Contents

Timeline v de Sitter, Willem 72
Introduction 1 Dukas, Helen 74
Absentmindedness 3 E = mc² 76
Anti-Semitism 4 Eddington, Sir Arthur 79
Arms Race 8 Education 82
 Atomic Bomb 9 Ehrenfest, Paul 85
Awards 16 Einstein, Elsa Löwenthal 88
Beauty and Equations 17 Einstein, Mileva Maric 93
Besso, Michele 18 Einstein Field Equations 100
Black Holes 21 Einstein-Podolsky-Rosen Argument 101
Bohr, Niels Henrik David 25 Einstein Ring 106
Books about Einstein 30 Einstein Tower 107
Born, Max 33 Einsteinium 108
Bose-Einstein Condensate 34 Electrodynamics 108
Brain 36 Ether 110
Brownian Motion 39 FBI 113
Career 41 Freud, Sigmund 116
Causality 44 Friedmann, Alexander 117
Childhood 46 Germany 119
Children 49 God 124
Clothes 58 Gravitation 126
Communism 59 Gravitational Waves 128
Correspondence 62 Grossmann, Marcel 129
Cosmological Constant 63 Hair 131
Cosmology 65 Heisenberg, Werner Karl 132
Curie, Marie 68 Hidden Variables 137
Death 70 Hilbert, David 138
iv Contents

Inventions 142
Israel 144
Japan 146
Jokes about Einstein 148
Judaism 149
Kaluza-Klein Theory 151
League of Nations 153
Lemaître, Georges 154
Lenard, Philipp 156
Lorentz, Hendrik 158
Mach, Ernst 161
Mathematics 164
McCarthyism 166
Michelson-Morley Experiment 167
Millikan, Robert 171
Miracle Year 174
Monroe, Marilyn 179
Mysticism 179
Myths and Misconceptions 181
Nazism 184
Newton, Isaac 188
Nobel Prize in Physics 190
Olympia Academy 195
Oppenheimer, J. Robert 197
Pacifism 199
Parents 202
Patent Office 205
Pauli, Wolfgang Ernst 207
Photochemistry 209
Photoelectric Effect 210
Photons 213
Pipe 215
Planck, Max 216
Poincaré, Henri 220
Popular Works 222
Positivism 223
Princeton 226
Quantum Mechanics 230
Reference Frames 237
Relativity, General Theory of 239
Relativity, Special Theory of 247
Religion 255
Roosevelt, Franklin D. 258
Russell-Einstein Manifesto 260
Schroedinger, Erwin 261
Solvay Conferences 265
Space-Time 267
Spinoza, Baruch (Benedictus) 268
Stark, Johannes 270
Switzerland 272
Thought Experiments 274
Time Travel 276
Twin Paradox 279
Uncertainty Principle 280
Unified Theory 282
United States 284
Violin 288
Wave-Particle Duality 289
Women, Einstein and 291
Wormholes 293
Zionism 295

Acknowledgments 298
Selected Bibliography 300
Index 302
Timeline

1879  On March 14, Albert Einstein is born in Ulm, Germany, to Hermann Einstein (1847–1902) and Pauline Koch Einstein (1858–1920) at 11:30 A.M.
1880  The Einstein family moves to Munich.
1881  On November 18, Einstein’s sister Maria (nicknamed Maja) is born in Munich.
1885  Six-year-old Einstein begins taking violin lessons, which he dislikes at first, but grows to love.
1885–1888  Einstein attends primary school. At home, a family relative gives him a Jewish education.
1888–1894  Einstein attends the Luitpold Gymnasium for secondary school. During this time, the family becomes friends with Max Talmey (né Talmud), a medical student who introduces Einstein to many scientific books and topics.
1890  Einstein experiences what he later will describe as his brief “religious paradise,” in which he embraces Judaism whole-heartedly and keeps kosher.
1892  At the age of thirteen, Einstein rejected organized religion and chose not to have the traditional Jewish bar mitzvah.
1894  The Einstein family moves to Milan, Italy, but they leave Albert behind in Munich so he can finish school. Einstein is so miserable that he drops out of school and shows up unannounced in Milan.
1895  Einstein takes an application exam to enter the Swiss Polytechnic University, known as ETH, but he fails anything that doesn’t have to do with science and math. He goes off to the Swiss town of Aarau to study before retaking the exam. Einstein writes what might be termed his “first paper,” a study on how ether reacts to magnetism, which he mails to his uncle Caesar Koch. He also meets his first girlfriend, Marie Winteler.
1896  Einstein renounces his German citizenship. In the fall, he enters the ETH as a physics student and meets a fellow student, Mileva Maric (1875–1948). Einstein's parents dislike Mileva the moment they hear of her, but she would come to be his first wife.

1900  Einstein graduates from the ETH, but does not have a job. He submits his first paper (on capillarity) to the renowned German journal *Annalen der Physik*.

1901  Einstein officially becomes a Swiss citizen, and within a month is informed he doesn’t have to serve in the army due to flat feet. Unable to find other work, he takes a job as a tutor in Schaffhausen. He and Mileva have a secret tryst in Italy where she becomes pregnant. Once visibly pregnant, Mileva moves in with her parents in Hungary.

1902  Einstein moves to Bern, hoping that a job at the patent office will come through. Mileva and Einstein's daughter, Lieserl, is born. Einstein never meets his daughter and it is unclear whether she died at a young age or was given up for adoption. Einstein gets a job at the Bern Patent Office, where he will stay for seven years. His father, Hermann Einstein, dies in Milan, but on his deathbed he finally gives permission to his son to marry Mileva. Einstein publishes two papers in *Annalen der Physik*.

