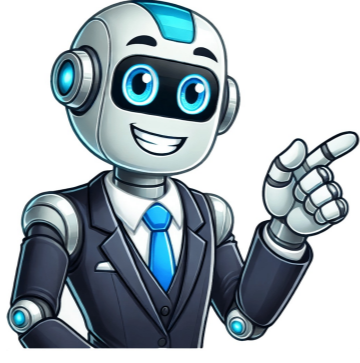


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Advice on how to cut costs with the same result without losing quality. Bridgewater Nova Scotia Canada Mateusz MuchaMateusz is a professional problem-solver with a lifelong passion for software development and numbers. In 2014, he launched Omni Calculator, a groundbreaking tool that allows him to accomplish his life mission: helping people make better decisions whenever calculations are needed. Today, Mateusz serves as the CEO of Omni Calculator, which attracts over 18 million visitors monthly. When he is not busy growing the business, he enjoys sports, with cycling being his favorite. See full profileCheck our editorial policy and Julia ZulańskaBogna Szyk and Jack Bowater433 people find this calculator helpfulOur Ohm's law calculator is a neat little tool to help you find the relationships between voltage, current and resistance across a given conductor. The Ohm's law formula and voltage formula are mainly used in electrical engineering and electronics. Also, if you know how to calculate power dissipation, you may find it very useful when studying electronic circuits. All of these calculations you can do with our Ohm Calculator. In the rest of the article you'll find: The Ohm's Law formula; How to use the voltage formula; What the equation for power is; How to calculate power; and Ohm's law for anisotropic materials. Prefer watching rather than reading? Check out our video lesson on resistors and Ohm's law here. Watch this on YouTube Ohm's Law is one of the basic laws of physics. It describes the relationship between voltage, amperage (otherwise known as current) and resistance. Voltage refers to the potential difference between two points in an electrical field. Amperage is related to the flow of electrical charge carriers, usually electrons or electron-deficient atoms. The last term, resistance, is the substance's opposition to the flow of an electric current. Ohm's law states that the current flows through a conductor at a rate that is proportional to the voltage between the ends of this conductor. In other words, the relationship between voltage and current is constant. $I \cdot V = \text{const}$ The Ohm's law formula can be used to calculate the resistance as the quotient of the voltage and current. It can be written as: $R = V / I$ Where: R - resistance in Volts - I - Current Resistance is expressed in ohms. Both the unit and the rule are named after Georg Ohm - the physicist and inventor of Ohm's law. Remember that the Ohm's law formula relates only to substances that are able to induce power, such as metals and ceramic. However, there are many other materials for which the Ohm's law formula cannot be used, such as semiconductors and insulators. Ohm's law is also only valid under certain conditions, like a fixed temperature. For details on current flow through a conductor in an AC circuit, check out our skin depth calculator. Looking for a real-life application of the Ohm's law? Make sure to check out the LED resistor calculator!The voltage formula is one of three mathematical equations related to Ohm's law. It is the formula provided in the previous paragraph but rewritten so that you can calculate voltage on the basis of current and resistance, that is the voltage formula is the product of current and resistance. The equation is: $V = I \times R$ This value is measured in volts. Another value you can calculate on the grounds of Ohm's law is power. Power is the product of voltage and current, so the equation is as follows: $P = V \times I$ With this formula you can calculate, for example, the power of a light bulb. If you know that the battery voltage is 18 V and current is 6 A, you can find that the wattage will be 108 W with the following calculation: $P = 6A \times 18V = 108 \text{ watts}$ If you are still not sure how to calculate power with the provided formulas, or simply want to save your time, you can use our Ohm's Law calculator. The structure of this tool is not too complicated, just input any two of the four values to receive the other two. The Ohm's law calculator is based on the power formula together with the Ohm's law formula. All you need to do to get the value you are looking for is to type: Voltage (expressed in volts) Current (expressed in amperes) Then the Ohm's Law Calculator will give you two values - resistance (expressed in ohms) and power (expressed in watts). If you need this result in another unit, you can use our watts to amps calculator. There is another version of Ohm's law that uses the position of electrical properties within the conductor. Some prefer it over the previous formula due to