By the end of this section, you will be able to:Explain the limit where a deformation of material is elasticDescribe the range where materials show plastic behaviorAnalyze elasticity and plasticity on a stress-strain diagramWe referred to the proportionality constant between stress and strain as the elastic modulus. But why do we call it that? What does it mean for an object to be elastic and how do we describe its behavior?Elasticity is the tendency of solid objects and materials to return to their original shape after the external forces (load) causing a deformation are removed. An object is elastic when it comes back to its original size and shape when the load is no longer present. Physical reasons for elastic behavior vary among materials and depend on the microscopic structure of the material. For example, the elasticity of polymers and rubbers is caused by stretching polymer chains under an applied force. In contrast, the elasticity of metals is caused by resizing and reshaping the crystalline cells of the lattices (which are the material structures of metals) under the action of externally applied forces.The two parameters that determine the elasticity of a material are its elastic modulus and its elastic limit. A high elastic modulus is typical for materials that are hard to deform; in other words, materials that require a high load to achieve a significant strain. An example is a steel band. A low elastic modulus is typical for materials that are easily deformed under a load; for example, a rubber band. If the stress under a load becomes too high, then when the load is removed, the material no longer comes back to its original shape and size, but relaxes to a different shape and size: The material becomes permanently deformed. The elastic limit is the stress value beyond which the material no longer behaves elastically but becomes permanently deformed.Our perception of an elastic material depends on both its elastic limit and its elastic modulus. For example, all rubbers are characterized by a low elastic modulus and a high elastic limit; hence, it is easy to stretch them and the stretch is noticeably large. Among materials with identical elastic limits, the most elastic is the one with the lowest elastic modulus.When the load increases from zero, the resulting stress is in direct proportion to strain in the way given by (Figure), but only when stress does not exceed some limiting value. For stress values within this linear limit, we can describe elastic behavior in analogy with Hookes law for a spring. According to Hookes law, the stretch value of a spring under an applied force is directly proportional to the magnitude of the force. Conversely, the response force from the spring to an applied stretch is directly proportional to the stretch. In the same way, the deformation of a material under a load is directly proportional to the load, and, conversely, the resulting stress is directly proportional to strain. The linearity limit (or the proportionality limit) is the largest stress value beyond which stress is no longer proportional to strain. Beyond the linearity limit, the relation between stress and strain is no longer linear. When stress becomes larger than the linearity limit but still within the elasticity limit, behavior is still elastic, but the relation between stress and strain becomes nonlinear.For stresses beyond the elastic limit, a material exhibits plastic behavior. This means the material deforms irreversibly and does not return to its original shape and size, even when the load is removed. When stress is gradually increased beyond the elastic limit, the material undergoes plastic deformation. Rubber-like materials show an increase in stress with the increasing strain, which means they become more difficult to stretch and, eventually, they reach a fracture point where they break. Ductile materials such as metals show a gradual decrease in stress with the increasing strain, which means they become easier to deform as stress-strain values approach the breaking point. Microscopic mechanisms responsible for plasticity of materials are different for different materials.We can graph the relationship between stress and strain on a stress-strain diagram. Each material has its own characteristic strain-stress curve. A typical stress-strain diagram for a ductile metal under a load is shown in (Figure). In this figure, strain is a fractional elongation (not drawn to scale). When the load is gradually increased, the linear behavior (red line) that starts at the no-load point (the origin) ends at the linearity limit at point H. For further load increases beyond point H, the stress-strain relation is nonlinear but still elastic. In the figure, this nonlinear region is seen between points H and E. Ever larger loads take the stress to the elasticity limit E, where elastic behavior ends and plastic deformation begins. Beyond the elasticity limit, when the load is removed, for example at P, the material relaxes to a new shape and size along the green line. This is to say that the material becomes permanently deformed and does not come back to its initial shape and size when stress becomes zero.The material undergoes plastic deformation for loads large enough to cause stress to go beyond the elasticity limit at E. The material continues to be plastically deformed until the stress reaches the fracture point (breaking point). Beyond the fracture point, we no longer have one sample of material, so the diagram ends at the fracture point. For the completeness of this qualitative description, it should be said that the linear, elastic, and plasticity limits denote a range of values rather than one sharp point.Figure 12.25 Typical stress-strain plot for a metal under a load: The graph ends at the fracture point. The arrows show the direction of changes under an ever-increasing load. Points H and E are the linearity and elasticity limits, respectively. Between points H and E, the behavior is nonlinear. The green line originating at P illustrates the metals response when the load is removed. The permanent deformation has a strain value at the point where the green line intercepts the horizontal axis.The value of stress at the fracture point is called breaking stress (or ultimate stress). Materials with similar elastic properties, such as two metals, may have very different breaking stresses. For example, ultimate stress for aluminum is $2.2\,\,{10}^{8}\text{Pa}$ and for steel it may be as high as $20.0\,\,{10}^{8}\text{Pa},$ depending on the kind of steel. We can make a quick estimate, based on (Figure), that for rods with a ${1\text{-in}}^{2}$ cross-sectional area, the breaking load for an aluminum rod is $3.2\,\,{10}^{4}\,\text{lb},$ and the breaking load for a steel rod is about nine times larger.SummaryAn object or material is elastic if it comes back to its original shape and size when the stress vanishes. In elastic deformations with stress values lower than the proportionality limit, stress is proportional to strain. When stress goes beyond the proportionality limit, the deformation is still elastic but nonlinear up to the elasticity limit.An object or material has plastic behavior when stress is larger than the elastic limit. In the plastic region, the object or material does not come back to its original size or shape when stress vanishes but acquires a permanent deformation. Plastic behavior ends at the breaking point. First Equilibrium Condition$$\sum _{k}{\overset{\to }{F}}_{k}=\overset{\to }{0}$$Second Equilibrium Condition$$\sum _{k}{\overset{\to }{\tau }}_{k}\,=\overset{\to }{0}$$Linear relation betweenstress and strain$$\text{stress}=\text{(elastic modulus)}\,\,\text{strain}$$Youngs modulus$$Y=\frac{\text{tensile stress}}{\text{tensile strain}}=\frac{{F}_{\perp }}{A}\,\frac{{L}_{0}}{L}$$Bulk modulus$$B=\frac{\text{bulk stress}}{\text{bulk strain}}=p\frac{{V}_{0}}{V}$$Shear modulus$$S=\frac{\text{shear stress}}{\text{shear strain}}=\frac{{F}_{\parallel }}{A}\,\frac{{L}_{0}}{x}$$ Note: Unless stated otherwise, the weights of the wires, rods, and other elements are assumed to be negligible. Elastic moduli of selected materials are given in (Figure).What is meant when a fishing line is designated as a 10-lb test?Steel rods are commonly placed in concrete before it sets. What is the purpose of these rods?A uniform rope of cross-sectional area ${0.50\,\text{cm}}^{2}$ breaks when the tensile stress in it reaches $6.00\,\,{10}^{6}{\text{N/m}}^{2}.$ (a) What is the maximum load that can be lifted slowly at a constant speed by the rope? (b) What is the maximum load that can be lifted by the rope with an acceleration of ${4.00\,\text{m/s}}^{2}\text{?}$One end of a vertical metallic wire of length 2.0 m and diameter 1.0 mm is attached to a ceiling, and the other end is attached to a 5.0-N weight pan, as shown below. The position of the pointer before the pan is 4.000 cm. Different weights are then added to the pan area, and the position of the pointer is recorded in the table shown. Plot stress versus strain for this wire, then use the resulting curve to determine Youngs modulus and the proportionality limit of the metal. What metal is this most likely to be?Added load (including pan)(N)Scale reading(cm)04.000154.036254.073354.109454.146554.181654.221754.266854.316An aluminum $(\rho =2.7\,{\text{g/cm}}^{3})$ wire is suspended from the ceiling and hangs vertically. How long must the wire be before the stress at its upper end reaches the proportionality limit, which is $8.0\,\,{10}^{7}{\text{N/m}}^{2}\text{?}$The coefficient of static friction between the rubber eraser of the pencil and the tabletop is ${\mu }_{s}=0.80.$ If the force $\overset{\to }{F}$ is applied along the axis of the pencil, as shown below, what is the minimum angle at which the pencil can stand without slipping? Ignore the weight of the pencil. A pencil rests against a corner, as shown below. The sharpened end of the pencil touches a smooth vertical surface and the eraser end touches a rough horizontal floor. The coefficient of static friction between the eraser and the floor is ${\mu }_{s}=0.80.$ The center of mass of the pencil is located 9.0 cm from the tip of the eraser and 11.0 cm from the tip of the pencil lead. Find the minimum angle θ for which the pencil does not slip.A uniform 4.0-m plank weighing 200.0 N rests against the corner of a wall, as shown below. There is no friction at the point where the plank meets the corner. (a) Find the forces that the corner and the floor exert on the plank. (b) What is the minimum coefficient of static friction between the floor and the plank to prevent the plank from slipping? A 40-kg boy jumps from a height of 3.0 m, lands on one foot and comes to rest in 0.10 s after he hits the ground. Assume that he comes to rest with a constant deceleration. If the total cross-sectional area of the bones in his legs just above his ankles is $3.0\,{\text{cm}}^{2},$ what is the compression stress in these bones? Leg bones can be fractured when they are subjected to stress greater than $1.7\,\,{10}^{8}\,\text{Pa}.$ Is the boy in danger of breaking his leg?Two thin rods, one made of steel and the other of aluminum, are joined end to end. Each rod is 2.0 m long and has cross-sectional area $9.1\,{\text{mm}}^{2}.$ If a 10,000-N tensile force is applied at each end of the combination, find: (a) stress in each rod; (b) strain in each rod; and, (c) elongation of each rod. Two rods, one made of copper and the other of steel, have the same dimensions. If the copper rod stretches by 0.15 mm under some stress, how much does the steel rod stretch under the same stress?A horizontal force $\overset{\to }{F}$ is applied to a uniform sphere in direction exact toward the center of the sphere, as shown below. Find the magnitude of this force so that the sphere remains in static equilibrium. What is the frictional force of the incline on the sphere? When a motor is set on a pivoted mount seen below, its weight can be used to maintain tension in the drive belt. When the motor is not running the tensions ${T}_{1}$ and ${T}_{2}$ are equal. The total mass of the platform and the motor is 100.0 kg, and the diameter of the drive belt pulley is $16.0\,\text{cm.}$ when the motor is off, find: (a) the tension in the belt, and (b) the force at the hinged platform support at point C. Assume that the center of mass of the motor plus platform is at the center of the motor.Two wheels A and B with weights w and 2w, respectively, are connected by a uniform rod with weight w/2, as shown below. The wheels are free to roll on the sloped surfaces. Determine the angle that the rod forms with the horizontal when the system is in equilibrium. Hint: There are five forces acting on the rod, which is two weights of the wheels, two normal reaction forces at points where the wheels make contacts with the wedge, and the weight of the rod. Weights are gradually added to a pan until a wheel of mass M and radius R is pulled over an obstacle of height d, as shown below. What is the minimum mass of the weights plus the pan needed to accomplish this?In order to lift a shovelful of dirt, a gardener pushes downward on the end of the shovel and pulls upward at distance ${l}_{2}$ from the end, as shown below. The weight of the shovel is $m\overset{\to }{g}$ and acts at the point of application of ${\overset{\to }{F}}_{2}.$ Calculate the magnitudes of the forces ${\overset{\to }{F}}_{1}$ and ${\overset{\to }{F}}_{2}$ as functions of ${l}_{1},$ ${l}_{2},$ mg, and the weight W of the load. Why do your answers not depend on the angle θ that the shovel makes with the horizontal? A uniform rod of length 2R and mass M is attached to a small collar C and rests on a cylindrical surface of radius R, as shown below. If the collar can slide without friction along the vertical guide, find the angle θ for which the rod is in static equilibrium.The pole shown below is at a 90.0 bend in a power line and is therefore subjected to more shear force than poles in straight parts of the line. The tension in each line is $4.00\,\,1{0}^{4}\text{N},$ at the angles shown. The pole is 15.0 m tall, has an 18.0 cm diameter, and can be considered to have half the strength of hardwood. (a) Calculate the compression of the pole. (b) Find how much it bends and in what direction. (c) Find the tension in a guy wire used to keep the pole straight if it is attached to the top of the pole at an angle of 30.0 with the vertical. The guy wire is in the opposite direction of the bend. breaking stress (ultimate stress)value of stress at the fracture pointelasticobject that comes back to its original size and shape when the load is no longer presentelastic limitstress value beyond which material no longer behaves elastically and becomes permanently deformedlinearity limit (proportionality limit)largest stress value beyond which stress is no longer proportional to strainplastic behaviormaterial deforms irreversibly, does not go back to its original shape and size when load is removed and stress vanishesstress-strain diagramgraph showing the relationship between stress and strain, characteristic of a material ,the free encyclopedia that anyone can edit.107,766 active editors 7,028,600 articles in EnglishLiz Truss (born 26July 1975) is a British politician who was prime minister from September to October2022. A Liberal Democrat in her youth, she defected to the Conservatives in 1996. After several bids for public office she was elected as an MP in 2010 and served continuously in government in the Cameron, May and Johnson ministries, latterly as foreign secretary. After Johnson resigned in July2022 Truss stood in the election to replace him, defeating Rishi Sunak and becoming the leader of the party. Two days after her appointment as prime minister Queen ElizabethII died, freezing government business for ten days during a national mourning period; after its conclusion Truss's ministry announced a mini-budget which was received badly by markets, the fallout from which subsequently engulfed her government. Facing a rapid loss of confidence in her leadership, Truss resigned fifty days into her premiership and was succeeded by Sunak, becoming the shortest-serving British prime minister.(Fullarticle...)Recently featured: Lesley J. McNairSecond Test, 1948 Ashes seriesDaily News BuildingArchiveBy emailMore featured articlesAboutUSSSabine, which took 35 years to finish... that the Potomac-class frigates (example pictured) were built slowly for the sake of quality, only for the last ships to be outdated by the time they were finished?... that Indonesian mystic Mbah Suro reportedly consumed only coffee and cigarettes for two years?... that the United States' first capitol building was later sold for $425 and then demolished?... that the mascot of an Australian HIV prevention campaign was a condom-wielding superhero?... that Audichron estimated that Don Elliot Heald's voice was heard on 12 million Audichron phone calls a day in 1971?... that the British indie rock band Girl Ray named themselves after the surrealist visual artist Man Ray?... that avery r. young became the first poet laureate of Chicago in 2023?... that by spinning off Lord Fitzhenry (1794) from a four-volume work in progress, Elizabeth Gunning was paid for two novels instead of one?... that American Civil War chaplain Thomas Mooney was pulled from service after baptizing a cannon?ArchiveStart a new articleNominate an articleOzzy OsbourneArmed clashes erupt in the CambodiaThailand border conflict.Ozzy Osbourne (pictured), the lead singer of Black Sabbath, dies at the age of 76.A fighter jet crashes into a college in Dhaka, Bangladesh, killing more than 30 people.In golf, Scottie Scheffler wins the Open Championship.A tourist boat capsizes during a thunderstorm in H Long Bay, Vietnam, leaving at least 36 people dead.Ongoing: Gaza warRussian invasion of UkrainetimelineSudanese civil wartimelineRecent deaths: Chuck MangioneHulk HoganThomas Anthony DurkinGiora EpsteinBatrice Uria-MonzonRex WhiteNominate an articleJuly 26: Independence Day in the Maldives (1965), Kargil Vijay Diwas in IndiaHillary Clinton1551 The Knights Hospitaller surrendered the Castello of Gozo to the Ottoman Empire following a brief siege, leading to the mass enslavement and dispersal of the Gozitan population.1778 On the orders of Catherine the Great the first of tens of thousands of Greek and Armenian Christians were removed from Crimea and resettled in Pryazovia.1953 In Short Creek, Arizona, police conducted a mass arrest of approximately 400 Mormon fundamentalists for polygamy.1993 Asiana Airlines Flight 733 crashed into a mountain during a failed attempt to land at Mokpo Airport, South Korea, leading to the deaths of 68 people on board.2016 Hillary Clinton (pictured) became the first female nominee for president of the United States by a major political party at the Democratic National Convention in Philadelphia.Carl Jung (b.1875)Ana Mara Matute (b.1925)George W. Romney (d.1995)Olivia de Havilland (d.2020)More anniversaries: July 25July 26July 27ArchiveBy emailList of days of the yearAboutCytoplasmic streaming is a biological process in which cytoplasm flows inside a cell, driven by forces from the cytoskeleton. It is usually observed in large plant and animal cells, as well as amoebae, fungi, and slime moulds. It is likely that its function is, at least in part, to speed up the transport of molecules and organelles around the cell. The process was first discovered by the Italian scientist Bonaventura Corti in 1774, within the algae genera Nitella and Chara. While its mechanism is not fully understood, what is clearly visible in plant cells which exhibit cytoplasmic streaming is the motion of the chloroplasts moving with the cytoplasmic flow. This motion results from fluid being entrained by moving motor molecules of the plant cell. This video, taken through a microscope, shows cytoplasmic streaming occurring in an onion epidermal cell.Video credit: Heiti PavesRecently featured: Hudson YardsEmperor angelfishAmlia RodriguesArchiveMore featured picturesCommunity 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 WikivoyageFree travel guide WiktionaryDictionary and thesaurusThis Wikipedia is written in English. Many other Wikipedias are available; some of the largest are listed below. 1,000,000+ articles DeutschEspaolFranaisItalianoNederlandsPolskiPortugusSvenskaTing Vit 250,000+ articles Bahasa IndonesiaBahasa MelayuBn-lm-gCataletinaDanskEestiEsperantoEuskaraMagyarNorsk bokmlRomnSimple EnglishSloveninaSrpskiSrpskohrvatskiSuomiTrkeOzbekcha 50,000+ articles AsturianuAzrbaycancaBosanskiFryskGaeilgeGalegoHrvatskiKurdLatvieuLietuviNorsk nynorskShqipSloveninaRetrieved from " 2This article is about the year 1965. For other uses, see 1965 (disambiguation).1965JanuaryFebruaryMarchAprilMayJuneJulyAugustSeptemberOctoberNovemberDecemberFrom top to bottom, left to right: The Vietnam War escalates as the United States begins regular bombing campaigns in Operation Rolling Thunder and deploys ground combat troops for the first time; the Indo-Pakistani War of 1965 erupts over Kashmir, drawing international concern and resulting in thousands of casualties before a UN-brokered ceasefire; the Voting Rights Act of 1965 is signed into law by President Lyndon B. Johnson, prohibiting racial discrimination in voting; Malcolm X is assassinated while delivering a speech in New York City, silencing one of the most influential and controversial voices in the civil rights movement; the Dominican Civil War breaks out as constitutionalist and loyalist factions clash, prompting a U.S. military intervention amid fears of a second Cuba; former British Prime Minister Winston Churchill dies at the age of 90, prompting a global outpouring of tributes and a state funeral attended by world leaders; the Battle of Ia Drang becomes the first major battle between U.S. and North Vietnamese forces, signaling a new phase of intense ground combat in the Vietnam War; the Indonesian mass killings of 196566 begin following an attempted coup, leading to the deaths of an estimated 500,000 to 1,000,000 people in a brutal anti-communist purge; the Selma to Montgomery marches for voting rights take place in Alabama, culminating in the violent crackdown known as Bloody Sunday and ultimately leading to new federal protections.Calendar yearYearsMillennium2ndmillenniumCenturies19thcentury20thcentury 21stcenturyDecades1940s1950s1960s 1970s1980sYears1962196319641965 196619671968vte1965 by topicSubjectAnimationArchaeologyArchitectureArtAviationAwardsComicsFilmLiteraturePoetryMeteorologyMusicCountryJazzRail transportRadioScienceSpaceflightSportsFootballTelevisionAmericanBelgianBrazilianBritishScottishCanadianDanishIrishItalianBy countryAfghanistanArgentinaAustraliaBelgiumBrazilBulgariaCanadaDenmarkFranceGermanyIndiaIndonesiaIrelandIranIsraelItalyJapanKuwaitLuxembourgMalaysiaNew ZealandNorwayPakistanPhilippinesPortugalSingaporeSouth AfricaSouth KoreaSoviet UnionSpainSwedenSwitzerlandThailandTurkeyUnited KingdomUnited StatesLists of leadersSovereign statesSovereign state leadersTerritorial governorsReligious leadersLawBirth and death categoriesBirthsDeathsEstablishments and disestablishments categoriesEstablishmentsDisestablishmentsWorks categoryWorksIntroductionsvte1965 in various calendarsGregorian calendar1965MCMLXVAb urbe condita2718Armenian calendar1414 Assyrian calendar6715Bah calendar121122Balinese saka calendar18861887Bengali calendar13711372Berber calendar2915British Regnal year13Eliz.214Eliz.2Buddhist calendar2509Burmese calendar1327Byzantine calendar74737474Chinese calendar (WoodDragon)4662 or 4455to (WoodSnake)4663 or 4456Coptic calendar16811682Discordian calendar3131Ethiopian calendar19571958Hebrew calendar57255726Hindu calendars- Vikram Samvat20212022- Shaka Samvat18861887- Kali Yuga50655066Holocene calendar11965Igbo calendar965966Iranian calendar13431344Islamic calendar13841385Japanese calendarShwa 40()Javanese calendar18961897Juche calendar54Julian calendarGregorian minus 13 daysKorean calendar4298Minguo calendarROC 5454Nanakshahi calendar497Thai solar calendar2508Tibetan calendar(male Wood-Dragon)2091 or 1710 or 938to(female Wood-Snake)2092 or 1711 or 939Wikimedia Commons has media related to 1965.1965 (MCMLXV) was a common year starting on Friday of the Gregorian calendar, the 1965th year of the Common Era (CE) and Anno Domini (AD) designations, the 965th year of the 2ndmillennium, the 65th year of the 20thcentury, and the 6th year of the 1960s decade. Calendar year Main article: January 1965Main article: February 1965January 14 The First Minister of Northern Ireland and the Taoiseach of the Republic of Ireland meet for the first time in 43 years.January 20Lyndon B. Johnson is sworn in for a full term as President of the United States.Indonesian President Sukarno announces the withdrawal of the Indonesian government from the United Nations.January 29 Hakamets, the first ice rink of Finland, is inaugurated in Tampere.[1]January 30 The state funeral of Sir Winston Churchill takes place in London with the largest assembly of dignitaries in the world until the 2005 funeral of Pope John Paul II.[2]February 4 Trofim Lysenko is removed from his post as director of the Institute of Genetics at the Academy of Sciences in the Soviet Union. Lysenkoist theories are now treated as pseudoscience.[3][4]February 12 The African and Malagasy Common Organization (Organization Commune Africaine et Malgache; OCAM) is formed as successor to the Afro-Malagasy Union for Economic Cooperation (Union Africaine et Malgache de Cooperation Economique; UAMCE), formerly the African and Malagasy Union (Union Africaine et Malgache; UAM).February 18: Flag of the newly independent GambiaFebruary 15 The maple leaf is adopted as the flag of Canada, replacing the Canadian Red Ensign flag.February 18 The Gambia becomes independent from the United Kingdom.February 20Ranger 8 crashes into the Moon, after a successful mission of photographing possible landing sites for the Apollo program astronauts.Suat Hayri rgpl forms the new (interim) government of Turkey (29th government).February 21 Malcolm X is gunned down while giving a speech at the Audubon Ballroom in Harlem.Main article: March 1965Main article: April 1965March 2 Vietnam War: Operation Rolling Thunder The United States Air Force 2nd Air Division, United States Navy and South Vietnamese air force begin a 312-year aerial bombardment campaign against North Vietnam.March 7Mass in the Catholic Church worldwide is said in local languages (rather than Latin) for the first time.