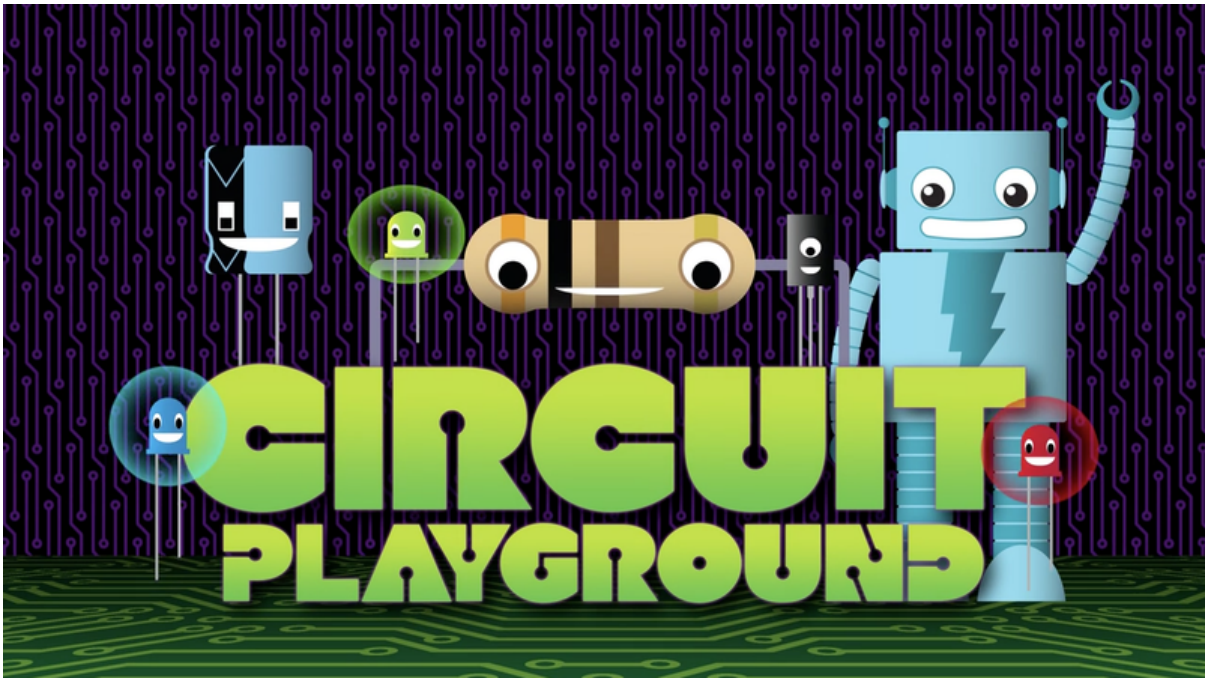
Circuit Playground - A is for Ampere

Created by lady ada



https://learn.adafruit.com/circuit-playground-a-is-for-ampere

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Video

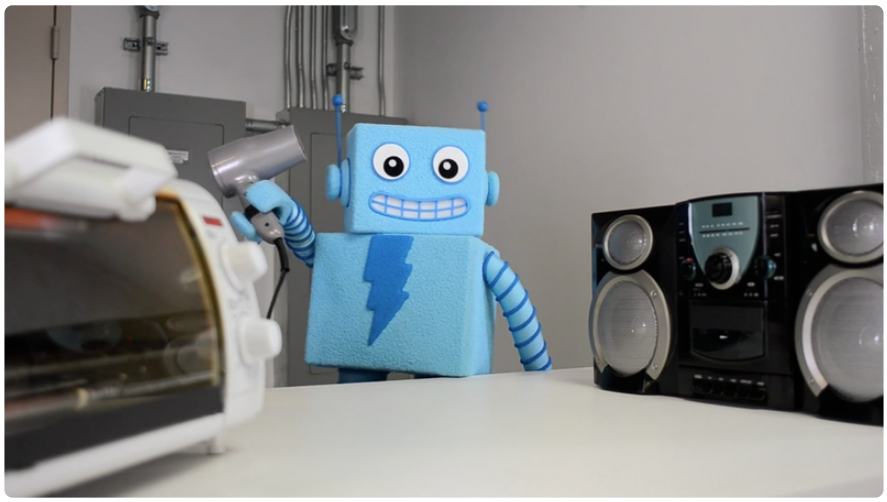
"A is for Ampere" - Circuit Playground Episode 1! Learn all about electronics with Ladyada, ADABOT and special guests!

Ampere describes the number of electrons that flow through a circuit in one second. It is named after André-Marie Ampère..

