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By Maham Liaqat & Fiza Rafique Updated on March 15, 2024"Electronic" relates to devices or systems using electrical components to function, while "electronical" is an uncommon and often incorrect variation of "electronic.""Electronic" refers to technology and devices that operate through the controlled flow of electrons in circuits, such as computers, smartphones, and digital watches. These devices utilize components like transistors, diodes, and integrated circuits to perform a wide range of functions, from simple calculations to complex data processing. On the other hand, "electronical" is an outdated or less standard variant of "electronic," rarely used in contemporary language.Electronic devices are integral to modern life, influencing communication, entertainment, healthcare, and more. They rely on electronic principles to manipulate and store information, making tasks faster and more efficient. In contrast, the term "electronical" does not find a specific application today and is mostly encountered in older texts or in non-standard English usage, where it might have once served a similar descriptive purpose as "electronic."The development and innovation in the field of electronics have led to the miniaturization of devices and the expansion of their capabilities, showcasing the rapid evolution of technology. Meanwhile, the rarity of "electronical" highlights the dynamic nature of language and terminology, especially in rapidly advancing fields like technology, where clarity and precision are paramount.In education and industry, "electronic" is the universally accepted term, used in academic programs, professional titles, and industry standards. The decline in the use of "electronical" reflects a natural linguistic preference for simpler, more streamlined terms, especially in technical and scientific discourse.Pertaining to devices or systems using electronic components to perform their functions.An outdated or less common form of "electronic," rarely used in modern language.Widely used in modern English to describe anything related to electronics.Rarely used, considered archaic or non-standard.Applied in a vast array of fields, including computing, telecommunications, and consumer electronics.Lacks a specific context in contemporary usage due to its rarity.Central to discussions on modern technology and innovation.Lacks relevance in current technological discourse.Reflects the current, standardized terminology in technology and electronics.Demonstrates the evolution and streamlining of language in technical fields.Relating to devices or systems that operate using the controlled flow of electrons.Electronic gadgets like smartphones have become essential in daily life.An older or less standard term that was used to describe electronic principles or devices.In early texts, electronical devices were mentioned, which today we simply call electronic.Involving circuits or devices characterized by their use of semiconductor components.Electronic engineering is a field that focuses on the design and application of such circuits.Reflecting historical usage in the context of electrical engineering or electronics.Electronical engineering might appear in historical documents but is now known as electronic engineering.Pertaining to music produced or manipulated by electronic instruments.Electronic music genres have gained popularity due to their innovative sounds.Found in older literature or documents before "electronic" became the standard.Electronical components are mentioned in texts predating the widespread adoption of modern electronics terminology.Referring to the control or transmission of information using electronic systems.Electronic communication has revolutionized how we share information globally.Can be seen in poetic or creative writing to evoke a historical or archaic tone.The novel set in the early 20th century described the fascination with electronical wonders of the time.Involving or using devices that operate on the principles of electronics.The electronic voting system improved the efficiency and accuracy of the election process.Occasionally used in non-standard English or in specific jargon.Some hobbyist forums might still use electronical to add a vintage or stylistic flair.(of a device) having or operating with components such as microchips and transistors that control and direct electric currentsCarried out or accessed by means of a computer or other electronic device, especially over a networkThe electronic edition of the newspaperOf or relating to electrons.Of, based on, operated by, or otherwise involving the controlled conduction of electrons or other charge carriers.Of, relating to, or produced by means of electronicsOf or relating to music produced or altered by electronic means, as by a tape recorder or synthesizer.Of, implemented on, or controlled by a computer or computer network.Of or pertaining to an electron or electrons.Operating on the physical behavior of electrons, especially in semiconductors.Generated by an electronic device.Of or pertaining to the Internet.Of or pertaining to an electron or electrons; as, electronic energy.Using the methods or principles of electronics as part of the working mechanism; - of devices; as, electronic circuit; electronic devices; electronic entertainment devices.Using computerized storage or transmission of information; as, electronic banking; electronic mail; electronic fund transfer.Of or pertaining to electronics.Of or relating to electronics; concerned with or using devices that operate on principles governing the behavior of electrons;Of or concerned with electrons;Language evolves, and "electronical" has been largely replaced by "electronic" for simplicity and standardization, particularly in technical fields.While "electronical" might have been used historically, it is now considered outdated or non-standard, with "electronic" being the preferred term.Examples include laptops, digital