I'm not a robot

With a core of enriched uranium fuel assemblies in place, a nuclear reactor can be “started up” using a neutron source: a radioactive substance that emits enough neutrons to jump-start the nuclear chain reaction described above. One commonly used neutron source is californium-252, which spontaneously undergoes both alpha decay and nuclear fission, generating neutrons. Another option is to use a mixture of the chemical element beryllium and a radioactive isotope of antimony (antimony-124 or Sb-124): in this case, the high energy gamma ray given off by the Sb-124 as it undergoes radioactive decay interacts with the nearby beryllium atoms, causing them to eject neutrons. An antimony-124/beryllium neutron source encased in aluminum (so as to avoid contamination of the pool water) is used at MNR to initiate a nuclear chain reaction in the reactor core after protracted shutdowns. Along with a means of instigating nuclear fission in the reactor core, it is important to be able to control the rate at which the uranium atoms are undergoing fission. If the nuclear chain reaction is allowed to propagate unchecked, the rate of fission will increase rapidly as more and more neutrons are produced, resulting in a massive and nearly instantaneous release of energy and heat. In contrast, in a nuclear reactor, the rate at which the nuclear fuel undergoes fission is rigorously controlled using “control rods”: cylinders of neutron absorbing material that are inserted into the reactor core to absorb a portion of the neutrons released by the fission of the uranium-235 fuel. To initiate a chain reaction when a reactor is being started up, the control rods are partially withdrawn so that they absorb fewer neutrons; once the reactor is critical (i.e. a chain reaction is occurring), the control rods are inserted slightly further into the core in order to slow the rate of fission to the required value and maintain it at that level. Schematic representation of a controlled nuclear chain reaction – note that the neutron absorbers block two of the fission pathways shown in the earlier figure. Control rods must be fabricated from a material that readily absorbs or “captures” neutrons, but is not prone to nuclear fission as a consequence. Materials appropriate for this application include boron carbide and the heavy metal cadmium. MNR uses control rods composed of an alloy of silver, indium and cadmium because each of these three metals is able to capture neutrons of a different kinetic energy than the other two, making the alloy highly efficient at regulating the neutron population or “flux” within the reactor core, and thereby controlling the rate of fission. View of the reactor core at MNR with control rods visible (photo credit: Science Media Lab). The other significant component in controlling the rate of fission in a nuclear reactor is the “moderator”. When uranium-235 undergoes fission, the atom flies apart, ejecting fission products and neutrons that are travelling at ~14,000 km/s (50 million km/h). These so-called fast neutrons can cause induced nuclear fission in other uranium-235 atoms, but the probability of this occurring is relatively low: neutron capture and subsequent fission is approximately a thousand times more likely to occur for slower-moving or “thermal” neutrons. The role of the neutron moderator is to decrease or moderate the speed (kinetic energy) of the fast neutrons and convert them to slow moving thermal neutrons to enhance nuclear fission. Of course, the term “slow” is relative: thermal neutrons are still travelling at approximately 2,200 m/s, or 7,920 km/h! A material suitable for use as a moderator must be able to slow down neutrons without absorbing or “capturing” them. Commonly used neutron moderators include deionized (purified) water, “heavy water” (in which the hydrogen atoms of the water molecules are replaced by the heavier isotope deuterium) and graphite, a high-density form of carbon. Heavy water has the advantage of absorbing very few neutrons, allowing the nuclear chain reaction to progress efficiently, but is far more expensive than regular “light” water. Like the majority of nuclear reactors operational today, McMaster Nuclear Reactor utilizes stringently purified light water as its moderator, as the ready availability of light water is more than sufficient compensation for the decreased fission efficiency that results from its neutron absorptivity. In many nuclear reactors, including MNR, the moderator also doubles as a reactor coolant. Controlled and uncontrolled chain reactions represent two categories of nuclear processes with significant implications for energy production and weaponry. Understanding the difference between controlled and uncontrolled chain reactions is essential for grasping the nuances of nuclear technology. What is the difference between controlled and uncontrolled chain reaction? A controlled chain reaction is carefully managed to maintain a steady and controlled release of energy, whereas an uncontrolled chain reaction occurs rapidly and uncontrollably, leading to a sudden and potentially destructive release of energy. Key Areas Covered 1. What is Controlled Chain Reaction – Definition, Features 2. What is Uncontrolled Chain Reaction – Definition, Features 3. Similarities Between Controlled and Uncontrolled Chain Reaction – Outline of Common Features 4. Difference Between Controlled and Uncontrolled Chain Reaction – Comparison of Key Differences 5. FAQ: Controlled and Uncontrolled Chain Reaction – Answers to Frequently Asked Questions Key Terms Controlled Chain Reaction, Uncontrolled Chain Reaction What are Controlled Chain Reactions A controlled chain reaction involves the self-sustaining multiplication of nuclear reactions, typically fission, where the nucleus of an atom splits into two or more smaller nuclei, releasing a significant amount of energy. In a controlled chain reaction, scientists take measures to manage the rate of reactions, preventing uncontrolled escalation and ensuring a steady release of energy. This is crucial in nuclear power plants, where controlled chain reactions occur within fuel rods, generating heat that is harnessed to produce electricity. Control rods made of materials that absorb neutrons are strategically inserted or removed to regulate the reaction, maintaining a stable and manageable process. Figure 1: Fission Chain Reaction The delicate balance between control and instability underscores the importance of precision in nuclear technology. As technology advances, mastering controlled chain reactions becomes increasingly vital for meeting energy demands sustainably and minimizing the risks associated with nuclear technologies. What are Uncontrolled Chain Reactions An uncontrolled chain reaction is a rapid and uncontrollable multiplication of nuclear reactions, typically fission, leading to a release of energy that cannot be managed or contained. Uncontrolled chain reactions pose significant risks in various scientific, industrial, and nuclear contexts. They can lead to catastrophic outcomes, as witnessed in events like the Chornobyl disaster. Moreover, the continuous splitting of atomic nuclei releases an immense amount of energy, generating heat and radiation. Beyond nuclear incidents, chain reactions also manifest in chemical processes. For instance, in industrial settings, the failure to manage chemical reactions can result in runaway reactions, where the release of energy triggers further reactions, often escalating in an uncontrolled manner. This poses threats to both human safety and the environment. Figure 2: Atomic Bomb In a broader sense, societal and technological advancements can also exhibit chain reaction effects. The interconnected nature of systems in our increasingly globalized world means that a disruption in one area can trigger a cascade of consequences across various domains. In fact, this is evident in economic markets, where a financial crisis in one region can spark a chain reaction affecting economies worldwide. Both controlled and uncontrolled chain reactions involve the continuous multiplication of reactions. They both release energy during the process. A controlled chain reaction is a nuclear reaction started under controlled conditions, allowing for moderation and regulation of the reaction rate. On the other hand, an uncontrolled chain reaction is a nuclear reaction occurring spontaneously or triggered by external factors, leading to rapid and potentially explosive reactions. A controlled chain reaction is initiated by controlled conditions, typically involving the introduction of a neutron at a specific rate, allowing for moderation and control of the reaction, while an uncontrolled chain reaction is initiated spontaneously or by external factors, such as the sudden release of neutrons without moderation or control, leading to rapid and potentially explosive reactions. Controlled chain reactions proceed at a steady and manageable rate, allowing for sustained energy release, as seen in nuclear power plants. On the other hand, uncontrolled chain reactions can escalate rapidly, leading to an exponential increase in reactions, potentially resulting in a nuclear meltdown or explosion. Controlled chain reactions release energy in a controlled manner, utilized for power generation in nuclear reactors, while uncontrolled chain reactions can release a large amount of energy rapidly, leading to destructive consequences, as observed in nuclear weapons or accidents. In conclusion, the difference between controlled and uncontrolled chain reactions lies in the careful management of energy release. Controlled chain reactions, crucial for sustainable energy generation, involve careful regulation within nuclear power plants. In contrast, uncontrolled chain reactions, exemplified by catastrophic events like Chornobyl, pose inherent risks due to their rapid and uncontrollable nature. The shared characteristics of continuous reaction multiplication and energy release underscore their fundamental similarity, while the divergent paths of controlled steadiness and uncontrolled escalation highlight the critical importance of precision in nuclear technology advancement. FAQ: Controlled and Uncontrolled Chain Reaction 1. What is an uncontrolled chain reaction example? An example of an uncontrolled chain reaction is an atomic bomb. In this case, the rapid and unregulated chain reaction of nuclear fission happens when a critical mass of fissile material, such as highly enriched uranium or plutonium, is brought together suddenly, resulting in an explosive release of energy. 