1903  On January 6, Einstein and Mileva marry. Einstein, Conrad Habicht, and Maurice Solovine start the Olympia Academy, a group of friends that discuss scientific and philosophical thoughts of the day. Einstein publishes one paper in *Annalen der Physik*, describing the theory of the foundations of thermodynamics.

1904  Einstein’s first son, Hans Albert, is born on May 14.

1905  Known as Einstein’s “miracle year” or “Annus mirabilis,” Einstein publishes five papers in the *Annalen der Physik* including his papers on the photoelectric effect, Brownian motion, special relativity, and $E = mc^2$.

1907  Einstein begins to incorporate gravity into his previous theories. This will eventually grow into the general theory of relativity.

1908  Einstein takes a part-time, nontenured teaching position at the University of Bern. He works with a co-author (J. J. Laub) for the first time, and together they publish two papers in *Annalen der Physik*.

1909  Einstein is finally offered a full-time professorship and he quits his job at the patent office to work at the University of Zurich.
1910  On July 28, Mileva and Einstein’s second son, Eduard (known as Tete) is born.

1911  Einstein moves his family to Prague for a new job at the Karl Ferdinand University. In October, at the age of thirty-two, Einstein is the youngest scientist invited to the first ever Solvay Conference in Brussels, and he is honored with giving the closing presentation.

1912  The Einsteins move back to Zurich, where Einstein takes a job as a professor at the ETH, his alma mater. On a visit to Berlin, he re-meets his cousin Elsa Einstein and begins an affair with her.

1913  Einstein attends the Second Solvay Conference in Brussels.

1914  Einstein moves to Berlin to take a job at the Kaiser Wilhelm Institute. Within a few months, Mileva and their sons move back to Zurich and so begins the formal separation of Einstein’s marriage. In August, World War I begins and, in response, Einstein signs the pacifist document the “Manifesto to Europeans.” This was the first of many political documents that Einstein signed.


1917  Einstein publishes his first paper on cosmology and introduces the cosmological constant. Possibly exhausted after the intense work of the previous years, Einstein collapses and becomes seriously ill. Elsa Einstein helps nurse him back to health, though he does not fully recover until 1920.

1919  In February, Einstein and Mileva finalize their divorce and, a few months later, Einstein marries Elsa. In May, Sir Arthur Eddington leads an expedition to view a solar eclipse and see whether starlight bends around the sun according to the laws of relativity. It does, and the general theory of relativity is therefore heralded as being “proven.” Overnight, Einstein becomes a celebrity.

1920  Einstein’s mother, Pauline, who has been living with him and Elsa, dies at his residence. Einstein feels the first obvious effects of anti-Semitism as the Anti-Relativity Society holds a conference rallying against his “Jewish” theories. Einstein uncharacteristically writes a heated defense of his work in a Berlin newspaper.

1921  That spring, Einstein visits the United States for the first time, not to give science lectures, but for political reasons: he travels with Zionist Chaim Weizmann to raise funds for the Hebrew University of
viii Timeline

Jerusalem. President Warren Harding invites him to the White House. While he is in Chicago, Einstein meets the Nobel Prize–winning physicist Robert Millikan, who will eventually lure him to the United States with a job at Caltech.

1922 Einstein publishes his first paper on unified field theory, the still unfinished attempt to join the theories of relativity and quantum mechanics on which he would focus for the rest of his life. On June 24, foreign minister Walther Rathenau, a prominent and assimilated German Jew, is assassinated. After being told he may be next, Einstein leaves Berlin for awhile. He takes a lecture tour through Japan and in November it is announced that he has been awarded the 1921 Nobel Prize in physics for his work on the photoelectric effect.

1923 On the way back from Japan, Einstein stops in Israel, delivers the inaugural address at Hebrew University, and is made the first honorary citizen of Tel Aviv. In July, he travels to Gothenburg, Sweden and delivers his Nobel Prize lecture. Despite the fact that he won the prize for the photoelectric effect, he gives a talk on relativity.

1924 Satyendra Nath Bose of Dacca University sends a paper to Einstein entitled “Planck’s Law and the Hypothesis of Light Quanta.” The two men will collaborate to describe a new state of matter today called Bose-Einstein condensation. Einstein’s stepdaughter, Ilse, marries writer Rudolph Kayser.

1927 In May, Einstein’s oldest son, Hans Albert, marries Frida Knecht against his father’s wishes. Einstein attends the fifth Solvay Conference along with Niels Bohr and other early crafters of quantum mechanics. While many of the scientists leave feeling comfortable that they have hammered out the proper interpretation of the new science known as the Copenhagen interpretation, Einstein disagreed with it vehemently.

1928 Helen Dukas, Einstein’s secretary on whom he would grow more and more dependent, begins to work for the Einstein family.

1929 Einstein is invited to visit with the Belgian royal family. He meets Queen Elizabeth of Belgium and they write letters to each other for the rest of his life.

1930 Einstein travels to the United States for the second time, visiting the California Institute of Technology as a visiting scholar. Einstein’s first grandson, Bernard Caesar, is born to Hans Albert
Einstein. Einstein’s stepdaughter Margot marries Dimitri Marianoff, who, after their divorce, would write a tell-all biography of his ex-father-in-law.

1931 After Edwin Hubble shows that the universe is expanding, Einstein rejects his previous notion of a “cosmological constant,” a term he’d included in his general relativity theories specifically to explain why the universe was not expanding. Einstein visits the United States for the third time, again to teach at Caltech.

1932 Einstein receives an offer for a professorship at the Institute for Advanced Study in Princeton, which he accepts. Originally planning to maintain a part-time job in Berlin, as well, he leaves Germany for the United States in December.