Learn more: http://www.adafruit.com/coloringbook (https://adafru.it/cc6)

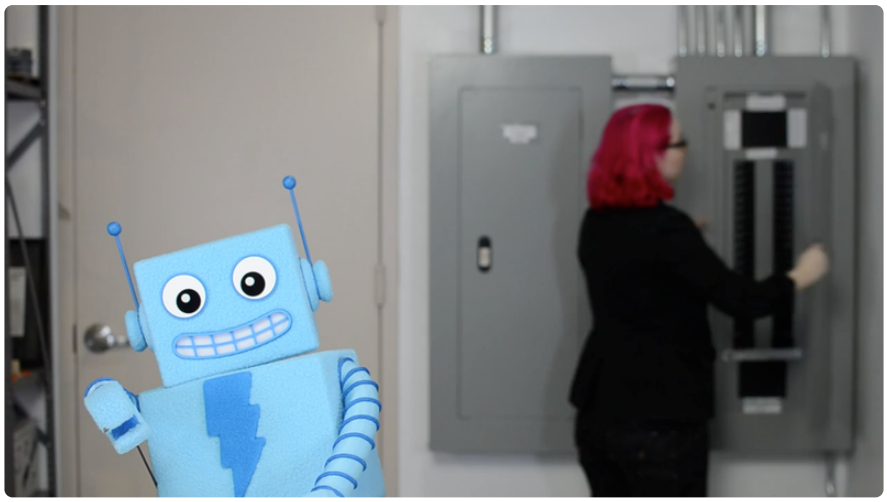
Transcript

A is for Ampere



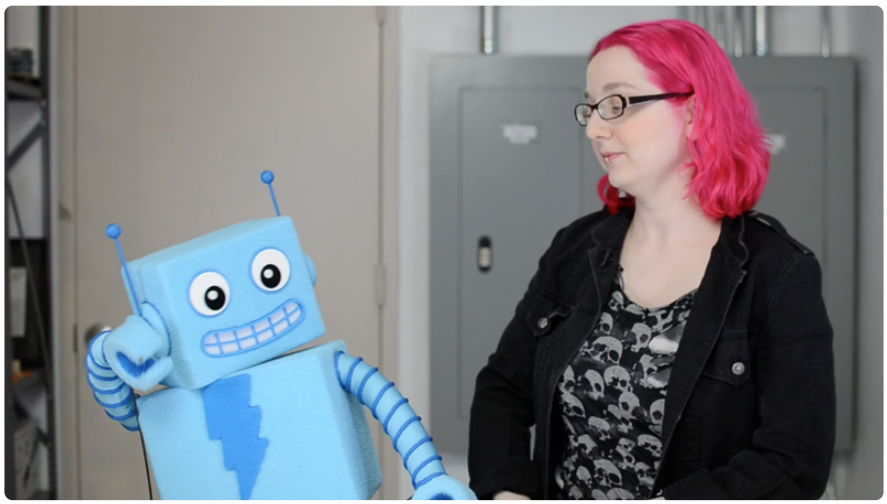
Adabot: “Uh - ohhh ...”

Adabot: “Did I break something?”



Ladyada: “Looks like you tripped the circuit breaker, Adabot.”

Adabot: “Wait - who did I trip?!”



Ladyada: “No, no - The circuit breaker isn’t a person, it’s a device in that box over there.”

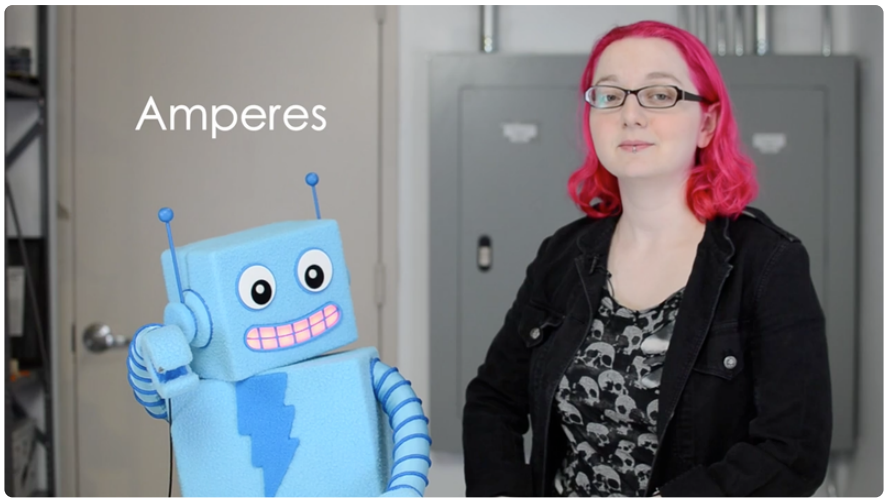
Ladyada: “The circuit breaker turns off all the electricity when we draw too much electrical current.”

Adabot: “Ohhh ...”

Ladyada: "And it’s also something *only* a grown-up should touch.”

Adabot: “Committed to memory!”