[5][6]"Bloody Sunday": Some 200 Alabama State Troopers attack 525 civil rights demonstrators in Selma, Alabama, as they attempt to march to the state capitol of Montgomery.March 8 Vietnam War: Some 3,500 United States Marines arrive in Da Nang, South Vietnam, becoming the first American ground combat troops in Vietnam.March 9 The "Turnaround Tuesday" march from Selma to Montgomery, Alabama, under the leadership of Martin Luther King Jr., stops at the site of "Bloody Sunday", to hold a prayer service and return to Selma, in obedience to a court restraining order. On the same day, White supremacists attack three white ministers, leaving Unitarian Universalist minister James J. Reeb in a coma.March 10 An engagement is announced between Princess Margriet of the Netherlands and Pieter van Vollenhoven, who will become the first commoner and the first Dutchman to marry into the Dutch royal family.March 18 Cosmonaut Alexei Leonov leaves his Voskhod 2 spacecraft for 12 minutes, becoming the first person to walk in space.[7]March 20"Poupe de cire, poupe de son", sung by France Gall (music and lyrics by Serge Gainsbourg), wins the Eurovision Song Contest 1965 (staged in Naples) for Luxembourg.[8]The Indo-Pakistani War of 1965 begins.March 23Events of March 23, 1965: Large student demonstration in Morocco, joined by discontented masses, meets with violent police and military repression.Gemini 3: NASA launches the United States' first 2-person crew (Gus Grissom, John Young) into Earth orbit.The first issue of The Vigilant is published from Khartoum.March 25 Martin Luther King Jr. and 25,000 civil rights activists successfully end the 4-day march from Selma, Alabama, to the capitol in Montgomery.March 28 At least 400 are killed or missing after an earthquake triggered a series of dam failures in La Ligua, Chile.[9]March 30 The second ODECA charter, signed by Central American states on December 12, 1962, becomes effective.April 3 The world's first space nuclear power reactor, SNAP-10A, is launched by the United States from Vandenberg AFB, California. The reactor operates for 43 days and remains in low Earth orbit.April 5 At the 37th Academy Awards, My Fair Lady wins 8 Academy Awards, including Best Picture and Best Director. Rex Harrison wins an Oscar for Best Actor. Mary Poppins takes home 5 Oscars. Julie Andrews wins an Academy Award for Best Actress for her performance in the title role. Sherman Brothers receives 2 Oscars including Best Song, "Chim Chim Cher-ee".April 6 The Intelsat I ("Early Bird") communications satellite is launched. It becomes operational May 2 and is placed in commercial service in June.April 9 The West German parliament extends the statute of limitations on Nazi war crimes.April 12 A historic and extremely destructive tornado outbreak struck the Midwest region of the United States, killing 266.April 18 Consecration of Saint Clement of Ohrid Macedonian Orthodox Cathedral in Toronto, Canada.April 23 The Pennine Way officially opens.April 24The 1965 Yerevan demonstrations start in Yerevan, demanding recognition of the Armenian genocide.The bodies of Portuguese opposition politician Humberto Delgado and his secretary Arajaryr Moreira de Campos are found in a forest near Villanueva del Fresno, Spain (they were killed February 12).In the Dominican Republic, officers and civilians loyal to deposed President Juan Bosch mutiny against the right-wing junta running the country, setting up a provisional government. Forces loyal to the deposed military-imposed government stage a countercoup the next day, and civil war breaks out, although the new government retains its hold on power.April 26 Rede Globo is founded in Rio de Janeiro, Brazil.April 28U.S. troops occupy the Dominican Republic.Vietnam War: Prime Minister of Australia Robert Menzies announces that the country will substantially increase its number of troops in South Vietnam, supposedly at the request of the Saigon government (it is later revealed that Menzies had asked the leadership in Saigon to send the request at the behest of the Americans).April 29 Australia announces that it is sending an infantry battalion to support the South Vietnam government.Main article: May 1965Main article: June 1965May 1Bob Askin replaces Jack Renshaw as Premier of New South Wales.The Battle of Dong-Yin occurs as a conflict between Taiwan and the People's Republic of China.May 9 Pianist Vladimir Horowitz returns to the stage after a 12-year absence, performing a legendary concert in Carnegie Hall in New York.May 12 West Germany and Israel establish diplomatic relations.Muhammad Ali standing over Sonny ListonMay 25 Muhammad Ali knocks out Sonny Liston in the first round of their championship rematch with the "Phantom Punch" at the Central Maine Civic Center in Lewiston.May 27 Internazionale beats Benfica 10 at the San Siro, Milan and wins the 196465 European Cup in Association football.May 29 A mining accident in Dhanbad, India, kills 274.May 31 Scottish racing driver Jim Clark wins the Indianapolis 500, later this year winning the Formula One world driving championship.June 1 A coal mine explosion in Fukuoka, Japan, kills 237.June 2 Vietnam War: The first contingent of Australian combat troops arrives in South Vietnam.June 7 Kakanj mine disaster: A mining accident in Kakanj, Bosnia and Herzegovina, results in 128 deaths.June 10 Vietnam War Battle of Dong Xoai: About 1,500 Viet Cong mount a mortar attack on ng Xoi, overrunning its military headquarters and the adjoining militia compound.June 19Houari Boumedienne's Revolutionary Council ousts Ahmed Ben Bella, in a bloodless coup in Algeria.Air Marshal Nguyen Cao Ky, head of the South Vietnamese Air Force, was appointed prime minister at the head of the military junta, with General Nguyn Vn Thiu becoming a figurehead president, ending two years of short-lived military juntas.[10][non sequitur]June 20 Police in Algiers break up demonstrations by people who have taken to the streets chanting slogans in support of deposed President Ahmed Ben Bella.June 22 The Treaty on Basic Relations between Japan and the Republic of Korea is signed in Tokyo.June 25 A U.S. Air Force Boeing C-135 Stratolifter bound for Okinawa crashes just after takeoff at MCAS El Toro in Orange County, California, killing all 85 on board.Main article: July 1965Main article: August 1965July The Commonwealth secretariat is created.July 14 U.S. spacecraft Mariner 4 flies by Mars, becoming the first spacecraft to return images from the Red Planet.July 15 Greek Prime minister Georgios Papandreou and his government are dismissed by King Constantine II.July 16 The Mont Blanc Tunnel, a highway tunnel between France and Italy, is inaugurated by presidents Giuseppe Saragat and Charles de Gaulle.July 24 Vietnam War: Four F-4C Phantoms escorting a bombing raid at Kang Chi are targeted by antiaircraft missiles, in the first such attack against American planes in the war. One is shot down and the other 3 sustain damage.July 26 The Maldives obtains full independence from Great Britain.[11]July 27 Edward Heath becomes Leader of the British Conservative Party.July 28 Vietnam War: U.S. President Lyndon B. Johnson announces his order to increase the number of United States troops in South Vietnam from 75,000 to 125,000, and to more than double the number of men drafted per month - from 17,000 to 35,000.July 30 War on Poverty: U.S. President Lyndon B. Johnson signs the Social Security Act of 1965 into law, establishing Medicare and Medicaid.August 7 Tunku Abdul Rahman, Prime Minister of Malaysia, recommends the expulsion of Singapore from the Federation of Malaysia following a deterioration of PAPUMNO relations, negotiating its separation with Lee Kuan Yew, Prime Minister of Singapore.August 9Proclamation of Singapore: Singapore is expelled from the Federation of Malaysia, which recognises it as a sovereign nation. Lee Kuan Yew announces Singapore's independence and assumes the position of Prime Minister of the new island nation a position he holds until 1990.An explosion at an Arkansas missile plant kills 53.Indonesian president Sukarno collapses in public.August 11 Racial rioting in the Los Angeles, California neighborhood of Watts breaks out after an African American motorist, Marquette Frye,[12] is stopped on suspicion of drunken driving. Six days of unrest are quelled by over 14,000 members of the California National Guard. There are 34 deaths and over $40 million in property damage. It is the largest and costliest urban rebellion of the Civil Rights movement.[13]August 18 Vietnam War: Operation Starlite 5,500 United States Marines destroy a Viet Cong stronghold on the Van Tuong peninsula in Qung Ngi Province, in the first major American ground battle of the war. The Marines were tipped off by a Viet Cong deserter who said that there was an attack planned against the U.S. base at Chu Lai.August 19 At the conclusion of the Frankfurt Auschwitz trials, 66 ex-SS personnel receive life sentences, 15 others shorter ones.August 21 NASA launches Gemini 5 (Gordon Cooper, Pete Conrad) on the first 1-week space flight, as well as the first test of fuel cells for electrical power on such a mission.August 30 An avalanche buries a dam construction site at Saas-Fee, Switzerland, killing 90 workers.August 31 U.S. President Johnson signs a law penalizing the burning of draft cards with up to 5 years in prison and a $1,000 fine.Main article: September 1965Main article: October 1965September 2Pakistani troops enter the Indian sector of Kashmir, while Indian troops counter at Lahore.The People's Republic of China announces that it will reinforce its troops on the Indian border.Vietnam War: In a follow-up to August's Operation Starlite, United States Marines and South Vietnamese forces initiate Operation Piranha on the Batangan Peninsula, 23 miles (37km) south of the Chu Lai Marine base.September 8India opens 2 additional fronts against Pakistan.The Pakistan Navy destroys Indian Port of Dwarka. Operation Dwarka (Pakistan celebrates Victory Day annually).September 9U.N. Secretary General U Thant negotiates with Pakistan President Ayub Khan.U Thant recommends China for United Nations membership.September 14 The fourth and final period of the Second Vatican Council opens.September 16 In Iraq, Prime Minister Arif Abd ar-Razzaq's attempted coup fails.September 17 King Constantine II of Greece forms a new government with Prime Minister Stephanos Stephanopoulos, in an attempt to end a 2-year-old political crisis.September 18In Denmark, Palle Srensen shoots 4 policemen in pursuit; he is apprehended the same day.Comet IkeyaSeki is first sighted by Japanese astronomers.Soviet Premier Alexei Kosygin invites the leaders of India and Pakistan to meet in the Soviet Union to negotiate.September 19 Pakistani Forces achieve a decisive victory at the Battle of Chawinda, ultimately halting the Indian advance and successfully stabilizing the Sialkot Front, it is the world's largest tank battle since the Battle of Kursk in the Second World War between Nazi Germany and the Soviet UnionSeptember 20 Vietnam War: An USAF F-104 Starfighter piloted by Captain Philip Eldon Smith is shot down by a Chinese MiG-19 Farmer. The pilot is held until March 15, 1973.September 21 Gambia, Maldives and Singapore are admitted as members of the United Nations.September 22 Radio Peking announces that Indian troops have dismantled their equipment on the Chinese side of the border.September 24Fighting resumes between Indian and Pakistani troops.The British governor of Aden cancels the constitution and takes direct control of the protectorate, due to the bad security situation.September 27 The largest tanker ship at this time, Tokyo Maru, is launched in Yokohama, Japan.September 28Fidel Castro announces that anyone who wants to can emigrate to the United States.Taal Volcano in Luzon, Philippines, erupts, killing hundreds.September 30The Indonesian army, led by General Suharto, crushes an alleged communist coup attempt (see Transition to the New Order and 30 September Movement).The classic family sci-fi show Thunderbirds debuts on ITV in the United Kingdom.October 3 Fidel Castro announces that Che Guevara has resigned and left Cuba.October 4At least 150 are killed when a commuter train derails at the outskirts of Durban, KwaZulu-Natal, South Africa.Prime minister Ian Smith of Rhodesia and Arthur Bottomley of the Commonwealth of Nations begin negotiations in London.Pope Paul VI makes the first papal visit to the United States. He appears for a Mass in Yankee Stadium and makes a speech at the United Nations.The University of California, Irvine opens its doors.October 5 Pakistan severs diplomatic relations with Malaysia because of their disagreement in the UN.October 6 Ian Brady, a 27-year-old stock clerk from Hyde in Cheshire, is arrested for allegedly hacking to death (with a hatchet) 17-year-old apprentice electrician Edward Evans at a house on the Hattersley housing estate.October 7 Seven Japanese fishing boats are sunk off Guam by Super Typhoon Carmen; 209 are killed.October 8Indonesian mass killings of 19651966: The Indonesian army instigates the arrest and execution of communists which last until next March.[14]The 7 Fundamental Principles of the Red Cross and Red Crescent are adopted at the XX International Conference in Vienna, Austria.The International Olympic Committee admits East Germany as a member.October 10 The first group of Cuban refugees travels to the U.S.October 12Per Borten forms a government in Norway.The U.N. General Council recommends that the United Kingdom try everything to stop a rebellion in Rhodesia.October 13 Congo President Joseph Kasavubu fires Prime Minister Moise Tshombe and forms a provisional government, with variste Kimba in a leading position.October 15 Vietnam War: The Catholic Worker Movement stages an anti-war protest in Manhattan. One draft card burner is arrested, the first under the new law.October 17 The New York World's Fair at Flushing Meadows, closes. Due to financial losses, some of the projected site park improvements fail to materialize.October 18 The Indonesian government outlaws the Communist Party of Indonesia.[15]October 20 Ludwig Erhard is re-elected Chancellor of West Germany (he had first been elected in 1963).October 21Comet IkeyaSeki approaches perihelion, passing 450,000 kilometres (280,000mi) from the sun.The Organization of African Unity meets in Accra, Ghana.October 22African countries demand that the United Kingdom use force to prevent Rhodesia from declaring unilateral independence.Colonel Christophe Soglo stages a second coup in Dahomey.October 25 The Soviet Union declares its support of African countries in case Rhodesia unilaterally declares independence.October 27Brazilian president Humberto de Alencar Castelo Branco removes power from parliament, legal courts and opposition parties.Sleyman Demirel of AP forms the new government of Turkey (30th government).October 28 Pope Paul VI promulgates Nostra aetate, a "Declaration on the Relation of the (Roman Catholic) Church with Non-Christian Religions" by the Second Vatican Council which includes a statement that Jews are not collectively responsible for the death of Jesus (Jewish deicide).October 29 An 80-kiloton nuclear device is detonated at Amchitka Island, Alaska, as part of the Vela Uniform program, code-named Project Long Shot.October 30 Vietnam War: Near Da Nang, United States Marines repel an intense attack by Viet Cong forces, killing 56 guerrillas. A sketch of Marine positions is found on the dead body of a 13-year-old Vietnamese boy who sold drinks to the Marines the day before.Main article: November 1965Main article: December 1965November 1 A trolleybus plunges into the Nile at Cairo, Egypt, killing 74 passengers.November 3 French President Charles de Gaulle announces (just short of his 75th birthday) that he will stand for re-election.November 5 Martial law is announced in Rhodesia. The United Nations General Assembly accepts British intent to use force against Rhodesia if necessary by a vote of 829.November 6 Freedom Flights begin: Cuba and the United States formally agree to start an airlift for Cubans who want to go to the United States (by 1971, 250,000 Cubans take advantage of this program).November 8 Vietnam War Operation Hump: The United States Army 173rd Airborne is ambushed by over 1,200 Viet Cong.November 11In Rhodesia (modern-day Zimbabwe), the white-minority government of Ian Smith unilaterally declares de facto independence ('UDI').United Airlines Flight 227 crashes short of the runway and catches fire at Salt Lake City International Airport, killing 43 out of 91 passengers and crew.November 12 A UN Security Council resolution (voted 100) recommends that other countries not recognize independent Rhodesia.November 13The SSYarmouth Castle burns and sinks 60 miles (97km) off Nassau, Bahamas, with the loss of 90 lives.British theatre critic Kenneth Tynan says "fuck" during a discussion on BBC satirical programme BBC-3 for what many believed was the first time on British television. The corporation later issues a public apology.November 14 Vietnam War Battle of Ia Drang: In the Ia Drang Valley of the Central Highlands in Vietnam, the first major engagement of the war between regular United States and North Vietnamese forces begins.November 15 U.S. racer Craig Breedlove sets a new land speed record of 600.601mph (966.574km/h).November 16 Venera program: The Soviet Union launches the Venera 3 space probe from Baikonur, Kazakhstan toward Venus (on March 1, 1966, it becomes the first spacecraft to reach the surface of another planet).November 20 The United Nations Security Council recommends that all states stop trading with Rhodesia.November 22 The United Nations Development Programme (UNDP) is established as a specialized agency of the United Nations.November 23 Soviet general Mikhail Kazakov assumes command of the Warsaw Pact.November 24 Congolese lieutenant general Mobutu ousts Joseph Kasavubu and declares himself president.November 26 At the Hammaguir launch facility in the Sahara Desert, France launches a Diamant A rocket with its first satellite, Astrix-1 on board, becoming the third country to enter outer space.November 27Tens of thousands of Vietnam War protesters picket the White House, then march on the Washington Monument.Vietnam War: The Pentagon tells U.S. President Lyndon B. Johnson that if planned major sweep operations to neutralize Viet Cong forces during the next year are to succeed, the number of American troops in Vietnam will have to be increased from 120,000 to 400,000.November 28 Vietnam War: In response to U.S. President Lyndon B. Johnson's call for "more flags" in Vietnam, Philippines President-elect Ferdinand Marcos announces he will send troops to help fight in South Vietnam.November 29 The Canadian satellite Alouette 2 is launched.December 5Charles de Gaulle is re-elected as French president with 10,828,421 votes.The "Glasnost Meeting" in Moscow becomes the first spontaneous political demonstration, and the first demonstration for civil rights in the Soviet Union.December 8: End of the Second Vatican CouncilDecember 8The Second Vatican Council closes.Rhodesian prime minister Ian Smith warns that Rhodesia will resist a trade embargo by neighboring countries with force.The Race Relations Act becomes the first legislation to address racial discrimination in the UK.December 9 A Charlie Brown Christmas, the first Peanuts television special, debuts on CBS in the United States. It becomes a Christmas tradition.December 15The Caribbean Free Trade Association (CARIFTA) is formed.Gemini 6 and Gemini 7 perform the first controlled rendezvous in Earth orbit.December 20 The World Food Programme is made a permanent agency of the United Nations.December 21The Soviet Union announces that it has shipped rockets to North Vietnam.In West Germany, Konrad Adenauer resigns as chairman of the Christian Democratic Party.The United Nations adopts the International Convention on the Elimination of All Forms of Racial Discrimination.A new 1-hour German-American production of the ballet The Nutcracker, with an international cast that includes Edward Villella in the title role, makes its U.S. television debut. It is repeated annually by CBS over the next 3 years but after that is virtually forgotten until issued on DVD in 2009 by Warner Archive.December 22 A military coup is launched in Dahomey.December 25 The Yemeni Nasserist Unionist People's Organisation is founded in Ta'izz.December 30: Ferdinand Marcos is the 10th President of the PhilippinesDecember 30Ferdinand Marcos becomes President of the Philippines.President Kenneth Kaunda of Zambia announces that Zambia and the United Kingdom have agreed on a deadline before which the Rhodesian white government should be ousted.December 31 Bokassa takes power in the Central African Republic.Aborigines are given the vote in Queensland, Australia.Hainzl Industriesysteme GmbH company is founded in Austria.[16]Tokyo officially becomes the largest city of the world, taking the lead from New York City.[17]World population19651960 1970 World3,334,874,0003,021,475,000 313,399,0003,692,492,000 357,618,000 Africa313,744,000277,398,000 36,346,000357,283,000 43,539,000 Asia1,899,424,0001,701,336,000 198,088,0002,143,118,000 243,694,000 Europe634,026,000604,401,000 29,625,000655,855,000 21,829,000 Latin America250,452,000218,300,000 32,152,000284,856,000 34,404,000 Northern America219,570,000204,152,000 15,418,000231,937,000 12,367,000 Oceania17,657,00015,888,000 1,769,00019,443,000 1,786,000Julia OrmondVinnie JonesJoely RichardsonDiane LaneJanuary 4Julia Ormond, British actress[18]Yvan Attal, Israeli-born French actor and directorJanuary 5Vinnie Jones, British footballer-turned-actor[19]Patrik Sjberg, Swedish high jumper[20]January 9Haddaway, German singerFarah Khan, Indian choreographer, film directorJoely Richardson, British actressJanuary 10 Butch Hartman, American animator and voice actorJanuary 12Nikolai Borschevsky, Russian ice hockey playerMaybrit Illner, German television journalist and presenterRob Zombie, American musicianJanuary 14Shamil Basayev, Chechen terrorist (d. 2006)Marc Delissen, Dutch field hockey playerBob Essensa, Canadian ice hockey playerJanuary 15Adam Jones, American musician, guitarist of metal band ToolJames Nesbitt, Northern Irish actor[21]January 20 Sophie, Duchess of Edinburgh, wife of Prince Edward, Duke of EdinburghJanuary 21 Jam Master Jay, American DJ, rapper and producer (d. 2002)January 22DJ Jazzy Jeff, American disc jockeyDiane Lane, American actressJanuary 23 Catherine Guillouard, French businesswomanJanuary 24 Porfirio Fisac, Spanish basketball coachJanuary 25 Esa Tikkanen, Finnish ice hockey playerJanuary 26 Natalia Yurchenko, Soviet artistic gymnastJanuary 27Alan Cumming, Scottish actorIgnacio No, Argentine artistJanuary 29Dominik Haek, Czech hockey playerJo Min-su, South Korean actressChris RockAdama BarrowMichael BayDr. DreFebruary 1Dave Callaghan, South African cricketerBrandon Lee, Chinese-American actor (d. 1993)Sherilyn Fenn, American actressPrincess Stphanie of MonacoFebruary 3 Maura Tierney, American actressFebruary 5 Gheorghe Hagi, Romanian footballer, manager and club owner[22]February 7 Chris Rock, African-American actor, comedian, and film directorFebruary 8 Dicky Cheung, Hong Kong actorFebruary 11 Roberto Moya, Cuban athlete (d. 2020)February 12 Brett Kavanaugh, American attorney and Supreme Court JusticeFebruary 15 Hctor Beltrn Leyva, Mexican drug lord (d. 2018)February 16 Adama Barrow, Gambian politician, 3rd President of GambiaFebruary 17 Michael Bay, American film director[23]February 18 Dr. Dre, African-American rapper and music producerFebruary 23Kristin Davis, American actress[24]Michael Dell, American computer manufacturer[25]Vincent Chalvon-Demersay, French producerHelena Sukov, Czech tennis player[26]February 25 Sylvie Guillem, French ballerinaFebruary 27 Claudia Zobel, Filipina actress (d. 1984)February 28 Park Gok-ji, South Korean film editorAamir KhanMark CarneyRick HarrisonThe UndertakerSarah Jessica ParkerMarch 1Mike Dean, Record producerStewart Elliott, Canadian jockeyJack Tu, Taiwanese-Canadian cardiologist (d. 2018)March 2 Ami Bera, American politician[27]March 3Tedros Adhanom, Director of the World Health OrganizationMarch 4Greg Alexander, Australian rugby league playerPaul W. S. Anderson, British filmmaker, producer and screenwriterMarch 5 Harry Bevers, Dutch politicianMarch 8Mac Jack, South African educator and politician (d. 2020)Caio Jnior, Brazilian football forward and manager (d. 2016)March 9 Antonio Saca, 43rd President of El SalvadorMarch 11Catherine Fulop, Venezuelan actress, model, beauty pageant contestant, and television presenterJesse Jackson Jr., African-American politicianLaurence Llewelyn-Bowen, British designer and television presenterMarch 14 Aamir Khan, Indian film director, producer, film and scriptwriter and actorMarch 16Utut Adianto, Indonesian chess grandmaster and politicianMark Carney, Canadian economist and politician, 24th Prime Minister of Canada[28]March 22 Rick Harrison, American businessman and reality television personalityMarch 23 Marti Pellow, Scottish singer (Wet Wet Wet)March 24Rob MacCachren, American racecar driverThe Undertaker, American professional wrestlerMarch 25Stefka Kostadinova, Bulgarian high jumper and president of the Bulgarian Olympic CommitteeSarah Jessica Parker, American actressMarch 26 Prakash Raj, Indian actor, producer and directorMarch 29 Voula Patoulidou, Greek athleteMarch 30 Piers Morgan, British journalist and television personalityRobert Downey Jr.Martin LawrenceLeni RobredoKevin JamesApril 1Brian Marshall, Canadian retired track and field athleteBekir Bozda, Turkish theologian, lawyer, and politicianApril 3 Nazia Hassan, Pakistani pop singer-songwriter, lawyer and social activist (d. 2000)April 4 Robert Downey Jr., American actor, producer, and singerApril 6Black Francis, American musicianRica Reinisch, German swimmerApril 9 Paulina Porizkova, Swedish-American model and actressApril 10Anna-Leena Hrknen, Finnish author[29]Jure Robi, Slovenian cyclist (d. 2010)April 11 Eelco van Asperen, Dutch computer scientistApril 12 Kim Bodnia, Danish actor and directorApril 15 Linda Perry, American musicianApril 16 Martin Lawrence, American actor, comedian, and producerApril 18 Camille Coduri, English actressApril 19 Suge Knight, American record producer and convicted felonApril 20 Jovy Marcelo, Filipino racing driver (d. 1992)April 21 Julio Robaina, Republican politician, Mayor of Hialeah, FloridaApril 23 Leni Robredo, 14th Vice President of the PhilippinesApril 24 Michel Leclerc, French director and screenwriterApril 25 douard Ferrand, French politician (d. 2018)April 26 Kevin James, American comedian and actorApril 27 Edwin Poots, Irish politicianApril 29 David Shafer, American politician, GeorgiaApril 30 Adrian Pasdar, Iranian-American actor and voice artistTrent ReznorJohn C. ReillyYahya JammehBrooke ShieldsMay 2 Myriam Hernndez, Chilean singerMay 3Gary Mitchell, Irish playwrightRob Brydon, Welsh