1933 On January 30, the Nazis are voted into power in Germany. In March, they raid Einstein’s summer house. Einstein briefly returns to Europe, staying in Belgium, but he never sets foot in Germany again. He resigns from the Prussian Academy of Sciences and then the Bavarian Academy of Sciences. In October, Einstein moves to Princeton for good, along with his wife, Elsa, his secretary, Helen Dukas, and research assistant, Walther Mayer.

1934 Einstein publishes his first collection of popular articles, entitled Mein Weltbild (The World As I See It). His stepdaughter Ilsa Kayser dies in Paris, at the age of 37. His other stepdaughter, the newly divorced Margot, moves to Princeton.

1935 Einstein applies for permanent residency in the United States. He publishes a paper with Boris Podolsky and Nathan Rosen, in which he presents an argument that quantum mechanics is not a complete theory and needs additional work.

1936 On December 20, Einstein’s wife, Elsa, dies at the age of sixty.

1938 Einstein co-authors a book called The Evolution of Physics with Leopold Infeld.

1939 Einstein’s sister Maja moves to Princeton. On August 2, Einstein sends a letter to President Franklin D. Roosevelt cautioning that the Europeans have discovered how to control nuclear reactions and that the United States must invest in similar research lest the Axis powers create atomic weapons.

1940 Einstein becomes a U.S. citizen in October. (He retains his Swiss citizenship.)
1944 Einstein handwrites a copy of his 1905 paper on special relativity and it is auctioned for six million dollars. The money is donated to the war effort.

1945 Einstein formally retires from the Institute for Advanced Study in Princeton, but he continues working on physics theories. His focus for much of the rest of his life is on perfecting a unified field theory that he believes will bring the theories of quantum mechanics and relativity together.

1946 Einstein becomes the president of the Emergency Committee of Atomic Scientists. He continues to speak out against war and writes a letter to the United Nations calling for a single world government.

1948 In August, Einstein's first wife, Mileva, dies in Zurich. Doctors discover that Einstein has an aneurysm on his abdominal aorta.

1949 Einstein publishes Autobiographical Notes, the closest he ever comes to an autobiography. He does not write about his personal life, but instead, discusses how he developed his scientific theories.

1950 Einstein signs his will. He publishes his second collection of popular works, Out of My Later Years.

1951 Einstein's sister Maja dies in June.

1952 Einstein is offered the presidency of Israel. He declines.

1954 Einstein writes in support of J. Robert Oppenheimer, who has been accused of anti-Americanism by Senator McCarthy.


1973 Einstein's older son, Hans Albert, dies in Boston.

1982 Einstein's secretary, Helen Dukas, who guarded his correspondence ferociously after his death, dies.

1986 Einstein's stepdaughter, Margot, dies.

1987–today Einstein's letters and papers are collated and published. Historical information about the scientist suddenly becomes plentiful and numerous pieces of information that had been held under wraps are made public.
Introduction

Tackling a human life in alphabetical order is a fascinating task. Instead of a continuous story that includes highs and lows, descriptions of a personality with both strengths and weaknesses, a tale of triumphs coupled with failures, an encyclopedia spotlights a single topic to the exclusion of others. Every aspect of the subject’s life is presented starkly and without mitigating factors.

Consequently, as we wrote these entries about Albert Einstein, our impressions of him regularly changed as we were confronted with different—and sometimes contradictory—slices of the man’s life. When writing about his theories, we were in awe that he had the genius and imagination to make such creative leaps. When writing about his family life, we were forced to accept that he was a poor husband and father, casting away his first wife and two sons and cheating on his second wife. He was obsessed to the point of eccentricity with the support of pacifist causes, yet he urged on the development of the first atomic weapon. He created modern relativity theory, and yet refused to accept the second great theory of the twentieth century: quantum mechanics. He was a statesman on par with the world’s greatest political leaders, yet he was a homebody who demanded in the United States a re-creation of his German household, never comfortable in his adopted country. He was a devoted Jew who detested religion.

And yet, parsing out a biography in this way has its advantages. *Einstein: A to Z* is designed to be as casual or as specific as the reader wishes. You want to know if Marilyn Monroe ever met Einstein? Turn to “M.” How did Einstein’s theories open up the possibility of time travel? Go to “T.” Flip to “Children” and learn of Einstein’s illegitimate daughter and his messy, complicated, and all-to-human family life. Go to “Relativity” or “E = mc²” and you’ll get a detailed description of Einstein’s science. Read the book straight through, from “Absentmindedness” to “Zionism,” and you’ll know it all. (If you’re
looking for a place to start, Aries's favorite entry is “Brain” and Karen's favorite entry is “Wormholes.”)

Most important, you will learn that the contradictions of Einstein's life could not obscure his contributions. His theories, one more elegant than the last, nourished and created the very foundation for twentieth-century science. Ultimately, as we wrote this book, we realized that Einstein quite simply was all his contradictions simultaneously: stubborn, brilliant, modest, self-centered, generous, passionate. A biography presented in bite-size entries, as this book is, offers the chance to see the truth behind an icon in a way that is rarely possible.

So, flip to a random page, read the book in order, or put it on your shelf as a desk reference. We hope you enjoy it as much as we've enjoyed writing it.
Absentmindedness

Unkempt hair, wrinkled clothes, and disorderly class lectures. Einstein’s famous persona embodied—indeed, created—the image of the “absentminded genius.”

Whether a love of science automatically results in an inability to keep track of day-to-day details, anyone immersed in thought does learn to block distractions. And since Einstein’s work was often on his mind, it’s no surprise that anyone who wanted him to focus on practical matters sometimes found him mentally out to lunch.