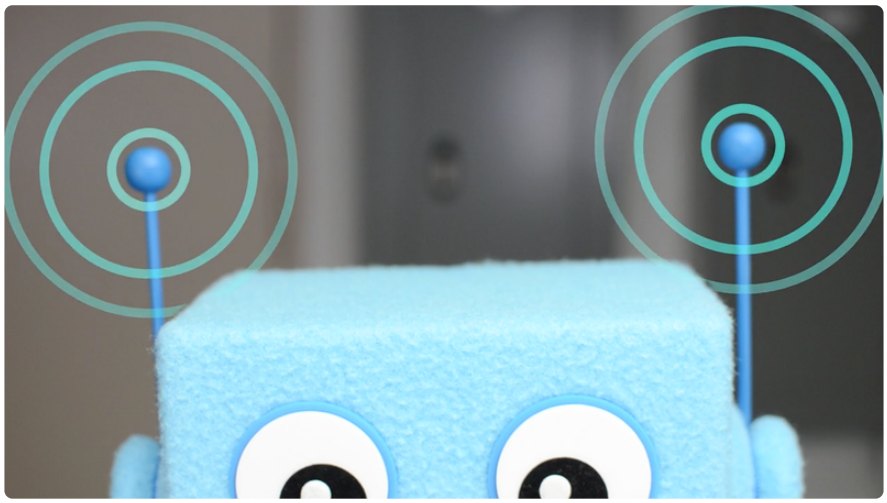
Adabot: “Wow - powering all my stuff must use *a lot* of current.”



Ladyada: “That's right - and we measure electrical current in amperes.”

Adabot: “Huh ... why do we call it that?”

Ladyada: “The ampere is named after the scientist - Mr. André-Marie Ampère.”



Adabot: “Accessing database.”

Adabot: “André-Marie Ampère - a French scientist from the 1800’s.”

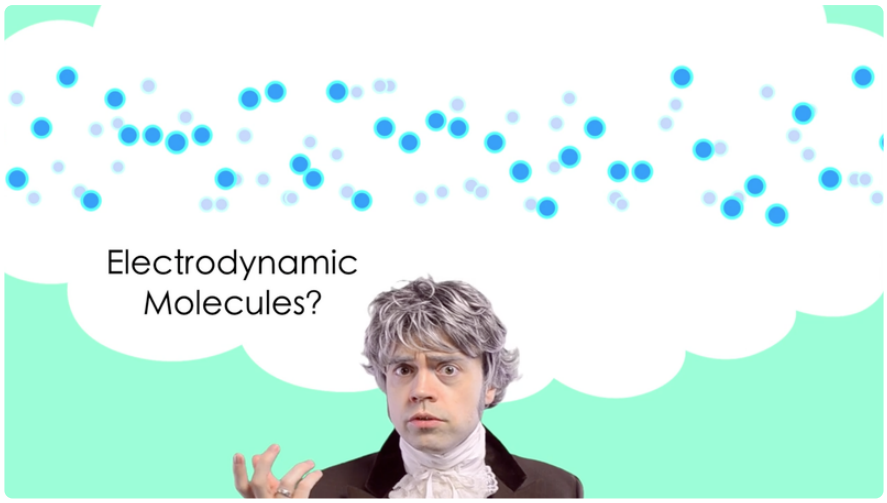
Ladyada: “That's right and Mr. Ampère was very curious about how electricity works.”

Adabot: “Curious - like me!”

André-Marie Ampère: “This is true.”

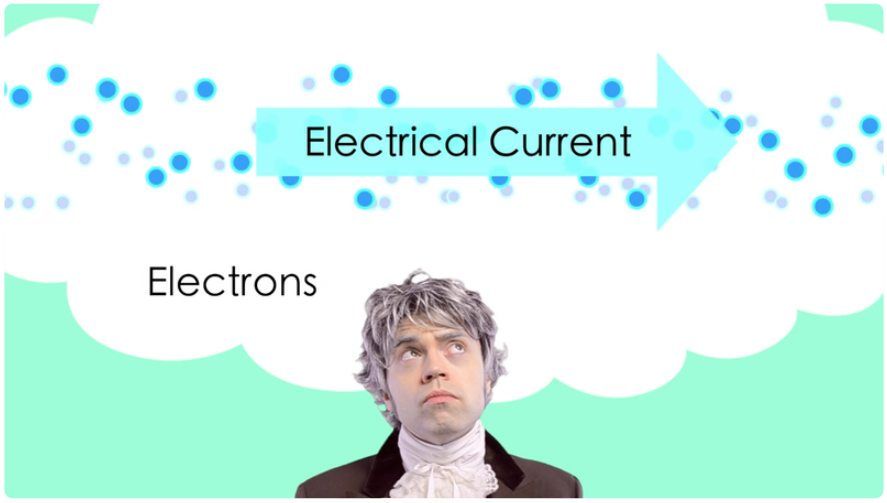
Ladyada: “And he conducted many experiments to learn about electricity.”

Ladyada: “The results of his experiments showed Mr. Ampère that electricity is created by the movement of many teeny objects ...”



Ladyada: “... which are so small we can’t even see them.”

André-Marie Ampère: “Electrodynamic molecules!”