its dimensional view. Conductive materials comply with Ohm's law when the specific resistance of the materials does not depend on the value and direction of the applied electric field. You can find the following formula if you click on the Ohm's law for anisotropic materials: $\rho = E / J$, where ρ - Specific resistance of the conductive material (the wire resistance calculator may help you find the appropriate value for specific material); E - Electric field vector; and J - Current density vector. As far as isotropic materials go, it's best to use the first formula as it's much less complicated. Isotropic materials are those with the same electrical properties in all directions, such as metals and glass. This formula might come in handy when you work with anisotropic materials like wood or graphite.FAQsOhm's law gives the relation between the current flowing through a conductor and the potential difference applied across its ends. It states that the current is directly proportional to the potential difference.No, Ohm's law does not apply to semiconductors. According to Ohm's law, the relation between current and the applied voltage (also known as the V-I characteristic) is linear. However, the V-I characteristic of a semiconductor is non-linear.To calculate resistance using Ohm's law, follow the given instructions: Measure the voltage drop across the resistor using a voltmeter. Determine the current through the resistor using an ammeter. Divide the voltage drop by the current. Congrats! You have calculated the resistance using Ohm's law. To calculate the voltage drop across a resistor using Ohm's law, proceed as follows: Find out the resistance of the resistor. Measure the current through the resistor using an ammeter. Multiply the current by the resistance to get the voltage drop using Ohm's law. Check out 57 similar electronics and circuits calculators! Listen May 09, 2022 5 min read Understanding how to calculate the voltage drop across a resistor is fundamental to electronics. This seemingly simple calculation forms the backbone of circuit analysis and design. This comprehensive guide will delve into the theory behind voltage drop, explore different methods of calculation, and provide practical examples to solidify your understanding. We'll also cover troubleshooting scenarios and advanced considerations. Ohm's Law: The Foundation of Voltage Drop Calculation The cornerstone of calculating voltage drop across a resistor is Ohm's Law. This fundamental law of electricity states that the voltage (V) across a resistor is directly proportional to the current (I) flowing through it and its resistance (R). Mathematically, it's represented as: $V = I \times R$ Where: V is the voltage measured in Volts (V) I is the current measured in Amperes (A) R is the resistance measured in Ohms (Ω) This simple equation allows us to calculate any one of the three variables (V, I, or R) if we know the other two. For calculating voltage drop specifically, we need the current flowing through the resistor and the resistor's value. Understanding Voltage Drop Voltage drop isn't a loss of energy in the sense of disappearing; it's a transformation. As current flows through a resistor, the electrical energy is converted into other forms of energy, primarily heat (in most resistors). This conversion of energy manifests as a voltage drop across the resistor. The voltage at one end of the resistor will be higher than the voltage at the other end, representing the potential energy used up in this conversion process. Methods for Calculating Voltage Drop Let's explore different scenarios and the appropriate methods to calculate the voltage drop: 1. Direct Application of Ohm's Law (Series Circuit) In a simple series circuit, where only one resistor is present, the calculation is straightforward. Measure or determine the current flowing through the circuit (using an ammeter or by applying Kirchhoff's Current Law for more complex circuits) and the resistance of the resistor. Then, simply apply Ohm's Law: $V = I \times R$ Example: A 10 Ω resistor has a current of 2A flowing through it. The voltage drop across the resistor is: $V = 2A \times 10\Omega = 20V$ 2. Using Kirchhoff's Voltage Law (KVL) (Complex Circuits) In circuits with multiple resistors or other components, Ohm's Law alone might not be sufficient. Kirchhoff's Voltage Law (KVL) states that the sum of all voltage drops around a closed loop is equal to zero. This is crucial for analyzing complex circuits. Example: Consider a circuit with two resistors, R1 (10 Ω) and R2 (20 Ω), connected in series with a 12V battery. The total voltage drop across the resistors must equal the battery voltage: $V_{R1} + V_{R2} = 12V$. Calculate the total current: $I = V / R_{total} = 12V / 30\Omega = 0.4A$ (The current is the same throughout a series circuit). Calculate the voltage drop across each resistor: $V_{R1} = I \times R1 = 0.4A \times 10\Omega = 4V$ $V_{R2} = I \times R2 = 0.4A \times 20\Omega = 8V$ Verify KVL: $V_{R1} + V_{R2} = 4V + 8V = 12V$ (This equals the battery voltage, confirming KVL). 