actor, comedian, impressionist and presenterMay 7Owen Hart, Canadian professional wrestler (d. 1999)[30]Norman Whiteside, Northern Irish football playerMay 9 Steve Yzerman, Canadian hockey playerMay 10 Linda Evangelista, Canadian supermodelMay 11 Monsour del Rosario, Filipino Olympic athlete and actorMay 12 Rene Simonsen, Danish model and writerMay 13 Jos Antonio Delgado, Venezuelan mountain climber (d. 2006)May 14 Eoin Colfer, Irish novelistMay 16Rodica Dunca, Romanian artistic gymnastKrist Novoselic, American musician and activist (Nirvana)May 17 Trent Reznor, American rock musician (Nine Inch Nails)May 19 Philippe Dhondt, French singerMay 23Melissa McBride, American actress (The Walking Dead)May 24Carlos Franco, Paraguayan golferJohn C. Reilly, American actor and comedianShinichir Watanabe, Japanese anime directorMay 25 Yahya Jammeh, President of the GambiaMay 29 Emilio Snchez, Spanish tennis playerMay 30 Guadalupe Grande, Spanish poet (d. 2021)May 31 Brooke Shields, American actress and modelMick FoleyFrank GrilloElizabeth HurleyKim DickensJune 1Larisa Lazutina, Russian cross-country skierNigel Short, English chess playerJune 2 Steve and Mark Waugh, Australian cricketersJune 4Mick Doohan, Australian motorcycle racerAndrea Jaeger, American tennis player[31]June 6Cam Neely, Canadian ice hockey playerMegumi Ogata, Japanese voice actress and singer[32]June 7Mick Foley, American professional wrestlerDamien Hirst, British artistChristine Roque, French singerJune 8Frank Grillo, American actor[33]Rob Pilatus, German model, dancer and singer (d. 1998)June 10Veronica Ferres, German actressElizabeth Hurley, English model and actressJune 11 Manuel Uribe, morbidly obese Mexican (d. 2014)June 12 Carlos Luis Morales, Ecuadorian journalist (d. 2020)June 13 Infanta Cristina of Spain, Spanish princessJune 15 Bernard Hopkins, American boxerJune 16 Andrea M. Ghez, American astronomer, recipient of the Nobel Prize in Physics[34]June 17Dana Eskelson, American actress[35]Dan Jansen, American speedskaterDara O'Kearney, Irish ultra runner and professional poker playerJune 18Kim Dickens, American actressHani Mohsin, Malaysian celebrity, actor and host (d. 2006)June 21Yang Liwei, Chinese major general, military pilot and China National Space Administration astronautGabriella Selmeczi, Hungarian jurist and politicianTim Lajcik, Czech American mixed martial artist, stuntman, actor and writerJune 22 Anubhav Sinha, Indian film directorJune 23 Paul Arthurs, English Musician (Oasis)June 24 Son Hyun-joo, South Korean actorJune 25 Jean Castex, French politicianJune 26 Jana Hybkov, Czech politician and diplomatJune 27Frdric Lemoine, French businessmanS. Manikavasagam, Malaysian politicianJune 28 Belayneh Dinsamo, Ethiopian long-distance runnerJune 29Vronique Laury, French businesswomanDado Villa-Lobos, Brazilian musicianMatthew Weiner, American television writer, director and producer[36]June 30Philippe Duquesne, French actorCho Jae-hyun, South Korean actorMitch Richmond, American basketball playerConnie NielsenHailemariam DesalegnShawn MichaelsSlashIlleana DouglasJeremy PivenJ. K. RowlingJuly 1Teddy McCarthy, hurler and Gaelic footballerCarl Fogarty, English motorcycle racerMohammed Abdul Hussein, Iraqi former footballerRamdas Ambatkar, Indian politician, Maharashtra MLC (d. 2025)[37]July 2 Fredrik Sejersted, Norwegian juristJuly 3Komsan Pohkong, Thai lawyerShinya Hashimoto, Japanese professional wrestler (d. 2005)Connie Nielsen, Danish actressTommy Flanagan, Scottish actorJuly 4 Tracy Letts, American actor, playwright and screenwriterJuly 5Kathryn Erbe, American actressEyran Katsenelenbogen, Israeli jazz pianistJuly 7Paula Devicq, Canadian actressJeremy Kyle, English radio and television presenterJuly 10Danny Boffin, Belgian footballerPrincess Alexia of Greece and DenmarkAlec Mapa, American comedianJuly 11 Ernesto Hoost, Dutch kickboxerJuly 12 Mama Kandeh, Gambian politicianJuly 13 Akina Nakamori, Japanese singer and actressJuly 14 Lou Savarese, American boxerJuly 15 Dafna Rechter, Israeli actress and singerJuly 17Santiago Segura, Spanish actor, screenwriter, producer and directorRosa Gumataotao Rios, 43rd Treasurer of the United StatesAlex Winter, British actorJuly 18 Eva Ionesco, French actress, film director and screenwriterJuly 19Dame Evelyn Glennie, Scottish virtuoso percussionistHailemariam Desalegn, 15th Prime Minister of EthiopiaJuly 21 Guni Bergsson, Icelandic footballerJuly 22 Shawn Michaels, American professional wrestlerJuly 23Grace Mugabe, First Lady of ZimbabweSlash (Saul Hudson), English-born American rock guitaristJuly 25 Illeana Douglas, American actress and producer[38]July 26Vladimir Cruz, Cuban actorJeremy Piven, American actorJimmy Dore, American comedian and political commentatorJuly 27Jos Luis Chilavert, Paraguayan footballer[39]Trifon Ivanov, Bulgarian footballer (d. 2016)[40]July 28 Daniela Mercury, Brazilian singer, songwriter, dancer, producer, actress and television hostJuly 29 Chang-Rae Lee, Korean-American novelistJuly 31 J. K. Rowling, English authorSir Sam MendesViola DavisKyra SedgwickAugust 1 Sam Mendes, English film directorAugust 2Sandra Ng, Hong Kong actressHisanobu Watanabe, Japanese baseball player and coachAugust 4Terri Lyne Carrington, American jazz drummerDennis Lehane, American crime writerFredrik Reinfeldt, Swedish Prime Minister[41]August 5 Monica Ward, Italian actress and voice actressAugust 6 David Robinson, American basketball playerAugust 10Claudia Christian, American actress, writer, singer, musician, and directorMike E. Smith, American jockeyJohn Starks, American basketball playerAugust 11 Viola Davis, African-American actressAugust 15 Vincent Kok, Hong Kong director and actorAugust 16 Michael O'Gorman, American coxswain (d. 2018)August 19Kevin Dillon, American actorMaria de Medeiros, Portuguese actressKyra Sedgwick, American actressJames Tomkins, Australian rowerAugust 22 David Reimer, Canadian man, born male but reassigned female and raised as a girl after a botched circumcision (d. 2004)[42]August 24 Reggie Miller, American basketball player and commentatorAugust 25 Mia Zapata, American singer (d. 1993)August 26 Azela Robinson, Mexican actressAugust 28Satoshi Tajiri, Japanese video game designer and Pokmon creator[43]Amanda Tapping, Canadian actressShania Twain, Canadian country singer and songwriterAugust 31 Daniel Bernhardt, Swiss actor and martial artistCharlie SheenBashar al-AssadDmitry MedvedevKyle ChandlerTim ScottPetro PoroshenkoSeptember 1 Craig McLachlan, Australian actor and singerSeptember 2 Lennox Lewis, British boxerSeptember 3Costas Mandylor, Greek-Australian actorCharlie Sheen, American actor and producerSeptember 5 Derby Makinka, Zambian footballer (d. 1993)September 6 Gleisi Hoffmann, Brazilian lawyer and politicianSeptember 7 Jürgen Klinsmann, German footballer and managerSeptember 9 Hugh Grant, English actor and producerSeptember 10 Marco Pastors, Dutch politicianSeptember 11Bashar al-Assad, President of SyriaMoby, American musicianSeptember 12Einstein Kristiansen, Norwegian cartoonist, designer, and television presenterSeptember 14 Dmitry Medvedev, former President of RussiaSeptember 15 Fernanda Torres, Brazilian actressSeptember 16 Katy Kurtzman, American actress, director and producerSeptember 17Kyle Chandler, American actorYuji Naka, Japanese video game programmerSeptember 19Goldie, English record producer and DJIliya Lazarov, Bulgarian politicianTim Scott, African-American former politician and businessmanTshering Tobgay, former Prime Minister of BhutanSeptember 20 Robert Rusler, American actorSeptember 21Cheryl Hines, American actressJohanna Vuoksenmaa, Finnish film directorDavid Wenham, Australian actorPamila Jayapal, American politicianSeptember 23 Mark Woodforde, Australian tennis playerSeptember 25 Scottie Pippen, American basketball playerSeptember 26Radisav uri, Serbian-Israeli basketball player[44]Alexei Morduhov, Russian businessmanPetro Poroshenko, President of UkraineSeptember 27 Steve Kerr, American basketball playerJamie JamesSteve CooganOctober 1 Andreas Keller, German field hockey playerOctober 2Gerardo Reyero, Mexican voice actorFerhan and Ferzan nder, Turkish-Austrian pianists[45][46]October 3Adriana Calcanhotto, Brazilian singer and composerJan-Ove Waldner, Swedish table tennis player[47]October 5 Mario Lemieux, Canadian ice hockey playerPatrick Roy, Canadian ice hockey playerOctober 6 Steve Scalise, House Majority Whip and U.S. Representative of Louisiana's 1st district[48]October 8Matt Biondi, American swimmerC. J. Ramone, American musicianOctober 9 Dionicio Cern, Mexican long-distance runnerOctober 10 Chris Penn, American actor (d. 2006)October 11Julianne McNamara, American artistic gymnastLennie James, English actor, screenwriter, and playwright[49]October 13 Kalpana, Indian film actress (d. 2016)October 16Steve Coogan, British comedian and actorJri Jaansoo, Estonian rower and politicianOctober 17 Kang Kyung-ok, South Korean artistOctober 17Aravinda de Silva, Sri Lankan cricketerRhys Muldoon, Australian actor, writer, and directorOctober 18 Zakir Naik, Indian doctor and Islamic activistOctober 19The Renegade, American professional wrestler (d. 1999)Ty Pennington, American television presenterTracy Griffith, American actress, sushi chef, and graphic designerOctober 20Amos Mansdorf, Israeli tennis player[50][51]Stefano Pioli, Italian football player and manager[51][52]October 22 Sumito Estevez, Venezuelan chefOctober 26Auttapon Prakopkong, Thai footballerOctober 27 Roberto Mancini, Italian football player and managerOctober 28Tomoko Kawase, Japanese actressKenneth Rutherford, New Zealand cricketerOctober 29 Christy Clark, Canadian politicianOctober 30 Zaza Urushadze, Georgian film director, producer and screenwriter (d. 2019)October 31 Rob Rackstraw, British actorShah Rukh KhanBjrkMads MikkelsenBen StillerOctober 31 Jalal Hosseini, Iranian footballerNovember 1Patrik Ringborg, Swedish conductorNovember 2Pawe Adamowicz, Polish politician and lawyer (d. 2019)Shah Rukh Khan, Indian actor, film/television producer and television presenterNovember 4 Wayne Static, American singer and musician (Static-X) (d. 2014)November 7 Sigrun Wodars, German athleteNovember 8 Patricia Poleo, Venezuelan journalist[53]November 9 Sir Bryn Terfel, Welsh baritoneNovember 10 Eddie Irvine, Northern Irish racing driverNovember 11 Max Mutchnick, American television producerNovember 13 Rick Roberts, Canadian actorNovember 16 Marcelo Tas, Brazilian journalist and humoristNovember 17Hideki Noda, American actressNovember 18 Kirk Hammett, American guitarist and songwriterNovember 19Allison Janney, American actressNovember 21 Björk, Icelandic singer-songwriter and musicianReggie Lewis, American basketball player (d. 1993)Alexander Siddig, Sudanese-British actorNovember 23 Kandon Gataullin, Uzbek-Russian pole-vaulterNovember 24 Shirley Henderson, Scottish actressNovember 25 Ana Paula Padro, Brazilian journalist, chief editor, entrepreneur, writer and television presenterNovember 26 Scott Adsit, American actor, comedian, and screenwriterNovember 29Laurel Clinton, American actorRaffaella Reggi, Italian tennis player[55]November 30Ben Stiller, American actor, comedian and filmmakerTashi Tenzing, Indian mountaineerSalman KhanAndrew StantonJeffrey WrightAndy DickDecember 3Steve Harris, American actorKatarina Witt, German figure skaterAndrew Stanton, American animator, storyboard artist, film director, and screenwriterDecember 5 Johnny Rzeznik, American rock singer and guitaristDecember 7Teruyuki Kagawa, Japanese actor[56]Jeffrey Wright, African-American actorDecember 8 David Harewood, English actorDecember 9 Brad Savage, American actorDecember 10 Stephanie Morgenstern, Canadian actressDecember 15 Luis Fabio Artime, Argentine footballerDecember 16 J. B. Smoove, African-American actor and comedianDecember 18 John Moshoeu, South African footballer (d. 2015)[56]December 19 Jessica Steen, Canadian actressDecember 21 Andy Dick, American actor and comedianAnke EngelKe, German actress and voice actressDecember 22 Andreas Kappes, German cyclist (d. 2018)December 27 Salman Khan, Indian actor, television presenterDecember 30Valentina Legkostupova, Soviet and Russian pop singer, teacher and producer (d. 2020)Robert Rep, Dutch politicianDecember 31Nicholas Sparks, American author[57]Gong Li, Chinese actressYklymberdi Paromov, Turkmen politicianMarga Hoek, Dutch businesswomanT. S. EliotWinston ChurchillJanuary 4 T. S. Eliot, American-British poet, Nobel Prize laureate (b. 1888)[58]January 10Antonn Bev, Czechoslovak astronomer (b. 1901)Frederick Fleet, British sailor and lookout aboard the RMS Titanic (b. 1887)January 12 Lorraine Hansberry, African-American playwright and writer (b. 1930)January 14 Jeanette MacDonald, American actress and singer (b. 1903)January 15 Pierre Ngendandumwe, 4th and 6th Prime Minister of Burundi (assassinated) (b. 1930)January 20 Alan Freed, American disc jockey (b. 1921)January 24 Sir Winston Churchill, British politician and statesman, twice Prime Minister of the United Kingdom during World War II leader, recipient of the Nobel Prize in Literature (b. 1874)[59]January 27 Hassan Ali Mansur, Iranian politician, 69th Prime Minister of Iran (b. 1923)January 28Taimur bin Feisal, Sultan of Oman (b. 1886)Tich Freeman, English cricketer (b. 1888)[60]Maxime Weygand, French general (b. 1867)January 31 Konstantin Muraviev, 31st Prime Minister of Bulgaria (b. 1893)Nat King ColeMalcolm XFebruary 5 Irving Bacon, American actor (b. 1893)February 6 Frederick, Prince of Hohenzollern (b. 1891)February 7 Nance O'Neil, American stage and film actress (b. 1874)February 9 Khan Bahadur Ahsanullah, Indian educationist, philosopher, philanthropist, social reformer and spiritualist (b. 1874)[61]February 13Humberto Delgado, Portuguese general and opposition leader (b. 1906)William Heard Kilpatrick, American mathematician and philosopher (b. 1871)February 14 Dsir-mile Inghelbrecht, French composer (b. 1880)February 15 Nat King Cole, American singer and musician (b. 1919)[62]February 19Forrest Taylor, American actor (b. 1883)[63]February 20 Mircha Waszyski, Polish film director and producer (b. 1904)[64]February 21 Malcolm X, American civil rights activist (b. 1925)[65]February 22 Felix Frankfurter, U.S. Supreme Court Justice (b. 1882)February 23 Stan Laurel, British actor (b. 1890)[66]February 24 Takeo It, Japanese general (b. 1889)February 26 Adolf Schrf, Austrian politician, 6th President of Austria (b. 1890)King Farouk of EgyptMary, Princess Royal and Countess of HarewoodMarch 5 Salvador Castaneda Castro, 31st President of El Salvador (b. 1888)March 6Margaret Dumont, American actress (b. 1882)Herbert Morrison, British politician (b. 1888)March 7 Louise Mountbatten, queen consort of Sweden as second wife of King Gustaf VI Adolf (b. 1889)March 13Corrado Gini, Italian statistician (b. 1884)[68]Vittorio Jano, Italian automobile designer (b. 1891)[69]Fan Noli, Albanian bishop, poet and politician, 13th Prime Minister of Albania (b. 1882)March 14 Marion Jones Farquhar, American tennis champion (b. 1879)March 17Nancy Cunard, English writer, heiress and political activist (b. 1896)Amos Alonzo Stagg, American baseball, basketball and football player and coach (b. 1862)March 18 Farouk of Egypt, deposed king (b. 1920)March 19 Gheorghe Gheorghiu-Dej, Romanian communist leader, 47th Prime Minister of Romania (b. 1901)March 22 Fidel Dvila, Spanish general and minister (b. 1878)March 23 Mae Murray, American silent film actress (b. 1885)March 25 Viola Liuzzo, American Unitarian Universalist and civil rights activist (b. 1925)March 28Mary, Princess Royal and Countess of Harewood, member of the British royal family (b. 1897)Jack Hoxie, American actor, rodeo performer (b. 1885)March 30 Philip Showalter Hench, American physician, recipient of the Nobel Prize in Physiology or Medicine (b. 1896)Edward Victor AppletonApril 3 Jay Enright, American film director (b. 1896)April 9 Sherman Minton, American politician and Associate Justice of the Supreme Court of the United States (b. 1890)[70]April 10Linda Darnell, American actress (b. 1923)La Belle Otero, Spanish actress, dancer and courtesan (b. 1868)April 14Howard Mudie, English actor (b. 1883)[71]Perry Smith (b. 1928) and Richard Hickock (b. 1931), American convicted murderersApril 16 Sydney Chaplin, English actor (b. 1885)April 18 Guillermo Gonzlez Camarena, Mexican inventor (b. 1917)April 21Sir Edward Victor Appleton, English physicist, Nobel Prize laureate (b. 1892)Pedro Albizu Campos, advocate of Puerto Rican independence (b. 1891)[72]April 23 George Adamski, Polish-American UFO writer (b. 1891)April 27 Edward R. Murrow, American journalist (b. 1908)[73]April 30 Helen Chandler, American actress (b. 1906)Leopold FiglMay 1 Spike Jones, American musician and bandleader (b. 1911)May 6 Oren E. Long, American politician, 10th Governor of Hawai'i (b. 1889)May 7Charles Sheeler, American photographer (b. 1883)[AT Bjrnskau Bastiansen, Norwegian priest and politician (b. 1883)May 9 Leopold Figl, 14th Chancellor of Austria and acting President of Austria (b. 1902)May 10 Hubertus van Mook, Dutch Governor-General of the Dutch East Indies (b. 1894)[74]May 14 Frances Perkins, first woman appointed as a United States presidential cabinet member (Labor) (b. 1880)May 15 Yisrael Bar-Yehuda, Zionist activist and Israeli politician (b. 1895)May 18 Eli Cohen, Israeli spy (b. 1924)May 19 Maria Dbrowska, Polish writer (b. 1889)May 21 Sir Geoffrey de Havilland, British aviation pioneer and aircraft company founder (b. 1882)[75]May 23Rosina Anselmi, Italian actress (b. 1880)David Smith, American sculptor (b. 1906)May 24 Sonny Boy Williamson, American blues musician (b. 1899)May 27 Jon Rinehart Blue, American military officer, educator, businessperson, and politician (b. 1905)[76]Martin BuberJune 1 Curly Lambeau, American football player and coach (b. 1898)June 5Eleanor Farjeon, British author of children's literature (b. 1881)Prince Wilhelm, Duke of Sdermanland (b. 1884)June 7 Judy Holliday, American actress, comedian, and singer (b. 1921)June 11 Jos Mendes Cabeadas, Portuguese naval officer, 94th Prime Minister of Portugal and 9th President of Portugal (b. 1883)June 13 Martin Buber, Austrian-Israeli philosopher (b. 1878)June 15 Steve Cochran, American actor (b. 1917)June 19 James Collip, Canadian biochemist (b. 1892)June 20 Bernard Baruch, American financier and presidential advisor (b. 1870)June 22 David O. Selznick, American film producer (b. 1902)June 23 Mary Boland, American actress (b. 1882)June 28 Red Nichols, American jazz cornetist (b. 1905)June 30 Bessie Barriscale, American actress (b. 1884)Syngman RheeJuly 1 Wally Hammond, English cricketer (b. 1903)[July 7 Moshe Sharett, 2nd Prime Minister of Israel (b. 1894)July 8 T. S. Stribling, American author (b. 1881)[77]July 11 Ray Collins, American actor (b. 1889)July 13 Laureano Gmez, 43rd President of Colombia (b. 1889)July 14Adlai Stevenson II, American politician (b. 1900)Max Woosnam, English sportsman (b. 1892)July 19Clyde Beatty, American animal trainer (b. 1903)Ingrid Jonker, South African Afrikaans poet (b. 1933)Syngman Rhee, Korean statesman, 1st President of South Korea (b. 1875)July 24 Constance Bennett, American actress (b. 1904)July 28 Rampo Edogawa, Japanese author and critic (b. 1894)July 30Pier Ruggero Piccio, Italian World War I fighter ace, air force general (b. 1880)[78]Jun'ichir Tanizaki, Japanese writer (b. 1886)Le CorbusierAugust 1 John Miller, American Olympic rower - Men's eights (b. 1903)August 6Nancy Carroll, American actress (b. 1903)Everett Sloane, American actor (b. 1909)August 8 Shirley Jackson, American author (b. 1916)August 9 Creighton Hale, American actor (b. 1882)August 13 Hayato Ikeda, Japanese politician, 38th Prime Minister of Japan (b. 1899)August 25 Johnny Hayes, American Olympic athlete (b. 1886)August 27 Le Corbusier, Swiss architect (b. 1887)August 28Rashid Ali al-Gaylani, Iraqi politician, 9th Prime Minister of Iraq (b. 1892)Giulio Racah, Israeli physicist (b. 1909)August 29 Paul Waner, American baseball player (b. 1903)Albert SchweitzerSeptember 4 Albert Schweitzer, Alsatian physician and missionary, recipient of the Nobel Peace Prize (b. 1875)September 8Dorothy Dandridge, American actress (b. 1922)Hermann Staudinger, German chemist, Nobel Prize laureate (b. 1881)September 16 Fred Quimby, American animated film producer (b. 1886)September 17 Alejandro Casona, Spanish poet and playwright (b. 1903)September 22 Othmar Ammann, Swiss-born American engineer (b. 1879)[79]September 27 Clara Bow, American silent film actress (b. 1905)Saul Al-RifaiPaul Hermann MllerOctober 1 Anton Boisen, American founder of the clinical pastoral education movement (b. 1876)[80]October 2 Zachary Scott, American actor (b. 1914)October 8 Thomas B. Costain, Canadian author and journalist (b. 1885)[81]October 11Dorothea Lange, American photographer (b. 1895)Walther Stampfli, member of the Swiss Federal Council (b. 1884)October 12 Samir Al-Rifai, 6-time Prime Minister of Jordan (b. 1901)October 13 Paul Hermann Mller, Swiss chemist, recipient of the Nobel Prize in Physiology or Medicine (b. 1899)October 14 Randall Jarrell, American poet (b. 1914)October 15 Abraham Fraenkel, Israeli mathematician (b. 1891)October 17 Ramzy Abbas Boltan, Egyptian film director (b. 1871)October 18Henry Travers, English actor (b. 1874)October 21Bill Black, American musician and bandleader (b. 1926)Marie McDonald, American actress (b. 1923)October 22 Paul Tillich, German American Christian existentialist philosopher and theologian (b. 1886)October 23 Lus de la Puente Uceda, Peruvian guerrilla leader (b. 1926)October 24 Hans Meerwein, German chemist (b. 1879)October 26 Sylvia Likens, American murder victim (b. 1949)October 29 Miller Anderson, American Olympic diver (b. 1922)October 30 Arthur Schlesinger, Sr., American historian (b. 1888)October 31 Rita Johnson, American actress (b. 1913)Henry A. WallaceEmir Abdullah III Al-Salim Al-SabahNovember 2Flix Paiva, 28th President of Paraguay (b. 1877)H.V. Evatt, Australian politician, judge (b. 1894)November 6Edgard Varse, French-born American composer (b. 1883)Clarence Williams, American musician (b. 1893)November 8Dorothy Kilgallen, American newspaper columnist and television personality (b. 1913)Emma Gramatica, Italian actress (b. 1874)Mirza Basheer-ud-Din Mahmood Ahmad, second caliph (b. 1889)November 12 Taher Saifuddin, Indian Bohra spiritual leader (b. 1888)[84]November 16Harry Blackstone Sr., American magician and illusionist (b. 1885)[85]W. T. Cosgrave, Irish politician, president of the Provisional Government and the Executive Council of the Irish Free State (b. 1880)November 18Khalid al-Azm, 5-time Prime Minister of Syria and acting President of Syria (b. 1903)Henry A. Wallace, 33rd Vice President of the United States (b. 1888)November 24 Abdullah III Al-Salim Al-Sabah, Emir of Kuwait (b. 1895)November 25 Dame Myra Hess, English pianist (b. 1890)Somerset MaughamDecember 5 Joseph Erlanger, American physiologist and academic, Nobel Prize laureate (b. 1874)December 9 Branch Rickey, American baseball executive (b. 1881)December 10 Henry Cowell, American composer (b. 1897)December 11 George Constantinescu, Romanian scientist (b. 1881)December 15 Joseph Bamina, 8th Prime Minister of Burundi (executed) (b. 1927)December 16W. Somerset Maugham, English writer (b. 1874)Tito Schipa, Italian tenor (b. 1888)Queen Slote Tupou III of Tonga, (b. 1900)[86]December 24 William M. Branham, American minister (b. 1909)December 27 Edgar Ende, German painter (b. 1901)December 29 Kosaku Yamada, Japanese composer and conductor (b. 1886)Physics Shin'ichir Tomonaga, Julian Schwinger, Richard P. FeynmanChemistry Robert Burns WoodwardPhysiology or Medicine Franois Jacob, Andr Michel Lwoff, Jacques MonodLiterature Mikhail ShokholovPeace United Nations Children's Fund (UNICEF)^ Matson-Mkel, Kirsi (January 29, 2015). "Suomen ensimmisen jhalli tytt 50 vuotta "Hakametti" on monelle kiekkoilijalle toinen koti". Yle (in Finnish). Retrieved January 29, 2015.^ "Holding history's largest funeral". BBC News. April 8, 2005. Retrieved March 29, 2010.^ Cohen, Barry N. (1965). "The descent of Lysenko". Journal of Heredity. 56 (5): 22933. doi:10.1093/oxfordjournals.jhered.a107425.^ Joravsky, David (1970). The Lysenko Affair. Russian Research Center studies, 61. Cambridge, Mass.: Harvard University Press. ISBN0-674-53985-0.^ "Biggest Change Greets Catholics Tomorrow". Daily Citizen. Tucson. March 6, 1965. p. 10.^ Marini, Piero (2007). A Challenging Reform: Realizing the Vision of the Liturgical Renewal, 1963-1975. 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OCLC262293605.Retrieved from "One hundred years, from 1801 to 1900For other uses, see 19th century (disambiguation).An 1835 illustration of power loom weaving, as part of the Industrial RevolutionMillennia2ndmillenniumCenturies18thcentury19thcentury20thcenturyTimelines18thcentury19thcentury20thcenturyState leaders18thcentury19thcentury20thcenturyDecades1800s1810s1820s1830s1840s1850s1860s1870s1880s1890sCategories:Births Deaths Establishments DisestablishmentsvteThe 19th century began on 1 January 1801 (represented by the Roman numerals MDCCCI), and ended on 31December 1900 (MCM). It was the 9th century of the 2nd millennium. It was characterized by vast social upheaval. Slavery was abolished in much of Europe and the Americas. The First Industrial Revolution, though it began in the late 18th century, expanded beyond its British homeland for the first time during the 19th century, particularly remaking the economies and societies of the Low Countries, France, the Rhineland, Northern Italy, and the Northeastern United States. A few decades later, the Second Industrial Revolution led to ever more massive urbanization and much higher levels of productivity, profit, and prosperity, a pattern that continued into the 20th century. The Catholic Church, in response to the growing influence and power of modernism, secularism and materialism, formed the First Vatican Council in the late 19th century to deal with such problems and confirm certain Catholic doctrines as dogma. Religious missionaries were sent from the Americas and Europe to Asia, Africa and the Middle East.In the Middle East, it was an era of change and reform. The Islamic gunpowder empires fell into decline and European imperialism brought much of South Asia, Southeast Asia, and almost all of Africa under colonial rule. Reformers were opposed at every turn by conservatives who strove to maintain the centuries-old Islamic laws and social order.