Ladyada: “Nowadays, we call these teeny objects - ‘electrons.’ ”

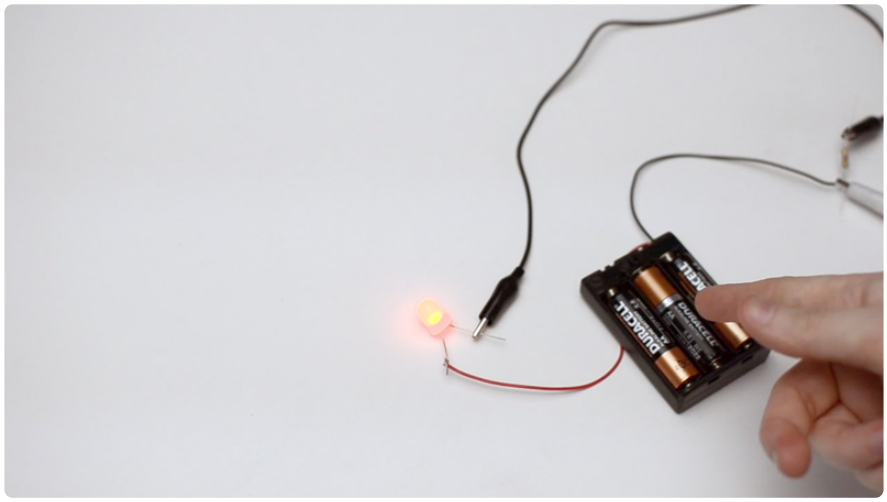
Ladyada: “And when electrons move we call that ‘electrical current.’ ”

André-Marie Ampère: “Makes sense to me.”

Adabot: “Oh! Now I get it Ladyada but, how do we measure amperes?”

Ladyada: “That’s easy - we use a multimeter.”

André-Marie Ampère: “Oh - I wish *I* ‘ad one of dzose!”



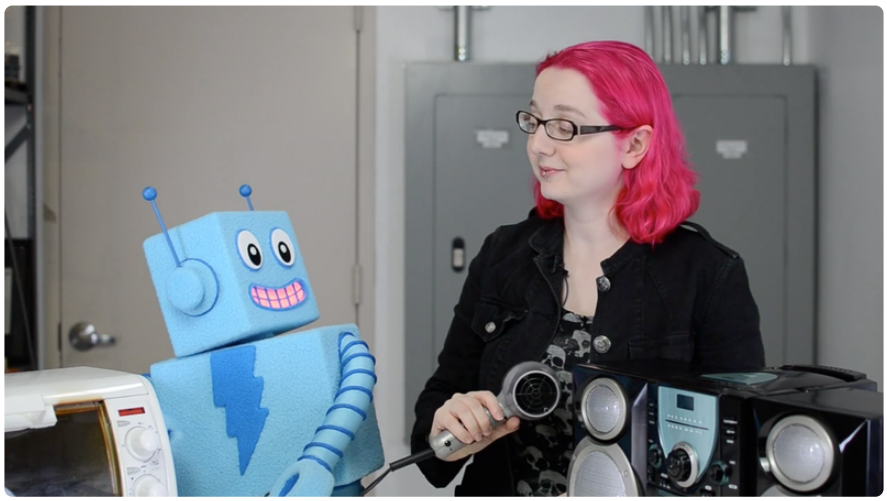
Ladyada: “In this circuit, electrons flow from one end of the battery, through the LED, and then back to the other end of the battery.”

Ladyada: “By sending the current through a multimeter, we’re able to measure the amount of electrons flowing through.”

Ladyada: “So this LED is using …”

Adabot: “0.05 amperes!”

Ladyada: “Correct.”



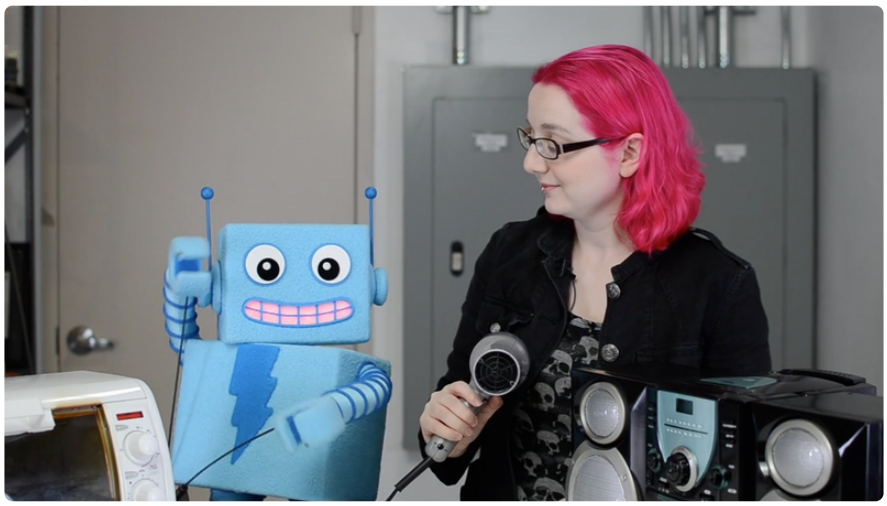
Adabot: “I wish I could *see* electrons move.”

Ladyada: “Well, you may not be able to see every single electron, but you can see the *effects* of electrical current.”

Adabot: “Really? How do we do that?”

