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Electrical energy is an important concept in science, yet one that is frequently misunderstood. What exactly is electrical energy, and what are some of the rules applied when using it in calculations? Electrical energy is a form of energy resulting from the flow of electric charge. Energy is the ability to do work or apply force to move an object. In the case of electrical energy, the force is electrical attraction or repulsion between charged particles. Electrical energy may be either potential energy or kinetic energy, but it's usually encountered as potential energy, which is energy stored due to the relative positions of charged particles or electric fields. The movement of charged particles through a wire or other medium is called current or electricity. There is also static electricity, which results from an imbalance or separation of the positive and negative charges on an object. Static electricity is a form of electrical potential energy. If sufficient charge builds up, the electrical energy may be discharged to form a spark (or even lightning), which has electrical kinetic energy. By convention, the direction of an electric field is always shown pointing in the direction a positive particle would move if it was placed in the field. This is important to remember when working with electrical energy because the most common current carrier is an electron, which moves in the opposite direction compared with a proton. The British scientist Michael Faraday discovered a means of generating electricity as early as the 1820s. He moved a loop or disc of conductive metal between the poles of a magnet. The basic principle is that electrons in copper wire are free to move. Each electron carries a negative electrical charge. Its movement is governed by attractive forces between the electron and positive charges (such as protons and positively-charged ions) and repulsive forces between the electron and like-charges (such as other electrons and negatively-charged ions). In other words, the electric field surrounding a charged particle (an electron, in this case) exerts a force on other charged particles, causing it to move and thus do work. Force must be applied to move two attracted charged particles away from each other. Any charged particles may be involved in producing electrical energy, including electrons, protons, atomic nuclei, cations (positively-charged ions), anions (negatively-charged ions), positrons (antimatter equivalent to electrons), and so on. Electrical energy used for electric power, such as wall current used to power a light bulb or computer, is energy that is converted from electric potential energy. This potential energy is converted into another type of energy (heat, light, mechanical energy, etc). For a power utility, the motion of electrons in a wire produces the current and electric potential. A battery is another source of electrical energy, except the electrical charges may be ions in a solution rather than electrons in a metal. Biological systems also use electrical energy. For example, hydrogen ions, electrons, or metal ions may be more concentrated on one side of a membrane than the other, setting up an electrical potential that can be used to transmit nerve impulses, move muscles, and transport materials. Specific examples of electrical energy include: The SI unit of potential difference or voltage is the volt (V). This is the potential difference between two points on a conductor carrying 1 ampere of current with the power of 1 watt. However, several units are found in electricity, including: Unit Symbol Quantity Volt V Potential difference, voltage (V), electromotive force (E) Ampere (amp) A Electric current (I) Ohm Ω Resistance (R) Watt W Electric power (P) Farad F Capacitance (C) Henry H Inductance (L) Coulomb C Electric charge (Q) Joule J Energy (E) Kilowatt-hour kWh Energy (E) Hertz Hz Frequency f) Always remember, a moving charged particle, whether it be a proton, electron, or ion, generates a magnetic field. Similarly, changing a magnetic field induces an electric current in a conductor (e.g., a wire). Thus, scientists who study electricity typically refer to it as electromagnetism because electricity and magnetism are connected to each other. Electricity is defined as the type of energy produced by a moving electrical charge.Electricity is always associated with magnetism.The direction of the current is the direction a positive charge would move if placed in the electrical field. This is opposite to the flow of electrons, the most common current carrier. In a nation recognized for its obsession with efficiency, it's no surprise that Germany is jumpstarting the rise of an aggressively energy-efficient trend in home building: "passive houses." In a recent New York Times article, part of the paper's The Energy Challenge series, readers are welcomed into the ordinary looking Kaufmann home in Darmstadt, Germany, on a cold and bleak day. Inside, there is no furnace burning (there's actually no furnace at all) and the Kaufmann clan is dressed comfortably sans sweaters and heavy wool socks. What's going on