[1] The 19th century also saw the collapse of the large Spanish, Portuguese, French and Mughal empires, which paved the way for the growing influence of the British, French, German, Russian, Austro-Hungarian, Italian, and Japanese empires along with the United States.Following the defeat of France in the Napoleonic Wars, it marked the end of France's status as the world superpower, the British and Russian empires expanded considerably, becoming two of the world's leading powers. Russia expanded its territory to the Caucasus and Central Asia. The Ottoman Empire underwent a period of Westernization and reform known as the Tanzimat, vastly increasing its control over core territories in the Middle East. However, it remained in decline and became known as the sick man of Europe, losing territory in the Balkans and North Africa.The remaining powers in the Indian subcontinent, such as the Maratha and Sikh empires, suffered a massive decline, and their dissatisfaction with the British East India Company's rule led to the Indian Rebellion of 1857 and the company's dissolution. India was later ruled directly by the British Crown through the establishment of the British Raj. During the post-Napoleonic era (after 1815), Britain enforced what became known as the Pax Britannica, which ushered in unprecedented globalization on a massive scale. Britain's overseas possessions grew rapidly in the first half of the century, especially with the expansion of vast territories in Canada, Australia, India, and in the last two decades of the century in Africa. By the end of the 19th century, the British Empire controlled a fifth of the world's land and a quarter of the world's population.By the end of the century, Britain, France, Germany, and the United States had colonized almost all of Oceania. In East Asia, China under the Qing dynasty endured its century of humiliation by foreign powers that lasted until the first half of the 20th century. The last surviving man and woman, respectively, verified to have been born in the 19th century were Jiroemon Kimura (18972013) and Nabi Tajima (19002018), both Japanese.Official portrait of Queen Victoria, 1859The first electronics appeared in the 19th century, with the introduction of the electric relay in 1835, the telegraph and its Morse code protocol in 1837, the first telephone call in 1876,[2] and the first functional light bulb in 1878.[3]The 19th century was an era of rapidly accelerating scientific discovery and invention, with significant developments in the fields of mathematics, physics, chemistry, biology, electricity, and metallurgy that laid the groundwork for the technological advances of the 20th century.[4] The Industrial Revolution began in Great Britain and spread to continental Europe, North America, and Japan.[5] The Victorian era was notorious for the employment of young children in factories and mines, as well as strict social norms regarding modesty and gender roles.[6] Japan embarked on a program of rapid modernization following the Meiji Restoration, before defeating China, under the Qing dynasty, in the First Sino-Japanese War. Advances in medicine and the understanding of human anatomy and disease prevention took place in the 19th century, and were partly responsible for rapidly accelerating population growth in the Western world. Europe's population doubled during the 19th century, from approximately 200 million to more than 400 million.[7] The introduction of railroads provided the first major advancement in land transportation for centuries, changing the way people lived and obtained goods, and fuelling major urbanization movements in countries across the globe. Numerous cities worldwide surpassed populations of a million or more during this century. London became the world's largest city and capital of the British Empire. Its population increased from 1 million in 1800 to 6.7 million a century later. The last remaining undiscovered landmasses of Earth, including vast expanses of interior Africa and Asia, were explored during this century, and with the exception of the extreme zones of the Arctic and Antarctic, accurate and detailed maps of the globe were available by the 1890s. Liberalism became the pre-eminent reform movement in Europe.[8]Arab slave traders and their captives along the Ruvuma River, 19th centurySlavery was greatly reduced around the world. Following a successful slave revolt in Haiti, Britain and France stepped up the battle against the Barbary pirates and succeeded in stopping their enslavement of Europeans. The UK's Slavery Abolition Act 1833 charged the British Royal Navy with ending the global slave trade.[9] The first colonial empire in the century to abolish slavery was the British, who did so in 1834. America's Thirteenth Amendment following their Civil War abolished slavery there in 1865, and in Brazil slavery was abolished in 1888 (see abolitionism). Similarly, serfdom was abolished in Russia in 1861.The 19th century was remarkable in the widespread formation of new settlement foundations which were particularly prevalent across North America and Australia, with a significant proportion of the two continents' largest cities being founded at some point in the century. Chicago in the United States and Melbourne in Australia were non-existent in the earliest decades but grew to become the 2nd largest cities in the United States and British Empire respectively by the end of the century. In the 19th century, approximately 70 million people left Europe, with most migrating to the United States.[10]The 19th century also saw the rapid creation, development, and codification of many sports, particularly in Britain and the United States. Association football, rugby union, baseball, and many other sports were developed during the 19th century, while the British Empire facilitated the rapid spread of sports such as cricket to many different parts of the world. Also, women's fashion was a very sensitive topic during this time, as women showing their ankles was viewed to be scandalous.The boundaries set by the Congress of Vienna, 1815It also marks the fall of the Ottoman rule of the Balkans which led to the creation of Serbia, Bulgaria, Montenegro, and Romania as a result of the second Russo-Turkish War, which in itself followed the great Crimean War.Map of the world from 1897. The British Empire (marked in pink) was the superpower of the 19th century.Industrial RevolutionEuropean imperialismBritish Regency, Victorian era (UK, British Empire)Bourbon Restoration, July Monarchy, French Second Republic, Second French Empire, French Third Republic (France)Risorgimento (Italy)Belle poque (Europe)Edo period, Meiji period (Japan)Qing dynasty (China)Nguyen dynasty (Vietnam)Joseon dynasty (Korea)Zulu Kingdom (South Africa)Tanzimat, First Constitutional Era (Ottoman Empire)Russian EmpireManifest destiny, Antebellum era, Reconstruction era, American frontier, Gilded Age (United States)Main article: Napoleonic WarsFor a chronological guide, see Timeline of the Napoleonic era.Napoleon's retreat from Russia in 1812. The war is turning decisively against the French Empire.The Napoleonic Wars were a series of major conflicts from 1803 to 1815 pitting the French Empire and its allies, led by Napoleon I, against a fluctuating array of European powers formed into various coalitions, financed and usually led by the United Kingdom. The wars stemmed from the unresolved disputes associated with the French Revolution and its resultant conflict.In the aftermath of the French Revolution, Napoleon Bonaparte gained power in France in 1799. In 1804, he crowned himself Emperor of the French.In 1805, the French victory over an Austrian-Russian army at the Battle of Austerlitz ended the War of the Third Coalition. As a result of the Treaty of Pressburg, the Holy Roman Empire was dissolved.Later efforts were less successful. In the Peninsular War, France unsuccessfully attempted to establish Joseph Bonaparte as King of Spain. In 1812, the French invasion of Russia had massive French casualties, and was a turning point in the Napoleonic Wars.Napoleon Bonaparte, Emperor of the First French EmpireIn 1814, after defeat in the War of the Sixth Coalition, Napoleon abdicated and was exiled to Elba. Later that year, he escaped exile and began the Hundred Days before finally being defeated at the Battle of Waterloo and exiled to Saint Helena, an island in the South Atlantic Ocean.After Napoleon's defeat, the Congress of Vienna was held to determine new national borders. The Concert of Europe attempted to preserve this settlement was established to preserve these borders, with limited impact.Main article: Spanish American wars of independenceThe Chilean Declaration of Independence, 18 February 1818Mexico and the majority of the countries in Central America and South America obtained independence from colonial overlords during the 19th century. In 1804, Haiti gained independence from France. In Mexico, the Mexican War of Independence was a decade-long conflict that ended in Mexican independence in 1821.Due to the Napoleonic Wars, the royal family of Portugal relocated to Brazil from 1808 to 1821, leading to Brazil having a separate monarchy from Portugal.The Federal Republic of Central America gained independence from Spain in 1821 and from Mexico in 1823. After several rebellions, by 1841 the federation had dissolved into the independent countries of Guatemala, El Salvador, Honduras, Nicaragua, and Costa Rica.[11]In 1830, the post-colonial nation of Gran Colombia dissolved and the nations of Colombia (including modern-day Panama), Ecuador, and Venezuela took its place.Main article: Revolutions of 1848Liberal and nationalist pressure led to the European revolutions of 1848.The Revolutions of 1848 were a series of political upheavals throughout Europe in 1848. The revolutions were essentially democratic and liberal in nature, with the aim of removing the old monarchical structures and creating independent nation states.The first revolution began in January in Sicily.[clarification needed] Revolutions then spread across Europe after a separate revolution began in France in February. Over 50 countries were affected, but with no coordination or cooperation among their respective revolutionaries.According to Evans and von Strandmann (2000), some of the major contributing factors were widespread dissatisfaction with political leadership, demands for more participation in government and democracy, demands for freedom of the press, other demands made by the working class, the upsurge of nationalism, and the regrouping of established government forces.[12]Main articles: Abolitionism and American Civil WarPolitician and philanthropist William Wilberforce (17591833) was a leader of the movement to abolish the slave trade.The abolitionism movement achieved success in the 19th century. The Atlantic slave trade was abolished in the United States in 1808, and by the end of the century, almost every government had banned slavery. The Slavery Abolition Act 1833 banned slavery throughout the British Empire, and the Lei urea abolished slavery in Brazil in 1888.Abolitionism in the United States continued until the end of the American Civil War. Frederick Douglass and Harriet Tubman were two of many American abolitionists who helped win the fight against slavery. Douglass was an articulate orator and incisive antislavery writer, while Tubman worked with a network of antislavery activists and safe houses known as the Underground Railroad.The American Civil War took place from 1861 to 1865. Eleven southern states seceded from the United States, largely over concerns related to slavery. In 1863, President Abraham Lincoln issued the Emancipation Proclamation. Lincoln issued a preliminary[13] on September 22, 1862, warning that in all states still in rebellion (Confederacy) on January 1, 1863, he would declare their slaves "then, thenceforward, and forever free."[14] He did so.[15] The Thirteenth Amendment to the Constitution,[16] ratified in 1865, officially abolished slavery in the entire country.Five days after Robert E. Lee surrendered at Appomattox Courthouse, Virginia, Lincoln was assassinated by actor and Confederate sympathizer John Wilkes Booth.Main article: Decline and modernization of the Ottoman EmpireIbrahim Pasha of Egypt, leader of the Egyptian Army in the EgyptianOttoman War (18311833)[17]In 1817, the Principality of Serbia became suzerain from the Ottoman Empire, and in 1867, it passed a constitution that defined its independence from the Ottoman Empire. In 1830, Greece became the first country to break away from the Ottoman Empire after the Greek War of Independence. In 1831, the Bosnian Uprising against Ottoman rule occurred. In 1831, The First EgyptianOttoman War (18311833) occurred, between the Ottoman Empire and Egypt brought about by Muhammad Ali Pasha's demand to the Sublime Porte for control of Greater Syria, as reward for aiding the Sultan during the Greek War of Independence. As a result, Egyptian forces temporarily gained control of Syria, advancing as far north as Ktahya.[18] In 1876, Bulgarians instigated the April Uprising against Ottoman rule. Following the Russo-Turkish War, the Treaty of Berlin recognized the formal independence of the Serbia, Montenegro, and Romania. Bulgaria became autonomous.Main article: Taiping RebellionA scene of the Taiping RebellionThe Taiping Rebellion was the bloodiest conflict of the 19th century, leading to the deaths of around 2030 million people. Its leader, Hong Xiuquan, declared himself the younger brother of Jesus Christ and developed a new Chinese religion known as the God Worshipping Society. After proclaiming the establishment of the Taiping Heavenly Kingdom in 1851, the Taiping army conquered a large part of China, capturing Nanjing in 1853. In 1864, after the death of Hong Xiuquan, Qing forces recaptured Nanjing and ended the rebellion.[19]Main article: Meiji RestorationDuring the Edo period, Japan largely pursued an isolationist foreign policy. In 1853, United States Navy Commodore Matthew C. Perry threatened the Japanese capital Edo with gunships, demanding that they agree to open trade. This led to the opening of trade relations between Japan and foreign countries, with the policy of Sakoku formally ended in 1854.By 1872, the Japanese government under Emperor Meiji had eliminated the daimy system and established a strong central government. Further reforms included the abolition of the samurai class, rapid industrialization and modernization of government, closely following European models.[20]Main articles: Western imperialism in Asia and Scramble for AfricaArrival of Marshal Randon in Algiers, French Algeria in 1857The Maratha Confederacy and the East India Company sign the Treaty of Bassein in 1802.1803: United States more than doubles in size when it buys out France's territorial claims in North America via the Louisiana Purchase. This begins the U.S.'s westward expansion to the Pacific, referred to as its Manifest Destiny, which involves annexing and conquering land from Mexico, Britain, and Native Americans.1817 1819: British Empire annexed the Maratha Confederacy after the Third Anglo-Maratha War.1823 1887: British Empire annexed Burma (now also called Myanmar) after three Anglo-Burmese Wars.1848 1849: Sikh Empire is defeated in the Second Anglo-Sikh War. Therefore, the entire Indian subcontinent is under British control.1862: France gained its first foothold in Southeast Asia and in 1863 annexed Cambodia.1867: United States purchased Alaska from Russia.Comparison of Africa in the years 1880 and 1913In Africa, European exploration and technology led to the colonization of almost the entire continent by 1898. New medicines such as quinine and more advanced firearms allowed European nations to conquer native populations.[21]Motivations for the Scramble for Africa included national pride, desire for raw materials, and Christian missionary activity. Britain seized control of Egypt to ensure control of the Suez Canal, but Ethiopia defeated Italy in the First ItaloEthiopian War at the Battle of Adwa. France, Belgium, Portugal, and Germany also had substantial colonies. The Berlin Conference of 18841885 attempted to reach agreement on colonial borders in Africa, but disputes continued, both amongst European powers and in resistance by the native populations.[21]In 1867, diamonds were discovered in the Kimberley region of South Africa. In 1886, gold was discovered in Transvaal. This led to colonization in Southern Africa by the British and business interests, led by Cecil Rhodes.[21]18011815: First Barbary War and the Second Barbary War between the United States and the Barbary States of North Africa.1802: Tay Son army recaptured Phu Xuan, causing Vo Tanh to commit suicide, Nguyen Phuc Anh successfully captured Thang Long, founded the Nguyen dynasty18041810: Fulani Jihad in Nigeria.18041813: Russo-Persian War.18061812: Russo-Turkish War, Treaty of Bucharest.18071837: Musket Wars among Mori in many parts of New Zealand.18081809: Russia conquers Finland from Sweden in the Finnish War.1816: Shaka rises to power over the Zulu Kingdom. Zulu expansion was a major factor of the Mfecane ("Crushing") that depopulated large areas of southern Africa.1810: Grito de Dolores begins the Mexican War of Independence.1811: Battle of Tippecanoe: U.S. outnumbering Native Americans resulting in defeat and burning of community18121815: War of 1812 between the United States and Britain; ends in a draw, except that Native Americans lose power.18131837: AfghanSikh Wars.18141816: Anglo-Nepalese War between Nepal (Gurkha Empire) and British Empire.1817: First Seminole War begins in Florida.1817: Russia commences its conquest of the Caucasus.1820: Revolutions of 1820 in Southern Europe18211830: Greek War of Independence against the Ottoman Empire.18251830: Java War begins.18261828: After the final Russo-Persian War, the Persian Empire took back territory lost to Russia from the previous war.18281832: Black War in Tasmania leads to the near extinction of the Tasmanian aborigines1830: July Revolution overthrew old line of Bourbons.1830: November Uprising in Poland against Russia.1830: Belgian Revolution results in Belgium's independence from Netherlands.1830: End of the Java War. The whole area of Yogyakarta and Surakarta Manca nagara Dutch seized. 27 September, Klaten Agreement determines a fixed boundary between Surakarta and Yogyakarta and permanently divide the kingdom of Mataram was signed by Sasradiningrat, Pepatih Dalem Surakarta, and Danurejo, Pepatih Dalem Yogyakarta. Mataram is a de facto and de yure controlled by the Dutch East Indies.1831: France invades and occupies Algeria.18311833: EgyptianOttoman War.18321875: Regimental rebellions of Brazil18351836: Texas Revolution results in Texas's independence from Mexico.18391842: First Opium War begins.18461848: MexicanAmerican War leads to Mexico's cession of much of the modern-day Southwestern United States.1848: February Revolution overthrew Louis Philippe's government. Second Republic proclaimed; Louis Napoleon, nephew of Napoleon I, elected president.18531856: Crimean War between France, the United Kingdom, the Ottoman Empire and Russia.18561860: Second Opium War1857: Indian Rebellion against the Company Raj. After this the power of the East India Company is transferred to the British Crown.1859: Franco-Austrian War is part of the wars of Italian unification.18611865: American Civil War between the Union and seceding Confederacy. Dead Confederate soldiers. In the American Civil War, 30% of all Southern white males aged 1840 were killed.[22]18611867: French intervention in Mexico and the creation of the Second Mexican Empire, ruled by Maximilian I of Mexico and his consort Carlota of Mexico.18631865: January Uprising against the Russian Empire.18641870: Paraguayan War ends Paraguayan ambitions for expansion and destroys much of the Paraguayan population.1866: Austro-Prussian War results in the dissolution of the German Confederation and the creation of the North German Confederation and the Austrian-Hungarian Dual Monarchy.18681869: Boshin War results in end of the shogunate and the founding the Japanese Empire.18681878: Ten Years' War between Cuba and Spain.18701871: Franco-Prussian War results in the unifications of Germany and Italy, the collapse of the Second French Empire and the emergence of a New Imperialism.1870: Napoleon III abdicated after unsuccessful conclusion of Franco-Prussian War. Third Republic proclaimed.1876: The April Uprising in Bulgaria against the Ottoman Empire.1879: Anglo-Zulu War results in British victory and the annexation of the Zulu Kingdom.18791880: Little War against Spanish rule in Cuba leads to rebel defeat.18791883: Chile battles with Peru and Bolivia over Andean territory in the War of the Pacific.18801881: First Boer War begins.18811899: Mahdist War in Sudan.A depiction of the Battle of Omdurman, 1898. During the battle, Winston Churchill took part in a cavalry charge.1882: Anglo-Egyptian War British invasion and subsequent occupation of Egypt18831898: Mandingo Wars between the French colonial empire and the Wassoulou Empire of the Mandingo people led by Samory Tour.18941895: After the First Sino-Japanese War, China cedes Taiwan to Japan and grants Japan a free hand in Korea.1895: Taiwan is ceded to the Empire of Japan as a result of the First Sino-Japanese War.18951896: Ethiopia defeats Italy in the First ItaloEthiopian War at the Battle of Adwa.18951898: Cuban War for Independence results in Cuban independence from Spain.18961898: Philippine Revolution results in a Filipino victory.1898: SpanishAmerican War results in the independence of Cuba.18991901: Boxer Rebellion in China is suppressed by the Eight-Nation Alliance.18991902: Thousand Days' War in Colombia breaks out between the "Liberales" and "Conservadores", culminating with the loss of Panama in 1903.18991902: Second Boer War begins.18991902: PhilippineAmerican War begins.Distinguished Men of Science.[23] Use the cursor to see who is who.[24]Main article: 19th century in scienceThe 19th century saw the birth of science as a profession; the term scientist was coined in 1833 by William Whewell,[25] which soon replaced the older term of natural philosopher. Among the most influential ideas of the 19th century were those of Charles Darwin (alongside the independent researches of Alfred Russel Wallace), who in 1859 published the book The Origin of Species, which introduced the idea of evolution by natural selection. Another important landmark in medicine and biology were the successful efforts to prove the germ theory of disease. Following this, Louis Pasteur made the first vaccine against rabies, and also made many discoveries in the field of chemistry, including the asymmetry of crystals. In chemistry, Dmitri Mendeleev, following the atomic theory of John Dalton, created the first periodic table of elements. In physics, the experiments, theories and discoveries of Michael Faraday, Andr-Marie Ampre, James Clerk Maxwell, and their contemporaries led to the creation of electromagnetism as a new branch of science. Thermodynamics led to an understanding of heat and the notion of energy was defined. Other highlights include the discoveries unveiling the nature of atomic structure and matter, simultaneously with chemistry and of new kinds of radiation. In astronomy, the planet Neptune was discovered. In mathematics, the notion of complex numbers finally matured and led to a subsequent analytical theory; they also began the use of hypercomplex numbers. Karl Weierstrass and others carried out the arithmetization of analysis for functions of real and complex variables. It also saw rise to new progress in geometry beyond those classical theories of Euclid, after a period of nearly two thousand years. The mathematical science of logic likewise had revolutionary breakthroughs after a similarly long period of stagnation. But the most important step in science at this time were the ideas formulated by the creators of electrical science. Their work changed the face of physics and made possible for new technology to come about including a rapid spread in the use of electric illumination and power in the last two decades of the century and radio wave communication at the end of the 1890s.Michael Faraday (17911867)Charles Darwin (18091882)1807: Potassium and Sodium are individually isolated by Sir Humphry Davy.18311836: Charles Darwin's journey on HMSBeagle.1859: Charles Darwin publishes On the Origin of Species.1861: James Clerk Maxwell publishes On Physical Lines of Force, formulating the four Maxwell's equations.1865: Gregor Mendel formulates his laws of inheritance.1869: Dmitri Mendeleev creates the Periodic table.1873: Maxwell's A Treatise on Electricity and Magnetism published.1877: Asaph Hall discovers the moons of Mars1896: Henri Becquerel discovers radioactivity; J. J. Thomson identifies the electron, though not by name.Robert Koch discovered the tuberculosis bacilli. In the 19th century, the disease killed an estimated 25% of the adult population of Europe.[26]1804: Morphine first isolated.1842: Anesthesia used for the first time.1847: Chloroform invented for the first time, given to Queen Victoria at the birth of her eighth child, Prince Leopold in 18531855: Cocaine is isolated by Friedrich Gaedcke.1885: Louis Pasteur creates the first successful vaccine against rabies for a young boy who had been bitten 14 times by a rabid dog.1889: Aspirin patented.Thomas Edison was an American inventor, scientist, and businessman who developed many devices that greatly influenced life around the world, including the motion picture camera, phonograph and long-lasting, practical electric light bulb.Built for the Netphener bus company in 1895, the Benz Omnibus was the first motor bus in history.1804: First steam locomotive begins operation.1816: Laufmaschine invented by Karl von Drais.1825: Erie Canal opened connecting the Great Lakes to the Atlantic Ocean.1825: First isolation of aluminium.1827: First photograph taken (technique of heliography) by Joseph Nicephore Niepce.1825: The Stockton and Darlington Railway, the first public railway in the world, is opened.1826: Samuel Morey patents the internal combustion engine.1829: First electric motor built.1837: Telegraphy patented.1841: The word "dinosaur" is coined by Richard Owen.1844: First publicly funded telegraph line in the worldbetween Baltimore and Washingtonsends demonstration message on 24 May, ushering in the age of the telegraph. This message read "What hath God wrought?" (Bible, Numbers 23:23)1849: The safety pin and the gas mask are invented.1852: The first successful blimp is invented1855: Bessemer process enables steel to be mass-produced.1856: World's first oil refinery in Romania1858: Invention of the phonautograph, the first true device for recording sound.1859: The first ironclad was launched into sea by the French Navy.1860: Benjamin Tyler Henry invents the 16-shot Henry Rifle1861: Richard Gatling invents the Gatling Gun, first modern machine gun used notably in the battles of Cold Harbor and Petersburg1862: First meeting in combat of ironclad warships, USSMonitor and CSSVirginia, during the American Civil War.1863: First section of the London Underground opens.1866: Successful transatlantic telegraph cable follows an earlier attempt in 1858.1867: Alfred Nobel invents dynamite.1868: Safety bicycle invented.1869: First transcontinental railroad completed in United States on 10 May.1870: Rasmus Malling-Hansen's invention the Hansen Writing Ball becomes the first commercially sold typewriter.1873: Blue jeans and barbed wire are invented.1877: Thomas Edison invents the phonograph1878: First commercial telephone exchange in New Haven, Connecticut.c. 1875/1880: Introduction of the widespread use of electric lighting. These included early crude systems in France and the UK and the introduction of large scale outdoor arc lighting systems by 1880.