2. What are the names of two types of chain reactions? The two main types of chain reactions are radical reactions and nuclear fission. Radical reactions are initiated and propagated by highly reactive molecules called radicals, forming and breaking covalent bonds to create new radicals. Meanwhile, nuclear fission involves the splitting of an atomic nucleus into smaller nuclei, releasing a significant amount of energy and often neutrons. 3. Is the hydrogen bomb controlled or uncontrolled? The hydrogen bomb works with the principle of uncontrolled fusion reaction. Though it involves nuclear fusion, which could potentially spiral out of control, the bomb’s design includes measures to regulate the reaction and prevent uncontrolled escalation. 4. How do nuclear power plants operate? Nuclear power plants operate by controlling the rate of nuclear reactions, typically through the use of control rods to adjust the number of neutrons available for fission. This controlled fission generates heat, which produces steam, driving turbines connected to generators to produce electricity. Reference: 1. “Fission Chain Reactions and Their Control.” Encyclopedia Britannica. 2. “Nuclear Chain Reaction.” Wikipedia. Wikipedia Foundation. Image Courtesy: 1. “Fission chain reaction” By User:Fastfission – Own work (Public Domain) via Commons Wikimedia 2. “Atomic bomb with mushroom cloud” (Public Domain) via Public Domain Pictures This topic is part of the HSC Physics course under the section Properties of the Nucleus. HSC Physics Syllabus model and explain the process of nuclear fission, including the concepts of controlled and uncontrolled chain reactions, and account for the release of energy in the process (ACSPH033, ACSPH034) Nuclear Fission, Controlled Chain Reactions and Nuclear Reactor Nuclear fission is a type of transmutation where a large nuclide splits to form two smaller nuclides. In nuclear fission, the binding energy of the products is greater than that of the parent nuclide. The total mass of products is also smaller than the mass of reactants. By Einstein's mass-energy equivalence principle, this mass difference is transformed into energy. As a result, energy is released during nuclear fission, typically in the form of kinetic energy and heat. Calculations involving nuclear fission can be found here. In addition to small daughter nuclides, neutrons are sometimes formed from fission. The emitted neutrons are important as they allow for chain reactions to occur. Diagram shows nuclear fission of uranium-235 to form two smaller nuclide fragments: krypton-92 and barium-141. This process involves the formation of an intermediate (uranium-236) and emission of 3 neutrons. While a parent nuclide can undergo fission spontaneously, nuclear fission is sometimes induced by firing a neutron with sufficient kinetic energy into a heavy isotope (e.g. uranium-235). When the neutron is captured by the parent nucleus, an unstable nuclide is temporarily formed (due to changes in neutron to proton ratio). Consequently, fission occurs to produce smaller nuclides that are more stable. What is a Chain Reaction? A chain reaction in nuclear physics refers to the process during which nuclear fission reactions become self-sustaining. In other words, one fission can induce another without any further intervention. Critical reaction - each fission reaction produces exactly one further fission reaction and maintains constant reaction rate. This kind of perfect reaction is called a critical reaction and the amount of fissionable material used to facilitate this one-for-one sustainability is called the critical mass (smallest amount of fissile material that will facilitate sustained chain reaction). Uncontrolled Chain Reaction Uncontrolled chain reaction occurs when more than one further fission reaction is induced by neutrons emitted from fission. The amount of fissionable material required to facilitate this an uncontrolled chain reaction must exceed the critical mass. The rate of fission and power of an uncontrolled chain reaction are exponentially increasing. As a result, uncontrolled chain reactions are seen in the use of nuclear weapons. While moderators are used in uncontrolled chain reactions to increase the likelihood of successful fission, control rods are not used. Controlled Chain Reaction A controlled chain reaction refers to a chain reaction whose rate of fission is controlled and thus the generated energy is also controlled. A controlled chain reaction allows for fission to occur in a self-regenerating manner while limiting the amount of energy produced to a sufficient but safe level. The rate of fission and power of a controlled chain reaction is constant, and can be controlled with the use of moderators and control rods. As a result, controlled chain reactions are used in nuclear power plants (nuclear generators). A controlled chain reaction requires: fissionable material that meets the critical mass control rods moderator Control Rods Control rods are materials that capture free neutrons emitted from fission. Since absorbed neutrons cannot induced further fission reactions, the use of control rods reduces the rate of fission and hence is essential to facilitate a controlled chain reaction. While all neutrons in an uncontrolled chain reaction are allowed to induced fission reactions, the number of neutrons allowed to do this in a controlled chain reaction is determined by the number of control rods used. Control rods are commonly made of cadnium or boron. Moderator For a neutron to induce fission, it must first be captured in the parent nuclide to form a temporary unstable nuclide. This unstable nuclide will then undergo fission. A neutron can only be captured if its kinetic energy (speed) is not too low nor too high. The kinetic energies of neutrons emitted from fission are typically too high to successfully induced further fission and cause a chain reaction to occur. Diagram illustrates a simple set-up of moderated and controlled chain reaction of Uranium-235. Moderators are positioned after each 'row' of fissile material (Uranium-235) to slow down emitted neutrons. Controlled rods are dispersed throughout the reaction chamber to reduce reaction rate. Moderators slow down free neutrons produced in the fission reactions. The slowing down of neutrons increases the likelihood of successful fission reactions and hence increases the rate of fission. Moderators are required for both controlled and uncontrolled chain reactions. Examples of moderators include heavy water, graphite. Nuclear Generators A nuclear generator harnesses the energy produced from controlled chain fission reactions. This energy is initially in the form of heat which is used to transform water into steam (at high pressure). The steam is used to power a turbine which in turn powers an electric generator. It is important for controlled chain reactions to occur as it would otherwise be unsafe. Fuel Rods Fuel rods are hollow rods made of metal, typically alloy steel, and contain a sub-critical mass of fuel or fissionable material (usually enriched uranium oxide or plutonium). They are inserted into the reactor in a grid pattern and their combined fuel provides enough fissionable material for critical mass. Moderator & control rods Moderators and control rods are essential to cause a controlled chain reaction to occur. The number of moderators and control rods in a reaction chamber can be adjusted to change the rate of fission. Moderators increase the rate of fission. Removal of moderators therefore decreases the rate of fission. Control rods decreases the rate of fission. Removal of control rods therefore increases the rate of fission. Coolant The heat produced by the fission reaction is transferred to the coolant. The coolant in a nuclear reactor prevents the fuel rods from melting and transfers the heat to the water. The water that is heated at the heat exchange will turn into steam which drives a turbine and produces electricity via an electric generator. Shielding Multiple layers of shielding surround the reactor for safety and efficiency reasons. A graphite shield reflected neutrons back into the core, followed by a thermal shield to prevent unwanted heat loss, a pressure vessel to isolate and contain everything inside the core and a biological shield of 3 metres of concrete mixed with lead pellets to absorb gamma rays and neutrons. Previous section: Modelling Radioactive Decay (Calculation) Next section: Mass Defect and Binding Energy BACK TO MODULE 8: FROM THE UNIVERSE TO THE ATOM Figure 1. A neutron strikes a 235U nucleus and causes a fission event. This releases more neutrons. Unlike in the figure, on average one new fission event happens as a result of these released neutrons. A nuclear chain reaction occurs when the output of one nuclear reaction causes more nuclear reactions to occur. These chain reactions are almost always a series of fission events, which give off excess neutrons. It is these excess neutrons that can go on to cause more fission events to occur, hence the name chain reaction. Nuclear chain reactions are essential to the operation of nuclear power plants. Chemical reactions involve different chemical species recombining. Nuclear reactions involve different flavours of nuclei (called nuclear species) interacting. Many chemical reactions are also chain reactions, with many similarities to nuclear chain reactions. These similarities include: That the reactions are sustained when chemical or nuclear species available to react. The chain reaction stops when the species are removed or are used up. That the chain reactions are controlled (starting, speeding up, slowing down and stopping) by adding or removing chemical or nuclear species in that chain. Energy is often released as the reactions occur. Released energy is often output as thermal energy, becoming heat that can be harnessed by heat engines to do useful work like make electricity. While these similarities exist, there are some important differences as well. Nuclear reactions release roughly one million times as much energy as chemical reactions. This means that chemical chain reactions occur much more easily than nuclear reactions. For example, fire is a chemical chain reaction. Nuclear chain reactions require careful engineering and as far as we know, a natural nuclear chain reaction has only occurred once.