3. Using Voltage Dividers (for Series Circuits) In series circuits, the voltage divider rule provides a convenient shortcut for calculating the voltage drop across individual resistors: $V_R = (R / R_{total}) \times V_{total}$ Where: V_R is the voltage drop across a specific resistor (R) R is the resistance of the specific resistor. R_total is the total resistance of the circuit. V_total is the total voltage applied to the circuit. Using the previous example: Voltage drop across R1 (10 Ω): $V_{R1} = (10\Omega / 30\Omega) \times 12V = 4V$ Voltage drop across R2 (20 Ω): $V_{R2} = (20\Omega / 30\Omega) \times 12V = 8V$ This method simplifies calculations, especially in circuits with many resistors. 4. Using Circuit Simulation Software For very complex circuits, circuit simulation software (like LTSpice, Multisim, or Tina-TI) offers a powerful way to visualize and analyze voltage drops. These programs allow you to input the circuit schematic, define component values, and simulate the circuit's behavior, providing precise voltage readings at any point. Practical Applications and Troubleshooting Understanding voltage drop is essential in various applications: Power Supply Design: Ensuring adequate voltage reaches the load while accounting for voltage drops across wires and components. LED Circuits: Controlling the current (and thus brightness) of LEDs by carefully selecting resistors to ensure the appropriate voltage drop. Troubleshooting Faulty Circuits: Measuring voltage drops across components can help identify faulty or overloaded components. Signal Integrity: In high-speed digital circuits, minimizing voltage drops across connecting wires and traces is critical to maintain signal quality. Troubleshooting Low Voltage Issues: If you're experiencing unexpectedly low voltages at a load in a circuit, consider these possibilities: High Resistance in Wires: Long or thin wires can have significant resistance, leading to considerable voltage drops. Faulty Connections: Loose or corroded connections create high resistance, resulting in voltage drops. Overloaded Circuit: Drawing more current than the circuit can handle will increase the voltage drop across components and wires. Using a multimeter to measure voltage at various points in the circuit can pinpoint the location of the problem. Advanced Considerations: Temperature Effects: The resistance of many resistors changes with temperature. This can affect voltage drop calculations, especially in high-power circuits. Non-Linear Resistors: Some components (like diodes and transistors) exhibit non-linear resistance, making voltage drop calculations more complex. AC Circuits: In AC circuits, the impedance (a combination of resistance and reactance) replaces resistance in Ohm's Law, and calculations become more involved. Phasors and complex numbers are often used in analysis. Conclusion Calculating the voltage drop across a resistor is a fundamental skill for anyone working with electronics. While Ohm's Law forms the basis of these calculations, understanding Kirchhoff's laws and voltage divider principles is crucial for analyzing more complex circuits. Mastering these concepts and utilizing simulation software will empower you to design, troubleshoot, and optimize electronic circuits effectively. Remember that careful attention to detail and thorough understanding of the underlying principles are essential for accurate and reliable results. Regular practice with various circuit examples will enhance your skills and understanding. Understanding how to calculate voltage drop across a resistor is very fundamental for anyone who is into electronics or electrical engineering. In this step-by-step guide, we will break down the process, making it accessible and very simple even for beginners. By the end, you'll have a solid grasp of this crucial concept, enabling you to analyze, solve and design circuits with confidence. Before that let's brush up the concept of Ohm's law: A common way to show the behavior of a circuit device is its characteristic. This is a graph of the current "I" through the device as a function of applied voltage "V" across it. This device, the resistor, has the simple linear $V = I \times R$ characteristic shown in fig. above. This linear relationship of the device is expressed by Ohm's