# Types of circuits and ohm's law worksheet answer key

At the end of this section, you will be able to: Explain the origin of Ohm's law. Calculate tensions, currents or resistances with Ohm's law. Explain what an ohmic material is. Describe a simple circuit. What motivates the current? We can think of various devices, such as batteries, generators, wall sockets, and so on - that are needed to maintain a current. All of these devices create a potential difference and are loosely referred to as voltage sources. When a voltage source is connected to a conductor, it applies a potential V difference that creates an electric field. The electric field in turn exerts a force on the charges, causing the current. The current that passes through most substances is directly proportional to the V voltage applied to it. The German physicist Georg Simon Ohm (1787-1854) was the first to demonstrate experimentally that the current of a wire is directly proportional to the applied voltage: [latex]I-propto-V-[/latex]. This important relationship is known as Ohm's Law. It can be considered a cause-and-effect relationship, with the tension of the cause and the current of the effect. It is an empirical law such as friction, a phenomenon observed experimentally. Such a linear relationship does not always occur. Resistance and simple circuits If tension feeds the current, what prevents it? The electrical property that interferes with the current (roughly similar to friction and air resistance) is called resistance R. Collisions of moving loads with atoms and molecules in a substance transfer energy to the substance and limit the current. Resistance is defined as inversely proportional to the current, or [latex]I-propto 'frac{1}'s 'R'[/latex]. So, for example, the current is cut in half if the resistance doubles. The combination of the relationship of the current to the voltage and the current to the resistance gives [latex]I-frac-V-R-[/latex]. This relationship is also called ohm's law. Ohm's law in this form really defines resistance for certain materials. Ohm's law (like Hooke's law) is not universally valid. The many substances for which Ohm's law is valid are called ohmic. These include good conductors such as copper and aluminum, and some poor conductors in certain circumstances. Ohmic materials have an R-strength that is independent of V voltage and current I. An object that has simple resistance is called resistance, even if its resistance is weak. The unit for resistance is an ohm and is given the symbol Ω (Greek omega majus below). Reorganization I - V/R gives R - V/I, and therefore the resistance units are 1 ohm - 1 volt per amp: 'Omega'. Figure 1 shows the diagram of a single circuit. A single circuit has a single source of tension and a single resistance. It can be assumed that the wires connecting the voltage source to the resistance have negligible resistance or that their resistance can be included in Figure R. 1. A simple electrical circuit that a closed path for the current to flow is provided by conductors (usually wires) connecting a charge to the terminals of a battery, represented by the red parallel lines. The zigzag symbol represents unique resistance and includes any resistance in the connections to the voltage source. How strong is an automobile headlight through which 2.50 A circulates when 12.0V is applied to it? Strategy We can reorganize Ohm's law as indicated by I V/R and use it to find resistance. Rearrangement of the solution I - V/R and substitution of known values gives [latex] R-frac-V-I-frac-text{12}-text.{4} This is a relatively low resistance, but it is greater than the cold resistance of the lighthouse. As we will see in resistance and resistance, resistance generally increases with temperature, and therefore the bulb has a lower resistance when it is turned on for the first time and will draw much more current during its brief warm-up period. Resistance varies on many orders of magnitude. Some ceramic insulators, such as those used to support power lines, have resistances of 1012 Ω or more. A dry person may have a hand-to-foot resistance of 105 Ω, while the resistance of the human heart is about 103 Ω. A one-metre-long piece of large diameter copper wire can have a resistance of 10-5 Ω, and superconductors have no resistance at all (they are not ohmic). Resistance is linked to the shape of an object and the matter it is composed of, as seen in resistance and resistance. An additional insight is gained by solving I-V/R for V, giving V-IR This expression for V can be interpreted as the voltage drop through resistance produced by the flow of current I. The term IR drop is often used for this voltage. For example, the lighthouse in example 1 above has an ir drop of 12.0 V. If the voltage is measured at different points in a circuit, it is seen increase at the source of voltage and decrease in resistance. The voltage is similar to the pressure of the fluid. The voltage source is like a pump, creating a pressure difference, causing the current — the charge flow. Resistance is like a pipe that reduces pressure and limits flow because of its strength. Energy