Physics You Learned

Physics Concepts	Is There an Equation?
A closed circuit is required in order for electricity to flow. A closed circuit consists of a continuous loop that allows electricity to leave and return to the source without reversing direction.	
When an electric source, such as a generator, provides current to a circuit, work is being done.	
There are two types of **electric charge**—positive and negative, which are equal in magnitude. **Protons** carry the positive charge, while **electrons** carry the negative charge.	
A unit of charge is a **coulomb**, and is equal to 6.25×10^{18} electrons.	
The **current** (I) in any given point of a circuit equals the charge flowing past that point per second. When one coulomb of charge flows past the point each second, the current is one **ampere** (A).	
One **volt** equals one **joule** of energy for each coulomb of charge delivered a load in an electric circuit. Another term for **voltage** is potential difference.	
A **series circuit** consists of only one conducting path and all the current passes through each element in the circuit. The total current (I_T) provided by the battery is equal to the current ($I_1, I_2, \ldots$) in the elements in the circuit.	$I_T = I_1 = I_2 = I_3$
In a series circuit, the total voltage (V_T) equals the sum of the voltage drops around the circuit ($V_1, V_2, \ldots$). The battery voltage is shared among the elements in the circuit.	$V_T = V_1 + V_2 + V_3$
A **parallel circuit** consists of multiple current paths and the current provided by the battery is shared among them. The total current (I_T) is equal to the sum of the currents in the branches ($I_1, I_2, \ldots$).	$I_T = I_1 + I_2 + I_3$
In a parallel circuit, the total voltage (V_T) is the same in all circuit branches connected in parallel.	$V_T = V_1 = V_2 = V_3$
The total current entering a junction in an electric circuit must equal the total current leaving the junction.	
Ohm's law states that the current in a circuit element (I) equals the voltage (V) across a circuit element divided by the element's resistance (R). Resistance is measured in **ohms** (Ω).	$I = \frac{V}{R}$
Electric power (P) supplied to a circuit element equals the product of the circuit current (I) times the voltage (V) across the circuit element. **Power** is measured in **watts** (W).	$P = VI$
In a properly operating circuit, when the circuit power exceeds the designed load limit, a **fuse** or **circuit breaker** will operate to interrupt the current flow.	
Active Physics Plus — Electric power (P) equals the voltage squared (V^2) divided by the resistance (R), or the current squared (I^2) times the resistance. Both these relationships hold true for each element in a circuit.	$P = \frac{V^2}{R}$ $P = I^2R$

An open switch will stop the flow of current in a circuit element when it is placed in series with that element.	
When measuring voltage in a circuit element, the voltmeter is always connected in parallel with that element.	
When measuring current in a circuit element, the ammeter is always placed in series with that circuit element.	
In a series circuit, the total resistance (R_T) for **resistors** connected in series is equal to the sum of the individual resistances $(R_1, R_2, \ldots)$. The more resistors added in series, the higher the total circuit resistance and the lower the total circuit current for a fixed voltage.	$R_T = R_1 + R_2 + R_3$
In a parallel circuit, the inverse of the total resistance $\left(\frac{1}{R_T}\right)$ is equal to the sum of the inverses of the individual resistances $\left(\frac{1}{R_1}, \frac{1}{R_2}, \ldots\right)$. The more resistors added in parallel, the lower the total circuit resistance and the higher the total circuit current for a fixed voltage.	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
The **heat** gained (Q_{gained}) by one object in a closed system is equal to the heat lost (Q_{lost}) by another object in a closed system. The **law of conservation of energy** states that for a closed system, no energy is lost or gained.	$Q_{gained} = Q_{lost}$
The **specific heat** of a material (c) is a measure of the amount of heat which must be added per gram to increase the temperature by one degree.	
The amount of heat gained or lost (ΔQ) by an object is equal to its mass (m) times its specific heat (c) times its change in temperature (ΔT).	$\Delta Q = mc\Delta T$
Temperature is a measure of the average random kinetic energy of a material's molecules.	
The **first law of thermodynamics** states that heat added to a system (ΔQ) is equal to the increase in the internal energy (ΔU) of the system plus any work (W) done by the system. When heat is added, it increases the system's temperature, does work, or both.	$\Delta Q = \Delta U + W$
The **second law of thermodynamics** states that systems naturally move toward increasing **entropy**, or greater disorder. The flow of time in the universe is in the direction of increasing entropy.	
Efficiency equals the useful energy output divided by the total energy input. Efficiency is a measure of how much useful output energy is obtained from the input energy required to make a system operate.	Efficiency = $\frac{\text{useful energy output}}{\text{total energy input}}$
Electric energy (E) equals electric power (P) multiplied by the operating time (t). Electric energy is measured in kilowatt-hours (kWh). One kilowatt hour is equal to 3,600,000 joules (J).	$E = Pt$ $E = (VI)t$
Heat may be transferred through three processes – convection, conduction and radiation. **Convection** transfers heat to surrounding molecules by flow in fluids. **Conduction** transfers heat through direct contact and **radiation** transfers heat via electromagnetic waves. Radiation does not require a medium for transmission and therefore can occur in a vacuum.	