Law: $V = IR$ Here, the constant of proportionality R is known as the resistance of the device and is equal to the slope of the V-I characteristic. The unit of resistance is ohm, the symbol is Ω . Any device with a linear V-I characteristic could be treated as a resistive in nature. What is the voltage drop across a resistor? The voltage drop across a resistor is nothing but the voltage value across a resistor. Sometimes it is also called 'voltage over the resistor' or simply 'Voltage drop'. It is generally indicated as: $V(\text{drop})$ or ' V_r ' or ' V_d ' For multiple resistors, it is written as V_{r1} , V_{r2} , and so on. As we all know, a resistor is a device that offers resistance to the current flowing through it. Then, by applying Ohm's law, the resistor will offer a voltage drop across a resistive device and it is given as: $V(\text{drop}) = I \times R$ where, I = current through the resistor in (A) ampere R = resistance in (Ω) ohms $V(\text{drop}) =$ voltage drop in (V) volts How to calculate voltage drop over resistance step-wise : Step1: Simplify the given circuit. If the circuit is full of resistors in series and parallel, then rearrange the resistors to make it appear simple connections. (check the practical example below) Step2: Then, find the equivalent resistance. For parallel use this formula: $1 / Req = 1 / R1 + 1 / R2 \dots$ And for series use this: $Req = R1 + R2 + \dots$ Step3: Find the current through each resistor. (Current through the series resistor is same and current through the parallel resistors is different and depends on its value) Step4: Apply the formula from Ohm's law to calculate voltage drop. $V=IR$ One way is to check this link -> Voltage Drop Across Resistor Calculator online tool. There is also another way to find the voltage drop, simply you can calculate it by using Voltage Divider Formula The voltage across series circuit. Practical examples: Case I: If there is only one resistor in series with a battery or a power supply as shown in this circuit. In this circuit, the voltage drop across the resistor is the same as that of power supply. This is because both the components have common potential points shared between them (point A & point B) . $V_s = V_{drop} = 5 \text{ volts}$ (say) Case II: If there are two or more resistors in series with a battery as shown in this circuit. In this circuit, we have to calculate the total current "I" through the circuit. $I(\text{total}) = V(\text{supply}) / R(\text{equivalent})$. $I(\text{total}) = 5 / 30 = 0.166 \text{ A}$ Then, the Voltage drop across R1 will be: $V_{r1} = I \times R1$ The voltage drop across R2 will be: $V_{r2} = I \times R2$ Also, voltage drop across Rn will be: $V_{rn} = I \times Rn \rightarrow V_{r1} = I \times R1 = 0.166 \times 10 = 1.66 \text{ volts}$ & $V_{r2} = I \times R2 = 0.166 \times 20 = 3.33 \text{ volts}$ The voltage across parallel resistors: Case I: There are two resistors in parallel with a battery or a power supply as shown in this circuit. In this circuit, the voltage drop across these parallel resistors is the same as that of power supply. This is because both the resistors have common potential points shared between them (point A & point B), so the voltage will be the same but the current will be different. $V_s = V_{drop} = V_{r1} = V_{r2} = 5 \text{ volts}$ (say) Case II: There is one resistor in series and two resistors with a power supply as shown in this circuit. In this circuit, we need to calculate the current "I" through each component. $I1 = I(\text{total}) = Is = V(\text{supply}) / R(\text{equivalent})$ Here, $R(\text{equivalent}) = R1 + Rp$. Also, $1 / Rp = 1 / R2 + 1 / R3$. $Rp = 12\Omega$ & $R(\text{equivalent}) = 22\Omega$ $I2 = I1 = R3 / (R2+R3)$ $I3 = I1 \times (R2 / (R2+R3))$ The Voltage drop across R1 will be $V_{r1} = R1 \times I1$ A voltage drop across R2 will be $V_{r2} = I2 \times R2$ Voltage drop across R3 will be $V_{r3} = I3 \times R3$ Putting values we get, $\text{Total}, I1 = V / V(\text{supply}) / R(\text{equivalent}) = 5 / 22 = 0.227 \text{ amps}$. $I1 = 0.227 \text{ A}$ Voltage drop across 10 ohm $\rightarrow V_{r1} = 10 \times I1 = 10 \times 0.227 \text{ volts}$. $V_{r1} = 2.27 \text{ volts}$ Now, $I2 = I1 \times (R3 / (R1+R2))$. $I2 = 0.1362 \text{ A}$ Voltage drop across 20 ohm $\rightarrow V_{r2} = 20 \times I2 = 0.1362 \text{ volts}$. $V_{r2} = 2.724 \text{ volts}$ Now, $I3 = I1 \times (R2 / (R1+R2))$. $I3 = 0.09 \text{ A}$ Voltage drop across 30 ohm $\rightarrow V_{r2} = 30 \times I2 = 30 \times 0.09 \text{ volts}$. $V_{r3} = 2.7 \text{ volts}$ Method 2: Find $I1 = V(\text{supply}) / R(\text{equivalent}) = 0.227 \text{ A}$ Then, Voltage drop across R1 will be $V_{r1} = R1 \times I1 = (10 \times 0.227 = 2.27 \text{ volts}$. Equivalent voltage at point 'A' will be equals to $Veq = Va = Vs - V_{r1}$. $Va = 5 - 2.27 = 2.73 \text{ volts}$ Therefore, we get equal potential value across R2 & R3. Thus, $Va = V_{r2} = V_{r3} = 2.73 \text{ volts}$ Method 3: In this method, we use a digital mult-meter or you can say a voltmeter. All you need is to set the mult-meter to voltage mode. Now using its 2 probes check the voltage across the required resistor by connecting probes across it. (in fig. voltmeter reading is for indications only) Voila !! You got it. This is the easiest way to find a voltage drop across resistor in any circuit. Electrical circuits are paths that transmit electric current, and they generally consist of a power source (providing voltage to the system, fittingly measured in volts), wires that allow the current to flow, resistors that resist the current and expend voltage, and a switch to open and close the current flow. Sometimes, however, a drop in voltage can occur when there's not enough energy flowing through the circuit. In such cases, knowing how to calculate a voltage drop (loss of energy) across resistors can help you determine if a device isn't getting enough power to work properly. First, it's important to understand what Ohm's law is because it distinguishes the relationship between the current, resistance, and voltage of a circuit. This law is often represented by the equation " $V = IR$," where V stands for the voltage, I stands for the current measured in amperes (A), and R stands for the resistance measured in ohms (Ω). Now, you can start calculating voltage drop across resistors in a simple electrical series circuit. Let's say that you have a series circuit with a 30-volt battery and two resistors -- the first at 4 ohms and the second at 6 ohms. You need to determine the total resistance first, which just involves adding the two resistances to get 10 ohms. Next, you need to find the current with the Ohm's law equation. So, you'll need to divide the voltage (30 volts) by the total resistance (10 ohms), which gives you 3 amps. Finally, you can find the voltage drop by plugging in the current and resistance of each resistor into the Ohm's law equation, which gives you 12 volts for resistor one and 18 volts for resistor two. If you do the math correctly, the sum of the voltage drops will equal the total voltage. Still using Ohm's law, it's possible to calculate voltage drop and the potential voltage at points before, between, and after each resistor in a series circuit; it just requires a slightly different approach. Let's say that resistor one is 4 ohms and resistor two is 6 ohms. The first point of interest (A) before resistor one is 60 volts, the second point (B) between resistor one and two is 40 volts, and the potential at a third point (C) after resistor two is unknown. The voltage drop across resistor one is the difference between the potential at the surrounding points of interest. So, you would subtract point B from point A to get the voltage drop of 20 volts across resistor one. By dividing the first voltage drop (20 volts) by the resistor's value (4 ohms), which is 5 amps. Since the same current flows through resistor two, you can determine the voltage drop across the second resistor by multiplying its value (6 ohms) to the current (5 amps), which comes to 30 volts. On the other hand, the characteristics of a parallel circuit are different from a series circuit. The primary difference is that current flows through multiple paths and can vary while the voltage is the same for each path. Another difference, though, is that the voltage is applied equally across the multiple paths. Since each component receives the same voltage, it's much simpler to calculate the voltage drop across a resistor in a parallel circuit. Let's say that you have a 30-volt battery with three resistors on a parallel circuit. The voltage drop across each resistor will be 30 volts. Understanding how to calculate the voltage drop is part of the foundational knowledge for people interested in creating their own electronic circuits. Finding the voltage drop can be confusing as calculation methods can change depending on the circuit and the number of resistors within the circuit, which we will explain in this article. Before we jump in straight into how to calculate the voltage drop across resistors, we are going to look at basic knowledge useful not only for calculating the voltage drop across a resistor but also for developing any kind of electronic circuit. Talking about calculating the voltage drop across a resistor wouldn't make sense if we don't understand what is the voltage drop across