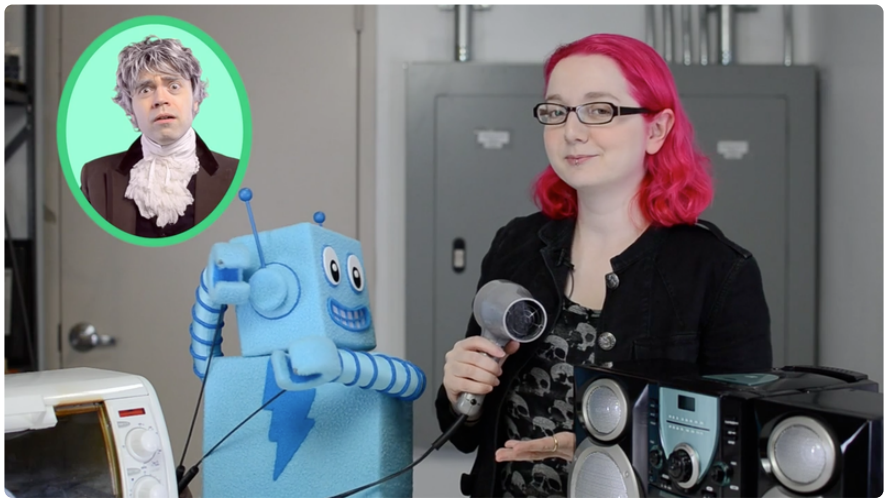
Ladyada: “Well, you can see it when your boom box makes sound or, when your toaster heats up.”

Ladyada: “And you can feel it when your blowdryer blows hot air at you.”



Adabot: “I get it, electrical current makes electricity *go*!”

Adabot: “Those electrons are amazing!”



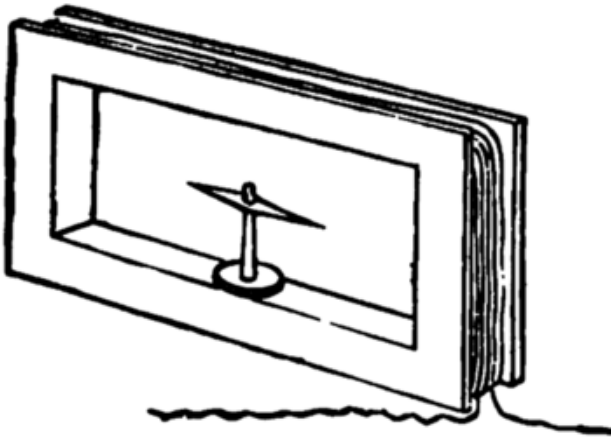
Ladyada: “That's right, Adabot. Hey, you know you don’t have any hair, right?”

Adabot: “WHA-?!”

André-Marie Ampère: “Zut Alors!”

END

What is an ampere?

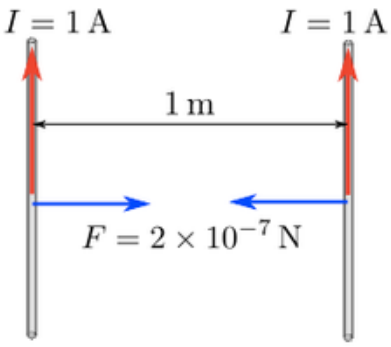


The **ampere** (SI unit (https://adafru.it/cc7) symbol: A; SI dimension (https://adafru.it/cc8) symbol: I), often shortened (https://adafru.it/cc9) to **Amp**, is the SI (https://adafru.it/cca) unit of electric current (https://adafru.it/ccb) (quantity symbol: I,i) and is one of the seven SI base units (https://adafru.it/ccc). It is named after André-Marie Ampère (https://adafru.it/Cct) (1775–1836), French mathematician and physicist, considered the father of electrodynamics.

In practical terms, the ampere is a measure of the amount of electric charge (https://adafru.it/cce) passing a point in an electric circuit per unit time with 6.241 × 1018 electrons (https://adafru.it/ccf), or one coulomb (https://adafru.it/ccg) per second constituting one ampere.

The practical definition may lead to confusion with the definition of a coulomb (i.e., 1 ampere-second), but in practical terms this means that measures of a constant current (e.g., the nominal flow of charge per second through a simple circuit) will be defined in amperes (e.g., "a 20 mA circuit") and the flow of charge through a circuit over a period of time will be defined in coulombs (e.g., "a variable-current circuit that flows a total of 10 coulombs over 5 seconds"). In this way, amperes can be viewed as a flow rate, i.e. number of (charged) particles transiting per unit time, and coulombs simply as the number of particles.

From: Wikipedia "A **(https://adafru.it/cch)**mpere **(https://adafru.it/cch)**"



Definition

Ampère's force law (https://adafru.it/19nD) states that there is an attractive or repulsive force between two parallel wires carrying an electric current. This force is used in the formal definition of the ampere, which states that it is "the constant current that will produce an attractive force of 2 × 10−7 newton (https://adafru.it/ccj) per metre of length between two straight, parallel conductors of infinite length and negligible circular cross section (https://adafru.it/cck) placed one metre (https://adafru.it/ccl) apart in a vacuum (https://adafru.it/ccm)".

The SI (https://adafru.it/ccn) unit of charge, the coulomb (https://adafru.it/ccg), "is the quantity of electricity carried in 1 second by a current of 1 ampere".[10] (https://adafru.it/cch)Conversely, a current of one ampere is one coulomb of charge going past a given point per second:

$$1\ \mathrm{A} = 1\,\frac{\mathrm{C}}{\mathrm{s}}.$$

In general, charge Q is determined by steady current I flowing for a time t as Q = It.