[1] Nuclear chain reactions require an abundance of careful planning. When they do occur, there is substantially more energy available, leading to nuclear having a much higher energy density for its fuel. In order to sustain a nuclear chain reaction, every fission event must lead to exactly one more fission event. The most convenient nuclear species to use for nuclear chain reactions is a fissile isotope of uranium, 235U. When 235U undergoes fission, it gives off, on average, ~2.5 neutrons per fission event. Careful engineering must go into having those neutrons go on to create more fission events. Contrary to what one may expect, difficulties arise in getting enough neutrons to go on and make a sustained nuclear reaction, rather than having too many nuclear reactions. If every fission event leads to exactly one more fission event, the nuclear chain reaction is said to be critical. Figure 2 shows a simplification of the fission chain reaction. Figure 2. A nuclear fission chain reaction of uranium-235 atoms.[2] In a real nuclear reactor, most of the released neutrons are lost, rather than leading to another fission event. The video below has a member of the Energy Education team explaining nuclear chain reactions: For Further Reading References Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Controlled and uncontrolled chain reactions represent two categories of nuclear processes with significant implications for energy production and weaponry. Understanding the difference between controlled and uncontrolled chain reactions is essential for grasping the nuances of nuclear technology. What is the difference between controlled and uncontrolled chain reaction? A controlled chain reaction is carefully managed to maintain a steady and controlled release of energy, whereas an uncontrolled chain reaction occurs rapidly and uncontrollably, leading to a sudden and potentially destructive release of energy. Key Areas Covered 1. What is Controlled Chain Reaction – Definition, Features 2. What is Uncontrolled Chain Reaction – Definition, Features 3. Similarities Between Controlled and Uncontrolled Chain Reaction – Outline of Common Features 4. Difference Between Controlled and Uncontrolled Chain Reaction – Comparison of Key Differences 5. FAQ: Controlled and Uncontrolled Chain Reaction – Answers to Frequently Asked Questions Key Terms Controlled Chain Reaction, Uncontrolled Chain Reaction What are Controlled Chain Reactions A controlled chain reaction involves the self-sustaining multiplication of nuclear reactions, typically fission, where the nucleus of an atom splits into two or more smaller nuclei, releasing a significant amount of energy. In a controlled chain reaction, scientists take measures to manage the rate of reactions, preventing uncontrolled escalation and ensuring a steady release of energy. This is crucial in nuclear power plants, where controlled chain reactions occur within fuel rods, generating heat that is harnessed to produce electricity. Control rods made of materials that absorb neutrons are strategically inserted or removed to regulate the reaction, maintaining a stable and manageable process. Figure 1: Fission Chain Reaction The delicate balance between control and instability underscores the importance of precision in nuclear technology. As technology advances, mastering controlled chain reactions becomes increasingly vital for meeting energy demands sustainably and minimizing the risks associated with nuclear technologies. What are Uncontrolled Chain Reactions An uncontrolled chain reaction is a rapid and uncontrollable multiplication of nuclear reactions, typically fission, leading to a release of energy that cannot be managed or contained. Uncontrolled chain reactions pose significant risks in various scientific, industrial, and nuclear contexts. They can lead to catastrophic outcomes, as witnessed in events like the Chornobyl disaster. Moreover, the continuous splitting of atomic nuclei releases an immense amount of energy, generating heat and radiation. Beyond nuclear incidents, chain reactions also manifest in chemical processes. For instance, in industrial settings, the failure to manage chemical reactions can result in runaway reactions, where the release of energy triggers further reactions, often escalating in an uncontrolled manner. This poses threats to both human safety and the environment. Figure 2: Atomic Bomb In a broader sense, societal and technological advancements can also exhibit chain reaction effects. The interconnected nature of systems in our increasingly globalized world means that a disruption in one area can trigger a cascade of consequences across various domains. In fact, this is evident in economic markets, where a financial crisis in one region can spark a chain reaction affecting economies worldwide. Both controlled and uncontrolled chain reactions involve the continuous multiplication of reactions. They both release energy during the process. A controlled chain reaction is a nuclear reaction started under controlled conditions, allowing for moderation and regulation of the reaction rate. On the other hand, an uncontrolled chain reaction is a nuclear reaction occurring spontaneously or triggered by external factors, leading to rapid and potentially explosive reactions. A controlled chain reaction is initiated by controlled conditions, typically involving the introduction of a neutron at a specific rate, allowing for moderation and control of the reaction, while an uncontrolled chain reaction is initiated spontaneously or by external factors, such as the sudden release of neutrons without moderation or control, leading to rapid and potentially explosive reactions. Controlled chain reactions proceed at a steady and manageable rate, allowing for sustained energy release, as seen in nuclear power plants. On the other hand, uncontrolled chain reactions can escalate rapidly, leading to an exponential increase in reactions, potentially resulting in a nuclear meltdown or explosion. Controlled chain reactions release energy in a controlled manner, utilized for power generation in nuclear reactors, while uncontrolled chain reactions can release a large amount of energy rapidly, leading to destructive consequences, as observed in nuclear weapons or accidents. In conclusion, the difference between controlled and uncontrolled chain reactions lies in the careful management of energy release. Controlled chain reactions, crucial for sustainable energy generation, involve careful regulation within nuclear power plants. In contrast, uncontrolled chain reactions, exemplified by catastrophic events like Chornobyl, pose inherent risks due to their rapid and uncontrollable nature. The shared characteristics of continuous reaction multiplication and energy release underscore their fundamental similarity, while the divergent paths of controlled steadiness and uncontrolled escalation highlight the critical importance of precision in nuclear technology advancement. FAQ: Controlled and Uncontrolled Chain Reaction 1. What is an uncontrolled chain reaction example? An example of an uncontrolled chain reaction is an atomic bomb. In this case, the rapid and unregulated chain reaction of nuclear fission happens when a critical mass of fissile material, such as highly enriched uranium or plutonium, is brought together suddenly, resulting in an explosive release of energy. 2. What are the names of two types of chain reactions? The two main types of chain reactions are radical reactions and nuclear fission. Radical reactions are initiated and propagated by highly reactive molecules called radicals, forming and breaking covalent bonds to create new radicals. Meanwhile, nuclear fission involves the splitting of an atomic nucleus into smaller nuclei, releasing a significant amount of energy and often neutrons. 3. Is the hydrogen bomb controlled or uncontrolled? The hydrogen bomb works with the principle of uncontrolled fusion reaction. Though it involves nuclear fusion, which could potentially spiral out of control, the bomb’s design includes measures to regulate the reaction and prevent uncontrolled escalation. 4. How do nuclear power plants operate? Nuclear power plants operate by controlling the rate of nuclear reactions, typically through the use of control rods to adjust the number of neutrons available for fission. This controlled fission generates heat, which produces steam, driving turbines connected to generators to produce electricity. Reference: 1. “Fission Chain Reactions and Their Control.” Encyclopedia Britannica. 