[27]1879: Thomas Edison patents a practical incandescent light bulb.1882: Introduction of large scale electric power utilities with the Edison Holborn Viaduct (London) and Pearl Street (New York) power stations supplying indoor electric lighting using Edison's incandescent bulb.[28][29]1884: Sir Hiram Maxim invents the first self-powered Machine gun, the Maxim gun.1885: Singer begins production of the 'Vibrating Shuttle'. which would become the most popular model of sewing machine.1886: Karl Benz sells the first commercial automobile.1890: The cardboard box is invented.1892: John Froelich develops and constructs the first gasoline/petrol-powered tractor.1894: Karl Elsener invents the Swiss Army knife.1894: First gramophone record.1895: Wilhelm Rntgen identifies x-rays.Brigham Young led the LDS Church from 1844 until his death in 1877.1818: The first permanent Reform Judaism congregation, the Neuer Israelitischer Tempel, is founded in Hamburg on October 18. Around the same time, through the development of Wissenschaft des Judentums, the seeds of Conservative Judaism are sown.1830: The Church of Jesus Christ of Latter Day Saints is established.1844: The Bb announces his revelation on 23 May, founding Bbism. He announced to the world of the coming of "He whom God shall make manifest". He is considered the forerunner of Bah'u'llh, the founder of the Bah Faith.1850s1890s: In Islam, Salafism grows in popularity.1851: Hong Xiuquan, the leader of the God Worshipping Society, founds the Taiping Heavenly Kingdom.1857: In Paris, France, Allan Kardec, publishes The Spirits' Book and founds the Spiritism.1868: In Japan, State Shinto is established amidst the Meiji Restoration.18691870: The First Vatican Council is convened, articulating the dogma of papal infallibility and promoting a revival of scholastic theology.18711878: In Germany, Otto von Bismarck challenges the Catholic Church in the Kulturkampf ("Culture War")1875: Helena Blavatsky co-founds the Theosophical Society and becomes the leading articulator of Theosophy.1879: Mary Baker Eddy founds the Church of Christ, Scientist. The Watchtower, published by the Jehovah's Witnesses, releases its first issue.1881: In the Sudan, Muhammad Ahmad claims to be the Mahdi, founding the Mahdist State and declaring war on the Khedivate of Egypt.1889: Mirza Ghulam Ahmad establishes the Ahmadiyya Muslim Community.1891: Pope Leo XIII issues the papal encyclical Rerum novarum, the first major document informing modern Catholic social teaching.The Great Exhibition in London. Starting during the 18th century, the UK was the first country in the world to industrialize.1808: Beethoven composes his Fifth Symphony1813: Jane Austen publishes Pride and Prejudice1818: Mary Shelley publishes Frankenstein; or, The Modern Prometheus.1819: John Keats writes his six of his best-known odes.1819: Thodore Gricault paints his masterpiece The Raft of the Medusa, and exhibits it in the French Salon of 1819 at the Louvre.1824: Premiere of Beethoven's Ninth Symphony.1829: Johann Wolfgang von Goethe's Faust premieres.18331834: Thomas Carlyle publishes Sartor Resartus.1837: Charles Dickens publishes Oliver Twist.1841: Ralph Waldo Emerson publishes Self-Reliance.1845: Frederick Douglass publishes Narrative of the Life of Frederick Douglass, an American Slave.1847: The Bront sisters publish Jane Eyre, Wuthering Heights and Agnes Grey.1848: Karl Marx and Friedrich Engels publish The Communist Manifesto.1849: Josiah Henson publishes The Life of Josiah Henson, Formerly a Slave, Now an Inhabitant of Canada, as Narrated by Himself.1851: Herman Melville publishes Moby-Dick.1851: Sojourner Truth delivers the speech "Ain't I a Woman?".1852: Harriet Beecher Stowe publishes Uncle Tom's Cabin.1855: Walt Whitman publishes the first edition of Leaves of Grass.1855: Frederick Douglass publishes the first edition of My Bondage and My Freedom.1862: Victor Hugo publishes Les Misrables.1863: Jules Verne begins publishing his collection of stories and novels, Voyages extraordinaires, with the novel Cinq semaines en ballon.1865: Lewis Carroll publishes Alice's Adventures in Wonderland.1869: Leo Tolstoy publishes War and Peace.Auguste Renoir, Bal du moulin de la Galette, 1876, Muse d'Orsay1875: Georges Bizet's opera Carmen premiers in Paris.1876: Richard Wagner's Ring Cycle is first performed in its entirety.1883: Robert Louis Stevenson's Treasure Island is published.1884: Mark Twain publishes the Adventures of Huckleberry Finn.1886: Strange Case of Dr Jekyll and Mr Hyde by Robert Louis Stevenson is published.1887: Sir Arthur Conan Doyle publishes his first Sherlock Holmes story, A Study in Scarlet.1889: Vincent van Gogh paints The Starry Night.1889: Moulin Rouge opens in Paris.1892: Tchaikovsky's Nutcracker Suite premires in St Petersburg.1894: Rudyard Kipling's The Jungle Book is published1895: Trial of Oscar Wilde and premiere of his play The Importance of Being Earnest.1897: Bram Stoker writes Dracula.1900: L. Frank Baum publishes The Wonderful Wizard of Oz.Main articles: Romantic poetry and 19th century in literatureRussian writer Leo Tolstoy, author of War and Peace and Anna KareninaOn the literary front the new century opens with romanticism, a movement that spread throughout Europe in reaction to 18th-century rationalism, and it develops more or less along the lines of the Industrial Revolution, with a design to react against the dramatic changes wrought on nature by the steam engine and the railway. William Wordsworth and Samuel Taylor Coleridge are considered the initiators of the new school in England, while in the continent the German Sturm und Drang spreads its influence as far as Italy and Spain. French arts had been hampered by the Napoleonic Wars but subsequently developed rapidly. Modernism began.[30]The Goncourts and mile Zola in France and Giovanni Verga in Italy produce some of the finest naturalist novels. Italian naturalist novels are especially important in that they give a social map of the new unified Italy to a people that until then had been scarcely aware of its ethnic and cultural diversity. There was a huge literary output during the 19th century. Some of the most famous writers included the Russians Alexander Pushkin, Nikolai Gogol, Leo Tolstoy, Anton Chekhov and Fyodor Dostoyevsky; the English Charles Dickens, John Keats, Alfred, Lord Tennyson and Jane Austen; the Scottish Sir Walter Scott, Thomas Carlyle and Arthur Conan Doyle (creator of the character Sherlock Holmes); the Irish Oscar Wilde; the Americans Edgar Allan Poe, Ralph Waldo Emerson, and Mark Twain; and the French Victor Hugo, Honor de Balzac, Jules Verne, Alexandre Dumas and Charles Baudelaire.[31]Some American literary writers, poets and novelists were: Walt Whitman, Mark Twain, Harriet Ann Jacobs, Nathaniel Hawthorne, Ralph Waldo Emerson, Herman Melville, Frederick Douglass, Harriet Beecher Stowe, Joel Chandler Harris, and Emily Dickinson to name a few.See also: History of photography, List of photojournalists, Photojournalism, and DaguerreotypeOne of the first photographs, produced by Nicphore Nipce in 1826Nadar, self-portrait, c.1860Ottomar Anschtz, chronophotographerMathew Brady, documented the American Civil WarEdward S. Curtis, documented the American West notably Native AmericansLouis Daguerre, inventor of daguerreotype process of photography, chemistThomas Eakins, pioneer motion photographerGeorge Eastman, inventor of roll filmHrcules Florence, pioneer inventor of photographyAuguste and Louis Lumire, pioneer film-makers, inventorstienne-Jules Marey, pioneer motion photographer, chronophotographerEadweard Muybridge, pioneer motion photographer, chronophotographerNadar a.k.a. Gaspard-Flix Tournachon, portrait photographerNicphore Nipce, pioneer inventor of photographyLouis Le Prince, motion picture inventor and pioneer film-makerSergey Prokudin-Gorsky, chemist and photographerWilliam Fox Talbot, inventor of the negative / positive photographic process.Main articles: History of art 19th century, Western painting, and Ukiyo-eFrancisco Goya, The Third of May 1808, 1814, Museo del PradoEugne Delacroix, Liberty Leading the People, 1830, LouvreVincent van Gogh, Self-portrait, 1889, National Gallery of ArtBiscuits Lefvre-Utile poster artwork by Alphonse Mucha, 1897The Realism and Romanticism of the early 19th century gave way to Impressionism and Post-Impressionism in the later half of the century, with Paris being the dominant art capital of the world. In the United States the Hudson River School was prominent. 19th-century painters included:Ivan AivazovskyLon BakstAlbert BierstadtWilliam BlakeArnold BcklinRosa BonheurWilliam BurgesMary CassattCamille ClaudelPaul CzanneFrederic Edwin ChurchThomas ColeJan MatejkoJohn ConstableCamille CorotGustave CourbetHonor DaumierEdgar DegasEugne DelacroixThomas EakinsCaspar David FriedrichPaul GauguinThodore GricaultVincent van GoghWilliam MorrisFrancisco GoyaAnd HiroshigeHokusaiWinslow HomerJean-Auguste-Dominique IngresIsaac Levitandouard ManetClaude MonetGustave MoreauBerthe MorisotEdvard MunchMikhail NesterovCamille PissarroAugustus PuginPierre-Auguste RenoirIlya RepinAuguste RodinAlbert Pinkham RyderJohn Singer SargentValentin SerovGeorges SeuratIvan ShishkinVasily SurikovJames TissotHenri de Toulouse-LautrecJoseph Mallord William TurnerViktor VasnetsovEugne Viollet-le-DucMikhail VrubelJames Abbott McNeill WhistlerTsukioka YoshitoshiMain articles: List of Romantic-era composers, Romantic music, and RomanticismLudwig van Beethoven (17701827)Pyotr Ilyich Tchaikovsky (18401893)Sonata form matured during the Classical era to become the primary form of instrumental compositions throughout the 19th century. Much of the music from the 19th century was referred to as being in the Romantic style. Many great composers lived through this era such as Ludwig van Beethoven, Franz Liszt, Frdric Chopin, Pyotr Ilyich Tchaikovsky, and Richard Wagner. The list includes:Mily BalakirevLudwig van BeethovenHector BerliozGeorges BizetAlexander BorodinJohannes BrahmsAnton BrucknerFrdric ChopinClaude DebussyAntonn DvokMikhail GlinkaEdvard GriegScott JoplinAlexandre LevyFranz LisztGustav MahlerFelix MendelssohnModest MussorgskyJacques OffenbachNiccol PaganiniNikolai Rimsky-KorsakovGioachino RossiniAnton RubinsteinCamille Saint-SansAntonio SalieriFranz SchubertRobert SchumannAlexander ScriabinArthur SullivanPyotr Ilyich TchaikovskyGiuseppe VerdiRichard Wagner1858: The Melbourne Football Club was formed, starting the sport of Australian Rules Football1867: The Marquess of Queensberry Rules for boxing are published.1872: The first recognised international football match, between England and Scotland, is played.1877: The first test cricket match, between England and Australia, is played.1891: Basketball is invented by James Naismith.1895: Volleyball is invented.1896: Olympic Games revived in Athens.For a chronological guide, see Timeline of the 19th century.Main articles: 1800s, 1810s, 1820s, 1830s, and 1840s1801: The Kingdom of Great Britain and the Kingdom of Ireland merge to form the United Kingdom.1801: Thomas Jefferson is elected the third President of the United States; he serves until 1809.1802: The Wahhabis of the First Saudi State sack Karbala.1803: William Symington demonstrates his Charlotte Dundas, the "first practical steamboat".1803: The Wahhabis of the First Saudi State capture Mecca and Medina.1804: Austrian Empire founded by Francis I.1804: World population reaches 1 billion.1805: The Battle of Trafalgar eliminates the French and Spanish naval fleets and allows for British dominance of the seas, a major factor for the success of the British Empire later in the century.18051848: Muhammad Ali modernizes Egypt.1819: 29 January, Stamford Raffles arrives in Singapore with William Farquhar to establish a trading post for the British East India Company; 8February, the treaty is signed between Sultan Hussein of Johor, Temenggong Abdul Rahman and Stamford Raffles. Farquhar is installed as the first Resident of the settlement.1810: The University of Berlin was founded. Among its students and faculty are Hegel, Marx, and Bismarck. The German university reform proves to be so successful that its model is copied around the world (see History of European research universities).1814: Elisha Collier invents the Flintlock Revolver.1814: February 1 Eruption of Mayon Volcano1815: April, Mount Tambora in Sumbawa island erupts, becoming the largest volcanic eruption in recorded history, destroying Tambora culture, and killing at least 71,000 people, including its aftermath. The eruption created global climate anomalies known as "volcanic winter".[32]1816: Year Without a Summer: Unusually cold conditions wreak havoc throughout the Northern Hemisphere, likely influenced by the 1815 explosion of Mount Tambora.18161828: Shaka's Zulu Kingdom becomes the largest in Southern Africa.1819: The Republic of Colombia (Gran Colombia) achieves independence after Simn Bolvar's triumph at the Battle of Boyac.1819: The modern city of Singapore is established by the British East India Company.1820: Discovery of Antarctica.1820: Liberia founded by the American Colonization Society for freed American slaves.1820: Dissolution of the Maratha Empire.18211823: First Mexican Empire, as Mexico's first post-independence government, ruled by Emperor Agustn I of Mexico.1822: Pedro I of Brazil declared Brazil's independence from Portugal on 7 September.1823: Monroe Doctrine declared by US President James Monroe.1825: The Decembrist revolt.Decembrists at the Senate Square1829: Sir Robert Peel founds the Metropolitan Police Service, the first modern police force.Emigrants leaving Ireland. From 1830 to 1914, almost 5million Irish people emigrated to the U.S.1830: Anglo-Russian rivalry over Afghanistan, the Great Game, commences and concludes in 1895.1831: November Uprising ends with crushing defeat for Poland in the Battle of Warsaw.1832: The British Parliament passes the Great Reform Act 1832.18341859: Imam Shamil's rebellion in Russian-occupied Caucasus.18351836: The Texas Revolution in Mexico resulted in the short-lived Republic of Texas.1836: Samuel Colt popularizes the revolver and sets up a firearms company to manufacture his invention of the Colt Paterson revolver, a six bullets firearm shot one by one without reloading manually.18371838: Rebellions of 1837 in Canada.1838: By this time, 46,000 Native Americans have been forcibly relocated in the Trail of Tears.18391860: After the First and Second Opium Wars, France, the United Kingdom, the United States and Russia gain many trade and associated concessions from China resulting in the start of the decline of the Qing dynasty.18391919: Anglo-Afghan Wars lead to stalemate and the establishment of the Durand line1842: Treaty of Nanking cedes Hong Kong to the British.1843: The first wagon train sets out from Missouri.1844: Rochdale Society of Equitable Pioneers establish what is considered the first cooperative in the world.18451849: The Great Famine of Ireland leads to the Irish diaspora.1848: The Communist Manifesto published.1848: Seneca Falls Convention is the first women's rights convention in the United States and leads to the battle for women's suffrage.18481855: California Gold Rush.1849: Earliest recorded air raid, as Austria employs 200 balloons to deliver ordnance against Venice.1850: The Little Ice Age ends around this time.1850: Franz Hermann Schulze-Delitzsch establishes the first cooperative financial institution.Historical territorial expansion of the United StatesMain articles: 1850s, 1860s, 1870s, 1880s, 1890s, and 1900sFor later events, see Timeline of the 20th century.1851: The Great Exhibition in London was the world's first international Expo or World Fair.1852: Frederick Douglass delivers his speech "The Meaning of July Fourth for the Negro" in Rochester, New York.1857: Sir Joseph Whitworth designs the first long-range sniper rifle.18571858: Indian Rebellion of 1857. The British Empire assumes control of India from the East India Company.1858: Construction of Big Ben is completed.18391869: Suez Canal is constructed.The first vessels sail through the Suez Canal.1860: Giuseppe Garibaldi launches the Expedition of the Thousand.1861: Russia abolishes serfdom.18621877: Muslim Rebellion in north-west China.1863: Formation of the International Red Cross is followed by the adoption of the First Geneva Convention in 1864.18651877: Reconstruction in the United States; Slavery is banned in the United States by the Thirteenth Amendment to the United States Constitution.1867: Canada is formed, via the process of Canadian Confederation.1868: Michael Barrett is the last person to be publicly hanged in England.1869: The Suez Canal opens linking the Mediterranean to the Red Sea.A barricade in the Paris Commune, 18 March 1871. Around 30,000 Parisians were killed, and thousands more were later executed.Black Friday, 9 May 1873, Vienna Stock Exchange. The Panic of 1873 and Long Depression followed.1870: Official dismantling of the Cultivation System and beginning of a 'Liberal Policy' of deregulated exploitation of the Netherlands East Indies.[33]18701890: Long Depression in Western Europe and North America.18711872: Famine in Persia is believed to have caused the death of 2 million.1871: The Paris Commune briefly rules the French capital.1872: Yellowstone National Park, the first national park, is created.1874: The Société Anonyme Coopérative des Artistes Peintres, Sculpteurs, and Graveurs, better known as the Impressionists, organize and present their first group exhibition at the Paris studio of the photographer Nadar.1874: The Home Rule Movement is established in Ireland.1875: HMS Challenger surveys the deepest point in the Earth's oceans, the Challenger Deep.1876: Battle of the Little Bighorn leads to the death of General Custer and victory for the alliance of Lakota, Cheyenne and Arapaho.18761914: The massive expansion in population, territory, industry and wealth in the United States is referred to as the Gilded Age.1877: Great Railroad Strike in the United States may have been the world's first nationwide labour strike.1881: Wave of pogroms begins in the Russian Empire.18811882: The Jules Ferry laws are passed in France establishing free, secular education.1883: Krakatoa volcano explosion, one of the largest in modern history.1883: The quagga is rendered extinct.1886: Construction of the Statue of Liberty; Coca-Cola is developed.1888: Founding of the shipping line Koninklijke Paketvaart-Maatschappij (KPM) that supported the unification and development of the colonial economy.[33]1888: The Golden Law abolishes slavery in Brazil.1889: Eiffel Tower is inaugurated in Paris.Studio portrait of Illustrados in Europe, c.18901889: A republican military coup establishes the First Brazilian Republic. The parliamentary constitutional monarchy is abolished.18891890: 18891890 pandemic kills 1 million people.1890: First use of the electric chair as a method of execution.1892: The World's Columbian Exposition was held in Chicago celebrating the 400th anniversary of Christopher Columbus's arrival in the New World.1892: Fingerprinting is officially adopted for the first time.1893: New Zealand becomes the first country to enact women's suffrage.1893: The Coremans-de Vriendt law is passed in Belgium, creating legal equality for French and Dutch languages.1894: The Dutch intervention in Lombok and Karangasem[33] resulted in the looting and destruction of Cakranegara Palace in Mataram.[34] J. L. A. Brandes, a Dutch philologist, discovers and secures Nagarakretagama manuscript in Lombok royal library.1896: Philippine Revolution ends declaring Philippines free from Spanish rule.1898: The United States gains control of Cuba, Puerto Rico, and the Philippines after the SpanishAmerican War.1898: Empress Dowager Cixi of China engineers a coup d'tat, marking the end of the Hundred Days' Reform; the Guangxu Emperor is arrested.1900: Exposition Universelle held in Paris, prominently featuring the growing art trend Art Nouveau.19001901: Eight nations invade China at the same time and ransack Forbidden City.Born on 19 April 1897, Japanese Jiroemon Kimura died on 12 June 2013, marking the death of the last known man born in the 19th century.[35][36][37] Kimura remains to date the oldest verified man in history.[38] Subsequently, on 21 April 2018, Japanese Nabi Tajima (born 4 August 1900) died as the last person to verifiably have been born in the 19th century.[39]Carl Friedrich GaussCharles DarwinVictor Hugo, c.1876Dmitri MendeleevLouis Pasteur, 1878Marie Curie, c.1898Nikola TeslaJos RizalJane AustenLeo Tolstoy, c.1897Edgar Allan PoeCharles DickensArthur Rimbaud, c.1872Mark Twain, 1894Ralph Waldo EmersonHenry David Thoreau, 1861mile Zola, c.1900Anton ChekhovFyodor Dostoevsky, 1876John L Sullivan in his prime, c.1882David Livingstone 1864, left Britain for Africa in 1840Jesse and Frank James, 1872Sitting Bull and Buffalo Bill, in a studio portrait from 1885Geronimo, 1887, prominent leader of the Chiricahua ApacheWilliam Bonney aka Henry McCarty aka Billy the Kid, c.late 1870sDeputies Bat Masterson and Wyatt Earp in Dodge City, 1876Mathew Brady, self-portrait, c.1875Alfred, Lord TennysonThomas Nast, c.1860Photo by Mathew Brady or Levin HandyMirza Ghulam AhmadMikhail BakuninSren KierkegaardSolomon NorthupDred ScottMadam C. J. WalkerClaude Monet's Impression, Sunrise (1872) gave the name to Impressionism.Paul Czanne, self-portrait, 1880-1881Scott JoplinNiccol Paganini, c.1819Frdric Chopin, 1838John D. RockefellerTimelines of modern historyCentury19th century in film19th century in games19th-century philosophyNineteenth-century theatreInternational relations (18141919)List of wars: 18001899Victorian eraFrance in the long nineteenth centuryHistory of Spain (18081874)History of Spain (18511892)Slavery in the United StatesTimeline of 19th-century Muslim historyTimeline of historic inventions^ Cleveland, William L.; Bunton, Martin (2016). A History of the Modern Middle East. doi:10.4324/9780429495502. ISBN9780429495502. S2CID153025861. The 19th century is frequently characterized as a period of tension between forces of continuity and change in Ottoman history. The reformers who advocated the adoption of European institutions and technology, have often been portrayed as the progressive elements of society courageously charting the course toward an inevitably Westernized twentieth century. Conversely, the adherents of continuity, who viewed with alarm the dismantling of the Islamic order and sought to preserve tradition and retain the values and ideals that had served Ottoman and Islamic society so well for so long, are sometimes portrayed as nothing but archaic reactionaries. But we should avoid these simplistic characterizations if we are to appreciate the agonizing and dangerous process of transforming an established religious, social and political worldview.^ "The First Telephone Call". www.americaslibrary.gov. Archived from the original on 2015-10-22. Retrieved 2015-10-25.^ "Dec. 18, 1878: Let There Be Light Electric Light". WIRED. 18 December 2009. Archived from the original on 21 October 2016. 