Einstein could get so caught up in his ideas that he would overlook the basics of life; when he was coming up with his general theory of relativity he neglected to sleep or eat. And once when his friends in Switzerland bought him a full tin of caviar for his twenty-fourth birthday, he was so engrossed in discussing inertia that he wolfed down the entire treat without noticing. (They made up for it a few days later, presenting him with a new tin of the stuff; this time chanting “Now we are eating caviar” to make sure their friend was paying attention.)

Einstein could become so engrossed in thought he’d forget where he was—once coming to a dead stop in the middle of a busy Princeton street—arguing his point as cars drove around the unconcerned scientist.

But nothing quite epitomizes the absentminded professor more than poor choice in clothing. The lecturer who shows up to class having forgotten to put on his pants is a timeless image, and Einstein had his share of similar stories. A classic comes from James Blackwood, who lived next door to Einstein and his wife, Elsa, in Princeton. In the biography Einstein: A Life by Denis Brian, Blackwood remembers his mother was once sitting in the Einstein living room, “talking with Elsa. Einstein was in the music room improvising on the piano. The music stopped and Einstein came past them, hair straying in all directions, no shirt or undershirt on, trousers sadly drooping and, I think, barefoot. He walked past them as if in a trance.” Blackwood said there was “no sense of embarrassment, no recognition of his mother’s
presence. He just drifted past and walked upstairs, while Mrs. Einstein clasped her hands and said, ‘Oh, Albertle!’” Einstein also had a lifelong habit of not wearing socks, and many believed he simply forgot to put them on.

Since Einstein was so famous, just about every move he made appeared in the news and was often seen as a sign of the man’s brilliance. So it’s not surprising that even his casual clothing—baggy sweatshirt, brown corduroy pants, and sock-free feet—became an iconographic image of his intelligence. The image of the absentminded professor was born; lack of concern with daily appearance became forever linked with genius. But who knows whether Einstein honestly forgot to put on his shirt and socks, or if he just didn’t embarrass easily. It’s clear that Einstein knowingly toyed with his public image. He took great delight in mocking his own wild hairstyle and sweatshirt-based attire, suggesting that he was very aware of—if not actually cultivating—his distracted persona. In truth, Einstein was just a man like any other, and not a tidy one at that. Perhaps he was absentminded. Or perhaps he just didn’t care.

See Clothes; Hair.

Anti-Semitism

As a Jew living in pre-World War II Germany, Einstein was subjected to vigorous anti-Semitic attacks, despite the fact that he wasn’t religiously observant. As anti-Semitic fervor rose, even his world-famous scientific theories were derided as a “Jewish fraud.”

In 1919, the year Germany lost World War I, Einstein lived in Berlin. Germany’s financial condition was sinking; inflation and unemployment soared. The country took another blow ten years later when the U.S. stock market crashed in October, sending the world economy into a tailspin. In Nazi Germany, the country’s problems were blamed on the Jews, who were said to be responsible for everything from pornography to a Communist plot to take over the world. The immoral Jews, claimed Hitler, were mounting a global takeover, and although he did not become Germany’s leader until 1933, his beliefs seeped into the country’s culture long before that. Hitler’s political party, the National Socialist German Worker’s Party, published a
leaflet in 1920 stating: “The Jewish big capitalist always plays our friend and do-gooder; but he only does it to make us into his slaves. The trusting worker is going to help him set up the world dictatorship of Jewry. Because that is their goal, as it states in the Bible. ‘All the peoples will serve you, all the wealth of the world will belong to you.’”

The year 1919 was also the year that the theory of general relativity was proven, and Einstein became an international celebrity overnight, without a doubt the most famous Jew in the world. His success attracted attention. In 1922 he wrote to fellow German scientist Max Planck (1858–1947), “The trouble is that the newspapers have mentioned my name too often, thus mobilizing the rabble against me.” Indeed, being a scientist made him all the more suspect; Hitler saw the physical sciences as materialistic and inferior to the high disciplines of art and music. So, long before World War II began, Einstein became one of the first to suffer from Nazi anti-Semitic propaganda.

Einstein’s politics didn’t help. He was a confirmed pacifist and spoke out against Germany’s behavior in World War I, demanding that the military be scrutinized for war crimes. Einstein believed the best way to achieve world peace was to have a single global government—it was nations themselves that divided society into artificial, and contentious, factions. In a country that licked its wounds after losing World War I by nurturing extreme nationalism, such beliefs didn’t endear him to the average German. The country looked for scapegoats, and Einstein was a natural target.

**Ad Hominem Attacks**

One of the loudest voices to speak against Einstein came from an unlikely source: the president of the German physics society, Philipp Lenard (1862–1947). Lenard won the Nobel Prize in 1905 for his work on cathode rays. His work on the photoelectric effect laid some of the groundwork for Einstein’s discoveries. Early in Einstein’s career, he corresponded with Lenard and discussed physics, but, as Germany’s politics turned dark, Lenard not only joined the anti-Semites, he became a rabid attack dog. His assaults against Einstein, two-sided and contradictory, alternated between denying relativity outright as a “Jewish fraud” and claiming Einstein’s theories were too good to be his own; he must have stolen his theories from Friedrich Hasenohrl, a full-blooded German who had died in World War I. Lenard insisted that if accurate “racial knowledge” had been disseminated earlier, everyone
would have known relativity was a deception from the beginning simply because Einstein was a Jew.