a resistor. Let's take the following circuits in the image below to help provide more clarity. Understanding Voltage Drop Across a Resistor In the image above, you will see two circuits. The first circuit with only one resistor, and the second circuit with two resistors. When talking about the voltage drop across a resistor, we are referring to the voltage across a resistor, or the voltage once the current flow has gone through a resistor. If you haven't heard of Ohm's law before, we are going to take a quick stop to understand it. Ohm's law is a formula commonly taught to students of electronics and it helps calculate the relationship between the voltage, current, and resistance of a circuit. Ohm's law is best described by using a pyramid displaying the relationships between these three values: Ohm's Law Formula Ohm's law states that if there are two known values in a circuit, such as the current and the resistances, we can find the third value by multiplying the position of the values in the pyramid and doing a simple calculation. Formulas to calculate Voltage, Current, and Resistance using Ohm's Law In this way, we can have the following formulas: Resistance is equal to the voltage divided by the current/Total resistance is equal to the current times the resistance/voltageCurrent is equal to the voltage divided by the resistance value A series circuit is a circuit where the current flows in only one direction through each component. In the following example, notice how there is one path and how the current has to flow across the two resistances, R1 and R2. Example of a Series Circuit Series circuits have one principle which we will need to take into account when calculating the voltage drop across resistors: the current is the same through all of the components of the circuit. If we apply this concept to the previous circuit, that means the current will be the same after resistance R1 and resistance R2. Unfortunately, we don't know the current that flows in the whole circuit in our previous example. Do you remember the ohm's law formula we covered earlier? By rearranging the elements correctly from the ohm's law pyramid, we can calculate the current using the voltage of the series circuit divided by the resistance. $\text{Current} = \text{Voltage} / \text{Resistance}$ Formula to Calculate the Current using Ohm's Law We know the voltage (V1) of the circuit is 9V. However, we don't know the total resistance of the circuit, even though we know all the resistance values of all the resistors of a circuit. How do you determine the total resistance value of the series circuit? This leads us to another principle of series circuits: The total resistance of a circuit is equal to the sum of all the individual resistances. $\text{Total Resistance} = R1 + R2 + Rn$ Formula to Calculate Total Resistance in a Series Circuit That means we can do a simple math calculation to get the total resistance of the circuit: $\text{Resistance} = 220\Omega + 220\Omega$ $\text{Resistance} = 440\Omega$ Knowing the resistance and the voltage of the circuit, we can now calculate the current using ohm's law: $\text{Current} = 9V / 440\Omega$ $\text{Current} = 0.2A$ At this point, why we are calculating the current of the circuit when we are looking for the voltage drop across the resistors of the circuit. To calculate the voltage drop of a resistor in a series circuit, we are going to use ohm's law which states that the voltage is equal to the current times the resistance value. $\text{Voltage} = \text{Current} \times \text{Resistance}$ Formula to Calculate the Voltage using Ohm's Law We are going to see a few examples to calculate the voltage drop. However, before checking at some examples, there is another principle that serves as guide to determine if the calculations are correct: the total voltage of a series circuit is equal to the sum of all of the individual voltages. $\text{Total Voltage} = V1 + V2 + Vn$ Formula to Calculate Total Voltage in a Series Circuit In this first example, we are going to continue with the original diagram we have been using to explain what the series circuit is and its related principles. Example #1: Calculate voltage drop of each resistor in a series circuit Given the following values: Total Voltage = 9VResistance R1 = 220 Ω Resistance R2 = 220 Ω Current = 0.02A Find the voltage drop of resistor R1 and resistor R2. Solution Voltage for Resistor R1 = 0.02A x 220 Ω Voltage for Resistor R1 = 4.5V Since the resistance value of resistor R2 is the same, we can infer the voltage drop for resistor R2 is the same as the voltage drop calculated for resistor R1. Voltage for Resistor R2 = 0.02A x 220 Ω Voltage for Resistor R2 = 4.5V In case we need to verify the voltage drop across each resistor, we can take as a reference the principle of summing all the individual voltages of the circuit should be equal to the voltage of the series circuit. $\text{Total Voltage} = \text{Voltage R1} + \text{Voltage R2}$ Total Voltage = 9V $\text{Voltage R1} + \text{Voltage R2} = 220\Omega \times 0.02A + 220\Omega \times 0.02A = 4.5V + 4.5V$ Let's look at a much simpler series circuit example. Given the following values: Voltage = 12VResistance R1 = 330 Ω Example #2: Calculate voltage drop of each resistor in a series circuit Find the voltage drop across the resistor R1 and the current that flows across resistor R1. Solution In this case, we don't need to calculate the voltage across resistor R1 as the exercise is already telling us the voltage. By using the principle of summing all the individual voltages of the circuit should be equal to the voltage of the series circuit, we can infer that voltage of resistor R1 is 12V. $\text{Total Voltage} = \text{Voltage R1}$ $12V = 12V$ To calculate the current through the circuit, we are going to use Ohm's law: $\text{Current} = \text{Voltage} / \text{Resistance}$ Here, $R(\text{equivalent}) = R1 + Rp$. Also, $1 / Rp = 1 / R2 + 1 / R3$. $Rp = 12\Omega$ & $R(\text{equivalent}) = 22\Omega$ $I2 = I1 = R3 / (R2+R3)$ $I3 = I1 \times (R2 / (R2+R3))$ The Voltage drop across R1 will be $V_{r1} = R1 \times I1$ A voltage drop across R2 will be $V_{r2} = I2 \times R2$ Voltage drop across R3 will be $V_{r3} = I3 \times R3$ Putting values we get, $\text{Total}, I1 = V / V(\text{supply}) / R(\text{equivalent}) = 5 / 22 = 0.227 \text{ amps}$. $I1 = 0.227 \text{ A}$ Voltage drop across 10 ohm $\rightarrow V_{r1} = 10 \times I1 = 10 \times 0.227 \text{ volts}$. $V_{r1} = 2.27 \text{ volts}$ Now, $I2 = I1 \times (R3 / (R1+R2))$. $I2 = 0.1362 \text{ A}$ Voltage drop across 20 ohm $\rightarrow V_{r2} = 20 \times I2 = 0.1362 \text{ volts}$. $V_{r2} = 2.724 \text{ volts}$ Now, $I3 = I1 \times (R2 / (R1+R2))$. $I3 = 0.09 \text{ A}$ Voltage drop across 30 ohm $\rightarrow V_{r2} = 30 \times I2 = 30 \times 0.09 \text{ volts}$. $V_{r3} = 2.7 \text{ volts}$ Method 2: Find $I1 = V(\text{supply}) / R(\text{equivalent}) = 0.227 \text{ A}$ Then, Voltage drop across R1 will be $V_{r1} = R1 \times I1 = (10 \times 0.227 = 2.27 \text{ volts}$. 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Understanding Voltage Drop Across a Resistor In the image above, you will see two circuits. The first circuit with only one resistor, and the second circuit with two resistors. When talking about the voltage drop across a resistor, we are referring to the voltage across a resistor, or the voltage once the current flow has gone through a resistor. If you haven't heard of Ohm's law before, we are going to take a quick stop to understand it. Ohm's law is a formula commonly taught to students of electronics and it helps calculate the relationship between the voltage, current, and resistance of a circuit. Ohm's law is best described by using a pyramid displaying the relationships between these three values: Ohm's Law Formula Ohm's law states that if there are two known values in a circuit, such as the current and the resistances, we can find the third value by modifying the position of the values in the pyramid and doing a simple calculation. Formulas to calculate Voltage, Current, and Resistance using Ohm's Law In this way, we can have the following formulas: Resistance is equal to the voltage divided by the current/Total resistance is equal to the current times the resistance/voltageCurrent is equal to the voltage divided by the resistance value A series circuit is a circuit where the current flows in only one direction through each component. In the following example, notice how there is one path and how the current has to flow across the two resistances, R1 and R2. Example of a Series Circuit Series circuits have one principle which we will need to take into account when calculating the voltage drop across resistors: the current is the same through all of the components of the circuit. If we apply this concept to the previous circuit, that means the current will be the same after resistance R1 and resistance R2. Unfortunately, we don't know the current that flows in the whole circuit in our previous example. Do you remember the ohm's law formula we covered earlier? By rearranging the elements correctly from the ohm's law pyramid, we can calculate the current using the voltage of the series circuit divided by the resistance. $\text{Current} = \text{Voltage} / \text{Resistance}$ Formula to Calculate the Current using Ohm's Law We know the voltage (V1) of the circuit