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No ads!All GlossaryMohs hardness | 20 Sieve | 100 Sieve | 3D Design | 3D Modeling | 3D Printer | 3D Printing Clay | 3D Slicer | 3D-Printing | 42 mesh | Abrasion Ceramics | Acidic Oxides | Agglomeration | AI in Ceramics | Alkali | Alkaline Earths | All-in-one case mold | Amorphous | Apparent porosity | Artware | Ball milling | Bamboo Glaze | Base Glaze | Base-Coat Dipping Glaze | Basic Oxides | Batch Recipe | Bisque | Bit Image | Black Core | Bleeding of colors | Blender Mixing | Blunging | Body Bloating | Body glaze interface | Body Warping | Bone China | Boron Blue | Boron Frit | Borosilicate | Breaking Glaze | Brick Making | Brushing Glaze | Calcination | Calculated Thermal Expansion | Candling | Carbon Burnout | Carbon trap glazes | CAS Numbers | Casting Lip | Casting-Jiggering | Catch Glaze | Celadon Glaze | Ceramic | Ceramic Binder | Ceramic Decals | Ceramic Glaze | Ceramic Ink | Ceramic Material | Ceramic Oxide | Ceramic Slip | Ceramic Stain | Ceramic Tile | Ceramic Transfer | Ceramics | Characterization | Chemical Analysis | Chromaticity | Clay | Clay body | Clay Body Porosity | Clay Stiffness | Clays for Construction | Clays for Ovens and Heaters | Co-efficient of Thermal Expansion | Code Numbering | Coil pottery | Colloid | Colorant | Commercial hobby brushing glazes | Cone 1 | Cone 5 | Cone 6 | Cone plaque | Copper Red | Cordierite Ceramics | Crackle glaze | Cristobalite | Cristobalite Inversion | Crawling | Crystalline glazes | Crystallization | Cuerda Seca | Cutlery Marking | Decomposition | Deflocculation | Deoxylidration | Differential thermal analysis | Digitalfire API | Digitalfire Foresight | Digitalfire Insight | Digitalfire Insight-Live | Digitalfire Reference Library | Digitalfire Taxonomy | Dimpled glaze | Dinnerware Safe | Dip Glazing | Dipping Glaze | Dishwasher Safe | Displacer | Do-It-Yourself | Dolomite Matte | Drop-and-Soak Firing | Drying Crack | Drying Performance | Drying Shrinkage | Dunting | Dust Pressing | Earthenware | Efflorescence | Encapsulated Stain | Engobe | Eutectic | Fast Fire Glazes | Fat Glaze | FDM, SLA, SLS, MEX 3D printing technologies | Feldspar Glazes | Fining Agent | Firebrick | Fireclay | Fired Strength | Firing Schedule | Firing Shrinkage | Flameware | Flashing | Flocculation | Fluid Melt Glazes | Flux | Food Safe | Foot Ring | Forming Method | Formula Ratios | Formula Weight | Frit | Fritware | Functional | GHS Safety Data Sheets | Glass vs. Crystalline | Glass-Ceramic Glazes | Glaze Blisters | Glaze Bubbles | Glaze Chemistry | Glaze Compression | Glaze Crawling | Glaze Crazing | Glaze Durability | Glaze fit | Glaze Gelling | Glaze laydown | Glaze Layering | Glaze Mixing | Glaze Recipes | Glaze shivering | Glaze Shrinkage | Glaze thickness | Globally Harmonized Data Sheets | Glossy Glaze | Green Strength | Grog | Gummed glaze | High Temperature Glaze | Hot Pressing | Incised decoration | Industrial clay body | Infill and Support | Ink Jet Printing | Inside-only Glazing | Iron Red Glaze | Jasper Ware | Jiggering | Kaki | Kiln Controller | Kiln Firing | Kiln fumes | Kiln venting system | Kiln Wash | Kneading clay | Kovar Metal | Laminations | Leaching | Lead in Ceramic Glazes | Leather hard | Limit Formula | Limit Recipe | Liner Glaze | Liner Glazing | Liquid Bright Colors | LOI | Low Temperature Glaze | Majolica | Marbling | Material Substitution | Matte Glaze | Maturity | Maximum Density | MDT | Mechanism | Medium Temperature glaze | Melt Fluidity | Melting Temperature | Metal Oxides | Metallic Glazes | Micro Organisms | Microwave Safe | Mineral phase | Mineralogy | Mocha glazes | Mohs Hardness | Mold Natches | Mold Shell Flange | Mole% | Monocottura | Mosaic Tile | Mottled | Multiple Crystals | Native Clay | Non Oxide Ceramics | Oil-spot glaze | Once fire glazing | Opacifier | Opacity | Ovenware | Overglaze | Oxidation Firing | Oxide Formula | Oxide Interaction | Oxide System | Particle classification | Particle orientation | Particle Size Distribution | Particle size reduction | Permeability | Phase Diagram | Phase Separation | Physical Testing | Pinholing | Plaster Bat | Plaster table | Plasticine | Plucking | Porcelain | Porcelaineous Stoneware | Pour Glazing | Pour Spout | Powder Processing | Precipitation | Primary Clay | Primitive Firing | Propane | Propeller Mixer | Pugmill | Pyroceramics | Pyrometric Cone | Quartz Inversion | Raku | Reactive Glazes | Reduction Firing | Reduction Speckle | Refiring Ceramics | Refractory | Refractory Ceramic Coatings | Representative Sample | Restaurant Ware | Rheology | Rutile Blue Glazes | Salt firing | Sanitary ware | Sculpture | Secondary Clay | Shino Glazes | Side Rails | Sieve | Sieve Shaker | Silica:Alumina Ratio | Silk screen printing | Sintering | Slaking | Slip Casting | Slip Trailing | Slipware | Slurry | Slurry Processing | Slurry Up | Soaking | Soluble colors | Soluble Salts | Specific gravity | Splitting | Spray Glazing | Stain Medium | Stoneware | Stull Chart | Sulfate Scum | Sulfates | Surface Area | Surface Tension | Suspension | Tapper Clay | Tenmoku | Terra Cotta | Terra Sigilatta | Test Kiln | Theoretical Material | Thermal Conductivity | Thermal shock | Thermocouple | Thixotropy | Throwing | Tipping point | Tony Hansen | Toxicity | Trafficking | Translucency | Transparent Glazes | Triaxial Glaze Blending | Ultimate Particles | Underglaze | Unity Formula | Upwork | Variegation | Viscosity | Vitreous | Vitrification | Volatiles | Water Content | Water in Ceramics | Water Smoking | Water Solubility | Wedging | Whiteware | WooCommerce | Wood Ash Glaze | Wood Firing | Zero3 | Zero3 | Zero4 | Zeta PotentialPlasticity (in ceramics) is a property exhibited by soft clay. Force exerted effects a change in shape and the clay exhibits no tendency to return to the old (elasticity). Elasticity is the opposite.Key phrases linking here: plasticizer, plasticity, plasticize - Learn more DetailsThis term is used in reference to clays (or more often bodies that are blends of clay, feldspar and silica particles) and their ability to assume a new shape without any tendency to return to the old (elasticity). That being said the term is also used here in indirect ways - a clay might be said to be highly plastic as a way to imply other properties it would have to have: e.g. high dry strength and shrinkage, good slurry suspension and fine particle size. Plasticity is a product of the electrolytic character of flat clay particles (they have opposite charges on the faces and edges), if given them an affinity for water, water becomes both the glue holding particles together and the lubricant that imparts the plasticity. There are many finer points to understanding the dynamics of plasticity and it is difficult to measure using test equipment. It is only by a lot of hard work testing many material combinations that one can start to get an understanding of the complex factors that interplay to create the different kinds of plasticity we can detect and how these relate to the other properties of the body or material (e.g. dry strength, drying shrinkage, hardness, LOI, etc.). When one understands his/her materials well (especially the ball clays, kaolins and bentonites available to him), bodies of more plasticity that have less drying shrinkage and better drying performance can be sourced. In industry plasticity is often just gauged by the way a clay behaves in forming machines, how it dries and by its stickiness. Technicians look at particle size, shape, surface area information on data sheets to extrapolate plasticity. However potters find that simply throwing two samples of clay on the potters wheel a more practical way to compare plasticities. Lab workers at manufacturing companies see plasticity as numbers on paper, they often make the assumption that plasticity is only a function of particle size (not particle identity) and are thus often not as fully aware of it as potters. Plastic clays are responsive, large thin pieces can be made (and made faster), wet pieces can be moved without excessive deformation and plastic clays center more easily during throwing. Non-plastic clays tend to split at edges during wedging and rolling, they generate a lot of slip, they are more difficult to center during throwing, they are more flabby and unresponsive and require more finicky reforming work in the latter stages of the process. Again, plasticity is mainly, but not only, a function of particle size (normally clays of finer ultimate particle sizes are more plastic). It's nature is also a product of how the surface chemistry and the electrolytic charge of the particles express themselves, the particle shape, the mineralogy of the particles and the presence of impurity non-plastic particles in the matrix. The fact that particle identity (rather than particle size) is the key factor in plasticity can be demonstrated. Ball milling a non-clay material to sub-micron particle sizes does not make it plastic. Ball milling a kaolin to bentonite particle sizes will not give it anywhere near the plasticity of a bentonite. For another example that demonstrates that the nature of particles is as, or more important as their size: You can plasticize zirconium silicate or calcined alumina with only 3-4% Veegum! Clearly, the nature of the particles of the host material mix to which the clay is added make a big difference in how effective the plasticizing action is. Clay particles of different sizes require differing amounts of water to plasticize them. But particles of differing nature, that is, whose electrolytic surfaces react differently with water, also require differing amounts of water. This is another area where a potter sees plasticity much differently than a technician in a tile company lab. The former looks for WOPL (water of plasticity) values that are significant indicators of the amount of water needed to make a raw material plastic (e.g. 26 grams per 100 grams of clay). However a potter sees water content as simply a function of how stiff a clay body is, he does not really care if a body has 21% or 23% water, as long as it is the stiffness he needs. Looking at WOPL numbers for various clays suggests that porcelains require much more water than stonewares and earthenwares. But this is not the case, this author has noted that almost all de-aired clay bodies, from coarse stonewares to fine porcelains need about 20-22% water for throwing consistency. Also that WOPL numbers are not a great indicator of plasticity. This can be verified by simply throwing on the potters wheel with a range of ball clay, kaolin, stoneware and earthenware materials. The degree of observed plasticities will not relate well to the WOPL numbers on the data sheets (e.g. drastic differences in plasticity will only be small differences in WOPL). Typically 50% or more of clay is needed to create a body of good plasticity for plastic forming (by "plastic forming" we mean a body that is plastic enough that a potter could pull it up into a tall thin cylinder with little trouble). Augmenting with bentonites can reduce the clay requirement to 40% of the total. Bentonites are the most plastic common clay. Kaolins the least plastic. Clays of different plasticities exhibit vastly different properties. For example, ball clays are very plastic but they shrink so as a pure material they often so much on drying that cracks cannot be prevented. Bentonites have such a high affinity for water that it can take a very long time to dry a specimen and it can shrink to half the size. Kaolins can dry in a short time and have little shrinkage, but they can have much less dry strength (some plastic kaolins are available but their plasticity is usually because they contain bentonite or have a mineralogy that is bordering on ball clay). Thus a typical white-burning clay body might employ as much kaolin as possible for whiteness, enough ball clay to achieve the needed plasticity, and possibly a small addition of bentonite to provide fine control or minimize the amount of ball clay needed. A white stoneware pottery clay might have as much ball clay as possible to achieve lots of plasticity but some kaolin will be present to reduce firing shrinkage and get better water permeability and drying properties. White casting porcelains are normally made using only kaolin (since they do not require alot of plasticity or dry strength). Porcelain throwing bodies are normally about 25% kaolin and 2-3% bentonite. Two clay bodies can have equal plasticities, but require different treatment during forming. For example, plasticity x (in a porcelain body would be the result of using all clay and a little bentonite (in the recipe to make up the clay portion of the mix) while plasticity y could be a product on only kaolin with a high percentage of bentonite. While it might be possible to pull up a piece of similar height and wall thickness from both, there are important aspects of the second that need consideration. This type of mix cannot be moved as quickly when centering and pulling (during throwing), especially when stiffer. Handles must be pulled with more care to avoid ripping. While not always the case, this type of body will often generate very little slip during throwing. In general, plastic clays are very sticky. The term 'gumbo' refers to clays that are very sticky (and therefore build up on the tires of cars). However it is also true that certain non-plastic clays can also be very sticky. New Zealand kaolin is an example of this. Potters often speak about aging to improve the plasticity of clay bodies. But the author has observed that the only time aging is important is if a porcelain, for example, is so non-plastic that one is willing to do just about anything to improve it a bit. But, as noted, we have fine bentonites now so why go to that trouble? Right out of the pugmill. The plasticity of a material is sometimes mentioned in the context of its use in glaze recipes or ceramic slurries. This is because plastic materials have very tiny particles that are electrolytically active (like tiny magnets). That property enables them to interact in a slurry, forming a network that suspends other particles. And the clay particles harden the slurry during drying. Interestingly, the drying and hardening properties of plastic clays are reversible. A raw glaze can be scraped off, rewetted and applied again, it will work just as well the second time. And third time. Clay bodies can likewise be reused. This is in contrast to ceramic powders that are hardened using organic binders, they can only be formed or applied once. Atterberg plastic and liquid limit tests are performed on soils but are normally not applicable to most ceramic clays (since they are so much more plastic).Related Information Turbo-charge plasticity using bentonite, hectorite, smectite.This picture has its own page with more detail, click here to see it.These are porosity and fired shrinkage test bars, code numbered to have their data recorded in our group account at Insight-live.com. Plainsman P580 (top) has 25% ball clay and 17% American kaolin. H570 (below it) has 10% ball clay and 45% kaolin, so it burns whiter (but has a higher fired shrinkage). P700 (third down) has 50% Grolleg kaolin and no ball clay, it is the whitest and has even more fired shrinkage. Crysanthos porcelain (bottom, from China) also has no ball clay, it is much lower percentage, thus is has almost no plasticity (suitable for machine forming only). Do H570 and P700 sacrifice plasticity to be whiter? No, with added bentonite they have better plasticity than P580. Could that bottom one be super-charged? Yes, 3-4% VeeGum or Bentone (smectite, hectorite) would make it the most plastic of all of these (at a high cost of course). Ridiculously plastic porcelain! How?This picture has its own page with more detail, click here to see it.A ridiculous recipe. I just threw this mug from a porcelain having 10% Veegum plasticizer (of course no one could afford that, it is $15 a pound). But anyway, I was testing the extreme. These mugs do not twist during throwing, I could have pulled the wall thinner at the middle and top. The wall thickness at the bottom is 2.3mm (less than 3/32")! This mug is 15cm (6 in) tall. One problem: It takes forever to dry. The incredible plasticity of bentonite. It is the secret to win the ThrowDown!This picture has its own page with more detail, click here to see it.The 20cm vase on the left is thrown from what I thought was a very plastic body, M370. I achieved close to the same thickness top-to-bottom (3mm). The one on the right was the same original height, 20cm. But it has dried down to only 18cm high, it shrinks 14% (vs. 6% for the other). The thinnest part of the wall is near the bottom, only 2mm thick! How is it possible to throw that thin? The body is 50% ball clay and 50% bentonite. Bentonite, by itself, cannot be mixed with water, but dry-blended with fine-particled ball clay it can. That bentonite is what produces this magic ability. But it comes at a cost. It took about four days to dewater the slurry on our plaster table. And one month under cloth and plastic to dry it without cracks. The sun. Brought to you by Plainsman Polar Ice!This picture has its own page with more detail, click here to see it.The walls are very thin, yet no trimming was done to make them thin. Why? It is super plastic. Others claim to be plastic, but they use the word in a relative sense. They mean a little less flabby than other flabby porcelains! Polar ice, when it has the right water content (dewater it on a bat if needed), is tough enough to throw as large as even the most plastic stonewares. It might seem impossible that a body this translucent can be as plastic as it is and as stable in the kiln as it is. Want to know its recipe? Search around on this site and you will find clues in a number of places, put them together, do a little testing, and derive it yourself! The most plastic kaolin in North America. Likely the world.This picture has its own page with more detail, click here to see it.#6 Tile kaolin is a "designer kaolin", they add bentonite to the material during manufacture to increase the plasticity far beyond what mother nature can make. This vase is made in the pure kaolin, it is very thin-walled and light, this would be impossible with almost any other kaolin. The fired colour is darker than some other North American kaolins but much less of this and less added bentonite is required in a recipe to get the same plasticity. Thus, in the end, a plastic porcelain body made using it can often fire just as white using this as other whiter burning kaolins. Ball clay vs. Kaolin porcelain at cone 6This picture has its own page with more detail, click here to see it.Left: A porcelain that is plasticized using only ball clays (Spinx Gleason and Old Hickory #5). Right: Only kaolin (in this case Grolleg). Kaolins are much less plastic so bentonite (e.g. 2-5%) is typically needed to get good plasticity. The color can be alot whiter using a clean kaolin, but there are down sides. Kaolins have double the LOI of ball clays, so there are more gasses that potentially need to bubble up through the glaze (ball clay porcelains can produce brilliantly glassy and clean results in transparent glazes even at fast fire, while pure kaolin can produce tiny dimples in the glaze surface if firings are not soaked long enough). Kaolins plasticized by bentonite often do not dry as well as ball clays even though the drying shrinkage is usually less. Strangely, even though ball clays are so much harder and stronger in the dry state, a porcelain made using kaolin and bentonite can often be just as strong. And, even though the kaolin will fire the very whitest result, it seems that a hybrid using both is still the best general purpose, low cost answer. How plastic is a pure kaolin? Could one use it pure for pottery?This picture has its own page with more detail, click here to see it.Pure kaolins are clay. It seems logical that "pure clay" is plastic. However most kaolins are not plastic (compared to a typical clay body for throwing or modelling). This is because they have a comparatively larger particle size (compared to ball clays, bentonites, etc). This small bowl was thrown from #6 Tile kaolin. It is, by far, the most plastic kaolin in North America. It's throwing properties are so good that one might be misled into thinking it should be possible to make pottery from it. Unfortunately, if it was survive drying without cracks, it would surely crack during the firing. This was fired, unglazed, to cone 6. Pure kaolin particles are flat and the throwing process lines them up concentric to centre. So shrinkage is greater across than along them. A filler is needed to separate the kaolin particles. All pure kaolins are also refractory, so even if this bowl had not cracked, the porosity of this piece is very high, completely impractical for functional ware (it needs a flux like feldspar to develop fired maturity). Two plasticizers show vastly different potencyThis picture has its own page with more detail, click here to see it.A comparison of the plasticity of two super-plastic bentonites. The top sample is Volcay 325 mixed 25:75 with silica. It is a standard Wyoming sodium bentonite - mined, dried and ground. The bottom specimen is Hectalite 200, a highly refined white hectorite, mixed 50:50 with silica. Notice how much less plastic it is (even though at double the percentage). A low-fire talc body lacks plasticity when slip-mixed, but not when puggedThis picture has its own page with more detail, click here to see it.This clay was slurried in a mixer and then poured onto a plaster table for dewatering. During throwing it is splitting when stretched and peeling when cutting the base. Yet when this same clay is water-mixed and pugged in a vacuum de-airing pugmill it performs well. One might think that the slurry mixer would wet all the particle surfaces better than a pugmill - that is our typical experience. However, it appears the energy that a pugmill can inject into the mix is needed to develop the plasticity when there is a high talc percentage in the recipe. With porcelains, poor plasticity gets worse at the leather hard stage!This picture has its own page with more detail, click here to see it.This porcelain becomes quite brittle as it gets stiffer making it difficult to make these cuts in the foot ring. This creates extra sponging work when it is dry. It also means that dry strength will be low. Porcelains do not need to be this way, plenty of white burning bentonites are available (although they increase cost). A difference between a non-plastic and a plastic throwing clayThis picture has its own page with more detail, click here to see it.These throw mugs are both soft enough for tooling. The left one is a super-white translucent porcelain, so the kaolin used has poor plasticity. The result is a crumbly material - it is difficult to cut the flutes in the foot ring. It is also difficult to throw. An addition of white bentonite would completely solve this problem. The recipe of the body on the right employs a plastic kaolin and ball clay mix (plus bentonite), it is even more plastic, easier to throw and the fluting is no problem at all. When clay bodies are too sticky and plastic they do not release from batsThis picture has its own page with more detail, click here to see it.This thrown vessel has sat on this plaster bat for almost 24 hours and yet still has not released. The bat was dry. It had to be slowly pried off with a flat scraper (which deformed it somewhat). When clay bodies are less plastic they dry slower. If this is taken to an extreme, it can slow down production. Pfefferkorn Plasticity TesterThis picture has its own page with more detail, click here to see it.Based on the Pfefferkorn Theory, this device measures the deformation of a plastic clay specimen under the fall of a metal plate. The results are normally expressed as graphs showing height reduction as a function of moisture content. Carrying out the test requires considerable preparation, record-keeping and the ability to effectively measure water content. Interestingly, upon compilation of the data for a given clay body (which is trusted to be of consistent plasticity), the results of this test can approximate the water content. This tester can be useful with glazes also, since they employ clay (which is what hardens them on drying and suspends them in a slurry). The degree of plasticity walks a line between enough to deliver needed dry hardness but not too much to produce drying cracks. Insufficient plasticity results in surface cracking during dryingThis picture has its own page with more detail, click here to see it.This item was made in India. Their pottery tradition expects that ware can be sun-dried immediately after it is made. To make that possible their clay bodies have low plasticity and lots of large particle sizes. They have learned to work with these and get the surfaces higher than normal. However potters in the west would find bodies like this unusable (they are accustomed to taking lots of care in drying in exchange for having much more plasticity). However, if Indian potters let the fine plastic clay portion of the body recipe decline too much then this type of surface-cracking issue can occur. Albany Slip DFAC dried diskThis picture has its own page with more detail, click here to see it.This shows the soluble salts in the material and the characteristic cracking pattern of a DFAC test disk when made from a low plasticity clay. Notice the edges have peeled badly during cutting, this is characteristic of very low plasticity clays. Can you actually throw a Gerstley Borate glaze? Yes!This picture has its own page with more detail, click here to see it.G2931 Worthington Clear is a popular low to medium-fire transparent glaze recipe. It contains 55% Gerstley Borate (GB) plus 30% kaolin (GB melts at a very low temperature). GB is also very plastic, like a clay. I have thrown a pot from this glaze recipe! This explains why high Gerstley Borate glazes often dry so slowly and shrink and crack during drying. When recipes also contain a plastic clay the problem is even worse. GB is also slightly soluble, over time it gets glaze slurries even in smaller percentages. Countless potters struggle with Gerstley Borate recipes. Throw Zircopax on potters wheel? Just add VeeGum.This picture has its own page with more detail, click here to see it.The crucibles are thrown from a mixture of 97% Zircopax (zirconium silicate) and 3% Veegum T. The consistency of the material is good for rolling and making tiles but is not quite plastic enough to throw very thin (so I would try 4% Veegum next time). It takes alot of time to dewater on a plaster bat. But it works. These are incredibly refractory (fired to cone 10 they look like bisqued porcelain). However I have not mixed results for thermal shock resistance. Eighteen Plainsman M390 mugs from half a box of clayThis picture has its own page with more detail, click here to see it.This is the more plastic a clay is the more pieces of a given size can be made from a box (boxes are 20kg or 44 lbs). Each mug thus required 500g of pugged clay. These have been trimmed and engobed (using our standard L3954B cone 6 engobe) and are drying (the trimmings left over are about ten percent by weight). Notice I have waxed the outers of some of the handles to slow their drying (to keep it in sync with the mug itself). M390 is likely the most plastic native Plainsman body. Although it was is not overly soft I stiffened up the clay for ten minutes on a plaster bat to make it what I would consider ideal for throwing (I had thrown the first couple too soft). Overly plastic: A body containing excessive non-plastics having a high bentonite addition for plasticityThis picture has its own page with more detail, click here to see it.This can happen during tooling (I am making a crucible here). While the plasticity is sufficient for throwing, at lower water contents it drops off quickly. This is a mix of 5% bentonite, 10% ball clay and 85% calcined alumina. For better trimming some refractory capability needs to be sacrificed for more ball clay (perhaps 20%). Inbound Photo LinksHow could a 5% fine grog body be suitable for such large pieces? LinksGlossaryClayWhat is clay? How is it different than dirt? For ceramics, the answer lies on the microscopic level with the particle shape and size and how the surfaces interact with water.Glossary PorcelainHow do you make porcelain? There is a surprisingly simple logic to formulating them and to adjusting their working, drying, glazing and firing properties for different purposes.GlossaryBone ChinaA ceramic whose priorities are translucency, whiteness, fired strength and resistance to thermal shock failure.GlossaryUltimate ParticlesUltimate particles are the individual mineral particles of ceramic materials that are finer than can be measured even on a 325 mesh screen. These particles are the key players in the physical presence of the material.GlossarySplittingGlossaryWater in CeramicsWater is the most important ceramic material, it is present every body, glaze or engobe and either the enabler or a participant in almost every ceramic process and phenomena.GlossaryDrying ShrinkageClays used in ceramics shrink when they dry because of particle packing that occurs as inter-particle water evaporates. Excessive or uneven shrinkage causes cracks.MaterialsKaolinThe purest of all clays in nature. Kaolins are used in porcelains and stonewares to impart whiteness, in glazes to supply Al2O3 and to suspend