Joining Lenard in speaking out against Einstein was another German, Paul Weyland. Weyland claimed to be the head of an organization called the Study Group of German Natural Philosophers, though he seems to have been the only member. The sole purpose of his organization seemed to be to entice money out of anti-Semitic financial supporters and then rally against Einstein, the Jewish scientist. (Indeed, it is unclear what motivated Weyland more: anti-Semitism or the search for money. Weyland ultimately lived a life on the run as a professional grifter.)

On August 24, 1920, Weyland and Lenard gathered a large crowd for a lecture against Einstein in Berlin’s Concert Hall. Einstein, against the advice of his friends, attended, sitting in the balcony where he seemed to be paying rapt attention and occasionally laughing at the speaker. Weyland claimed that the theory of relativity was merely a mass hypnosis of the public and was anathema to “pure” German thought.

Despite his good humor at the lecture, Einstein was defensive enough to submit an impetuous response, a letter to the editor of the Berlin newspaper, the *Berliner Tageblatt*, which published it on the front page. Einstein cited prominent scientists who did support the theory of relativity and then he pointed out the obvious: had he not been Jewish, or had he been more nationalist, he would never have received such attacks. In an uncharacteristic move, the normally high-minded scientist also personally derided Weyland and Lenard as both ignorant and vulgar. Of course, the letter did nothing to convince the opposition, and merely disturbed Einstein’s friends who wished he had kept more distance.

The anti-Semitic attacks continued. In a lecture in Berlin, one of the students stood up and yelled: “I’m going to cut the throat of that dirty Jew!” Days later, groups rallied outside another of Einstein’s physics lectures yelling denouncements.

Soon the verbal jousts grew into more dangerous threats. In 1922, the German foreign minister—and Einstein’s friend—Walther Rathenau, was assassinated. Rathenau was a thoroughly assimilated Jew who thought of himself as a German first and foremost. He was so confident that this anti-Semitic culture would pass that he dismissed all of his bodyguards, despite repeated threats on his life. On June 24, as he drove through the streets of Berlin in an open convertible, two
men with submachine guns and a hand grenade killed him. Einstein was shaken to the core. He attended Rathenau's funeral and was soon informed that his life was also in danger. Einstein wrote to Planck: “A number of people who deserve to be taken seriously have independently warned me not to stay in Berlin for the time being and, especially, to avoid all public appearances in Germany. I am said to be among those whom the nationalists have marked for assassination. Of course, I have no proof, but in the prevailing situation it seems quite plausible.” Newspapers in the United Kingdom reported that Einstein was forced to leave the country, but in fact, he merely left Berlin for a time.

**A New Cause**

Not only did Einstein not think of himself as an observant Jew, but he had always rejected nationalism of any kind. He was well known for making statements that he would never have taken up arms for the German cause in World War I, and that he sought a universal nation free from geographical or political boundaries. However, the intensity of what Einstein perceived to be the evils of fascism and anti-Semitism caused him to rethink his position. He determined that certain acts are so heinous that the right-thinking man may pick up arms to combat them.

The ferocity of the increasing anti-Semitism led Einstein—now in his forties—to join the Zionist campaign to found a Jewish state, led by Chaim Weizmann. To help the Zionists, Einstein accompanied Weizmann on a lecture tour through Europe and America—Einstein's first trip to the United States—seeking support for a nation where Jews could be free from prejudice. While Einstein's efforts to use his fame ultimately did a great deal of good for Jews around the world, some worried that his lectures were hurting the Jews back home. In the 1920s, much of the German Jewish population was integrated into society. They were fiercely loyal to the German government, and fought side-by-side with non-Jews in World War I. These Jews worried that Einstein's call for a separate nation would just make Germans hate them more. Indeed, it had already turned many Germans against Einstein.

In February 1933, Hitler, who had steadily been amassing power, was officially handed the reins to the German government. Einstein happened to be in the United States at the time, and he immediately renounced his German citizenship and spoke out against the Nazi
Arms Race

As the United States and the USSR stockpiled weapons during the Cold War that followed World War II, Einstein repeatedly stated his beliefs that amassing weapons was more likely to lead to conflict than to peace.

After the United States dropped two atomic bombs on Japan, it became clear that the devastating effect of nuclear weapons demanded a new theory of military strategy. Instead of using armies to actively defeat a foe, nations could now merely threaten other nations into submission. But if several nations had an equal ability to destroy, such that if one government launched a lethal attack on another, they could be assured of being killed themselves—a concept known as mutually assured destruction—the thinking went, there would be a balance of power throughout the world. Einstein disagreed. He said that building more weapons would never lead to greater peace, and...
he often spoke out against what he saw as an excuse for a nation’s violent nature. He described the arms race as having assumed a “hysterical character” and that it did nothing more than hasten the chances of mass destruction.

Einstein believed that giving the military too much power created a society addled with distrust of other nations, one that would inevitably go to war simply because they were so overwhelmingly prepared to do so. The only solution Einstein saw to ending the arms race was the development of a strong international government that would keep the power hungry in check and support weaker nations.

Einstein took it upon himself to prod other scientists to speak up against the arms race. In 1955, the British philosopher Bertrand Russell wrote Einstein of his “profound disquiet by the armaments race in nuclear weapons.” Einstein suggested that he and Russell organize a public declaration of their pacifist position, signed by twelve other internationally-known scientists. The Russell-Einstein manifesto was signed just days before Einstein died.

See Atomic Bomb; Russell-Einstein Manifesto; Pacifism.