2. “Nuclear Chain Reaction.” Wikipedia. Wikipedia Foundation. Image Courtesy: 1. “Fission chain reaction” By User:Fastfission – Own work (Public Domain) via Commons Wikimedia 2. “Atomic bomb with mushroom cloud” (Public Domain) via Public Domain Pictures Only one extra neutron is required to induce a Uranium-235 nucleus to split by fissionDuring the fission, it produces two or three neutrons which move away at high speedEach of these new neutrons can start another fission reaction, which again creates further excess neutronsThis process is called a chain reactionThe neutrons released by each fission reaction can go on to create further fissions, like a chain that is linked several times – from each chain comes two moreControlled Chain ReactionsIn a nuclear reactor, a chain reaction is required to keep the reactor runningWhen the reactor is producing energy at the correct rate, the number of free neutrons in the reactor needs to be kept constantThis means some must be removed from the reactorTo do this, nuclear reactors contain control rodsThese absorb neutrons without becoming dangerously unstable themselvesUncontrolled Chain ReactionsBecause each new fission reaction releases energy, uncontrolled chain reactions can be dangerousThe number of neutrons available increases quickly, so the number of reactions does tooA nuclear weapon uses an uncontrolled chain reaction to release a huge amount of energy in a short period of time as an explosionDid this page help you? How can financial brands set themselves apart through visual storytelling? Our experts explain how.Learn MoreThe Motorsport Images Collections captures events from 1895 to today’s most recent coverage.Discover The CollectionCurated, compelling, and worth your time. Explore our latest gallery of Editors’ Picks.Browse Editors' FavoritesHow can financial brands set themselves apart through visual storytelling? Our experts explain how.Learn MoreThe Motorsport Images Collections captures events from 1895 to today’s most recent coverage.Discover The CollectionCurated, compelling, and worth your time. Explore our latest gallery of Editors’ Picks.Browse Editors' FavoritesHow can financial brands set themselves apart through visual storytelling? Our experts explain how.Learn MoreThe Motorsport Images Collections captures events from 1895 to today’s most recent coverage.Discover The CollectionCurated, compelling, and worth your time. Explore our latest gallery of Editors’ Picks.Browse Editors' Favorites A controlled chain reaction refers to a nuclear reaction in which the rate of fission is carefully regulated and maintained at a steady level. This is achieved by controlling the number of neutrons produced and absorbed within the reactor. In contrast, an uncontrolled chain reaction is a nuclear reaction that rapidly escalates and becomes uncontrollable, leading to a sudden release of a large amount of energy. This can result in a nuclear explosion or a meltdown of the reactor. The key difference between the two lies in the ability to manage and control the rate of fission reactions, with controlled chain reactions being carefully monitored and regulated, while uncontrolled chain reactions can quickly spiral out of control. In the realm of nuclear physics and energy production, chain reactions play a crucial role. They are responsible for the release of vast amounts of energy, which can be harnessed for various purposes. However, not all chain reactions are created equal. Two distinct types of chain reactions exist: controlled and uncontrolled. In this article, we will explore the attributes of both controlled and uncontrolled chain reactions, highlighting their differences and implications.Controlled Chain ReactionA controlled chain reaction refers to a nuclear reaction where the rate of neutron production and absorption is carefully regulated. This regulation ensures that the reaction remains self-sustaining without spiraling out of control. One of the most well-known examples of a controlled chain reaction is the nuclear fission process used in nuclear power plants.In a controlled chain reaction, the fuel, typically uranium-235 or plutonium-239, is bombarded with slow-moving neutrons. These neutrons are absorbed by the fuel, causing it to become unstable and split into two smaller nuclei, releasing additional neutrons and a significant amount of energy in the process. However, to maintain control, the number of neutrons produced must be carefully balanced with the number of neutrons absorbed.Controlled chain reactions are achieved by using control rods made of materials like boron or cadmium. These control rods can be inserted or withdrawn from the reactor core to absorb excess neutrons and regulate the reaction. By adjusting the position of the control rods, the reaction rate can be controlled, allowing for a steady release of energy.One of the key advantages of a controlled chain reaction is its ability to sustain a steady and controlled release of energy over an extended period. This makes it suitable for power generation, where a constant and reliable energy supply is required. Additionally, the controlled nature of the reaction minimizes the risk of accidents and catastrophic events.However, controlled chain reactions also have their limitations. The fuel used in these reactions is typically limited, and the waste produced can be radioactive and require careful disposal. Furthermore, the potential for nuclear proliferation and the risk of accidents, although minimized, still exist and require stringent safety measures.Uncontrolled Chain ReactionIn contrast to controlled chain reactions, uncontrolled chain reactions refer to nuclear reactions that occur without any regulation or control mechanisms. These reactions can rapidly escalate, leading to a release of an enormous amount of energy in a short period. The most infamous example of an uncontrolled chain reaction is the atomic bomb.In an uncontrolled chain reaction, a critical mass of fissile material, such as highly enriched uranium or plutonium, is brought together rapidly. This causes an exponential increase in the number of neutrons produced, leading to a rapid and uncontrolled release of energy. The energy released in an uncontrolled chain reaction is so immense that it can cause devastating destruction and loss of life.Uncontrolled chain reactions are highly undesirable in most scenarios due to their destructive nature. However, they have been harnessed for military purposes, leading to the development of nuclear weapons. The immense energy released in an uncontrolled chain reaction can be used to create a devastating explosion, making it a potent weapon of mass destruction.While uncontrolled chain reactions have limited practical applications outside of weaponry, they have played a significant role in advancing our understanding of nuclear physics. The study of uncontrolled chain reactions has led to valuable insights into the behavior of nuclear materials and the potential risks associated with their uncontrolled release of energy.ConclusionControlled and uncontrolled chain reactions represent two distinct sides of the nuclear energy spectrum. Controlled chain reactions offer a reliable and steady source of energy, making them suitable for power generation. They can be carefully regulated and pose minimal risks when proper safety measures are in place. On the other hand, uncontrolled chain reactions are highly destructive and primarily associated with nuclear weapons. While they have limited practical applications, they have contributed to our understanding of nuclear physics.Understanding the attributes and implications of both controlled and uncontrolled chain reactions is crucial for the safe and responsible use of nuclear energy. By harnessing the power of controlled chain reactions while preventing the occurrence of uncontrolled chain reactions, we can continue to explore the potential of nuclear energy while minimizing the associated risks. Comparisons may contain inaccurate information about people, places, or facts. Please report any issues. Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. , the free encyclopedia that anyone can edit. 117,922 active editors 6,999,562 articles in English The first UK Phantom on a test flight in 1968 From 1968 to 1992, the United Kingdom used the McDonnell Douglas F-4 Phantom II as one of its principal combat aircraft. The Phantom was procured to serve in both the Royal Navy's Fleet Air Arm and the Royal Air Force (RAF) in several different roles. Most Phantoms operated by the UK were built as a special batch containing a significant amount of British technology. Two variants were initially built: the F-4K was a carrier-based air-defence interceptor for the Fleet Air Arm, while the F-4M was initially used by the RAF for tactical strike and reconnaissance, before transitioning to an air defence role in the 1970s. In the mid-1980s, a third Phantom variant was obtained when fifteen former US Navy F-4J aircraft were purchased to augment the UK's air defences. Although the Fleet Air Arm ceased using the Phantom in 1978, the RAF retained it until 1992, when it was withdrawn as part of a series of post-Cold War defence cuts. (Full article...) Recently featured: Transportation during the 2024 Summer Olympics and Paralympics Rhine campaign of 1796 Chinese characters Archive By email More featured articles About The aftermath of the Kirkby train crash ... that the train driver in the Kirkby train crash (pictured) was found to have been using his mobile phone before the collision? ... that a tour promoting the EP For Your Validation sold out in ten minutes? ... that despite being named in college as the best at his position in the U.S., football player Buster Maddox only appeared in one NFL game? ... that the Doctor Who episode "Lux" is set in Miami, Florida, despite being filmed in Penarth, Wales? ... that Jean-Mohammed Abd-el-Jalil, a Moroccan Franciscan friar, was permitted by the Pope to keep "Muhammad" as his baptismal name? ... that Robert Mugabe's motorcade was known for speeding and killing people? ... that Elizabeth Holtzman's opponent ran an ad saying "maybe I'd like to have her as a daughter, but not as a DA" before her election as the first female Brooklyn District Attorney? ... that fighter pilot Morton D. Magoffin made pilots in his group sprint around an airfield for not saluting him? Archive Start a new article Nominate an article Nicușor Dan Author Banu Mushtaq and translator Deepa Bhasthi win the International Booker Prize for Heart Lamp: Selected Stories. Nicușor Dan (pictured) is elected as president of Romania. In the Portuguese legislative election, the Democratic Alliance wins the most seats in parliament. Austria, represented by JJ with the song "Wasted Love", wins the Eurovision Song Contest. A tornado outbreak leaves at least 27 people dead in the Midwestern and Southeastern United States. Ongoing: Gaza war M23 campaign Russian invasion of Ukraine timeline Sudanese civil war timeline Recent deaths: Jim Irsay Yury Grigorovich Yuri Vladimirov Colton Ford Werenoi Benjamin Ritchie Nominate an article May 27 Manchu Prince Dorgon 1644 – Manchu regent Dorgon (depicted) defeated rebel leader Li Zicheng of the Shun dynasty at the Battle of Shanhai Pass, allowing the Manchus to enter and conquer the capital city of Beijing. 