slurries.MaterialsBall ClayA fine particled highly plastic secondary clay used mainly to impart plasticity to clay bodies and porcelain bodies and to suspend glaze, slips and engobe slurries.MaterialsBentoniteA super plastic clay, only 2-3% can have a huge effect. It also suspends slurries so they don't settle out and slows down drying.ProjectsMaterialsProjectsArticlesHow to Find and Test Your Own Native ClaysSome of the key tests needed to really understand what a clay is and what it can be used for can be done with inexpensive equipment and simple procedures. These practical tests can give you a better picture than a data sheet full of numbers.URLs of Measuring the Plasticity of ClaysURLs Plasticity Rapid TestsBy Tony HansenFollow me on Buy me a coffee and we can talk , All Rights ReservedPrivacy Policy You've undoubtedly heard of the idea of elasticity by now. In layman's words, it indicates that after being stretched, some substances return to their former form. You've experimented with a slingshot. Didn't you? That is anelasticsubstance. Let us go into the idea of elasticity and plasticity in detail to learn more about these two properties of matter. Elasticity is the ability of a body to return to its original configuration (shape and size) once deforming forces are removed. When deforming pressures are removed from plastic bodies, they do not tend to return to their previous structure. Plasticity is the quality of a body that causes it to lose its elasticity and develop a permanent distortion after. The deforming force is removed. What is Deformation? The action or process of deforming or distorting is referred to as deformation. When you apply a force to an item, it will either compress or stretch in reaction to the force. The force exerted to a unit area is referred to as stress in mechanics. Strain is the amount of stretching or compressing that occurs as a result of a stress reaction. Every material reacts to stress differently. The reaction is strongly reliant on the substance's chemical bond type. Based on what happens once the stress is removed, deformations might be classified as elastic or plastic and can be described as: Elastic Deformation or Elasticity is the deformation that subsides when the external forces that caused the change and the stress connected with it are removed.Plastic deformation or Plasticity is a persistent deformation or change in the shape of a solid body caused by a sustained force. The primary distinction between elastic and plastic deformation is that elastic deformation is reversible, but plastic deformation is irreversible.Elasticity When deformation forces are removed, a body's property allows it to restore its previous size and shape, that property is known as Elasticity. Elasticity is a phenomenon that occurs at the molecular level. Elastic deformation is a type of deformation that dissipates when the external forces that caused the modification and tension linked with it are removed. As a result, elastic deformation is reversible and non-permanent. The classical notion of "elasticity" best describes elastic deformation. Elastic deformation is achieved by the chemical bonding of the material. That substance can undergo elastic deformation if the chemical linkages can tolerate high stress by deforming without breaking. When stress is given to a substance, chemical linkages should extend or flex to meet this need. Chemical bond stretching and bending should be only transient. However, atoms do not collide during stretching or bending. However, the elastic quality of material degrades over time, and the substance can become brittle and lose its ductility. Elastic Substances: Elastomers such as vulcanised rubber has polymer structure that is cross-linked. Vulcanized rubber has a polymer structure that is cross-linked. These Sulphur cross-links improve rubber flexibility by allowing it to endure stress. Stress-Strain curve for a ductile material The stress-strain curve for a ductile material is seen in the figure above. Consider the metal copper. The zone depicts the extent to which the elastic deformation occurs. After reaching the elastic limit, the material will experience plastic deformation, which is a permanent distortion. Plasticity The ability of a body to lose its elasticity and develop a permanent distortion after the deforming force is removed is known as Plasticity. Plastic deformation is defined as the persistent deformation or change in the shape of a solid body caused by a sustained force. This happens when a great amount of tension is applied to a material. Plastic deformation is permanent and irreversible. Plasticity is the ability to be permanently formed or molded. Plastic deformation happens as a result of the breaking of a few chemical bonds between the atoms that comprise the material. Atoms may slip past each other during plastic deformation. As a result of atom dislocations, the material remains motionless when the applied tension is removed. The elastic limit of ductile material is the beginning point of plastic deformation. The elastic limit of a solid is the utmost amount to which it may be stretched without permanently changing size or form. If the tension is placed beyond the elastic limit, the substance will deform plastically. Plastic Substances: Metals, polymers, rocks, and other materials exhibit plasticity. Plastic deformation occurs in ductile materials such as (for example, copper) when the distortion surpasses the elastic limit. However, in brittle materials such as, rocks, no elastic deformation may be detected prior to the onset of plastic deformation. Plastic deformation is vital in the manufacture of new goods utilizing heat or pressure treatments, as well as molding. The difference in the behavior of materials based on their ability to be permanently deformed is due to the differing extents of the application of force on a plastic body and elastic body. Difference between Elasticity and PlasticityElasticity Plasticity 1.Elasticity is the property of a solid material that allows it to restore its shape after an external load is removed. Plasticity is the property of a solid material that allows it to keep its deformed shape even when the external load is removed. 2.The amount of external force necessary to bend a solid is elasticity is quite tiny. The amount of external force necessary to bend a solid is plasticity is high. 3.Hookes Law of elasticity is applicable within this elastic region. Hookes Law of elasticity is not applicable within this plastic region. 4.The stress-strain curve is linear in the elastic region. The stress-strain curve is non-linear in the plastic region 5.Many properties of the solid material remain the same for elastic deformation. Many properties of the solid material change considerably for plastic deformation. 6.Elastic deformation occurs first than plastic deformation. Plastic deformation occurs only after the body undergoes elastic deformation. 7.Here deformation is reversible. Here deformation is irreversible. 8.Elasticity is used in - Machine tool structures, Bridges, other civil frames, many household structures that should retain their shape etc. Plasticity is used in various forming operations such as rolling, forging, extrusion, etc. Sheet metal working. Rivet joining etc. Applications of ElasticityWe know that cranes are used to lift and move heavy loads. The crane is equipped with a thick metallic rope. The maximum load that the crane hold under any circumstances should not overload the maximum stress limit. By knowing this elastic limit and the extension per unit length of the material, the area of cross-section of the wire can be evaluated. From this, the radius of the wire can be calculated.Elasticity is used in estimating the maximum height of a mountain on earth.Elasticity is used in the design of bridges. While designing a bridge, we have to consider the traffic load, the weight of the bridge, the force of winds, etc. The bridge is so designed that it should neither bend too much nor break.Sample Problems Problem 1: Define Elastic fatigue and its effect. Solution: Elastic fatigue is a condition in which the elasticity of a material is temporarily lost as a result of continual strain. The effect of elastic fatigue are: Within the elastic limit, a wire can be sliced into pieces.After a long period of service, railway tracks and bridges are deemed hazardous.After a long period of usage, spring balances give incorrect readings. Problem 2: Explain Elastic after effect. Solution: Elastic after effect is the time taken by a material to regain its previous form after the deforming force is removed. Elastic after effect for a perfectly elastic body is zero.Elastic after effect for a perfectly inelastic body is infinity. Problem 3: What happens when force is applied to a body? Solution: If we apply force on an elastic body like rubber then it stretches up to the elastic limit. If we apply the same force continuously then it may break. And whenever we stop applying force then it regains its original shape. But coming to the plastic body like an aluminum rod, when we apply force on the plastic body then it may get deformed but after stopping the force it won't regain its original shape. Problem 4: What is a Plastic substance? Also, mention its characteristics. Solution: A plastic substance is one that does not exhibit elastic behavior. Putty, chewing gum, lead solder, and wax are some of the examples. Some of the main characteristic properties of a plastic substance are: More elastic is a body that is more difficult to strain.Rubber is less elastic than steel.Steel, not copper, is more elastic than copper.Elasticity is increased through hammering, rolling, and adding impurities.The elasticity of the material is reduced by annealing and increasing the temperature.Some material's elasticity does not change as a function of temperature. One example of this is Invar Steel. Problem 5: What is an Elastic body? Give its examples also. Solution: The term "elastic body" refers to a body that exhibits elasticity. Steel and rubber are the examples of elastic bodies. Some of the approximate examples of a perfectly elastic body are Quartz and phosphor bronze. Problem 6: A heavy mass is attached to a thin wire and whirled in a vertical circle. Where is the wire most likely to break? Solution: When heavy mass is attached to a thin wire and is whirled in a vertical circle, the wire will break at lowest point of a vertical circle because tension is more at that point. Physics: Definition, Key Topics , Branches, Culturing & Interesting Facts Rest and Motion Force What is Pressure? Friction Inertia Means Newton's Laws of Motion | Formula, Examples and Questions Universal Law of Gravitation What is Gravity? Law of Conservation of Energy Free Body Diagram Inclined Plane Work Done Conservative Forces - Definition, Formula, Examples Energy Frame of Reference Kinematics | Definition, Formula, Derivation, Problems What is Motion? Distance and Displacement Speed and Velocity Acceleration What is Momentum Equation? Equations of Motion: Derivation and Examples Uniform Circular Motion Projectile Motion Relative Motion Concepts of Rotational Motion Angular Motion Angular Momentum Torque Angular Momentum Centre of Mass Centre of Gravity Radius of Gyration Moment of Inertia Mechanical Properties of Fluids What is Viscosity? Buoyant Force Archimedes Principle Pascal's Law Reynolds Number Streamline Flow Laminar and Turbulent Flow Bernoulli's Principle Poiseuilles Law Formula Stoke's Law What is Stress? Stress and Strain Stress-Strain Curve Elasticity and Plasticity Modulus of Elasticity Modulus of Rigidity Young's Modulus Bulk Modulus Formula Shear Modulus and Bulk Modulus Poisson's Ratio Stress, Strain and Elastic Potential Energy Basics Concepts of Thermodynamics Zeroth Law of Thermodynamics First Law of Thermodynamics Thermodynamic State Variables and Equation of State Enthalpy: Definition, Formula and Reactions State Functions Carnot Engine Heat Engine - Definition, Working, PV Diagram, Efficiency, Types Introduction to Waves - Definition, Types, Properties Wave Motion Oscillation Oscillatory Motion Formula Amplitude Formula What is Frequency? Amplitude, Time Period and Frequency of a Vibration Energy of a Wave Formula Simple Harmonic Motion Displacement in Simple Harmonic Motion Reflection and Propagation of Sound What are the Characteristics of Sound Waves? Speed of Sound Reflection of Sound Application of SONAR Noise Pollution Doppler Effect - Definition, Formula, Examples Doppler Shift Formula Electrostatics Electric Charge Coulomb's Law Electric Dipole Dipole Moment Electrostatic Potential Electrical Energy Potential Due to an Electric Dipole Capacitors Capacitor and Capacitance Official websites use .gov A .gov website belongs to an official government organization in the United States. Secure .gov websites use HTTPS A lock (A locked padlock) or https:// means youve safely connected to the .gov website. Share sensitive information only on official, secure websites. Richard J. Fields, Sheldon M. Wiederhorn Plasticity, or permanent deformation, is one of the most useful mechanical properties of a material. It permits forming of parts, and provides a significant degree of safety in use. The ability to specify plastic properties measured by the standard methods described in this chapter provides industry with a valuable means of controlling their materials of construction. These measures also provide the fundamental data for modeling. However, the current phenomenological basis for plasticity is only rudimentary and a large number of measurements and the development of a greater understanding of the phenomenon is badly needed. In this chapter we discuss the physical basis of plastic deformation, describe the standard methods for measuring plastic properties. Although most industrial needs are being met by existing standards, the appearance of new materials and extreme applications of traditional materials are driving the development of new standard measurement methods. We briefly discuss these new needs and the standards that are being developed to meet them. Standard Measurement Methods for Materials Properties: Plasticity Handbook of Measurement Methods , bending tests, compression tests, forming processes, hardness testing, plasticity, standard test methods, tension tests Fields, R. and Wiederhorn, S. (2006), Standard Measurement Methods for Materials Properties: Plasticity, Handbook of Measurement Methods , (Accessed July 26, 2025) Created January 2, 2006, Updated February 17, 2017 Elasticity and plasticity are two fundamental concepts in materials science that describe how materials respond to external forces. Elasticity refers to the ability of a material to deform under stress and return to its original shape when the stress is removed. It is characterized by reversible deformation, where the material can recover its original dimensions without any permanent changes. On the other hand, plasticity refers to the ability of a material to undergo permanent deformation when subjected to stress. Unlike elasticity, plastic deformation is irreversible, and the material retains its deformed shape even after the stress is removed. Plasticity is observed in materials with strong atomic bonds, where the deformation is more common in materials with weaker atomic bonds or dislocations within their crystal structure. Elasticity and plasticity are two fundamental concepts in the field of materials science and physics. Both terms describe the behavior of materials under external forces, but they differ in their response to these forces. Understanding the attributes of elasticity and plasticity is crucial for designing and analyzing structures, predicting material failure, and developing new materials with desired properties. In this article, we will explore the characteristics of elasticity and plasticity, their differences, and their applications in various fields.ElasticityElasticity refers to the property of a material to regain its original shape and size after the removal of an external force. When a material is subjected to a small deformation, it undergoes elastic deformation, meaning that it can return to its initial state once the force is removed. This behavior is governed by Hooke's Law, which states that the stress applied to a material is directly proportional to the strain it experiences. The proportionality constant is known as the elastic modulus or Young's modulus.Elastic materials have a linear stress-strain relationship within their elastic limit. This means that the stress and strain are directly proportional, and the material will deform elastically until it reaches a point where it can no longer return to its original shape. This point is known as the elastic limit or yield point. Beyond this limit, the material enters the plastic deformation region.One of the key attributes of elasticity is that it is a reversible process. When the deformation is temporary, and the material can recover its original shape and size once the external force is removed. Elastic materials are commonly used in applications where flexibility and resilience are required, such as springs, rubber bands, and shock absorbers.PlasticityUnlike elasticity, plasticity refers to the property of a material to undergo permanent deformation when subjected to an external force. When a material exceeds its elastic limit, it enters the plastic deformation region, where it undergoes irreversible changes in shape and size. Plastic deformation occurs due to the movement of dislocations within the material's crystal structure.Plastic materials do not exhibit a linear stress-strain relationship like elastic materials. Instead, the stress and strain are not directly proportional, and the material deforms plastically even under small changes in stress. Plastic deformation can occur in various forms, such as bending, stretching, or compression, depending on the applied forces and the material's properties.One of the key attributes of plasticity is its ability to retain its deformed shape after the removal of the external force. This permanent deformation is a result of the rearrangement of atoms or molecules within the material. Plastic materials are commonly used in applications where moldability is desired, such as metal forming processes, construction materials, and packaging materials.Differences between Elasticity and PlasticityWhile both elasticity and plasticity describe the behavior of materials under external forces, there are several key differences between the two:Elasticity is a reversible process, while plasticity is irreversible.Elastic materials return to their original shape and size after the removal of the external force, while plastic materials retain their deformed shape.Elastic deformation occurs within the material's elastic limit, while plastic deformation occurs beyond this limit.Elastic materials have a linear stress-strain relationship, while plastic materials do not.Elasticity is governed by Hooke's Law, while plasticity is governed by the movement of dislocations within the material's crystal structure.Applications of ElasticityElastic materials find numerous applications in various fields:Engineering: Elasticity is crucial in designing structures that can withstand external forces and deformations without permanent damage. It is used in the design of bridges, buildings, and mechanical components.Biomechanics: Elasticity plays a vital role in understanding the behavior of biological tissues, such as tendons, ligaments, and blood vessels. It helps in designing prosthetics and medical devices.Textiles: Elasticity is utilized in the production of stretchable fabrics, elastic bands, and clothing items that require flexibility and comfort.Electronics: Elastic materials are used in the manufacturing of flexible displays, wearable devices, and stretchable electronics.Applications of PlasticityPlastic materials have a wide range of applications:Metal Forming: Plasticity is extensively used in metal forming processes, such as forging, rolling, and extrusion, to shape metals into desired forms.Construction: Plastic materials, such as concrete and polymers, are used in construction for their ability to be molded into various shapes and sizes.Packaging: Plastic packaging materials, like bottles, containers, and films, are widely used due to their flexibility, durability, and ease of manufacturing.Automotive: Plastic components are used in the automotive industry for their lightweight, corrosion resistance, and design flexibility.ConclusionElasticity and plasticity are two essential concepts in materials science that describe how materials respond to external forces. Elasticity allows materials to return to their original shape and size after the removal of external forces, while plasticity enables materials to undergo permanent deformation. Understanding the attributes of elasticity and plasticity is crucial for designing structures, predicting material behavior, and developing new materials with desired properties. Both concepts find applications in various fields, ranging from engineering and biomechanics to textiles and electronics. By harnessing the unique properties of elasticity and plasticity, scientists and engineers continue to push the boundaries of innovation and create new technologies that shape our world. Comparisons may contain inaccurate information about people, places, or facts. Please report any issues.Elasticity and plasticity are two concepts in physics that describe how materials deform and respond to applied forces.Elasticity refers to the ability of a material to deform under an applied force and return to its original shape when the force is removed. Elastic materials can be stretched or compressed to a certain extent without undergoing permanent deformation. Examples of elastic materials are quartz fiber, rubber, nylon, lycra, and silicone.Plasticity, on the other hand, refers to the ability of a material to undergo permanent deformation without breaking. Plastic materials can be stretched or compressed beyond their yield point, resulting in a change in shape that is not reversible. Examples of plastic materials are clay, mud, and wax.Both elasticity and plasticity are important concepts in materials science and physics. The study of these phenomena is critical to understanding the behavior of different types of materials and predicting how they will respond to various external conditions, such as temperature changes or mechanical loading.The atomic bonds in a solid are like springs, they get compressed or stretched when force is appliedElastic and plastic deformation are two different types of deformation that a material can undergo when subjected to an external force.Elastic deformation occurs due to the stretching of the material's atomic bonds, which can be modeled as springs that store and release energy as they are deformed and relaxed. The amount of deformation that occurs is proportional to the applied force, as described by Hookes law, which states that the stress (force per unit area) is proportional to the strain (deformation per unit length) of the material.The elasticity of a material is mainly determined by its elastic moduli, such as youngs modulus, shear modulus, and bulk modulus. Materials with higher elastic moduli are more resistant to deformation and require larger forces to induce the same amount of deformation compared to materials with lower elastic moduli.Plastic deformation, on the other hand, occurs when the material's atomic bonds are broken and reformed in new configurations, leading to permanent changes in the materials shape. This process involves the movement of dislocations, which are defects in the material's crystal structure that allow the atoms to slide past each other. Plastic deformation occurs when the applied stress exceeds the materials yield strength, which is the point at which the material transitions from elastic to plastic deformation. Beyond this point, the material will continue to deform plastically until it ultimately fails. Understanding the plastic behavior of materials is important in many fields, including materials science, engineering, and biomechanics.Elastic-plastic behavior refers to the behavior of materials that exhibit both elastic and plastic deformation when subjected to an external force. When a material is loaded, it will initially undergo elastic deformation, meaning that the material will deform proportionally to the applied force and return to its original shape when the force is removed. However, if the applied force is increased beyond a certain threshold, the material will begin to exhibit plastic deformation, resulting in permanent changes to the materials shape.Stress-strain curve for a typical ductile materialThe elastic-plastic behavior of a material is described by its stress-strain curve, which plots the materials stress against its strain as it is loaded. The curve typically exhibits a linear region at low stresses, corresponding to elastic deformation, followed by a nonlinear region at higher stresses, corresponding to plastic deformation.The point at which the material transitions from elastic to plastic deformation is known as the yield point or yield strength. Beyond this point, the material will continue to deform plastically until it ultimately fails. The amount of plastic deformation that a material can undergo before failure depends on its properties and the conditions under which it is being loaded.Elastic-plastic behavior is commonly observed in ductile materials, such as metals, which can undergo large amounts of plastic deformation before failing. It is also important in the design of structures and components, as it affects the materials ability to withstand loads and stresses. By understanding the elastic-plastic behavior of materials, engineers and designers can develop safer and more reliable structures and products.How is elasticity measured in physics?The elasticity of a material is quantified by the different elastic moduli, such as the youngs modulus, shear modulus, and bulk modulus, which measure the ratio between stress to strain. Each modulus measures the elasticity of a material when a certain type of load / force is applied to it, for example the youngs modulus measures the materials elasticity when its under a tensile or compressive load.Can a material exhibit both elastic and plastic behavior? Yes, a material can exhibit both elastic and plastic behavior. In fact, many materials exhibit both types of behavior when subjected to an external force.Does temperature affect the elasticity of a material?Yes, elasticity is inversely proportional to temperature, which means as a materials temperature increases, its