**Atomic Bomb**

_Einstein developed the scientific theory—_\( E = mc^2 \)—_that laid the groundwork for humans to get massive amounts of energy out of the atom, leading to the building of the atom bomb. In 1939, he also helped spur the creation of nuclear weapons by writing to President Franklin Roosevelt encouraging him to build such a bomb before the Germans did._

In 1935, Einstein gave a lecture at the annual meeting of the American Association for the Advancement of Science in Pittsburgh. After his talk, he was asked if it was possible to create a feasible power source by smashing atoms to release their intrinsic energy. He said it was as promising, “as firing at birds in the dark, in a neighborhood that has few birds.” Headlines for the local newspaper, the _Pittsburgh Post-Gazette_, said Einstein had wrecked all hope of deriving energy from the atom.

The headlines had it wrong. Einstein did believe it was possible to get energy out of an atom; what he meant was that it wasn’t going to be easy or practical in the near future. But as it turned out, scientists
just needed to focus on the right kind of atom—atoms of uranium. As early as July 1920, Einstein spoke about uranium to the Berlin newspaper, the Berliner Tageblatt, saying that “It might be possible, and it is not even improbable, that novel sources of energy of enormous effectiveness will be opened up.” At the same time, Einstein added the hefty caveat, “but this idea has no direct support from the facts known to us so far. It is very difficult to make prophecies, but it is within the realm of the possible. . . . For the time being, however, these processes can only be observed with the most delicate equipment. This needs emphasizing, because otherwise people immediately lose their heads.”

Others did appear to be losing their heads: In the same issue of the newspaper, Germany’s Privy Councilor declared: “We confidently believe that German science will now find a way [to create energy from uranium].” Germany also seemed to be the first country to conceive of using the energy in an atom for a weapon. Four years later, German scientists recommended that the German Army look into ways to build bombs that used chain reactions. One wrote, “The country that exploits it first will have an incalculable advantage over the others.”

**Energy from the Atom Becomes a Reality**

At the end of 1938, two scientists at Germany’s Kaiser Wilhelm Institute discovered that bombarding uranium nuclei with neutrons would split them in two. The information reached the Allies, because one of the scientists, Otto Hahn (1879–1968), wrote a letter to a former colleague, Lise Meitner (1878–1968), who had fled Germany to live in Sweden. That Christmas, Meitner and her nephew, Otto Frisch (1904–1979), wrote a notice about the discovery for the British journal Nature. Frisch also told Niels Bohr about the experiment just before Bohr left for the United States to spend a few months studying alongside Einstein at the Institute for Advanced Study in Princeton, New Jersey. Bohr reported the news to American physicists and suddenly the scientific community was abuzz with concern. Everyone was caught up in a frenzy of experimental activity to see whether splitting an atom and reaping its energy truly was possible.

At the time, Nazi Germany was on the rise and the scientific community, quite rightly, believed that Germany was attempting to build an atomic weapon. But while many physicists were studying atomic science, Einstein himself had only a passing knowledge of what was going on. It was far from his more theoretical interests in quantum
mechanics and finding a unified field theory. On March 14, 1939, the New York Times published an extensive interview with Einstein to coincide with his sixtieth birthday. Einstein speculated about his fellow physicists’ latest obsession. He said that so far, none of the science suggested a viable practical application, “However there is no single physicist with soul so poor who would allow this to affect his interest in this highly important subject.”

By that summer, however, Einstein had become fully versed in the true possibilities of atomic fission. Einstein had long since left Nazi Germany for his new home in Princeton, and often spent his summers in Long Island, New York. In the middle of July 1939, physicists Eugene Wigner and Leo Szilard—motivated by their growing fears—decided to pay a surprise visit to Einstein’s rental house on Great Peconic Bay. Szilard, a Hungarian Jew who had also fled Hitler’s Europe, wanted to convince Einstein to use his close relationship with the queen of Belgium to keep uranium out of Germany. At that time, the largest deposits of uranium ore discovered were in the Belgian Congo, and Einstein had continued a lively correspondence with the queen from the time they met in 1929.

Einstein wrote the letter and gave it to Szilard to relay to the queen via the American State Department. But Szilard rethought the idea and, after speaking to presidential advisers, returned to Einstein’s beach house. Szilard believed the person who really needed to know about the possibilities of a uranium bomb was the president of the United States. Szilard and Einstein wrote another letter, this one to Franklin Roosevelt. (Actually there were two letters to Roosevelt, one short and one long; Einstein signed both, but told Szilard that he preferred the second one.)

Albert Einstein
Old Grove Rd.
Nassau Point
Peconic, Long Island
August 2d, 1939

F.D. Roosevelt
President of the United States
White House
Washington, D.C.
Sir:

Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations.

In the course of the last four months it has been made probable—that it may become possible to set up a nuclear chain reaction in a large mass of uranium, by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future. This new phenomenon would also lead to the construction of bombs, and it is conceivable—though much less certain—that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.

The United States has only very poor ores of uranium in moderate quantities. There is good ore in Canada and the former Czechoslovakia, while the most important source of uranium is the Belgian Congo.

In view of this situation you may think it desirable to have some permanent contact maintained between the Administration and the group of physicists working on chain reactions in America. One possible way of achieving this might be for you to entrust with this task a person who has your confidence who could perhaps serve in an unofficial capacity. His task might comprise the following:

a) to approach Government Departments, keep them informed of the further development, and put forward recommendations for Government action, giving particular attention to the problems of securing a supply of uranium ore for the United States.

b) to speed up the experimental work, which is at present being carried on within the limits of the budgets of University laboratories, by providing funds, if such funds be required, through his contacts with private persons who are willing to make contributions for this cause, and perhaps also by obtaining the co-operation of industrial laboratories which have the necessary equipment.
I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizaecker, is attached to the Kaiser-Wilhelm-Institut in Berlin where some of the American work on uranium is now being repeated.