1799 – War of the Second Coalition: Austrian forces defeated the French Army of the Danube, capturing the strategically important Swiss town of Winterthur. 1954 – The security clearance of American nuclear physicist J. Robert Oppenheimer, head of Project Y, was revoked. 1967 – Australians voted overwhelmingly to include Indigenous Australians in population counts for constitutional purposes and to allow the federal government to make special laws affecting them in states. 1997 – A destructive F5-rated tornado tracked through a subdivision of homes northwest of Jarrell, Texas, killing 27 people. Diego Ramírez de Arellano (d. 1624)Julia Ward Howe (b. 1819)Cilla Black (b. 1943)Gérard Jean-Juste (d. 2009) More anniversaries: May 26 May 27 May 28 Archive By email List of days of the year About Anemonoides blanda, the Balkan anemone, Grecian windflower, or winter windflower, is a species of flowering plant in the family Ranunculaceae. The species is native to southeast Europe and the Middle East. It grows up to 10 to 15 centimetres (4 to 6 inches) tall and is valued for its daisy-like flowers, which appear in early spring, a time when little else is in flower. The flowers are found in various colors and are radially symmetrical, containing seven or more sepals and petals. This purple A. blanda flower was photographed in Bamberg, Germany. Photograph credit: Reinhold Möller Recently featured: Bluespotted ribbontail ray Black Lives Matter art Germanicus Archive More featured pictures Community portal – The central hub for editors, with resources, links, tasks, and announcements. Village pump – Forum for discussions about Wikipedia itself, including policies and technical issues. Site news – Sources of news about Wikipedia and the broader Wikimedia movement. Teahouse – Ask basic questions about using or editing Wikipedia. Help desk – Ask questions about using or editing Wikipedia. Reference desk – Ask research questions about encyclopedic topics. Content portals – A unique way to navigate the encyclopedia. Wikipedia is written by volunteer editors and hosted by the Wikimedia Foundation, a non-profit organization that also hosts a range of other volunteer projects: CommonsFree media repository MediaWikiWiki software development Meta-WikiWikimedia project coordination WikibooksFree textbooks and manuals WikidataFree knowledge base WikinewsFree-content news WikiquoteCollection of quotations WikisourceFree-content library WikispeciesDirectory of species WikiversityFree learning tools WiktionaryDictionary and thesaurus This Wikipedia is written in English. Many other Wikipedias are available; some of the largest are listed below. 1,000,000+ articles العربية Deutsch Español فارسی Français Italiano Nederlands 日本語 Polski Português Русский Svenska Українська Tiếng Việt 中文 250,000+ articles Bahasa Indonesia Bahasa Melayu Bân-lâm-gú Български Català Čeština Dansk Eesti Ελληνικά Esperanto Euskara עברית Հայերեն Magyar Norsk bokmål Română Simple English Slovenčina Srpski Srpskohrvatski Suomi Türkçe O’zbek 50,000+ articles Asturianu Azərbaycanca বাংলা Bosanski کوردی Frysk Gaeilge Galego Hrvatski ქართული Kurdî Latviešu Lietuvių Македонски Монгол Norsk nynorsk ਪੰਜਾਬੀ Shqip Slovenščina தமிழ் ไทย اردو Retrieved from " 2 This article needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.Find sources: "1644" – news · newspapers · books · scholar · JSTOR (August 2016) (Learn how and when to remove this message) Calendar year Years Millennium 2nd millennium Centuries 16th century 17th century 18th century Decades 1620s 1630s 1640s 1650s 1660s Years 1641 1642 1643 1644 1645 1646 1647 vte July 1: The Battle of Colberger Heide is fought between Sweden and Denmark-Norway off of the German coast. July 2: Parliament wins control of northern England from King Charles in the Battle of Marston Moor. 1644 by topic Arts and science Architecture Art Literature Music Science Leaders State leaders Colonial governors Religious leaders Birth and death categories Births – Deaths Establishments and disestablishments categories Establishments – Disestablishments Works category Works vte 1644 in various calendarsGregorian calendar1644MDCXLIVAb urbe condita2397Armenian calendar1093ԹՎ ՌՂԳAssyrian calendar6394Balinese saka calendar1565–1566Bengali calendar1050–1051Berber calendar2594English Regnal year19 Cha. 1 – 20 Cha. 1Buddhist calendar2188Burmese calendar1006Byzantine calendar7152–7153Chinese calendar癸未年 (Water Goat)4341 or 4134 — to —甲申年 (Wood Monkey)4342 or 4135Coptic calendar1360–1361Discordian calendar2810Ethiopian calendar1636–1637Hebrew calendar5404–5405Hindu calendars - Vikram Samvat1700–1

Luther initiated the Reformation with his Ninety-five Theses in 1517. 1514: The Battle of Chaldiran, the Ottoman Empire gains decisive victory against Safavid dynasty. 1515: Ascension of Francis I of France as King of France following the death of Louis XII. 1515: The Ottoman Empire wrests Eastern Anatolia from the Safavids after the Battle of Chaldiran. 1515: The Ottomans conquer the last beyliks of Anatolia, the Dulkadirs and the Ramadanids. 1516–1517: The Ottomans defeat the Mamluks and gain control of Egypt, Arabia, and the Levant. 1517: The Sweating sickness epidemic in Tudor England.[10] 1517: The Reformation begins when Martin Luther posts his Ninety-five Theses in Saxony. 1518: The Treaty of London was a non-aggression pact between the major European nations. The signatories were Burgundy, France, England, the Holy Roman Empire, the Netherlands, the Papal States and Spain, all of whom agreed not to attack one another and to come to the aid of any that were under attack. 1518: Mir Chakar Khan Rind leaves Baluchistan and settles in Punjab. 1518: Leo Africanus, also known as al-Hasan ibn Muhammad al-Wazzan al-Fasi, an Andalusian Berber diplomat who is best known for his book Descrittione dell'Africa (Description of Africa), is captured by Spanish pirates; he is taken to Rome and presented to Pope Leo X. 1518: The dancing plague of 1518 begins in Strasbourg, lasting for about one month. 1519: Leonardo da Vinci dies of natural causes on May 2.Europe at the time of the accession of Charles V in 1519 1519: Wang Yangming, the Chinese philosopher and governor of Jiangxi province, describes his intent to use the firepower of the fo-lang-ji, a breech-loading Portuguese culverin, in order to suppress the rebellion of Prince Zhu Chenhao. 1519: Barbary pirates led by Hayreddin Barbarossa, a Turk appointed to ruling position in Algiers by the Ottoman Empire, raid Provence and Toulon in southern France. 1519: Death of Emperor Maximilian; Charles I of Austria, Spain, and the Low Countries becomes Emperor of Holy Roman Empire as Charles V, Holy Roman Emperor (ruled until 1556). 1519–1522: Spanish expedition commanded by Magellan and Elcano are the first to Circumnavigate the Earth. 1519–1521: Hernán Cortés leads the Spanish conquest of the Aztec Empire. Ferdinand Magellan led the first expedition that circumnavigated the globe in 1519–1522. 1520–1566: The reign of Suleiman the Magnificent marks the zenith of the Ottoman Empire. 1520: The first European diplomatic mission to Ethiopia, sent by the Portuguese, arrives at Massawa 9 April, and reaches the imperial encampment of Emperor Dawit II in Shewa 9 October. 1520: Vijayanagara Empire forces under Krishnadevaraya defeat the Adil Shahi under at the Battle of Raichur 1520: Sultan Ali Mughayat Shah of Aceh begins an expansionist campaign capturing Daya on the west Sumatran coast (in present-day Indonesia), and the pepper and gold producing lands on the east coast. 1520: The Portuguese established a trading post in the village of Lamakera on the eastern side of Solor (in present-day Indonesia) as a transit harbour between Maluku and Malacca. 1521: Belgrade (in present-day Serbia) is captured by the Ottoman Empire. 1521: After building fortifications at Tuen Mun, the Portuguese attempt to invade Ming dynasty China, but are expelled by Chinese naval forces. 1521: Philippines encountered by Ferdinand Magellan. He was later killed in the Battle of Mactan in central Philippines in the same year. 1521: Jiajing Emperor ascended the throne of Ming dynasty, China. 1521: November, Ferdinand Magellan's expedition reaches Maluku (in present-day Indonesia) and after trade with Ternate returns to Europe with a load of cloves. 1521: Pati Unus leads the invasion of Malacca (in present-day Malaysia) against the Portuguese occupation. Pati Unus was killed in this battle, and was succeeded by his brother, sultan Trenggana. 1522: Rhodes falls to the Ottomans of Suleiman the Magnificent.[11]Sack of Rome of 1527 by Charles V's forces (painting by Johannes Lingelbach) 1522: The Portuguese ally themselves with the rulers of Ternate (in present-day Indonesia) and begin construction of a fort.[9] 1522: August, Luso-Sundanese Treaty signed between Portugal and Sunda Kingdom granted Portuguese permit to build fortress in Sunda Kelapa. 1523: Sweden gains independence from the Kalmar Union. 1523: The Cacao bean is introduced to Spain by Hernán Cortés 1524–1525: German Peasants' War in the Holy Roman Empire. 1524: Giovanni da Verrazzano is the first European to explore the Atlantic coast of North America between South Carolina and Newfoundland. 