f(c + h) - f(c)}}{h}$ exists.Let us check about $f(x) = |x|$ at x = 0.$ \Rightarrow f'(0) = \mathop {\lim }\limits_{h \to 0} \dfrac{{f(0 + h) - f(0)}}{h}$Now, putting in the function, we will get:-$ \Rightarrow f'(0) = \mathop {\lim }\limits_{h \to 0} \dfrac{{|0 + h| - |0|}}{h}$We can rewrite it as:$ \Rightarrow f'(0) = \mathop {\lim }\limits_{h \to 0} \dfrac{{|h|}}{h}$Now, it can be either equal to 1 or -1 depending on if h is approaching 0 from the right of the number line or left respectively. Therefore, the limits do not exist and thus the function is not differentiable.But we see that $f(x) = |x|$ is continuous because $\mathop {\lim }\limits_{x \to c} f(x) = \mathop {\lim }\limits_{x \to c} |x| = f(c)$ exists for all the possible values of c.Therefore, the given statement is false.Note: The students must note that "Every differentiable function is continuous". We use this fact in a lot of questions. So, let us prove this to know the reason behind it.Let us say we have a function f(x) which is differentiable at x = c.So, by using the definition of differentiability, we will get:-$f'(c) = \mathop {\lim }\limits_{x \to c} \dfrac{{f(x) - f(c)}}{{x - c}}$We can rewrite it as:$ \Rightarrow \mathop {\lim }\limits_{x \to c} f(x) - f(c) = \mathop {\lim }\limits_{x \to c} f'(c) \times (x - c)$Rewriting it again as follows:$ \Rightarrow \mathop {\lim }\limits_{x \to c} f(x) - f(c) = f'(c)\mathop {\lim }\limits_{x \to c} (x - c)$Simplifying the RHS, we will then obtain:-$ \Rightarrow \mathop {\lim }\limits_{x \to c} f(x) - f(c) = f'(c) \times 0$Simplifying the RHS further, we will then obtain:-$ \Rightarrow \mathop {\lim }\limits_{x \to c} f(x) - f(c) = 0$Therefore, we have:-$ \Rightarrow \mathop {\lim }\limits_{x \to c} f(x) = f(c)$Hence, the function is continuous at x = c.Therefore, it is proved that "Every differentiable function is continuous".Read LessBook your Free Demo session Have you ever wondered what makes a function differentiable? Jenn, Founder Calcworkshop®, 15+ Years Experience (Licensed & Certified Teacher) A function is formally considered differentiable if its derivative exists at each point in its domain, but what does this mean? It means that a function is differentiable everywhere its derivative is defined. So, as long as you can evaluate the derivative at every point on the curve, the function is differentiable. How To Determine Differentiability By using limits and continuity! The definition of differentiability is expressed as follows: f is differentiable on an open interval (a,b) if \(\lim _{h \rightarrow 0} \frac{f(c+h)-f(c)}{h}\) exists for every c in (a,b). f is differentiable, meaning \(f^{\prime}(c)\) exists, then f is continuous at c. Hence, differentiability is when the slope of the tangent line equals the limit of the function at a given point. This directly suggests that for a function to be differentiable, it must be continuous, and its derivative must be continuous as well. If we are told that \(\lim _{h \rightarrow 0} \frac{f(3+h)-f(3)}{h}\) fails to exist, then we can conclude that f(x) is not differentiable at x = 3 because it \(f^{\prime}(3)\) doesn't exist. Now, this leads us to some very important implications — all differentiable functions must therefore be continuous, but not all continuous functions are differentiable! What? Simply put, differentiable means the derivative exists at every point in its domain. Consequently, the only way for the derivative to exist is if the function also exists (i.e., is continuous) on its domain. Thus, a differentiable function is also a continuous function. But just because a function is continuous doesn't mean its derivative (i.e., slope of the line tangent) is defined everywhere in the domain. How so? For example, let's look at the graph \(f(x)=|x|\). We can easily observe that the absolute value graph is continuous as we can draw the graph without picking up your pencil. Absolute Value – Piecewise Function But we can also quickly see that the slope of the curve is different on the left as it is on the right. This suggests that the instantaneous rate of change is different at the vertex (i.e., x = 0). So, what do we do? We use one-sided limits and our definition of derivative to determine whether or not