cameras, and e-readers, which rely on electronic principles to operate."Electronic" pertains to devices or systems that function through the controlled movement of electrons, such as computers and smartphones.Yes, "electronic" music refers to a genre where sound is produced or modified through electronic means, often using synthesizers and computers.It's best to use "electronic" in formal and professional contexts due to its standardized and widely accepted usage.Fields like electronic engineering, consumer electronics, and information technology are closely associated with electronic principles and devices."Electronical" might appear in historical texts, specific jargons, or stylistic writing, but it's rare in contemporary usage."Electronic" is central to describing the function and innovation in current technology, from consumer gadgets to complex computing systems.Yes, "electrical" generally refers to systems or devices involving electricity, while "electronic" specifically involves the use of semiconductor devices and circuits.The term "electronic" has expanded with technological advancements, now encompassing a wide range of digital and computer-based technologies.As electronics evolve, the scope of "electronic" broadens to include new devices, applications, and technologies, reflecting ongoing innovation.Electronic devices have transformed communication, entertainment, work, and healthcare, making many tasks more efficient and accessible.Standardization ensures clarity and consistency, particularly in technical and scientific communication, facilitating better understanding and innovation.Fluctuant vs. FluctuationStogie vs. Cigar Fiza RafiqueFiza Rafique is a skilled content writer at AskDifference.com, where she meticulously refines and enhances written pieces. Drawing from her vast editorial expertise, Fiza ensures clarity, accuracy, and precision in every article. Passionate about language, she continually seeks to elevate the quality of content for readers worldwide. Unveiling the Wonders of Basic Electronics: A Beginners Guide Electronics today has become an integral part of our everyday lives. From smartphones and laptops to consumer electronics and transportation systems, basic electronics play a crucial role. This beginners guide will set you on the path to understanding this fascinating field. What is Electronics?Electronics is the study of electrical circuits consisting of active electrical components such as transistors, diodes, integrated circuits (IC), vacuum tubes, silicon-controlled rectifiers (SCRs). These components manipulate the flow of electrical current (electrons) to perform specific functions. History of Electronics Dates back to 1745 with Invention of the Leyden Jar by Pieter van Musschenbroek, a physicist and mathematician in Leiden, Netherlands. It followed by identification of electron in 1897 and then invention of the vacuum tube.In this chapter you can study in detail: Electronics DefinitionGlossary of Electronic TermsBefore you learn Basic Electronics, you must understand some of the common terms used in this field along with their meaning. #TermMeaning1.AC/DCAlternating Current / Direct Current2.CADComputer Aided Design3.CAMComputer Aided Manufacturing4.kVKilovolt. 1000 volts (103)5.PCBPrinted Circuit Board6.Ohms LawThis Law states the relationship between Voltage (V), Current (I), and Resistance (R): V=IRV=IR.7.Voltage (V)Electric potential difference between two points in a circuit, measured in volts (V).8.Current (I)Flow of electric charge in a circuit, measured in amperes (A).9.Resistance (R)Opposition of flow of electrical current using a resistor.10.CircuitA closed loop or path through which electric current flows.Here you can study in detail: Electronics GlossaryOhms LawNamed after the Great German Physicist and Mathematician Georg Simon Ohm, the Ohms Law is a fundamental principle in electronics and electrical engineering. This Law states that electric current is proportional to voltage and inversely proportional to resistance.Mathematically, the law states that V = IR, where V is the voltage difference, I is the current in amperes, and R is the resistance in ohms.Ohms LawHere you can study in detail: Ohms Law: Definition, Formula, ExampleElectricity and Electric CurrentElectronics is all about dealing with electricity and manipulating electric current in a circuit or wiring to achieve a pre-designed objective.ElectricityElectricity is flow of electrons (Negative Charge) between two points when there is a potential difference between them. There are various sources to generate electrical energy renewable and nonrenewable.Hydroelectricity is the most common method of generating electricity. Wind is a renewable source of generating energy. Solar energy is a renewable source to generate electricity. Artificially created solar cells store and convert solar energy into solar electricity. Fossil fuels such as coal and oil are used to generate heat and eventually electricity. Here you can learn in detail: How to Generate Electricity.Electric CurrentElectric current refers to the flow of electric charge in a conductor, through a circuit or wiring. This movement of electrons is usually from a higher potential (voltage) to a lower potential, forming a complete electrical circuit. It is typically measured in amperes (A).Electric Current are of 2 Types: (1) Alternating Current (AC); and (2) Direct Current (DC).Current or Electric Current (AC and DC)Static ElectricityESD or Static Electricity is transfer of electric charge between two different objects charged at different electric potentials. This happens when the two object are unintentionally brought in contact with each other.Power, Charge and Voltage (Potential Difference)Electric power is defined as the rate at which electrical energy is transferred by an electric circuit. The SI unit of power is the watt.Power FormulaElectric Charge may be defined as the quantity of unbalanced electricity in a body (either positive or