History

The ampere was originally defined as one tenth of the CGS system (https://adafru.it/cco) electromagnetic unit of current (now known as the abampere (https://adafru.it/ccp)), the amount of current that generates a force of two dynes (https://adafru.it/ccq) per centimetre of length between two wires one centimetre apart. The size of the unit was chosen so that the units derived from it in the MKSA system (https://adafru.it/cca) would be conveniently sized.

The "international ampere" was an early realization of the ampere, defined as the current that would deposit 0.001118000 grams of silver per second from a silver nitrate (https://adafru.it/ccr) solution. Later, more accurate measurements revealed that this current is 0.99985 A.

Realization

The standard ampere is most accurately realized using a watt balance (https://adafru.it/ccs), but is in practice maintained via Ohm's Law (https://adafru.it/19nE) from the units of electromotive force (https://adafru.it/ccu) and resistance (https://adafru.it/ccv), the volt (https://adafru.it/ccw) and the ohm (https://adafru.it/ccx), since the latter two can be tied to physical phenomena that are relatively easy to reproduce, the Josephson junction (https://adafru.it/ccy) and the quantum Hall effect (https://adafru.it/ccz), respectively.

At present, techniques to establish the realization of an ampere have a relative uncertainty (https://adafru.it/ccA) of approximately a few parts in 107, and involve realizations of the watt, the ohm and the volt.

Proposed future definition

Main article: New SI definitions (https://adafru.it/ccB)

Rather than a definition in terms of the force between two current-carrying wires, it has been proposed to define the ampere in terms of the rate of flow of elementary charges. Since a coulomb (https://adafru.it/ccg) is approximately equal to 6.2415093×1018 elementary charges (https://adafru.it/ccC) (such as electrons (https://adafru.it/ccf)), one ampere is approximately equivalent to 6.2415093×1018 elementary charges moving past a boundary in one second, or the reciprocal of the value of the elementary charges in coulombs. The proposed change would define 1 A as being the current in the direction of flow of a particular number of elementary charges per second. In 2005, the International Committee for Weights and Measures (https://adafru.it/ccD) (CIPM) agreed to study the proposed change. The new definition (https://adafru.it/ccB) is expected to be formally proposed at the 25th General Conference on Weights and Measures (https://adafru.it/ccE) (CGPM) in 2014.

Everyday examples

Main article: Orders of magnitude (current) (https://adafru.it/ccF)

The current drawn by typical constant-voltage energy distribution systems is usually dictated by the power (watts (https://adafru.it/ccG)) consumed by the system and the operating voltage. For this reason the examples given below are grouped by voltage level.

Portable gadgets

- Hearing aid (typically 1 mW at 1.4 V): 0.7 mA

Motor vehicles – 12 V DC

A typical motor vehicle has a 12 V battery. The various accessories that are powered by the battery might include:

- Instrument panel light (typically 2 W): 166 mA.
- Headlights (typically 60 W): 5 A each.
- Starter Motor (typically 1–2 kW): 80-160 A

North American domestic supply – 120 V AC

Most United States, Canada and Mexico domestic power suppliers run at 120 V.

Household circuit breakers (https://adafru.it/ccH) typically provide a maximum of 15 A or 20 A of current to a given set of outlets.

- 22-inch/56-centimeter portable television (35 W): 290 mA
- Tungsten light bulb (60–100 W): 500–830 mA
- Toaster, kettle (2 kW): 16.6 A
- Immersion heater (4.6 kW): 38.3 A

European domestic supply – 230 V AC

Most European domestic power supplies run at 230 V, so the current drawn by a particular European appliance (in Europe) will be less than for an equivalent North American appliance.

The current drawn by a number of typical appliances are:

- 22-inch/56-centimeter Portable Television (35 W): 150 mA
- Tungsten light bulb (60–100 W): 250–450 mA
- Compact Fluorescent Lamp (13–30 W): 58–112 mA

- Toaster, kettle (2 kW): 9 A
- Immersion heater (4.6 kW): 20 A

See also

- Ammeter (https://adafru.it/ccI)
- Ampacity (https://adafru.it/ccJ) (current-carrying capacity)
- Electric current (https://adafru.it/ccb)
- Electric shock (https://adafru.it/ccK)
- Hydraulic analogy (https://adafru.it/alv)
- Magnetic constant (https://adafru.it/ccL)

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André-Marie Ampère

André-Marie Ampère (20 January 1775 – 10 June 1836) was a French (https://adafru.it/ccN) physicist (https://adafru.it/ccO) and mathematician (https://adafru.it/ccP) who is generally regarded as one of the main founders of the science of classical electromagnetism (https://adafru.it/ccQ), which he referred to as "electrodynamics". The SI (https://adafru.it/cca) unit of measurement of electric current (https://adafru.it/ccb), the ampere (https://adafru.it/cch), is named after him.