conservation has important consequences here. The voltage source provides energy (causing an electric field and current), and resistance converts it into another form (such as thermal energy). In a single circuit (one with only one simple resistance), the voltage provided by the source is equivalent to the drop of through the resistance, since PE - q-V, and the same q flows through each. Thus, the energy provided by the voltage source and the energy converted by resistance are equal. (See Figure 2.) Figure 2. The voltage drop through resistance in a single circuit is equivalent to the output of the battery voltage. In one electrical circuit, the only resistance converts the energy provided by the source into another form. Energy conservation is demonstrated here by the fact that all the energy provided by the source is converted into another form by resistance alone. We will find that energy conservation has other important applications in circuits and is a powerful tool in circuit analysis. See how the equation form of Ohm's law relates to a simple circuit. Adjust tension and resistance, and see the current change according to Ohm's law. The sizes of the symbols in the equation change to match the circuit diagram. Click to run the simulation. A single circuit is a circuit in which there is a single source of tension and a single resistance. A statement of Ohm's law gives the relationship between current I, voltage V, and R resistance in a single circuit to be [latex]I-frac-V-R-[/latex]. Resistance has units of ohms (Ω), linked to volts and amps of 1 Ω - 1 V/A. There is a voltage or fall of IR through resistance, caused by the current flowing through it, given by V-IR. The ir fall through resistance means that there is a change in potential or tension through resistance. Is there a change in current as it goes through resistance? Explain. How does the IR fall into a resistance similar to the drop in pressure in a fluid that flows through a pipe? 1. What current flows through the bulb of a 3.00 V flashlight when its hot resistance is 3.60 Ω? 2. Calculate the actual strength of a pocket calculator that has a 1.35 V battery and through which 0.200 mA flows. 3. What is the effective resistance of a car's starter engine when 150 A flows through it as the car's battery applies 11.0 V to the engine? 4. How many volts are provided to operate an indicator light on a DVD player that has a resistance of 140 Ω, given that 25.0 mA passes through it? 5. a) Find the voltage drop in an extension cord with a resistance of 0.0600 Ω and through which 5.00 A flows. b) A cheaper cord uses a thinner wire and has a resistance of 0.300 Ω. What is the voltage drop in it when 5.00 A sinks? c) Why is the voltage of any device used reduced by this amount? What is the effect on the device? 6. An energy transmission line is suspended from the metal towers with glass insulation with a resistance of 1.00×109 Ω. What current passes through the insulator if the voltage is 200 kV? (Some high voltage lines are DC.) Ohm's Law: an empirical relationship indicating that current I is proportional to the potential difference V, ∝ V; it is often such as I - V/R, where R is resistance: the electrical property that hinders the current; for ohmic materials, it's the voltage/current ratio, R-V/I ohm: the resistance unit, given by 1 -1 V/A ohmic: a type of material for which Ohm's law is valid simple circuit: a circuit with a single voltage voltage and only one resistance 1. 0.833 A 3. $7.33 \times 10^{-2}$ Ω 5. a) 0.300 V (b) 1.50 V (c) The voltage provided to any device used is reduced because the total voltage drop from the wall at the final exit of the device is fixed. Thus, if the voltage drop on the extension cord is significant, the voltage drop through the device is greatly decreased, so that the power of the device can be greatly reduced, thus reducing the ability of the device to function properly. A modern method of power control is to insert a fast-working switch in line with an electrical charge, to turn the power on and off very quickly over time. Usually, a solid-state device such as a transistor is used: this circuit has been greatly simplified compared to that of a real pulse control power circuit. Just the transistor is shown (not the pulse circuit that is needed to control it to turn it on and off) for simplicity. All you need to know is that the transistor works like a simple single-throw switch (SPST), except that it is controlled by an electrical current rather than a mechanical force, and is capable of turning on and off millions of times per second without wear or fatigue. If the transistor is pulsed on and off fast enough, the power of the bulb can be changed as well as if it is controlled by variable resistance. However, there is very little energy wasted when using a fast-switching transistor to control electrical energy, unlike when variable resistance is used for the same task. This power control mode is commonly referred to as pulse width modulation, or PWM. Explain why PWM power control is much more effective than controlling charge power using standard resistance. Resistance.