negative) and construed as an excess or deficiency of electrons. It comes in two forms, positive (+) , and negative ( ). The unit of charge is the Coulomb, C. The symbol is Q.Unit of Charge Coulomb FormulaVoltage is an Electromotive Force or Potential Difference Measured in volts. Voltage = Pressure, measured in volts (V).VoltageLearn: Voltage Vs Current: Difference and Relationship with FormulaElectrical Wiring and CircuitsNow that you have got some basic idea about electricity, it is time to learn how to use it in a wiring and circuit.What is Electrical Wiring? Electrical wiring is an arrangement of conductors, components and electronic devices to transmit electrical energy from one point to another. It typically consists of an array of conductive wires, cables, switches, outlets, and other electrical devices.Learn: Electrical Wiring Symbols, Meanings and DrawingsWhat is an Electronic Circuit?An Electric Circuit is a conductive path for flow of current or electricity. It is also called electrical circuit. Understanding how to design and construct circuits is fundamental to basic electronics.Learn: Electronic Circuits for BeginnersElectronic ComponentsElectronic components are the basic devices that form the building blocks of electronic circuits. These small components are designed to perform specific functions or manipulate electrical signals in various ways. They are used to create circuits that process and control electrical currents, voltages, and signals.These components are available is both thru-hole and SMD Designs.Some of the Basic Electronic Components are: Resistor, Capacitor, Transistor, Diode, Inductor, ICs, operational amplifier, resistor array, logic gate etc.Passive ComponentsThese components are those that do not have gain or directionality.Example: Resistors, Capacitors, Diodes, Inductors.Passive Electronic ComponentsActive ComponentsThese components are those that have gain or directionality.Example: Transistors, Integrated Circuits or ICs, Logic Gates.Active Electronic ComponentsPCB DesigningNow that you have learnt most of the Basic Electronics, it is time to understand how to utilize the above knowledge to design a functional circuit board.PCB Designing is the First Step towards manufacturing PCB, which is one of the most important part of any electronic device or equipment such as Mobile Phone, Smartphone, Laptop and Desktop Computers etc. Modern-Day PCB Designing is done using Dedicated PCB Designing Software. You can use CAD PCB layout software such Eagle and Multisim or Free Software such as Fritzing or TinyCAD.The current generic standard for printed circuit board design is IPC-2221A. These information and guidelines is applicable for all Types of PCB including Single-Layer PCB and Multilayer PCB.Printed Circuit BoardA Printed Circuit Board (PCB) is a Sheet of Insulating Material such as Fiberglass, with Metallic Circuit or Conductive Track Printed or Etched on it for Electrical Conductivity. Electronic components are soldered along this conductive part to manipulate electric current and achieve the desired objective of the PCB. You can read in detail: What is a Printed Circuit BoardHands-on ExperimentationHands-on Experimentation is one of the most effective ways to learn basic electronics. Consider purchasing a bread board or a beginners electronics kit and start building simple circuits to enhance your knowledge.Conclusion Basic electronics form the foundation of our technological advancement. By learning the fundamental components, circuit types, and Ohms Law, you can learn, experiment, and start creating your own electronic wonders. Keep Learning!FAQs: Introduction to Basic Electronics Electricity is the flow of electrons (negative charge) through a conductor, generating power to perform some work. A resistor is an electronic component that limits or controls the flow of electrical current in a circuit, to manage voltage and current levels. The basic components of an electronic circuit include resistors, capacitors, inductors, diodes, transistors, and power sources such as batteries or power supplies. A capacitor stores and releases electrical energy. It consists of two conductive plates separated by an insulating material, capable of storing charge when connected to a voltage source. A diode is a two-terminal electronic component that allows current to flow in only one direction. It is generally used to convert AC (alternating current) to DC (direct current). Ohm's Law relates voltage (V), current (I), and resistance (R) in a circuit through the equation V = I R. It is a fundamental principle used to calculate voltage, current, or resistance when the other two are known. A transistor is a semiconductor device that can amplify or switch electronic signals and electrical power. It works by controlling the flow of current between its terminals, making it essential in various electronic devices like amplifiers, computers, and radios.Related Posts: View synonyms for electronicof or relating to electronics or to devices, circuits, or systems developed through electronics.of or relating to electrons or to an electron.