From: Wikipedia "André-Marie Ampère **(https://adafru.it/Cct)**"

Biography

Ampère was born on 20 January 1775 to Jean-Jacques Ampère, a prosperous businessman, and Jeanne Antoinette Desutières-Sarcey Ampère during the height of

the French Enlightenment (https://adafru.it/ccR). He spent his childhood and adolescence at the family property at Poleymieux-au-Mont-d'Or (https://adafru.it/19nF) near Lyon. Jean-Jacques Ampère, a successful merchant, was an admirer of the philosophy of Jean-Jacques Rousseau (https://adafru.it/ccT), whose theories of education (as outlined in his treatise Émile (https://adafru.it/ccU)) were the basis of Ampère's education. Rousseau believed that young boys should avoid formal schooling and pursue instead an "education direct from nature." Ampère's father actualized this ideal by allowing his son to educate himself within the walls of his well-stocked library. French Enlightenment masterpieces such as Georges-Louis Leclerc, comte de Buffon (https://adafru.it/ccV)'s Histoire naturelle, générale et particulière (begun in 1749) and Denis Diderot (https://adafru.it/ccW) and Jean le Rond d'Alembert (https://adafru.it/19oa)'s Encyclopédie (https://adafru.it/Ccv) (volumes added between 1751 and 1772) thus became Ampère's schoolmasters. The young Ampère, however, soon resumed his Latin (https://adafru.it/ccZ) lessons, which enabled him to master the works of Leonhard Euler (https://adafru.it/cd0) and Daniel Bernoulli (https://adafru.it/cd1).

French Revolution

In addition, Ampère used his access to the latest mathematical books to begin teaching himself advanced mathematics at age 12. In later life Ampère claimed that he knew as much about mathematics and science when he was eighteen as ever he knew; but, a polymath (https://adafru.it/cd2), his reading embraced history, travels, poetry, philosophy, and the natural sciences. His mother was a devout woman, so Ampère was also initiated into the Catholic faith (https://adafru.it/cd3) along with Enlightenment science. The French Revolution (https://adafru.it/cd4) (1789–99) that began during his youth was also influential: Ampère's father was called into public service (https://adafru.it/cd5) by the new revolutionary government, becoming a justice of the peace in a small town near Lyon. When the Jacobin (https://adafru.it/cd6) faction seized control of the Revolutionary government in 1792, his father Jean-Jacques Ampère resisted the new political tides, and he was guillotined (https://adafru.it/cd7) on 24 November 1793, as part of the Jacobin purges of the period.

In 1796 Ampère met Julie Carron. André-Marie Ampère took his first regular job in 1799 as a mathematics (https://adafru.it/cd8) teacher, which gave him the financial security to marry Carron and father his first child, Jean-Jacques (https://adafru.it/Ccx) (named after his father), the next year. (Jean-Jacques Ampère eventually achieved his own fame as a scholar of languages.) Ampère's maturation corresponded with the transition to the Napoleonic regime (https://adafru.it/cda) in France, and the young father and teacher found new opportunities for success within the technocratic structures favoured by the new French emperor. In 1802 Ampère was appointed a professor of physics (https://adafru.it/cdb) and chemistry (https://adafru.it/cdc) at the

École Centrale in Bourg-en-Bresse (https://adafru.it/cdd), leaving his ailing wife and infant son in Lyon. He used his time in Bourg to research mathematics, producing Considérations sur la théorie mathématique de jeu (1802; “Considerations on the Mathematical Theory of Games”), a treatise on mathematical probability (https://adafru.it/cde) that he sent to the Paris Academy of Sciences (https://adafru.it/cdf) in 1803.

Teaching career

After the death of his wife in July 1803, Ampère moved to Paris (https://adafru.it/cdg), where he began a tutoring post at the new École Polytechnique (https://adafru.it/Ccy) in 1804. Despite his lack of formal qualifications, Ampère was appointed a professor of mathematics at the school in 1809. As well as holding positions at this school until 1828, in 1819 and 1820 Ampère offered courses in philosophy (https://adafru.it/cdi) and astronomy (https://adafru.it/cdj), respectively, at the University of Paris (https://adafru.it/cdk), and in 1824 he was elected to the prestigious chair in experimental physics (https://adafru.it/cdl) at the Collège de France (https://adafru.it/Ccz). In 1814 Ampère was invited to join the class of mathematicians in the new Institut Impériale, the umbrella under which the reformed state Academy of Sciences would sit.

Ampère engaged in a diverse array of scientific inquiries during the years leading up to his election to the academy—writing papers and engaging in topics from mathematics and philosophy to chemistry and astronomy. Such breadth was customary among the leading scientific intellectuals of the day. Ampère claimed that "at eighteen years he found three culminating points in his life, his First Communion (https://adafru.it/cdn), the reading of Antoine Leonard Thomas's "Eulogy of Descartes", and the Taking of the Bastille (https://adafru.it/cdo). On the day of his wife's death he wrote two verses from the Psalms (https://adafru.it/cdp), and the prayer, 'O Lord, God of Mercy, unite me in Heaven with those whom you have permitted me to love on earth.' Serious doubts harassed him at times, and made him very unhappy. Then he would take refuge in the reading of the Bible (https://adafru.it/cdq) and the Fathers of the Church (https://adafru.it/cdr)."