1524: Ismail I, the founder of Safavid dynasty, dies and Tahmasp I becomes king.Gun-wielding Ottoman Janissaries and defending Knights of Saint John at the siege of Rhodes in 1522, from an Ottoman manuscript 1525: Timurid Empire forces under Babur defeat the Lodi dynasty at the First Battle of Panipat, end of the Delhi Sultanate. 1525: German and Spanish forces defeat France at the Battle of Pavia, Francis I of France is captured. 1526: The Ottomans defeat the Kingdom of Hungary at the Battle of Mohács. 1526: Mughal Empire, founded by Babur. 1527: Sack of Rome with Pope Clement VII escaping and the Swiss Guards defending the Vatican being killed. The sack of the city of Rome considered the end of the Italian Renaissance. 1527: Protestant Reformation begins in Sweden. 1527: The last ruler of Majapahit falls from power. This state (located in present-day Indonesia) was finally extinguished at the hands of the Demak. A large number of courtiers, artisans, priests, and members of the royalty moved east to the island of Bali; however, the power and the seat of government transferred to Demak under the leadership of Pangeran, later Sultan Fatah. 1527: June 22, The Javanese Prince Fatahillah of the Cirebon Sultanate successfully defeated the Portuguese armed forces at the site of the Sunda Kelapa Harbor. The city was then renamed Jayakarta, meaning "a glorious victory." This eventful day came to be acknowledged as Jakarta's Founding Anniversary. 1527: Mughal Empire forces defeat the Rajput led by Rana Sanga of Mewar at the Battle of Khanwa 1529: The Austrians defeat the Ottoman Empire at the siege of Vienna. 1529: Treaty of Zaragoza defined the antimeridian of Tordesillas attributing the Moluccas to Portugal and Philippines to Spain. 1529: Imam Ahmad Gurey defeats the Ethiopian Emperor Dawit II in the Battle of Shimbra Kure, the opening clash of the Ethiopian–Adal War. Spanish conquistadors with their Tlaxcallan allies fighting against the Otomies of Metztitlan in present-day Mexico, a 16th-century codex 1531–1532: The Church of England breaks away from the Catholic Church and recognizes King Henry VIII as the head of the Church. 1531: The Inca Civil War is fought between the two brothers, Atahualpa and Huáscar. 1532: Francisco Pizarro leads the Spanish conquest of the Inca Empire. 1532: Foundation of São Vicente, the first permanent Portuguese settlement in the Americas. 1533: Anne Boleyn becomes Queen of England. 1533: Elizabeth Tudor is born. 1534: Jacques Cartier claims Canada for France. 1534: The Ottomans capture Baghdad from the Safavids. 1534: Affair of the Placards, where King Francis I becomes more active in repression of French Protestants. 1535: The Münster Rebellion, an attempt of radical, millennialist, Anabaptists to establish a theocracy, ends in bloodshed. 1535: The Portuguese in Ternate depose Sultan Tabariji (or Tabarija) and send him to Portuguese Goa where he converts to Christianity and bequeaths his Portuguese godfather Jordao de Freitas the island of Ambon.[12] Hairun becomes the next sultan. 1536: Catherine of Aragon dies in Kimbolton Castle, in England.Territorial expansion of the Ottoman Empire under Suleiman (in red and orange) 1536: In England, Anne Boleyn is beheaded for adultery and treason. 1536: Establishment of the Inquisition in Portugal. 1536: Foundation of Buenos Aires (in present-day Argentina) by Pedro de Mendoza. 1537: The Portuguese establish Recife in Pernambuco, north-east of Brazil. 1537: William Tyndale's partial translation of the Bible into English is published, which would eventually be incorporated into the King James Bible. 1538: Gonzalo Jiménez de Quesada founds Bogotá. 1538: Spanish–Venetian fleet is defeated by the Ottoman Turks at the Battle of Preveza. 1539: Hernando de Soto explores inland North America. Nicolaus Copernicus 1540: The Society of Jesus, or the Jesuits, is founded by Ignatius of Loyola and six companions with the approval of Pope Paul III. 1540: Sher Shah Suri founds the Suri dynasty in South Asia, an ethnic Pashtun (Pathan) of the house of Sur, who supplanted the Mughal dynasty as rulers of North India during the reign of the relatively ineffectual second Mughal emperor Humayun. Sher Shah Suri decisively defeats Humayun in the Battle of Bilgram (May 17, 1540). 1541: Pedro de Valdivia founds Santiago in Chile. 1541: An Algerian military campaign by Charles V of Spain (Habsburg) is unsuccessful. 1541: Amazon River is encountered and explored by Francisco de Orellana. 1541: Capture of Buda and the absorption of the major part of Hungary by the Ottoman Empire. 1541: Sahib I Giray of Crimea invades Russia. 1542: The Italian War of 1542–1546 War resumes between Francis I of France and Emperor Charles V. This time Henry VIII is allied with the Emperor, while James V of Scotland and Sultan Suleiman I are allied with the French. 1542: Akbar The Great is born in the Rajput Umarkot Fort 1542: Spanish explorer Ruy López de Villalobos named the island of Samar and Leyte Las Islas Filipinas honoring Philip II of Spain and became the official name of the archipelago. 1543: Ethiopian/Portuguese troops defeat the Adal army led by Imam Ahmad Gurey at the Battle of Wayna Daga; Imam Ahmad Gurey is killed at this battle. 1543: Copernicus publishes his theory that the Earth and the other planets revolve around the Sun 1543: The Nanban trade period begins after Portuguese traders make contact with Japan. 1544: The French defeat an Imperial–Spanish army at the Battle of Ceresole.Scenes of everyday life in Ming China, by Qiu Ying 1544: Battle of the Shirts in Scotland. The Frasers and Macdonalds of Clan Ranald fight over a disputed chiefship; reportedly, 5 Frasers and 8 Macdonalds survive. 1545: Songhai forces sack the Malian capital of Niani 1545: The Council of Trent meets for the first time in Trent (in northern Italy). 1546: Michelangelo Buonarroti is made chief architect of St. Peter's Basilica. 1546: Francis Xavier works among the peoples of Ambon, Ternate and Morotai (Moro) laying the foundations for a permanent mission. (to 1547) 1547: Henry VIII dies in the Palace of Whitehall on 28 January at the age of 55. 1547: Francis I dies in the Château de Rambouillet on 31 March at the age of 52. 1547: Edward VI becomes King of England and Ireland on 28 January and is crowned on 20 February at the age of 9. 1547: Emperor Charles V decisively dismantles the Schmalkaldic League at the Battle of Mühlberg. 1547: Grand Prince Ivan the Terrible is crowned tsar of (All) Russia, thenceforth becoming the first Russian tsar. 1548: Battle of Uedahara: Firearms are used for the first time on the battlefield in Japan, and Takeda Shingen is defeated by Murakami Yoshikiyo. 1548: Askia Daoud, who reigned from 1548 to 1583, establishes public libraries in Timbuktu (in present-day Mali). 1548: The Ming dynasty government of China issues a decree banning all foreign trade and closes down all seaports along the coast; these Hai jin laws came during the Wokou wars with Japanese pirates. 1549: Tomé de Sousa establishes Salvador in Bahia, north-east of Brazil. 1549: Arya Penangsang with the support of his teacher, Sunan Kudus, avenges the death of Raden Kikin by sending an envoy named Rangkud to kill Sunan Prawoto by Keris Kyai Satan Kober (in present-day Indonesia). The Islamic gunpowder empires: Mughal Army artillerymen during the reign of Jalaluddin Akbar 1550: The architect Mimar Sinan builds the Süleymaniye Mosque in Istanbul. 1550: Mongols led by Altan Khan invade China and besiege Beijing. 1550–1551: Valladolid debate concerning the human rights of the Indigenous people of the Americas. 1551: Fifth outbreak of sweating sickness in England. John Caius of Shrewsbury writes the first full contemporary account of the symptoms of the disease. 1551: North African pirates enslave the entire population of the Maltese island Gozo, between 5,000 and 6,000, sending them to Libya. 1552: Russia conquers the Khanate of Kazan in central Asia. 1552: Jesuit China Mission, Francis Xavier dies. 1553: Mary Tudor becomes the first queen regnant of England and restores the Church of England under Papal authority. 1553: The Portuguese found a settlement at Macau. 1554: Missionaries José de Anchieta and Manuel da Nóbrega establishes São Paulo, southeast Brazil. 1554: Princess Elizabeth is imprisoned in the Tower of London upon the orders of Mary I for suspicion of being involved in the Wyatt rebellion. 1555: The Muscovy Company is the first major English joint stock trading company. 1556: Publication in Venice of Delle Navigiationi et Viaggi (terzo volume) by Giovanni Battista Ramusio, secretary of Council of Ten, with plan La Terra de Hochelaga, an illustration of the Hochelaga.[13] 1556: The Shaanxi earthquake in China is history's deadliest known earthquake during the Ming dynasty. 1556: Georgius Agricola, the "Father of Mineralogy", publishes his De re metallica. 1556: Akbar defeats Hemu at the Second battle of Panipat. 1556: Russia conquers the Astrakhan Khanate. 1556–1605: During his reign, Akbar expands the Mughal Empire in a series of conquests (in the Indian subcontinent).Political map of the world in 1556 1556: Mir Chakar Khan Rind captures Delhi with Humayun. 1556: Pomponio Algerio, radical theologian, is executed by boiling in oil as part of the Roman Inquisition. 1557: Habsburg Spain declares bankruptcy. Philip II of Spain had to declare four state bankruptcies in 1557, 1560, 1575 and 1596. 1557: The Portuguese settle in Macau (on the western side of the Pearl River Delta across from present-day Hong Kong). 1557: The Ottomans capture Massawa, all but isolating Ethiopia from the rest of the world. 1558: Elizabeth Tudor becomes Queen Elizabeth I at age 25. 1558–1603: The Elizabethan era is considered the height of the English Renaissance. 1558–1583: Livonian War between Poland, Grand Principality of Lithuania, Sweden, Denmark and Russia. 1558: After 200 years, the Kingdom of England loses Calais to France. 1559: With the Peace of Cateau Cambrésis, the Italian Wars conclude. 