(of a musical instrument) using electric or electronic means to produce or modify the sound.of, relating to, or controlled by computers or computerized systems: an electronic document.electronic voting;an electronic document.of or noting computerized products, services, or technologies: electronic banking.online electronic dictionaries;electronic banking.of, concerned with, using, or operated by devices in which electrons are conducted through a semiconductor, free space, or gasof or concerned with electronicsof or concerned with electrons or an electronan electronic energy level in a moleculeinvolving or concerned with the representation, storage, or transmission of information by electronic systemselectronic mailelectronic shoppingCollins English Dictionary Complete & Unabridged 2012 Digital Edition William Collins Sons & Co. Ltd. 1979, 1986 HarperCollins Publishers 1998, 2000, 2003, 2005, 2006, 2007, 2009, 2012Relating to electrical devices that amplify and process electrical signals. Audio amplifiers, radios, and digital circuitry are electronic devices. The scientific study of the behavior and design of electronic devices and circuits is called electronics. Compare electricElectronic is used to refer to equipment, such as television sets, computers, etc, in which the current is controlled by transistors, valves, and similar components and also to the components themselves. Electrical is used in a more general sense, often to refer to the use of electricity as a whole as opposed to other forms of energy: electrical engineering; an electrical appliance. Electric, in many cases used interchangeably with electrical, is often restricted to the description of particular devices or to concepts relating to the flow of current: electric fire; electric chargeelectronically adverbinterelectronic adjectivenonelectronic adjectivepreelectronic adjectiveunelectronic adjectiveOrigin of electronic1First recorded in 190005; electron + -icExamples are provided to illustrate real-world usage of words in context. Any opinions expressed do not reflect the views of Dictionary.com.By the 1960s, reservation electronics plants recruited Native women for circuit-board work with the promise of self-help development.Read more on The Wall Street JournalFlying a drone over the Caribbean is easier than over Ukraine, where electronic warfare has rendered many American-made drones ineffective or unusable, and the distances are shorter than in a hypothetical China-Taiwan conflict.Read more on The Wall Street JournalDuring the war, adapting to the urgent need for cash, many small businessmen who previously offered money transfer and exchange services began charging customers high commission to turn electronic transfers into cash.Because of these qualities, graphene is considered a "miracle material" and is already being explored for flexible electronic screens, highly sensitive sensors, advanced batteries, and next-generation solar cells.Read more on Science DailyTrading on Bursa Malaysias 1818 -0.36%decrease; red down pointing triangle derivatives market have also been halted as its products trade on CME Groups electronic trading platform, the Malaysian exchange said in a statement.Read more on The Wall Street Journalcomputerizedwww.thesaurus.comelectron holeelectronicaBrowse#aabbccddeeffgghhiijjkkllmmnnooppqqrrsstuuvvwwxxyyzzAboutCareersContact usCookies, terms, & privacyHelpFollow usGet the Word of the Day every day! 2025 Dictionary.com, LLC Also found in: Thesaurus, Medical, Legal, Financial, Acronyms, Idioms, Encyclopedia, Wikipedia.Related to electronic: Electronic Cigarette, Electronic band (-lk-trnk, lk-)adj.1. Of or relating to electrons.2. Of, based on, operated by, or otherwise involving the controlled conduction of electrons or other charge carriers, especially in a vacuum, gas, or semiconducting material.3. Of, relating to, or produced by means of electronics: electronic navigation; electronic books.4. Of or relating to music produced or altered by electronic means, as by a tape recorder or synthesizer.5. Of, implemented on, or controlled by a computer or computer network.American Heritage Dictionary of the English Language, Fifth Edition. Copyright 2016 by Houghton Mifflin Harcourt Publishing Company. Published by Houghton Mifflin Harcourt Publishing Company. All rights reserved. (lktrnk; ilk-) adj1. (Electronics) of, concerned with, using, or operated by devices in which electrons are conducted through a semiconductor, free space, or gas2. (Electronics) of or concerned with electronics3. (General Physics) of or concerned with electrons or an electron: an electronic energy level in a molecule. 4. (Electronics) involving or concerned with the representation, storage, or transmission of information by electronic systems: electronic mail; electronic shopping. Usage: Electronic is used to refer to equipment, such as television sets, computers, etc, in which the current is controlled by transistors, valves, and similar components and also to the components themselves. Electrical is used in a more general sense, often to refer to the use of electricity as a whole as opposed to other forms of energy: electrical engineering; an electrical appliance. Electric, in many cases used interchangeably with electrical, is often restricted to the description of particular devices or to concepts relating to the flow of current: electric fire; electric chargeCollins English Dictionary Complete and Unabridged, 12th Edition 2014 HarperCollins Publishers 1991, 1994, 1998, 2000, 2003, 2006, 2007, 2009, 2011, 2014 (lktrn k, i lk-) adj. 1. of or pertaining to electronics or to devices, circuits, or systems developed through electronics. 2. of or pertaining to electrons or to an electron. 3. (of a musical instrument) using electric or electronic means to produce or modify the sound. 4. of or controlled by computers. electronically, adv. Random House Kernerman Webster's College Dictionary, 2010 K Dictionaries Ltd. Copyright 2005, 1997, 1991 by Random House, Inc. All rights reserved. (-lktrnk) Relating to devices that work by the movement of electric charge carriers (such as electrons), especially across a vacuum or a semiconductor. The scientific study of this movement, along with the development of devices such as televisions and computer circuits that work by controlling this movement, is called electronics.Usage All electronic devices are electric, but not all electric devices are electronic. An electric device is simply one that is powered by electricity. An electric fan usually consists of an electric motor that moves fan blades in a circle. An electronic device usually has special components that control the movement of electrons across a vacuum (as in a vacuum tube) or a semiconductor. These components allow a great range of capabilities, from tuning in to radio and television channels, to performing complicated calculations on calculators, to reading the time from a digital watch.The American Heritage Student Science Dictionary, Second Edition. Copyright 2014 by Houghton Mifflin Harcourt Publishing Company. Published by Houghton Mifflin Harcourt Publishing Company. All rights reserved. electrical electronic1. 