For a time he took into his family the young student Antoine-Frédéric Ozanam (https://adafru.it/CcA) (1813–1853), one of the founders of the Conference of Charity (https://adafru.it/cdt), later known as the Society of Saint Vincent de Paul (https://adafru.it/cdu). Through Ampère, Ozanam had contact with leaders of the neo-Catholic (https://adafru.it/cdv) movement, such as François-René de Chateaubriand (https://adafru.it/CcB), Jean-Baptiste Henri Lacordaire (https://adafru.it/cdx), and Charles Forbes René de Montalembert (https://adafru.it/CcC). Ozanam was beatified (https://adafru.it/cdz) by Pope John Paul II (https://adafru.it/cdA) in 1997.

Work in electromagnetism

In September 1820, Ampère's friend and eventual eulogist François Arago (https://adafru.it/CcD) showed the members of the French Academy of Sciences the surprising discovery of Danish (https://adafru.it/cdC) physicist Hans Christian Ørsted (https://adafru.it/CcE) that a magnetic needle (https://adafru.it/cdE) is deflected by an adjacent electric current (https://adafru.it/ccb). Ampère began developing a mathematical and physical theory to understand the relationship between electricity (https://adafru.it/cdF) and magnetism (https://adafru.it/cdG). Furthering Ørsted's experimental work, Ampère showed that two parallel wires carrying electric currents attract or repel each other, depending on whether the currents flow in the same or opposite directions, respectively - this laid the foundation of electrodynamics. He also applied mathematics in generalizing physical laws from these experimental results. The most important of these was the principle that came to be called Ampère's law (https://adafru.it/19ob), which states that the mutual action of two lengths of current-carrying wire is proportional to their lengths and to the intensities of their currents. Ampère also applied this same principle to magnetism, showing the harmony between his law and French physicist Charles Augustin de Coulomb (https://adafru.it/cdI)'s law of magnetic action. Ampère's devotion to, and skill with, experimental techniques anchored his science within the emerging fields of experimental physics.

Ampère also provided a physical understanding of the electromagnetic relationship, theorizing the existence of an "electrodynamic molecule" (the forerunner of the idea of the electron (https://adafru.it/ccf)) that served as the component element of both electricity and magnetism. Using this physical explanation of electromagnetic motion, Ampère developed a physical account of electromagnetic phenomena that was both empirically demonstrable and mathematically predictive. In 1827 Ampère published his magnum opus, Mémoire sur la théorie mathématique des phénomènes électrodynamiques uniquement déduite de l'experience (Memoir on the Mathematical Theory of Electrodynamic Phenomena, Uniquely Deduced from Experience), the work that coined the name of his new science, electrodynamics, and became known ever after as its founding treatise. In 1827 he was elected a Foreign Member of the Royal Society (https://adafru.it/cdJ) and in 1828, a foreign member of the Royal Swedish Academy of Science (https://adafru.it/cdK). In recognition of his contribution to the creation of modern electrical science, an international convention signed in 1881 established the ampere (https://adafru.it/cdL) as a standard unit of electrical measurement, along with the coulomb (https://adafru.it/ccg), volt (https://adafru.it/ccw), ohm (https://adafru.it/ccx), and watt (https://adafru.it/ccG), which are named, respectively, after Ampère's contemporaries Charles-Augustin de Coulomb (https://adafru.it/cdM) of France (https://adafru.it/cdN), Alessandro Volta (https://adafru.it/cdO)

of Italy (https://adafru.it/cdP), Georg Ohm (https://adafru.it/cdQ) of Germany (https://adafru.it/cdR), and James Watt (https://adafru.it/cdS) of Scotland (https://adafru.it/cdT).

Writings

- Considerations sur la théorie mathématique du jeu, Perisse (https://adafru.it/CcG), Lyon Paris 1802, online lesen (https://adafru.it/cdV) im Internet-Archiv (https://adafru.it/cdW)
- André-Marie Ampère (1822) (in French), [read online (https://adafru.it/cdX) at Google Books (https://adafru.it/cdY) Recueil d'observations électro-dynamiques

contenant divers mémoires, notices, extraits de lettres ou d'ouvrages périodiques sur les sciences, relatifs a l'action mutuelle de deux courans électriques, à celle qui existe entre un courant électrique et un aimant ou le globe terrestre, et à celle de deux aimans l'un sur l'autre], Chez Crochard read online (https://adafru.it/cdX) at Google Books (https://adafru.it/cdY). Retrieved 2010-9-26

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External links

- Ampère and the history of electricity (https://adafru.it/ceb) - a French-language, edited by CNRS, site with Ampère's correspondence (full text and critical edition with links to manuscripts pictures, more than 1000 letters), an Ampère bibliography, experiments, and 3D simulations
- Ampère Museum (https://adafru.it/cec) - a French-language site from the museum in Poleymieux-au-Mont-d'or, near Lyon (https://adafru.it/ced), France (https://adafru.it/cdN)

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- André-Marie Ampère: The Founder of Electromagnetism (https://adafru.it/ceq) - Background information and related experiments

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