Yours very truly,

[signed] A. Einstein

While the existence of Einstein's letter to Roosevelt is often cited as one of the main reasons Roosevelt began the Manhattan Project, Roosevelt actually received quite a bit of information from all types of scientists before authorizing the project. In fact, Roosevelt was too preoccupied to pay attention to Einstein's letter right away—it was weeks before he read it, and even then it didn't immediately inspire him to action. Frustrated with the delay, Einstein sent Roosevelt two papers from the Physical Review describing advancements in science that could lead to releasing the atom's energy.

On September 1, 1939, Germany attacked Poland, and on September 3 World War II began. That same month, scientists in both France and the United States made a crucial discovery. When a uranium nucleus was split by a neutron, the atom's energy was released along with two neutrons. Those two neutrons could then split two more nuclei, releasing more energy, and more neutrons, which would then set off more uranium atoms, and so on and so on. If enough uranium could be induced to split this way—a process called fission—then it might set off a chain reaction that could create immense amounts of energy all from that single original atom.

The discovery of the possibility of a chain reaction renewed the scientific urge to get through to Roosevelt. Finally, on October 11, Roosevelt met with his friend and adviser Alexander Sachs. A colleague of Leo Szilard's, Sachs presented Einstein's letter in person, along with background material. According to reports, Roosevelt interrupted Sachs's presentation, "Alex," he said, "what you are after is to see that the Nazis don't blow us up." Sachs replied, "Precisely."

Finally, Roosevelt was ready to take action, and on October 19, 1939, he responded to Einstein's letter, saying he had chosen representatives of the military to investigate the issue. But the wheels of government turned slowly and, even though a committee was formed,
five more months went by. In an effort to spur things along, Szilard asked Einstein to write a second letter. That letter, dated March 7, 1940, didn’t seem to have much effect, for it wasn’t until the Japanese bombing of Pearl Harbor in December 1941 that the top-secret bomb project began in earnest.

Despite his standing as a physicist, and his obvious knowledge about molecular structure, Einstein was not part of the Manhattan Project. On December 19, as requested, Einstein supplied the science adviser to the president with some notes on isotope separation, and he also stated his interest in helping the U.S. war effort. But the FBI and army intelligence had come to the conclusion that Einstein was a security risk—thanks to his association with pacifist societies thought to be Communist fronts. Einstein later expressed relief that he wasn’t asked to help.

After Hiroshima

Einstein was haunted by the atomic bomb. When the first one was dropped on the Japanese city of Hiroshima, on August 6, 1945, Einstein reportedly reacted with despair, saying “Oh, weh” (essentially “Alas” or “Oy, vey”). Einstein’s secretary, Helen Dukas, made a public statement on Einstein’s behalf: “Military expediency demands that he [Einstein] remain uncommunicative on the subject until the authorities release details.”

It wasn’t until mid-September that Einstein made his first public comments on the new weapon. A New York Times reporter tracked him down at a summer cottage on Saranac Lake in upstate New York. In the ensuing article, titled “The Real Problem Is in the Hearts of Men,” Einstein said the only salvation for civilization was the creation of a world government: “As long as sovereign states continue to have separate armaments and armaments secrets, new world wars will be inevitable.”

Einstein never condemned the use of the bomb on Hiroshima or Nagasaki, and he never condemned the advance of technology, either. He strongly believed that science could not be stopped, even though discoveries could have catastrophic consequences. The trick, thought Einstein, was to make sure humans made intelligent decisions about how to use technology. To keep involved with making such decisions, Einstein became the chairman of the Emergency Committee of Atomic Scientists, a group that included a consider-
able number of the physicists of the Manhattan Project. The committee eventually disbanded without making a discernible political impact, but Einstein carried on, and up until his death he was the champion of a great number of appeals and proclamations. His last public act, published posthumously, was to sign his name to the Russell-Einstein manifesto, urging the United States and the USSR toward restraint in the arms race.

Despite his horror of a weapon capable of such mass destruction, Einstein did not see the atomic bomb as something fundamentally new—merely a more powerful tool to aid mankind’s penchant for war. In a particularly eloquent turn of phrase written in “Atomic War or Peace” for the November 1945 issue of Atlantic Monthly, Einstein said that the bomb had “affected us quantitatively, not qualitatively.”

Einstein also discussed the complex sense of guilt many scientists, including himself, had about creating such a weapon, when coupled with the simultaneous confidence that the war made it necessary. His attitude was summed up in a speech given on December 10 in New York. Einstein said, “We helped create this new weapon in order to prevent the enemies of mankind from achieving it first; given the mentality of the Nazis, this could have brought about untold destruction as well as enslavement of the peoples of the world. This weapon was delivered into the hands of the American and the British nations in their role as trustees of all mankind, and as fighters for peace and liberty; but so far we have no guarantee of peace nor any of the freedoms promised by the Atlantic Charter . . . the war is won, but the peace is not.”

\[ E = mc^2 \]

In addition to his letter to Roosevelt, Einstein’s most famous equation, \( E = mc^2 \), was the key that opened the door for scientists to even consider the fact that the mass of an atom might also hold a great amount of energy. But Einstein did not feel that he bore a special responsibility for the atomic bomb because of his theories. Years after the war had ended, when the ban on publication of pictures related to the bombing in Hiroshima and Nagasaki was lifted in 1952, the editor of a magazine in Japan, Katsu Hara, asked Einstein about his role. Einstein replied in a letter, “My participation in the production of the atomic bomb consisted of one single act: I signed a letter to President Roosevelt in which I emphasized the necessity of conducting large-
scale experimentation with regard to the feasibility of producing an atom bomb."