'electric'You use electric in front of nouns to talk about particular machines or devices that use electricity.The boat runs on an electric motor.I switched on the electric fire.2. 'electrical'You use electrical when you are talking in a more general way about machines, devices, or systems that use or produce electricity. Electrical is typically used in front of nouns such as equipment, appliance, and component.They sell electrical appliances such as dishwashers and washing machines.We are waiting for a shipment of electrical equipment.You also use electrical to talk about people or organizations connected with the production of electricity or electrical goods.Jan is an electrical engineer.They work in the electrical engineering industry.3. 'electronic'You use electronic to talk about a device that has transistors or silicon chips that control and change the electric current running through the device, or to describe a process or activity using electronic devices.Mobile phones, laptops and other electronic devices must be switched off.They use electronic surveillance systems.Collins COBUILD English Usage HarperCollins Publishers 1992, 2004, 2011, 2012 Adj.1.electronic - of or relating to electronics; concerned with or using devices that operate on principles governing the behavior of electrons; "electronic devices"2.electronic - of or concerned with electrons; "electronic energy"Based on WordNet 3.0, Farlex clipart collection. 2003-2012 Princeton University, Farlex Inc. adjectiveCollins Thesaurus of the English Language Complete and Unabridged 2nd Edition. 2002 HarperCollins Publishers 1995, 2002 elektronickelektronovinternetovelektroniskelektron-elektronik-elektronikingenirrafeinda-, rafeindatkni-, raftknilegurrafeinda-, raftkni-Collins Spanish Dictionary - Complete and Unabridged 8th Edition 2005 William Collins Sons & Co. Ltd. 1971, 1988 HarperCollins Publishers 1992, 1993, 1996, 1997, 2000, 2003, 2005 [lktrnk ilktrnk] adj lectroniqueCollins English/French Electronic Resource. HarperCollins Publishers 2005Collins German Dictionary Complete and Unabridged 7th Edition 2005. William Collins Sons & Co. Ltd. 1980 HarperCollins Publishers 1991, 1997, 1999, 2004, 2005, 2007Collins Italian Dictionary 1st Edition HarperCollins Publishers 1995 (ilektron) noun a very small particle within the atom. elektron eltron elektron das Elektron elektron electrn elektron elektron elektroni lectron elektron elektron elektron rafeind elettrone elektronas elektrons elektron elektronelektron elektron electro electron elektrn elektron elektron elektron elektron in t electronic (elktronik) adjective2. concerned or working with such machines. an electronic engineer. elektroniese eletnico elektronick Elektronik-... elektronikingenir; elektronik- electrnico elektroonika- shk- lectronicien , elektronski elektronikai, elektronikus ahli elektronika rafeinda-, raftkni- elettronico elektronikos elektronu- jurutera elektronik elektronischelektro- elektronik electrnico electronist elektronick elektronski elektronski elektron-, elektronik- elektronik ' thuc in t electronic mail noun (also e-mail, ~email) the system of sending messages by computer; the information sent this way. elektroniese pos correio eletnico elektronick pota, e-mail elektronische Post, e-mail e-post; e-mail correo electrnico elektronpost shkposti courrier lectronique , - elektronska pota, e-pota elektronikus posta, e-mail posta elettronica, e-mail elektroninis patas elektroniskais pasts, e-pasts mel elektronik elektronische post, e-mailelektronisk post, e-post poczta elektroniczna elektronick pota elektronska pota elektronska pota elektronisk post, e-post, e-mail e-mail, elektronik posta th in t electronics (elktroniks) noun singular the branch of science that deals with the study of the movement and effects of electrons and with their application to machines etc. elektronika eletnica elektronika die Elektronik elektronik electrnica elektroonika elektroniikka lectronique elektronika elektronika ilmu elektronika raftkni, rafeindatkni elettronico elektronika elektronika elektronik elektronik elektronicaelektronikkelektronika electrnica electronic elektronika elektronika elektronika elektrotehnika elektronik elektronik in t hc Kernerman English Multilingual Dictionary 2006-2013 K Dictionaries Ltd. elektronick elektronisk elektronisch electrnico elektroninen lectronique elektroniki elettronico elektronisch elektronisk elektroniczny eletrnico, eletrnico elektronisk elektronik in t Multilingual Translator HarperCollins Publishers 2009a. electrnico-a; ___ instrument instrumento ___; ___ monitoring monitoreo ___. English-Spanish Medical Dictionary Farlex 2012 Want to thank TFD for its existence? Tell a friend about us, add a link to this page, or visit the webmaster's page for free fun content. Link to this page: DSI and Safedocs have an existing alliance through which the companies have been providing digital document work flow solutions and fully electronic mortgage closing packages to lenders for over a year.Scientists have been designing and building electronic noses for more than 20 years.Firms need to be aware of the ease with which e-mail, voice mail and all electronic messages can become public, and the potential negative consequences of this. by Chris Woodford. Last updated: December 5, 2022. They store your money. They monitoryour heartbeat. They carry thesound of your voice into other people's homes. They bring airplanesinto land and guide cars safely to their destinationthey even fire offthe airbags if we get into trouble. It's amazing to think just how manythings "they" actually do. "They" are electrons: tiny particles within atoms that march around defined paths known