the slope on the left and right sides are equal. \begin{equation} \begin{array}{l} \lim _{h \rightarrow 0^{-}} \frac{f(x+h)-f(x)}{h}=\lim _{h \rightarrow 0^{-}} \frac{(-(x+h))-(-x)}{h}=\lim _{h \rightarrow 0^{-}} \frac{-x-h+x}{h} \lim _{h \rightarrow 0^{-}} \frac{-h}{\hbar}=\lim _{h \rightarrow 0^{-}}(-1)=-1 \\ \lim _{h \rightarrow 0^{+}} \frac{f(x+h)-f(x)}{h}=\lim _{h \rightarrow 0^{+}} \frac{((x+h))-(x)}{h}=\lim _{h \rightarrow 0^{+}} \frac{x+h-x}{h} \lim _{h \rightarrow 0^{+}} \frac{h}{h}=\lim _{h \rightarrow 0^{+}}(1)=1 \end{array} \end{equation} Photo Courtesy: [Breakingpic/Pexels] When you need to solve a math problem and want to make sure you have the right answer, a calculator can come in handy. Calculators are small computers that can perform a variety of calculations and can solve equations and problems. While there are more complicated calculators available, the simplest models perform four basic functions. They can help you solve most everyday math problems but won't be much help on an algebra exam.What a Four-Function Calculator Does A four-function calculator typically performs the four most basic operations of math. It can: Add Subtract Multiply Divide Depending on the complexity of the operation, a four-function calculator can be limiting. Since it might not be able to display many digits on its screen, it can be limited in terms of the size of numbers it can add. It's also not able to perform operations that would produce imaginary numbers. When You Can Use a Four-Function Calculator There are many instances in life when a four-function calculator can come in handy. You might find that you use one when creating your household budget, when measuring for furniture and deciding what will fit in your home or in a particular room, or when figuring out how to split a restaurant check with friends. If you're a student, there might be times when you are allowed to use a four-function calculator in class or on exams. Some standardized tests allow students to use simple calculators on certain parts of an exam. Students who have certain learning disabilities might be allowed to use a four-function calculator during exam sections that usually forbid the use of a calculator. Limitations of a Four-Function Calculator While a four-function calculator can perform basic addition, subtraction, division and multiplication, it can't perform more complex operations such as calculating logarithms or performing trigonometry. Usually, the display on a four-function calculator is small, allowing for a single line of numbers. Meanwhile, the displays on other types of calculators can be much larger, allowing you to input more complex equations or to display images and graphs. Additional Features You Might Find on a Four-Function Calculator The most basic of four-function calculators will let you perform the four basic mathematical operations. But some simple calculators have a few more bells and whistles. For example, it's not uncommon for a four-function calculator to also be able to calculate the square root of a number. Many models also have a "%" button that lets you work with percents, rather than inputting the number as a decimal. Other Types of Calculators If you only need a calculator for day-to-day, basic math problems, a four-function calculator will most likely meet your needs. You most likely won't even have to purchase a separate machine, as many cell or smartphones and computer operating systems include a simple calculator. But if you're taking an algebra course or are in a higher-level math course, you might be on the lookout for a calculator that can do a bit more than basic math. A scientific calculator is a device designed to perform mathematical, scientific and engineering functions. It usually has a memory setting and can store information about equations. A graphing calculator is even more complex and advanced than a scientific calculator. It usually has a relatively large screen, which allows it to display graphs and charts. Typically, a graphic calculator can come in handy if you're taking a math class such as calculus or are in a field that requires you to solve advanced equations regularly. MORE FROM REFERENCE.COM

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