And yet, because of \( E = mc^2 \) Einstein's name has been inextricably linked to nuclear weapons. It was a connection he always dismissed. In a 1947 edition of *Atlantic Monthly* magazine he said, "I do not consider myself the father of the release of atomic energy. My part in it was quite indirect. I did not, in fact, foresee that it would be released in my time. I believed only that it was theoretically possible." Einstein believed that it was impossible to predict how science could be applied, and he often commented that it would have been difficult for a lowly patent officer to see how his idea could create a bomb.

While Einstein's contribution to the Manhattan Project comes down to one unintended catalyst, the \( E = mc^2 \) equation, and an inconsequential one, the letter to Roosevelt, he is nevertheless tied to the atom bomb in the popular imagination. It's an ironic legacy for a man whose strongest connection to nuclear weapons was in speaking out against their being used again.

See *Arms Race; Pacifism; Roosevelt, Franklin D.; Russell-Einstein Manifesto.*

### Awards

_Einstein received hundreds of awards throughout his life and even after his death. Among the most significant is his 1921 Nobel Prize for Physics, and his being declared—posthumously—the "Man of the Century" by Time magazine. But Einstein also won a number of offbeat and downright odd awards that pleased him almost as much._

In addition to the Nobel Prize, the serious accolades Einstein received include the gold Copley medal from the British Royal Astronomical Society in 1926, and the Franklin Medal from the American Franklin Institute in 1935. Einstein also received honorary degrees from, if not quite every university in the world, a startling number of them, including Britain's Cambridge University, Harvard University in the United States, and Kobe University in Japan. In 1929, Einstein received the highest distinction of the German Physical Society—the Planck medal. For this, as well as many of his other awards, Einstein was humble, saying he was "ashamed" to receive such a high honor.
Einstein also received a number of awards for his work on pacifist and Zionist political causes. During the McCarthy communist hearings, Einstein was delighted to receive a membership card from the Chicago Plumber's and Sanitary Engineer's Union after he made a public statement that if he were to do it over in today's circumstances he would, "not try to become a scientist or scholar or teacher. I would rather choose to be a plumber or a peddler in the hope to find that a modest degree of independence is still available under present circumstances."

Einstein's reaction to his awards was to be either humbled or non-plussed at his various scientific honors. He called the corner where he kept his numerous honorary degrees and diplomas the "Protzenecke" or boasting corner. He was thoroughly bemused by some of his sillier accolades—in 1933, when Einstein heard that A. V. Fric named a flowering cactus plant, located on the highest mountain peak of the Cordilleras "Einsteinia," the physicist wrote the botanist saying, "you have given me great pleasure by your thoughtful act." Other such honors for Einstein included advertisers who wanted to name a hair tonic after him (he refused) and a certificate from a pipe manufacturer stating that Einstein was an "Honored Pipe Smoker."

See Nobel Prize in Physics.

**Beauty and Equations**

_Einstein held his theories up to one subjective ideal to determine if they were true: Were they beautiful?_

Einstein wasn't the first to examine the veracity of his equations in a subjective light—the long cherished concept of Occam's razor, attributed to the fourteenth-century philosopher William of Occam, states that if all other things are equal, then one should always embrace the simplest theory. But Einstein took this idea to an extreme degree, experiencing the beauty of an accurate equation as strongly as one might experience the joy of a Mozart opera or a DaVinci painting. He was not alone. To this day, many scientists talk of the profound enjoyment they receive from the simple elegance in some of Einstein's work.

When Einstein talked later in life about his discovery of the general theory of relativity, he described a moment when all his thoughts coalesced, and suddenly the forces of gravitation made sense. As he wrote
down the math he knew that it was “too beautiful to be wrong.” Even though it would be several years before there was outside proof of general relativity, the beauty of these equations that so simply described the universe was enough to convince Einstein he had found the correct solution. Indeed, the beauty of the equations was enough for him, without proof. When general relativity was confirmed by Sir Arthur Eddington’s famed trip to the Principe Islands to measure starlight as it bent past an eclipse, someone asked Einstein what he would have done if his theory hadn’t been supported. Einstein scoffed, saying he would have felt sorry for God, because “the theory was correct.”

Numerous scientists continue to use the gauge of beauty and simplicity to help guide their work, and many have described the beauty they perceived the first time they learned Einstein’s relativity theory. Here is an equation that explains the shape and movement of the entire universe but is short enough to write on your hand. It’s easy to understand why that can be perceived to be as beautiful as a perfect Bach concerto, every note in its place. To those who work with math, there is an appreciation akin to aesthetic pleasure for equations that explain a facet of nature so simply and completely.

There is, however, nothing inherent that suggests something beautiful is automatically good or true. In fact, the beauty of equations can be falsely seductive. Physicist Eugene Wigner (1902–1995) lamented the “unreasonable effectiveness of math,” and it is too easy to see patterns of numbers as pointing to some fundamental insight as opposed to merely being coincidence. Surely, Newton’s mechanics equations and Maxwell’s light equations are also beautiful, yet both have been shown to be incomplete. Nevertheless, Einstein said fairly often that he could never accept an equation that wasn’t beautiful, and this represents a trust in his physical intuition and innate understanding of math that certainly helped fuel his creativity.

Besso, Michele
(1873–1955)

Michele Besso was a friend, a sounding board, and a bit of an older brother to Einstein. Besso was six years older—and not only did he aid in some of Einstein’s scientific theories, but he often became directly involved in Einstein’s personal life, as he intervened in Einstein’s first marriage, negotiated the terms of his divorce, and offered advice about how to raise his sons.