ascircuits carrying electrical energy. One of the greatest things peoplelearned to do in the 20th century was to use electrons to controlmachines and process information. The electronics revolution, as thisis known, accelerated the computerrevolution and both these things have transformed many areas of ourlives. But how exactly do nanoscopically small particles, far too smallto see, achieve things that are so big and dramatic? Let's take acloser look and find out! Photo: The compact, electronic circuit board from a webcam.This board contains several dozen separate electronic components, mostly small resistors and capacitors,plus the large black microchip (bottom left) that does much of the work. Contents If you've read our article about electricity,you'll know it's a kind of energya veryversatile kind of energy that we can make in all sorts of ways and usein many more. Electricity is all about making electromagnetic energyflow around a circuit so that it will drive something like an electric motor or a heating element,powering appliances such as electric cars,kettles, toasters, andlamps.Generally, electrical appliances need a great deal of energy to makethem work so they use quite large (and often quite dangerous) electriccurrents. The 2500-watt heating element inside an electric kettleoperates on a current of about 10 amps. By contrast, electronic components use currentslikely to be measured in fractions of milliamps (which are thousandths of amps). In other words, a typical electric appliance is likely to be using currents tens, hundreds, or thousandsof times bigger than a typical electronic one. Electronics is a much more subtle kind of electricity in which tinyelectric currents (and, in theory, single electrons) are carefullydirected around much more complex circuits to process signals (such asthose that carry radio and television programs) or store and processinformation. Think of something like a microwaveoven and it's easy to see the difference between ordinaryelectricity and electronics. In a microwave, electricity provides thepower that generates high-energy waves that cook your food; electronicscontrols the electrical circuit that does the cooking. Artwork: Microwave ovens are powered by electric cables (gray) that plug into the wall.The cables supply electricity that powers high-current electrical circuits and low-current electronic ones.The high-current electrical circuits power the magnetron (blue), the device that makes the waves that cook your food,and rotate the turntable. The low-current electronic circuits (red) control these high-powered circuits,and things like the numeric display unit. Analog and digital electronics There are two very different ways of storing informationknown asanalog and digital. It sounds like quite an abstract idea, but it'sreally very simple. Suppose you take an old-fashioned photograph ofsomeone with a film camera. The camera captures light streaming inthrough the shutter at the front as a pattern of lightand dark areas on chemically treated plastic.The scene you'rephotographing is converted into a kind of instant, chemical paintingan"analogy" of what you're looking at. That's why we say this is an analogway of storing information. But if you take a photograph of exactly thesame scene with a digital camera,the camera stores a very different record. Instead of saving arecognizable pattern of light and dark, it converts the light and darkareas into numbers and stores those instead. Storing a numerical, codedversion of something is known as digital. Photo: Analog and digital electronics. The radio (back) is analog: it "soaks" up radio waves and turns them back into sound with electronic components like transistors and capacitors. The camera (front) is digital: it stores and processes photos as numbers. Electronic equipment generally works on information in either analogor digital format. In an old-fashioned transistor radio,broadcast signals enter the radio's circuitry via the antenna stickingout of the case. These are analog signals: they are radio waves,traveling through the air from a distant radio transmitter, thatvibrateup and down in a pattern that corresponds exactly to the words andmusic they carry. So loud rock music means bigger signals than quietclassical music. The radio keeps the signals in analog form as itreceives them, boosts them, and turns them back into sounds you canhear. But in a modern digital radio,things happen in a different way. First, the signals travel in digitalformatas coded numbers. When they arrive at your radio, the numbersare converted back into sound signals. It's a very different way ofprocessing information and it has both advantages and disadvantages.Generally, most modern forms of electronic equipment (including computers, cellphones, digital cameras, digital radios, hearing aids, and televisions) usedigital electronics. Electronic components If you've ever looked down on a city from a skyscraper window,you'll have marveled at all the tiny little buildings beneath you andthe streets linking them together in all sorts of intricate ways. Everybuilding has a function and the streets, which allow people to travelfrom one part of a city to another or visit different buildings inturn, make all the buildings work together. The collection ofbuildings, the way they're arranged, and the many connections betweenthem is what makes a vibrant city so much more than the sum of itsindividual parts. The circuits inside pieces of electronic equipment are a bit likecities too: they're packed with components(similar tobuildings) that do different jobs and the components are linkedtogether by cables or printed metal connections(similar tostreets). Unlike in a city, where virtually every building is uniqueand even two supposedly identical homes or office blocks may be subtlydifferent, electronic circuits are built up from a small number ofstandard components. But, just like LEGO, you can put thesecomponents together in an infinite number of different