is 9V. However, we don't know the total resistance of the circuit, even though we know all the resistance values of all the resistors of a circuit. How do you determine the total resistance value of the series circuit? This leads us to another principle of series circuits: The total resistance of a circuit is equal to the sum of all the individual resistances. $\text{Total Resistance} = R1 + R2 + Rn$ Formula to Calculate Total Resistance in a Series Circuit That means we can do a simple math calculation to get the total resistance of the circuit: $\text{Resistance} = 220\Omega + 220\Omega$ $\text{Resistance} = 440\Omega$ Knowing the resistance and the voltage of the circuit, we can now calculate the current using ohm's law: $\text{Current} = 9V / 440\Omega$ $\text{Current} = 0.2A$ At this point, why we are calculating the current of the circuit when we are looking for the voltage drop across the resistors of the circuit. To calculate the voltage drop of a resistor in a series circuit, we are going to use ohm's law which states that the voltage is equal to the current times the resistance value. $\text{Voltage} = \text{Current} \times \text{Resistance}$ Formula to Calculate the Voltage using Ohm's Law We are going to see a few examples to calculate the voltage drop. However, before checking at some examples, there is another principle that serves as guide to determine if the calculations are correct: the total voltage of a series circuit is equal to the sum of all of the individual voltages. $\text{Total Voltage} = V1 + V2 + Vn$ Formula to Calculate Total Voltage in a Series Circuit In this first example, we are going to continue with the original diagram we have been using to explain what the series circuit is and its related principles. Example #1: Calculate voltage drop of each resistor in a series circuit Given the following values: Total Voltage = 9VResistance R1 = 220 Ω Resistance R2 = 220 Ω Current = 0.02A Find the voltage drop of resistor R1 and resistor R2. Solution Voltage for Resistor R1 = 0.02A x 220 Ω Voltage for Resistor R1 = 4.5V Since the resistance value of resistor R2 is the same, we can infer the voltage drop for resistor R2 is the same as the voltage drop calculated for resistor R1. Voltage for Resistor R2 = 0.02A x 220 Ω Voltage for Resistor R2 = 4.5V In case we need to verify the voltage drop across each resistor, we can take as a reference the principle of summing all the individual voltages of the circuit should be equal to the voltage of the series circuit. $\text{Total Voltage} = \text{Voltage R1} + \text{Voltage R2}$ Total Voltage = 9V $\text{Voltage R1} + \text{Voltage R2} = 220\Omega \times 0.02A + 220\Omega \times 0.02A = 4.5V + 4.5V$ Let's look at a much simpler series circuit example. Given the following values: Voltage = 12VResistance R1 = 330 Ω Example #2: Calculate voltage drop of each resistor in a series circuit Find the voltage drop across the resistor R1 and the current that flows across resistor R1. Solution In this case, we don't need to calculate the voltage across resistor R1 as the exercise is already telling us the voltage. By using the principle of summing all the individual voltages of the circuit should be equal to the voltage of the series circuit, we can infer that voltage of resistor R1 is 12V. $\text{Total Voltage} = \text{Voltage R1}$ $12V = 12V$ To calculate the current through the circuit, we are going to use Ohm's law: $\text{Current} = \text{Voltage} / \text{Resistance}$ Here, $R(\text{equivalent}) = R1 + Rp$. Also, $1 / Rp = 1 / R2 + 1 / R3$. $Rp = 12\Omega$ & $R(\text{equivalent}) = 22\Omega$ $I2 = I1 = R3 / (R2+R3)$ $I3 = I1 \times (R2 / (R2+R3))$ The Voltage drop across R1 will be $V_{r1} = R1 \times I1$ A voltage drop across R2 will be $V_{r2} = I2 \times R2$ Voltage drop across R3 will be $V_{r3} = I3 \times R3$ Putting values we get, $\text{Total}, I1 = V / V(\text{supply}) / R(\text{equivalent}) = 5 / 22 = 0.227 \text{ amps}$. $I1 = 0.227 \text{ A}$ Voltage drop across 10 ohm $\rightarrow V_{r1} = 10 \times I1 = 10 \times 0.227 \text{ volts}$. $V_{r1} = 2.27 \text{ volts}$ Now, $I2 = I1 \times (R3 / (R1+R2))$. $I2 = 0.1362 \text{ A}$ Voltage drop across 20 ohm $\rightarrow V_{r2} = 20 \times I2 = 0.1362 \text{ volts}$. $V_{r2} = 2.724 \text{ volts}$ Now, $I3 = I1 \times (R2 / (R1+R2))$. $I3 = 0.09 \text{ A}$ Voltage drop across 30 ohm $\rightarrow V_{r2} = 30 \times I2 = 30 \times 0.09 \text{ volts}$. $V_{r3} = 2.7 \text{ volts}$ Method 2: Find $I1 = V(\text{supply}) / R(\text{equivalent}) = 0.227 \text{ A}$ Then, Voltage drop across R1 will be $V_{r1} = R1 \times I1 = (10 \times 0.227 = 2.27 \text{ volts}$. 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