1559: Sultan Hairun of Ternate (in present-day Indonesia) protests the Portuguese's Christianisation activities in his lands. Hostilities between Ternate and the Portuguese. The Mughal Emperor Akbar shoots the Rajput warrior Jaimal during the Siege of Chittorgarh in 1567 1560: Ottoman navy defeats the Spanish fleet at the Battle of Djerba. 1560: Elizabeth Bathory is born in Nyirbator, Hungary. 1560: By winning the Battle of Okehazama, Oda Nobunaga becomes one of the pre-eminent warlords of Japan. 1560: Jeanne d'Albret declares Calvinism the official religion of Navarre. 1560: Lazarus Church, Macau 1561: Sir Francis Bacon is born in London. 1561: The fourth battle of Kawanakajima between the Uesugi and Takeda at Hachimanbara takes place. 1561: Guido de Bres draws up the Belgic Confession of Protestant faith. 1562: Mughal emperor Akbar reconciles the Muslim and Hindu factions by marrying into the powerful Rajput Hindu caste. 1562–1598: French Wars of Religion between Catholics and Huguenots. 1562: Massacre of Wassy and Battle of Dreux in the French Wars of Religion. 1562: Portuguese Dominican priests build a palm-trunk fortress which Javanese Muslims burned down the following year. The fort was rebuilt from more durable materials and the Dominicans commenced the Christianisation of the local population.[12] 1563: Plague outbreak claimed 80,000 people in Elizabethan England. In London alone, over 20,000 people died of the disease. 1564: Galileo Galilei born on February 15 1564: William Shakespeare baptized 26 April 1565: Deccan sultanates defeat the Vijayanagara Empire at the Battle of Talikota. 1565: Mir Chakar Khan Rind dies at aged 97. 1565: Estácio de Sá establishes Rio de Janeiro in Brazil. 1565: The Hospitallers, a Crusading Order, defeat the Ottoman Empire at the siege of Malta (1565). 1565: Miguel López de Legazpi establishes in Cebu the first Spanish settlement in the Philippines starting a period of Spanish colonization that would last over three hundred years. 1565: Spanish navigator Andres de Urdaneta discovers the maritime route from Asia to the Americas across the Pacific Ocean, also known as the tornaviaje. 1565: Royal Exchange is founded by Thomas Gresham. 1566: Suleiman the Magnificent, ruler of the Ottoman Empire, dies on September 7, during the battle of Szigetvar.Siege of Valenciennes during the Dutch War of Independence in 1567 1566–1648: Eighty Years' War between Spain and the Netherlands. 1566: Da le Balle Contrade d'Oriente, composed by Cipriano de Rore. 1567: After 45 years' reign, Jiajing Emperor died in the Forbidden City, Longqing Emperor ascended the throne of Ming dynasty. 1567: Mary, Queen of Scots, is imprisoned by Elizabeth I. 1568: The Transylvanian Diet, under the patronage of the prince John Sigismund Zápolya, the former king of Hungary, inspired by the teachings of Ferenc Dávid, the founder of the Unitarian Church of Transylvania, promulgates the Edict of Torda, the first law of freedom of religion and of conscience in the World. 1568–1571: Morisco Revolt in Spain. 1568–1600: The Azuchi-Momoyama period in Japan. 1568: Hadiwijaya sent his adopted son and son in-law Sutawijaya, who would later become the first ruler of the Mataram dynasty of Indonesia, to kill Arya Penangsang. 1569: Rising of the North in England. 1569: Mercator 1569 world map published by Gerardus Mercator. 1569: The Polish–Lithuanian Commonwealth is created with the Union of Lublin which lasts until 1795. 1569: Peace treaty signed by Sultan Hairun of Ternate and Governor Lopez De Mesquita of Portugal. The Battle of Lepanto 1570: Ivan the Terrible, tsar of Russia, orders the massacre of inhabitants of Novgorod. 1570: Pope Pius V issues Regnans in Excelsis, a papal bull excommunicating all who obeyed Elizabeth I and calling on all Catholics to rebel against her. 1570: Sultan Hairun of Ternate (in present-day Indonesia) is killed by the Portuguese.[12] Babullah becomes the next Sultan. 1570: 20,000 inhabitants of Nicosia in Cyprus were massacred and every church, public building, and palace was looted. Cyprus fell to the Ottoman Turks the following year. 1571: Pope Pius V completes the Holy League as a united front against the Ottoman Turks, responding to the fall of Cyprus to the Ottomans. 1571: The Spanish-led Holy League navy destroys the Ottoman Empire navy at the Battle of Lepanto. 1571: Crimean Tatars attack and sack Moscow, burning everything but the Kremlin. 1571: American Indians kill Spanish missionaries in what would later be Jamestown, Virginia. 1571: Spanish conquistador Miguel López de Legazpi establishes Manila, Philippines as the capital of the Spanish East Indies. 1572: Brielle is taken from Habsburg Spain by Protestant Watergeuzen in the Capture of Brielle, in the Eighty Years' War. 1572: Spanish conquistadores apprehend the last Inca leader Tupak Amaru at Vilcabamba, Peru, and execute him in Cuzco. 1572: Jeanne d'Albret dies aged 43 and is succeeded by Henry of Navarre. 1572: Catherine de' Medici instigates the St. Bartholomew's Day massacre which takes the lives of Protestant leader Gaspard de Coligny and thousands of Huguenots. The violence spreads from Paris to other cities and the countryside. 1572: First edition of the epic The Lusiads of Luís Vaz de Camões, three years after the author returned from the East.[14] 1572: The 9 years old Taizi, Zhu Yijun ascended the throne of Ming dynasty, known as Wanli Emperor. 1573: After heavy losses on both sides the siege of Haarlem ends in a Spanish victory.St. Bartholomew's Day massacre of French Protestants 1574: in the Eighty Years' War the capital of Zeeland, Middelburg declares for the Protestants. 1574: After a siege of 4 months the siege of Leiden ends in a comprehensive Dutch rebel victory. 1575: Oda Nobunaga finally captures Nagashima fortress. 1575: Following a five-year war, the Ternateans under Sultan Babullah defeated the Portuguese. 1576: Tahmasp I, Safavid shah, dies. 1576: The Battle of Haldighati is fought between the ruler of Mewar, Maharana Pratap and the Mughal Empire's forces under Emperor Akbar led by Raja Man Singh. 1576: Sack of Antwerp by badly paid Spanish soldiers. 1577–1580: Francis Drake circles the world. 1577: Ki Ageng Pemanahan built his palace in Pasargede or Kotagede. 1578: King Sebastian of Portugal is killed at the Battle of Alcazarquivir. 1578: The Portuguese establish a fort on Tidore but the main centre for Portuguese activities in Maluku becomes Ambon.[12] 1578: Sonam Gyatso is conferred the title of Dalai Lama by Tumed Mongol ruler, Altan Khan. Recognised as the reincarnation of two previous Lamas, Sonam Gyatso becomes the third Dalai Lama in the lineage.[15] 1578: Governor-General Francisco de Sande officially declared war against Brunei in 1578, starting the Castilian War of 1578. 1579: The Union of Utrecht unifies the northern Netherlands, a foundation for the later Dutch Republic. 1579: The Union of Arras unifies the southern Netherlands, a foundation for the later states of the Spanish Netherlands, the Austrian Netherlands and Belgium.The Irish Gaelic chieftain's feast, from The Image of Ireland 1579: The British navigator Sir Francis Drake passes through Maluku and transit in Ternate on his circumnavigation of the world. The Portuguese establish a fort on Tidore but the main centre for Portuguese activities in Maluku becomes Ambon.[16] The fall of Spanish Armada 1580: Drake's royal reception after his attacks on Spanish possessions influences Philip II of Spain to build up the Spanish Armada. English ships in Spanish harbours are impounded. 1580: Spain unifies with Portugal under Philip II. The struggle for the throne of Portugal ends the Portuguese Empire. The Spanish and Portuguese crowns are united for 60 years, i.e. until 1640. 1580–1587: Nagasaki comes under control of the Jesuits. 1581: Dutch Act of Abjuration, declaring abjuring allegiance to Philip II of Spain. 1581: Bayinnaung dies at the age of 65. 1582: Oda Nobunaga commits seppuku during the Honnō-ji Incident coup by his general, Akechi Mitsuhide. 1582: Pope Gregory XIII issues the Gregorian calendar. The last day of the Julian calendar was Thursday, 4 October 1582 and this was followed by the first day of the Gregorian calendar, Friday, 15 October 1582 1582: Yermak Timofeyevich conquers the Siberia Khanate on behalf of the Stroganovs. 1583: Denmark builds the world's first theme park, Bakken. 1583: Death of Sultan Babullah of Ternate. 1584–1585: After the siege of Antwerp, many of its merchants flee to Amsterdam. According to Luc-Normand Tellier, "At its peak, between 1510 and 1557, Antwerp concentrated about 40% of the world trade...It is estimated that the port of Antwerp was earning the Spanish crown seven times more revenues than the Americas."[17] 1584: Ki Ageng Pemanahan died. Sultan Pajang raised Sutawijaya, son of Ki Ageng Pemanahan as the new ruler in Mataram, titled "Loring Ngabehi Market" (because of his home in the north of the market). 1585: Akbar annexes Kashmir and adds it to the Kabul SubahPortuguese fusta in India from a book by Jan Huygen van Linschoten 1585: Colony at Roanoke founded in North America. 1585–1604: The Anglo-Spanish War is fought on both sides of the Atlantic. 1587: Mary, Queen of Scots is executed by Elizabeth I. 1587: The reign of Abbas I marks the zenith of the Safavid dynasty. 1587: Troops that would invade Pajang Mataram Sultanate storm ravaged the eruption of Mount Merapi. Sutawijaya and his men survived. 1588: Mataram into the kingdom with Sutawijaya as Sultan, titled "Senapati Ingalaga Sayidin Panatagama" means the warlord and cleric Manager Religious Life. 1588: England repulses the Spanish Armada. 1589: Spain repulses the English Armada. 1589: Catherine de' Medici dies at aged 69. Abu'l-Fazl ibn Mubarak presenting Akbarnama to Mughal Azam Akbar, Mughal miniature 1590: Siege of Odawara: the Go-Hojo clan surrender to Toyotomi Hideyoshi, and Japan is unified. 1591: Gazi Giray leads a huge Tatar expedition against Moscow. 