places so theydo an infinite number of different jobs. These are some of the most important components you'll encounter: These are the simplest components in any circuit. Their job is to restrict the flow of electrons and reduce thecurrent or voltage flowing by converting electrical energy into heat.Resistors come in many different shapes and sizes. Variable resistors(also known as potentiometers) have a dial control on them so theychange the amount of resistance when you turn them. Volume controls inaudio equipment use variable resistors like these. Read more in our main article about resistors.Photo: A typical resistor on the circuit board from a radio. The electronic equivalents of one-way streets, diodes allow an electric current to flowthrough them in only one direction. They are also known as rectifiers.Diodes can be used to change alternating currents (ones flowing backand forth round a circuit, constantly swapping direction) into directcurrents (ones that always flow in the same direction).Read more in our main article about diodes.Photo: Diodes look similar to resistors but work in a different wayand do a completely different job. Unlike a resistor, which can be inserted into a circuiteither way around, a diode has to be wired in the right direction (corresponding to the arrowon this circuit board). These relatively simple components consist of two pieces of conducting material (such as metal) separated by anon-conducting (insulating) material called a dielectric. They areoften used as timing devices, but they can transform electricalcurrents in other ways too. In a radio, one of the most important jobs,tuning into the station you want to listen to, is done by a capacitor.Read more in our main article about capacitors.Photo: A small capacitor in a transistor radio circuit. Easily the most important components in computers, transistors canswitch tiny electric currents on and off or amplify them (transformsmall electric currents into much larger ones). Transistors that workas switches act as the memories in computers, while transistors workingas amplifiers boost the volume of sounds in hearing aids. Whentransistors are connected together, they make devices called logic gates that can carry out very basicforms of decision making. (Thyristors are a little bit like transistors, butwork in a different way.)Read more in our main article about transistors.Photo: A typical field-effect transistor (FET) on an electronic circuit board. There are various components that can turn light into electricity or vice-versa.Photocells (also known asphotoelectric cells) generate tiny electriccurrents when light falls on them and they're used as "magic eye" beamsin various types of sensing equipment, including some kinds of smoke detector.Light-emitting diodes (LEDs)work in the opposite way, converting small electric currentsinto light. LEDs are typically used on the instrument panels of stereoequipment. Liquid crystal displays (LCDs), such as those used inflatscreen LCD televisions and laptopcomputers, are more sophisticated examples of opto-electronics.Photo: An LED mounted in an electronic circuit. This is one of theLEDs that makes red light inside an optical computer mouse. Electronic components have something very important in common.Whatever job they do, they work by controlling the flow of electronsthrough their structure in a very precise way. Most of these componentsare made of solid pieces of partly conducting, partly insulatingmaterials called semiconductors (describedin more detail in ourarticle about transistors). Because electronics involves understandingthe precise mechanisms of how solids let electrons pass through them,it's sometimes known as solid-state physics.That's why you'll often see pieces of electronic equipment described as "solid-state." Electronic circuits and circuit boards The key to an electronic device is not just the components itcontains, but the way they are arranged in circuits. The simplestpossible circuit is a continuous loop connecting two components, liketwo beads fastened on the same necklace. Analog electronic appliancestend to have far simpler circuits than digital ones. A basic transistorradio might have a few dozen different components and a circuit boardprobably no bigger than the cover of a paperback book. But in somethinglike a computer, which uses digital technology, circuits are much moredense and complex and include hundreds, thousands, or even millions ofseparatepathways. Generally speaking, the more complex the circuit, the moreintricate the operations it can perform. Photo: The electronic circuit board from inside a computer printer. Which electronic componentscan you see here? I can make out some capacitors, diodes, and integrated circuits (the large black things, which are explained below). If you've experimented with simple electronics, you'll know that theeasiest way to build a circuit is simply to connect components togetherwith short lengths of copper cable. But the more components you have toconnect, the harder this becomes. That's why electronics designersusually opt for a more systematic way of arranging components on what'scalled a circuit board. A basic circuitboard is simply arectangle of plastic with copper connecting tracks on one side and lotsof holes drilled through it. You can easily connect components togetherby poking them through the holes and using the copper to link themtogether, removing bits of copper as necessary, and adding extra wiresto make additional connections. This type of circuit board is oftencalled "breadboard".Electronic equipment that you buy in stores takes this idea a stepfurther using circuit boards that are made automatically in factories.The exact layout of the circuit is printed chemically onto a plasticboard, with all the copper tracks created automatically during themanufacturing process. Components are then simply pushed throughpre-drilled holes and fastened into place with a kind of electricallyconducting adhesive known as