here? A Teutonic variation of the Twilight Zone about pod people desensitized to the cold? Not quite. The Kaufmann's live in one of 15,000 passive houses existing around the world, most of them in Europe (one of the first in the US is being completed in Berkeley, California). So what exactly is a passive house? It's a building -- modest in size -- that's been built to recycle heat. A passive house is constructed with innovative doors, windows, and insulation that prevent cold air from coming in and heat from going out. There are usually no heating systems (there's an emergency generator in chez Kaufmann). I mentioned the word pod earlier. A passive house isn't too dissimilar to one: The home's heat is generated primarily from the sun but also from the use of household appliances and from the bodies of those living inside of it. A bit strange, I know, and also an idea that strikes me as a bit stinky (not too mention stuffy). What happens to all the smells produced in an airtight home? Can a window in a hermetically sealed room be cracked after a garlicky dinner followed by cigar smoking? To eliminate stagnant air, passive houses feature progressive central ventilation systems: warm air going out passes side by side with clean cold air coming in. The cold air and hot air exchange heat with 90 percent efficiency. And, of course, windows can still be opened. These extremely energy-efficient and increasingly popular houses (at least in Germany, home to the Passivhaus Institut) are also affordable to build, their construction not costing much more than a "normal" home. Passive houses cannot be constructed just anywhere -- like an area with little sunlight and extreme hot and cold -- since they require collaboration between the sun, the climate, and the building itself. And due to their compact, airtight design, passive houses cannot be rambling mansions with square footage equivalent to a city block. And since all good German design eventually makes its way overseas, an interest in passive houses is growing in the US. However, setbacks in technology and cost could keep this movement slow moving. There's also probable resistance from those who may find a home with completely uniform air and temperature a bit disorienting (I'm one of them). I'll continue to track this innovative green building movement as it develops stateside. Can't say I'd love call a passive house home as I enjoy the shock of a cold room during the wintertime every so often. However, the shock of an outrageous heating bill in January is something I could definitely live without. Via [The NY Times] Media Platforms Design Team1. "If only I weren't so tired." It's hard to believe when you're reaching for the remote after an exhausting day, but exercise will actually energize you. "You just need to take that first step out the door," says exercise psychology professor John M. Noble, Ph.D., of the University of Nebraska at Omaha. Tell yourself that you can quit in 10 minutes if you really feel too drained to keep going. Chances are, you'll continue. And, you'll begin to notice results after just a few sessions. In a 2008 University of Georgia study of healthy but fatigued adults, exercising three times a week for six weeks significantly improved subjects' energy levels. And those doing low-intensity exercise, like walking, saw the most benefits.2. "I'm way too busy." Driving to the gym, changing your clothes, the actual workout, showering, driving home...who has the time? "Challenge the idea that you need to exercise in a gym," says Felicia Stoler, a doctor of clinical nutrition. Start with 15-minute chunks — say, a pre-breakfast dumbbell session, a lunchtime walk, and a post-dinner neighborhood lap with the family. These will add up — and show that if you commit to being fit, you can find time.3. "I don't feel comfortable around strangers." If the prospect of complicated workouts makes you anxious, rethink your plan, says Texas Tech University sports and exercise psychology professor Marc Lochbaum, Ph.D. His three-pronged approach: familiar movements (walking, crunches, or even aerobics videos), a friendly environment (in your home or neighborhood), and "your most nonjudgmental girlfriend to work out with." Later, if you want to conquer the gym, try a community center or Y, says nutrition and fitness expert Pamela M. Peeke, M.D. "They're less likely to have that 'gym-rat' feel. Start with one piece of equipment, and work from there."4. "It's just not fun." You might be underestimating how much you'll enjoy physical activity. Researchers at the University of British Columbia found that when people think about exercising, they tend to focus on the (generally unpleasant) first few minutes — and therefore dread starting. But after an hour-long workout, participants rate it positively. "So, find a happier way to warm up, like starting your playlist with your favorite songs," suggests lead author Matthew B. Ruby. "And think about enjoyable moves that will be coming up, as well as how good you feel after a session."NEXT: The Ultimate List of Reasons Why You Should Be Exercising »

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