1591: In Mali, Moroccan forces of the Sultan Ahmad al-Mansur led by Judar Pasha defeat the Songhai Empire at the Battle of Tondibi. 1592–1593: John Stow reports 10,675 plague deaths in London, a city of approximately 200,000 people. 1592–1598: Korea, with the help of Ming dynasty China, repels two Japanese invasions. 1593–1606: The Long War between the Habsburg monarchy and the Ottoman Turks. 1594: St. Paul's College, Macau, founded by Alessandro Valignano. 1595: First Dutch expedition to Indonesia sets sail for the East Indies with two hundred and forty-nine men and sixty-four cannons led by Cornelis de Houtman.[18] 1596: Birth of René Descartes. 1596: June, de Houtman's expedition reaches Banten the main pepper port of West Java where they clash with both the Portuguese and Indonesians. It then sails east along the north coast of Java losing twelve crew to a Javanese attack at Sidayu and killing a local ruler in Madura.[18] 1597: Romeo and Juliet is published. 1597: Cornelis de Houtman's expedition returns to the Netherlands with enough spices to make a considerable profit.[18] 1598: The Edict of Nantes ends the French Wars of Religion. 1598: Abbas I moves Safavids capital from Qazvin to Isfahan in 1598. 1598–1613: Russia descends into anarchy during the Time of Troubles. 1598: The Portuguese require an armada of 90 ships to put down a Solorese uprising.[12] (to 1599) 1598: More Dutch fleets leave for Indonesia and most are profitable.[18]Edo period screen depicting the Battle of Sekigahara 1598: The province of Santa Fe de Nuevo México is established in Northern New Spain. The region would later become a territory of Mexico, the New Mexico Territory in the United States, and the US State of New Mexico. 1598: Death of Toyotomi Hideyoshi, known as the unifier of Japan. 1599: The Mali Empire is defeated at the Battle of Jenné. 1599: The van Neck expedition returns to Europe. The expedition makes a 400 per cent profit.[18] (to 1600) 1599: March, Leaving Europe the previous year, a fleet of eight ships under Jacob van Neck was the first Dutch fleet to reach the 'Spice Islands' of Maluku.[18] 1600: Giordano Bruno is burned at the stake for heresy in Rome.Siege of Fiľakovo castle during the Long Turkish War 1600: Battle of Sekigahara in Japan. End of the Warring States period and beginning of the Edo period. 1600: The Portuguese win a major naval battle in the bay of Ambon.[19] Later in the year, the Dutch join forces with the local Hituese in an anti-Portuguese alliance, in return for which the Dutch would have the sole right to purchase spices from Hitu.[19] 1600: Elizabeth I grants a charter to the British East India Company beginning the English advance in Asia. 1600: Michael the Brave unifies the three principalities: Wallachia, Moldavia and Transylvania after the Battle of Şelimbăr from 1599. For later events, see Timeline of the 17th century. Polybius' The Histories translated into Italian, English, German and French.[20] Mississippian culture disappears. Medallion rug, variant Star Ushak style, Anatolia (modern Turkey), is made. It is now kept at the Saint Louis Art Museum. Hernan Cortes (1485–1547) Henry VIII, (1491–1547) King of England and Ireland Don Fernando Álvarez de Toledo (1507–1582) Suleiman the Magnificent, Sultan of the Ottoman Empire (1520–1566) Ivan IV the Terrible (1530–1584) Oda Nobunaga (1534–1582) Sir Francis Drake (c. 1540 – 1596) Alberico Gentili, (1552–1608) the Father of international law Philip II of Spain, King of Spain (1556–1598) Akbar the Great, Mughal emperor (1556–1605) Related article: List of 16th century inventions. The Columbian Exchange introduces many plants, animals and diseases to the Old and New Worlds. Introduction of the spinning wheel revolutionizes textile production in Europe. The letter J is introduced into the English alphabet. 1500: First portable watch is created by Peter Henlein of Germany.The Iberian Union in 1598, under Philip II, King of Spain and Portugal 1513: Juan Ponce de León sights Florida and Vasco Núñez de Balboa sights the eastern edge of the Pacific Ocean. 1519–1522: Ferdinand Magellan and Juan Sebastián Elcano lead the first circumnavigation of the world. 1519–1540: In America, Hernando de Soto expeditions map the Gulf of Mexico coastline and bays. 1525: Modern square root symbol (√) 1540: Francisco Vásquez de Coronado sights the Grand Canyon. 1541–42: Francisco de Orellana sails the length of the Amazon River. 1542–43: Firearms are introduced into Japan by the Portuguese. 1543: Copernicus publishes his theory that the Earth and the other planets revolve around the Sun 1545: Theory of complex numbers is first developed by Gerolamo Cardano of Italy. 1558: Camera obscura is first used in Europe by Giambattista della Porta of Italy. 1559–1562: Spanish settlements in Alabama/Florida and Georgia confirm dangers of hurricanes and local native warring tribes. 1565: Spanish settlers outside New Spain (Mexico) colonize Florida's coastline at St. Augustine. 1565: Invention of the graphite pencil (in a wooden holder) by Conrad Gesner. Modernized in 1812. 1568: Gerardus Mercator creates the first Mercator projection map. 1572: Supernova SN 1572 is observed by Tycho Brahe in the Milky Way. 1582: Gregorian calendar is introduced in Europe by Pope Gregory XIII and adopted by Catholic countries. c. 1583: Galileo Galilei of Pisa, Italy identifies the constant swing of a pendulum, leading to development of reliable timekeepers. 1585: earliest known reference to the 'sailing carriage' in China. 1589: William Lee invents the stocking frame. 1591: First flush toilet is introduced by Sir John Harrington of England, the design published under the title 'The Metamorphosis of Ajax'. 1593: Galileo Galilei invents a thermometer. 1596: William Barents discovers Spitsbergen. 1597: Opera in Florence by Jacopo Peri. Entertainment in the 16th century ^ a b Modern reference works on the period tend to follow the introduction of the Gregorian calendar for the sake of clarity; thus NASA's lunar eclipse catalogue states "The Gregorian calendar is used for all dates from 1582 Oct 15 onwards. Before that date, the Julian calendar is used." For dates after 15 October 1582, care must be taken to avoid confusion of the two styles. ^ de Vries, Jan (14 September 2009). "The limits of globalization in the early modern world". The Economic History Review. 63 (3): 710–733. CiteSeerX 10.1.1.186.2862. doi:10.1111/j.1468-0289.2009.00497.x. JSTOR 40929823. S2CID 219969360. SSRN 1635517. ^ Singh, Sarina; Lindsay Brown; Paul Clammer; Rodney Cocks; John Mock (2008). Pakistan & the Karakoram Highway. Vol. 7, illustrated. Lonely Planet. p. 137. ISBN 978-1-74104-542-0. Retrieved 23 August 2010. ^ Babur (2006). Babur Nama. Penguin Books. p. vii. ISBN 978-0-14-400149-1. ^ "16th Century Timeline (1501 to 1600)". fsmitha.com. Archived from the original on February 3, 2009. ^ "History of Smallpox – Smallpox Through the Ages" Archived 2019-09-24 at the Wayback Machine. Texas Department of State Health Services. ^ Ricklefs (1991), p.23 ^ "A LIST OF NATIONAL EPIDEMICS OF PLAGUE IN ENGLAND 1348–1665". Archived from the original on 2009-05-08. Retrieved 2009-04-25. ^ a b Ricklefs (1991), page 24 ^ The Sweating Sickness. Story of London.. Accessed 2009-04-25. Archived 2009-05-03. ^ Sandra Arlinghaus. "Life Span of Suleiman the Magnificent 1494–1566". Personal.umich.edu. Retrieved 2013-05-05. ^ a b c d e Ricklefs (1991), page 25 ^ "La Terra De Hochelaga – Jaques Cartier a Hochelaga". jacquescarter.org. Archived from the original on December 23, 2008. ^ "The Lusiads". World Digital Library. 1800–1882. Retrieved 2013-08-31. ^ Schwieger, Peter (2014). The Dalai Lama and the Emperor of China: a political history of the Tibetan institution of reincarnation. New York: Columbia University Press. ISBN 9780231538602. OCLC 905914446. ^ Miller, George, ed. (1996). To The Spice Islands and Beyond: Travels in Eastern Indonesia. New York: Oxford University Press. pp. xv. ISBN 967-65-3099-9. ^ Luc-Normand Tellier (2009). "Urban world history: an economic and geographical perspective". PUQ. p.308. ISBN 2-7605-1588-5 ^ a b c d e f Ricklefs (1991), page 27 ^ a b Ricklefs (1991), page 28 ^ Polybius: The Rise Of The Roman Empire, Page 36, Penguin, 1979. Langer, William. An Encyclopedia of World History (5th ed. 1973); highly detailed outline of events online free Media related to 16th century at Wikimedia Commons Timelines of 16th century events, science, culture and persons Retrieved from " 4 The following pages link to 16th century External tools (link count transclusion count sorted list) · See help page for transcluding these entries Showing 50 items. View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500)Bagpipes (links | edit) List of decades, centuries, and millennia (links | edit) Fashion (links | edit) Giovanni Boccaccio (links | edit) History of Mali (links | edit) History of Mauritius (links | edit) Post office (links | edit) Snare drum (links | edit) Republican Party (United States) (links | edit) 20th century (links | edit) 15th century (links | edit) 17th century (links | edit) 18th century (links | edit) 1624 (links | edit) 1626 (links | edit) 1642 (links | edit) 1661 (links | edit) 1608 (links | edit) 1492 (links | edit) 14th century (links | edit) 1st century (links | edit) 13th century (links | edit) 4th century (links | edit) 12th century (links | edit) 11th century (links | edit) 1564 (links | edit) 1648 (links | edit) 1572 (links | edit) 1623 (links | edit) 1662 (links | edit) 1490s (links | edit) 1640s (links | edit) 1597 (links | edit) 1690 (links | edit) 1688 (links | edit) 7th century (links | edit) 10th century (links | edit) 9th century (links | edit) 8th century (links | edit) 6th century (links | edit) 5th century (links | edit) 3rd century (links | edit) 2nd century (links | edit) 1573 (links | edit) 1570s (links | edit) 1574 (links | edit) 1436 (links | edit) 1476 (links | edit) 1542 (links | edit) 1540s (links | edit) View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500) Retrieved from " WhatLinksHere/16th_century"