solder. A circuit manufactured in this wayis known as a printed circuit board (PCB). Photo: Soldering components into an electroniccircuit. The smoke you can see comes from the solder melting and turning to a vapor. The blue plastic rectangle I'm soldering onto here is a typical printed circuit boardand you see various components sticking up from it, including a bunch of resistors at the front and a large integrated circuit at the top. Although PCBs are a great advance on hand-wired circuit boards,they're still quite difficult to use when you need to connect hundreds,thousands, or even millions of components together. The reason earlycomputers were so big, power hungry, slow, expensive, and unreliable isbecause their components were wired together manually in thisold-fashioned way. In the late 1950s, however, engineers Jack Kilby andRobert Noyce independently developed a way of creating electroniccomponents in miniature form on the surface of pieces of silicon. Usingthese integrated circuits, it rapidly becamepossible to squeeze hundreds, thousands, millions, and then hundreds of millions ofminiaturized components onto chips of silicon about the size of afinger nail. That's how computers became smaller, cheaper, and muchmore reliable from the 1960s onward. Photo: Miniaturization. There's more computing powerin the processing chip resting on my finger here than you would have found in a room-sizedcomputer from the 1940s! What is electronics used for? Electronics is now so pervasive that it's almost easier to think ofthings that don't use it than of things that do.Entertainment was one of the first areas to benefit, with radio (andlater television) both criticallydependent on the arrival ofelectronic components. Although the telephonewas invented before electronics was properly developed, moderntelephone systems, cellphone networks,and the computers networks atthe heart of the Internet all benefit fromsophisticated, digital electronics. Try to think of something you do that doesn't involve electronicsand you may struggle. Your car engineprobably has electronic circuitsin itand what about the GPS satellitenavigation device that tells you where to go? Even the airbag in yoursteering wheel is triggered by an electronic circuit that detects whenyou need some extra protection. Electronic equipment saves our lives in other ways too. Hospitalsare packed with all kinds of electronic gadgets, from heart-ratemonitors and ultrasound scanners to complex brain scanners and X-raymachines. Hearing aids were among the first gadgets to benefit from thedevelopment of tiny transistors in the mid-20th century, andever-smaller integrated circuits have allowed hearing aids to becomesmaller and more powerful in the decades ever since.Who'd have thought that electronsjust about the smallest things youcould ever imaginewould change people's lives in so many importantways? A brief history of electronics Photo: Sir J. J. Thomson, who discovered that electrons were negatively charged particles, at Cambridge University, in 1897. Thomson won the Nobel Prize in Physics in 1906 for his work. Photo by Bain News Service courtesy of US Library of Congress. 1874: Irish scientist George Johnstone Stoney(18261911) suggests electricity must be "built" out of tiny electricalcharges. He coins the name "electron" about 20 years later.1875: American scientist George R. Careybuilds a photoelectric cell that makes electricity when light shines onit.1879: Englishman Sir William Crookes(18321919) develops his cathode-ray tube (similar to an old-style,"tube"-based television) to studyelectrons (which were then known as "cathode rays").1883: Prolific American inventor Thomas Edison(18471931) discovers thermionic emission (also known as the Edisoneffect), where electrons are given off by a heated filament.1887: German physicist Heinrich Hertz(18571894) finds out more about the photoelectric effect, theconnection between light and electricity that Carey had stumbled on theprevious decade.1897: British physicist J.J. Thomson(18561940) shows that cathode rays are negatively charged particles.Thomson calls them "corpuscles," but they are soon renamed electrons.1904: John Ambrose Fleming(18491945), an English scientist, produces the Fleming valve (laterrenamed the diode). It becomes an indispensable component in radios.1906: American inventor Lee De Forest(18731961), goes one better and develops an improved valve known asthe triode (or audion), greatly improving the design of radios. DeForest is often credited as a father of modern radio.1947: Americans John Bardeen(19081991), Walter Brattain (19021987), andWilliam Shockley (19101989)develop the transistor at Bell Laboratories. It revolutionizes electronics and digitalcomputers in the second half of the 20th century.1958: Working independently, American engineers Jack Kilby (19232005) of Texas Instruments andRobert Noyce (19271990) of FairchildSemiconductor (and later of Intel) develop integrated circuits.1971: Marcian Edward (Ted) Hoff (1937) and Federico Faggin (1941)manage to squeeze all the key components of a computer ontoa single chip, producing the world's first general-purpose microprocessor, the Intel 4004.1987: American scientists Theodore Fulton and Gerald Dolan of Bell Laboratories develop the first single-electron transistor.2008: Hewlett-Packard researcher Stanley Williams builds the first working memristor, a newkind of magnetic circuit component that works like a resistor with a memory, first imagined by American physicist Leon Chua almost four decades earlier (in 1971). Chris Woodford is the author and editor of dozens of science and technology books for adults and children, including DK's worldwide bestselling Cool Stuff series and Atoms Under the Floorboards, which won the American Institute of Physics Science Writing award in 2016. You can hire him to write books, articles, scripts, corporate copy, and more via his website chriswoodford.com.

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