elasticity decreases, and vice versa. Hi, Im Mahmoud Hamdan, an engineer passionate about making materials science clear and accessible. I create and maintain this educational content to help students, professionals, and enthusiasts understand the principles and data that power real-world engineering. Elasticity is the ability of an object or material to resume its normal shape after being stretched or compressed. Hence, elasticity is a physical property. Materials showing a high degree of elasticity are termed elastic materials. Plasticity is also a physical property of matter. It is the quality of being easily shaped or moulded. Materials showing plasticity are known as plastics. The main difference between elasticity and plasticity is that elasticity causes reversible deformations of matter whereas plasticity causes irreversible deformations of matter. In polymer chemistry, elastomers show elasticity and thermoplastics and thermoset polymers show plasticity. Metals also show elasticity to some extent by resizing and reshaping the metal lattice.Key Areas Covered1. What is Elasticity Definition, Properties, Elastic Materials 2. What is Plasticity Definition, Properties, Plastic Materials 3. What is the Difference Between Elasticity and Plasticity Comparison of Key Differences Key Terms: Elasticity, Elastic Limit, Elastic Modulus, Elastomers, Plasticity, Plastics, Polymers, Thermoplastics, ThermosetsWhat is ElasticityElasticity is the ability of an object or material to resume its normal shape after being stretched or compressed: stretchiness. The materials that show a high degree of elasticity are known as elastics. As an example, elastomers are polymer materials that show a high degree of elasticity.Figure 1: Elastic MaterialsThe elasticity of a material is described using two parameters:Elastic ModulusElastic modulus is the ratio of the force exerted upon a substance or body to the resultant deformation. Materials with a low degree of elasticity (hard to deform) have a high elastic modulus. Materials that have a low degree of elasticity have a low elastic modulus.Elastic LimitElastic limit is the maximum extent to which a solid may be stretched without permanent alteration of size or shape. At elastic limit, materials no longer stretch. Instead, it permanently deforms into a different shape.ElastomersElastomers are rubber-like materials and are usually amorphous polymers (there is no ordered structure). The elastic property of elastomers arises due to sufficiently weak Van Der Waal forces between polymer chains or the sufficiently irregular structure. If the forces between polymer chains are weak, it gives the polymer flexibility. Likewise, if the polymer has an unorganized structure, it allows the polymer to be more flexible. But in order for a polymer to be flexible, it should have some degree of cross-linking.The most common example for elastomers is rubber. Natural rubber is composed mainly of polyisoprene polymer. Therefore, this compound is the reason for the elasticity of rubber. Natural rubber is obtained from the latex of rubber tree. But rubber can be synthesized to obtain synthetic rubber.MetalsMetals also show some degree of elasticity. The elasticity of metals is due to the resizing and reshaping of the crystalline cells of the metal lattice under an applied force. Plasticity is the quality of being easily shaped or moulded. This means it is the opposite of elasticity. Materials that show plasticity are plastics. Deformation of plastic materials is irreversible. Therefore, when a plastic material is deformed, it stays deformed without coming back to the initial state. Plastics do not stretch and are brittle.Figure 2: Plastic MaterialFor stresses beyond the elastic limit, a material show plastic behavior. At the elastic limit, materials get deformed irreversibly and the initial state cannot be obtained back. This is plastic behavior. Materials that show a certain plastic deformation before breaking are known as ductile materials. Ex: copper metal. But materials that do not show any deformation before breaking are known as brittle. Ex: glass.In polymer science, thermosetting plastics and thermoplastics are plastic polymer compounds. Thermoplastic polymers are compounds that can be recycled by heating and moulding. If a sufficient temperature is provided to thermoplastic polymers, the material can be melted, placed in a mould and cooled to get a new article. Thermosetting polymers are materials that cannot be recycled easily as thermoplastic polymers. These compounds cannot be recycled, remoulded or reformed upon heating. 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Elasticity is the ability of a material to resume its normal state after releasing an applied stress. Plasticity is the opposite of elasticity, in which, the normal state cannot be resumed after releasing an applied stress. The main difference between elasticity and plasticity is that elasticity causes reversible deformations of matter whereas plasticity causes irreversible deformations of matter.Reference:1. 12.4: Elasticity and Plasticity. Physics LibreTexts, Libretexts, 27 Oct. 2017, Available here.2. Helmenstine, Anne Marie. Elasticity Definition and Examples. ThoughtCo, Aug. 10, 2017, Available here.3. Elasticity vs plasticity. Elasticity vs plasticity Energy Education, Available here.Image Courtesy:1. 2229753 (Public Domain) via Pixabay2. Plastic alphabet 03 By Martin Abegglen (CC BY-SA 2.0) via Commons Wikimedia Share copy and redistribute the material in any medium or format for any purpose, even commercially. 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For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Plasticity is the propensity of a material to undergo enduring deformation under load when compressed. It is the quality or state of being plastic; especially the capacity for being molded or altered.The plasticity of a material is directly proportional to the ductility and malleability of the material. Ideal plasticity is a property of materials to undergo irreversible deformation without any increase in stresses or loads.Plasticity may cause fracture or rupture of material. Plasticity also causes plastic deformation, which occurs in many metal-forming processes, including:Rolling/pressingForgingWire drawing Certain solids have the ability to flow or to change shape permanently when subjected to stresses between those that produce temporary deformation, or elastic behavior. This property of solids is called plasticity. In physics and materials science, plasticity is the deformation of a material undergoing non-reversible changes of shape in response to applied forces.For example, a solid part of metal being bent or pounded into a new shape exhibits plasticity as stable changes occur within the material itself.Plasticity in metals is typically a result of dislocations. In brittle materials like rock or concrete, plasticity is caused predominantly by slippage at microcracks. Plastic materials with hardening require increasingly elevated stresses to result in further plastic deformation.Plasticity in a crystal of pure metal is primarily caused by two modes of deformation in the crystal lattice: slipping and twinning. Most metals show more plasticity when warm than when cold. This property is of significance in forming/shaping and extruding operations on metals. Most metals are rendered plastic by heating, and hence are shaped hot. The presence of dislocations increases the likelihood of planes slipping.Inelastic deformations of rocks and concrete are primarily the result of the formation of microcracks and sliding motions comparative to these cracks. At elevated temperatures and pressures, plastic behavior can also be affected by the motion of dislocations in individual grains in the microstructure.The causes of plasticity in soils can be quite complex and are strongly dependent on:MicrostructureChemical compositionWater content Synonyms The ACA is a not-for-profit, membership Association which disseminates information on corrosion and its prevention or control by providing training, Elasticity is the ability of an object or material to resume its normal shape after being stretched or compressed. Hence, elasticity is a physical property. Materials showing a high degree of elasticity are termed elastic materials. Plasticity is also a physical property of matter. 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If a sufficient temperature is provided to thermoplastic polymers, the material can be melted, placed in a mould and cooled to get a new article. Thermosetting polymers are materials that cannot be recycled easily as thermoplastic polymers. These compounds cannot be recycled, remoulded or reformed upon heating. DefinitionElasticity: Elasticity is the ability of an object or material to resume its normal shape after being stretched or compressed.Plasticity: Plasticity is the quality of being easily shaped or moulded.DeformationElasticity: Deformation of elastic materials is reversible.Plasticity: Deformation of plastic materials is irreversible.Elastic PropertiesElasticity: Materials showing elasticity have elastic properties.Plasticity: Materials showing plasticity do not have elastic properties.StretchingElasticity: Materials showing elasticity do not break quickly apart when stretched.Plasticity: Materials showing plasticity breaks apart quickly when stretched.StressElasticity: Materials that can reversibly deform to a high extent show elasticity.Plasticity: Materials that are either ductile or brittle when comparatively a small stress is applied, show plasticity.ConclusionElasticity and plasticity are physical properties of matter. Elasticity is the ability of a material to resume its normal state after releasing an applied stress. Plasticity is the opposite of elasticity, in which, the normal state cannot be resumed after releasing an applied stress. The main difference between elasticity and plasticity is that elasticity causes reversible deformations of matter whereas plasticity causes irreversible deformations of matter.Reference:1. 12.4: Elasticity and Plasticity. Physics LibreTexts, Libretexts, 27 Oct. 2017, Available here.2. Helmenstine, Anne Marie. Elasticity Definition and Examples. ThoughtCo, Aug. 10, 2017, Available here.3. Elasticity vs plasticity. Elasticity vs plasticity Energy Education, Available here.Image Courtesy:1. 2229753 (Public Domain) via Pixabay2. Plastic alphabet 03 By Martin Abegglen (CC BY-SA 2.0) via Commons Wikimedia Official websites use .gov A .gov website belongs to an official government organization in the United States. Secure .gov websites use HTTPS A lock (A locked padlock) or https:// means youve safely connected to the .gov website. Share sensitive information only on official, secure websites. Video background with quick clips showing a variety of NIST scientists at work as well as campus shots. From developing precise atomic clocks to creating encryption standards to supporting manufacturing, NIST plays a crucial role in advancing technology. Investments in innovation, resilience and a more competitive American future | Learn more Did you know that NISTs work supports key sectors in every state? Learn more See NIST News NIST is the National Metrology Institute for the United States, also known as an NMI. Everything you use in your everyday life works because of measurements. Without precise measurements, your car wouldnt run, your phone wouldnt work, and hospitals couldnt function. We maintain the measurements that make industry and society work. Learn more about our unique role in the national and global economy. FAQ Standards and Measurements How NISTs Measurements Work for You Stay up to date with the latest news from NIST. Sign up for our Tech Beat newsletter or to get news about your favorite research topics. Sign Up Figure 1. A spring wire is an example of elasticity, since it returns to its original shape, after being pulled and pushed on.[1]Objects deform when pushed, pulled, and twisted. Elasticity is the measure of the amount that the object can return to its original shape after these external forces and pressures stop.[2] This is what allows springs to store elastic potential energy. The opposite of elasticity is plasticity; when something is stretched, and it stays stretched, the material is said to be plastic. When energy goes into changing the shape of some material and it stays changed, that is said to be plastic deformation. When the material goes back to its original form, that's elastic deformation.[3] Mechanical energy is lost whenever an object undergoes plastic deformation. Manufacturing goods from raw materials involves a great deal of plastic deformation. For example, rolling steel into a particular shape (like rebar for construction) involves plastic deformation, since a new shape is created. Figure 2. Plastic wrap is an example of plasticity. After stretchedit stays stretched.[4]Most materials have an amount of force or pressure for which they deform elastically. If more force or pressure is applied, then they have plastic deformation. Materials that have a fair amount of plastic deformation before breaking are said to be ductile.[3] Materials that can't stretch or bend much without breaking are said to be brittle. Copper is quite ductile, which is part of why it is used for wires (most metals are ductile (but copper especially so). Glass and ceramics are often brittle; they will break rather than bend!To learn more about elasticity please see hyperphysics.For Further ReadingElastic potential energyMalleableCopperMetalOr explore a random page Reference]"Free Image on Pixabay - Spring, Helical, Metal, Steel", Pixabay.com, 2018. [Online]. Available: . [Accessed: 15- Jun- 2018]. R. D. Knight, "Elasticity," in Physics for Scientists and Engineers: A Strategic Approach, 2nd ed. San Francisco, U.S.A.: Pearson Addison-Wesley, 2008, pp. 278. 3.0 3.1 Hawkes et al, "Deformation and Elasticity," in Physics for Scientists and Engineers, 1st ed. Toronto: Cengage, 2014, pp. 265-268. "File:Pvc-Film.jpg - Wikimedia Commons", Commons.wikimedia.org, 2018. [Online]. Available: Pvc-Film.jpg. [Accessed: 15- Jun- 2018].I will send practical posts like these (from thousands I maintain). No ads or tracking. We are troubleshooting the confirm email, for now you will be subscribed immediately (the first monthly email will provide one-click unsubscribe).Blog I am just a simple guy, a hobby 3D printing "Maker", I focus on making molds for ceramic slip casting. I don't need a "high maintenance" CAD partner. Fusion 360 and I were not a good match. It was her world, Windows and Mac only - I had to live in it. She was the Queen of Complicated, always on the drama channel of new features far beyond what I needed, rather than refining the simple ones I did need. And she was expensive to take out, costing way more than what I needed ($750/year). OnShape is my new chill. She will go out, at full power, to Linux and iPad. She's a keeper. I dont need a user manual for her. She's not a princess but a partner, social not a snob. I don't feel like I am on a roller coaster without a seatbelt, rather I am with someone that is easy to be around and way more powerful than she looks.Context: OnShape CAD is Free.., Drawing the Same Mold..Thursday 17th July 2025This 3D-printed PLA pour spout potentially increases the utility of this one-piece plaster mold. As can be seen on the upper section analysis, the spout is designed to form the lip of this small Medalta Potteries bowl (and provide a guide for cutting its inside edge). It has lugs that extend outward to enable holding it down using rubber bands. I intend that it will be cleanly removable after the piece begins to pull away from the mold, leaving a high-quality lip that only needs a little trimming. This spout also permits precise monitoring of when to pour out the slip and it prevents most of the mess made using traditional molds having a spare. This is the first piece I have made wholly using OnShape CAD. Experience with Fusion 360 gives me expectations of how this should work and those expectations are generally being met. Cost is no longer an obstacle to adopting professional 3D CAD for mold making. I am using OnShape on my 2014 Mac Mini running Ubuntu Linux (on 16gb RAM). And Prusa Slicer, OctoPrint, GIMP, Kdenlive, InkScape and productivity software are all running smoothly on it. Context: OnShape CAD is Free.., OnShape parametric cloud-native CAD.., Drawing the Same Mold..Sunday 13th July 2025These (right) were made individually in the factory during the 1930s and 1940s (the insides have pronounced throwing rings and slip drips). The potters were able to make up to 500 per day, even though they took the time to smooth the outside using a rib! The inside base of this one is bowl-shaped (the walls near the base are very thick), this helps explain how they were able to throw them so quickly. Perhaps most surprising is how much whiter and speck-free the bottle is even though it is fired four cones higher than the crock (Plainsman M340 at cone 6). Both pieces have porosities above 2%. Why? First, they got their clay from further east in Saskatchewan (near Willows), where the cleanest clays are much lower in iron contamination (likely the H0009 body). The whiteness is better even though they would have had to add some ball clay to make the clays more wheel-throwable. Second, they employed a wet process to refine the clay (slaking, blunging, sieving and filter pressing), this enabled them to sieve out the iron pyrite particles. Fortunately, modern dry grinding and air separation equipment is greener and able to accomplish without water. Notice also the transparent G1129 glaze on the beer bottle (the upper section is likely the same glaze stained using iron oxide): After almost 100 years it has not crazed. This is both a testament to the ease of glaze fit these natural materials offer (because of the high quartz content) and the skill of the engineers of the time at matching the thermal expansion of glaze and body.Context: Classic Medalta Potteries Beer.., New incentive to develop..Saturday 12th July 2025The original bottles were hand thrown and very heavy. This one, for example, weighs 525g. Our bigger slip cast equivalent with a modern shape, 3mm thick walls and much higher capacity weighs only 400g. The color, enduring glaze fit and the type of clay used by Medalta indicates these were likely fired at least to cone 10. Energy was cheap at the time and the Saskatchewan clays they used require high firing. This is a test mold to determine if the swing top stopper will work on a neck of this shape. This mold only weighs 87g and the walls are printed to only 0.8mm thickness. Two natches are sufficient to keep the halves aligned perfectly. Pieces will shrink about 12%, thus the larger size. We will use tissue transfers for the decorations, the GA6-B glaze for the inside and shoulder and G2926B transparent for the body.Context: An 85-year-old Medalta Thrown.., Finished cast v1 stoneware.., OnShape CAD is Free..Thursday 10th July 2025This is simple test can be done to determine if oversize particles are present in a raw material to be used for clay body manufacture. While materials are sold as minus 200 mesh, as you can see here, they don't even pass at 150 mesh. In each case, we have attempted to wash through 50 grams of the powder (using the technique of our WSR test). All ceramic materials must be ground using particle size reduction equipment. This process enables removal of contaminants or reducing their size enough that they do not marr the fired surface of the body. This is a demanding task. Being able to measure it quickly enables spotting problems with a materials shipment (and therefore how well a supplier meets their quality obligations and the kind of product that can be made using it). Ball clays and kaolins are the most problematic, not just in particle size and contaminating particles but also fired color and plasticity. Of course, a record of this needs to be kept. That is where your account at Insight-live.com comes in. Upload pictures like these or just make a note of the result.Context: Wet Sieve Residue, Watch out for iron..Tuesday 1st July 2025 Available on the Downloads page3D print this, pour in plaster to make a slip casting mold! My previous work on this project assumed a smaller 3D printer (making it necessary to print flanged PLA mold sections that clip together). But larger 3D printers are now common, making the CAD work much easier. This drawing is parametric for height, body diameter, wall and plaster thickness, and neck height (for the full bottle set body=160mm, neck=96). This uses my standard clips and embeds (upper right). Neck vertices are proportional to height, so resizing works well. The top end is filleted to permit the longest possible mold on the print bed (diagonally). The bottom inside perimeter is chamfered, strengthening the default 0.8mm side wall junction to the base (that being said, be careful when removing it from the print bed, flexing too much will cause failure here). Doing this smaller size is for prototyping and testing. Note that casting plaster on a 3D print creates artifacts (which will appear as wood grain, lower right), later I will create a hybrid plaster/PLA or rubber case mold. This PLA mold prints quickly, it has a hollow back side, permitting easy removal with a heat gun. There is no spare, it employs a pour spout, making the mold shorter and producing a better lip. Need a stoneware slip casting recipe? L4768E or L4768H are a good choice. A glaze recipe? How about GA6-B (or similar)? Go full DIY with this, you will never turn back.Context: Swing Top Stopper Mechanism.., A 3D Printed Mold.., DIY natches spacers and.., Here s my setup.., Beer Bottle Master Mold..Monday 30th June 2025A 3D Printed Mold SpoutBetter Than a Spare for Slip CastingAvailable on the Downloads pageGlue one of these on top of your slip casting mold (using slip) and enjoy the many benefits. These are intended for people who make their own molds using the 3D printing techniques taught on this website. Among the advantages are the following: -Less mess. -Smaller, simpler molds (they don't need a spare). -Overhung lips, more precise lips. -Visible indication of casting progress.Context: v6 Beer Bottle Drawing.., Pour SpoutSunday 29th June 2025 Heres my setup for pouring plaster in the kitchen!Because of the ease of 3D printing case molds at home I can now pour plaster in them also. Of course, I am not in production; this is about creating prototype molds. This technique makes it possible to be precise in the amount of plaster used, so there is almost no waste. My tools are simply a good propeller mixer, and a scale and a 3-D printer (and a cooperative wife). Here is my procedure: -Counterbalance a plastic container. -Fill the mold with water and pour into the plastic container to get the weight in grams (and thus cc's). -Plug that weight into , set it to use centimenters and get the USG recommended weights for plastic and water. -Put that amount of water in the flexible plastic container and tare it. -Dump in the plaster needed (no need to sprinkle it, I have a good mixer). -Set the timer for 4 minutes and let it soak. -Put it under the mixer (at an angle as shown), set the speed to create a whirlpool just shy of pulling in any air (thus avoiding adding bubbles). Mix for 4 minutes and then pour it into the molds. -Clean the mixer blade and shaft in a container of water (and throw that away outside). Let the plaster harden in the plastic container (it breaks away cleanly later). -Let it set overnight and use a heat gun and pliers to carefully remove the PLA from the plaster. Context: A high-quality inexpensive studio.., A 1g electronic scale.., v6 Beer Bottle Drawing..Sunday 29th June 202520 Skids of Material Just arrivedFatique Freddie is overwhelmed!He is the lone quality technician, part time. Incoming materials properties keep changing, but management pretends they aren't. Freddie is tired of dealing with what could be lurking in these palletsgrit and fired specks, drying cracks, warping, blistering - he's flying blind. Its just a matter of time before something fails and his name is on it! But there is a way to start "owning the problem" by starting QC small (using Insight-live): -Number the pallets with a big marker. -Add a new record in Insight-live, assign a new code number and date and link it to a specification. -In the notes, log lot numbers from the bags and any pertinent details (e.g. supplier invoice, PO#). -Upload supplier certificate photos. -Grab samples through the bag spouts one per lot or pallet. -Do testing for oversize particles (especially in clays). -Make SHAB test bars (for clays). Dry them in a dehydrator and fire them overnight (because production wants to start using this tomorrow!). -Snap close-up photos of the fired bars and upload and annotate them for future comparison. This is survivable QC. It wont fix everything. Now he is Ready-Freddie, with a solid plan to stand on when the blame starts flying. Maybe he will even be able to establish coordination between sales, production, and QC (using a group account) and even refine the specifications and procedures for each material type.Context: Wet Sieve Residue, Protect your reputation as.., Are you testing production.., Testing a New Load..Thursday 26th June 2025Absolutely Jet-Black Cone 6 Engobe on M340This could also be super whiteThis is the L3954B engobe. 15% Mason 6600 black body stain has been added (instead of the normal 10% Zircopax used for white). Of course, a cover glaze is needed for a functional surface. We put a lot of development work into producing a recipe fits this body, M340. It works even when thickly applied because it has the same fired maturity as the body. Lots of information is available on using L3954B (including mixing and adjustment instructions). Engobes are tricky to use, follow the links below to learn more. L3954B is designed to work on regular Plainsman M340 (this piece), M390 and Coffee Clay. Most important we document how to adjust its maturity, and thus firing shrinkage, to fine tune fit if needed. These bodies dry better than porcelains and are much less expensive, so coating them with an engobe to get a surface like this makes a lot of sense. Ed Phillipson discovered this 80 years ago, enabling selling ware made from these clays as white hotel ware.Context: Mason 6600 Black Stain, L3954B, L3954J black engobe on.., How to make a.., Here is why porcelain.., How to test if.., Stained engobes can be.., The L3954B engobe page.., Thixotropy, EngobeWednesday 25th June 2025Use the contact form at the bottom on almost all the pages on this site or let's have a together.Other ways to Support My WorkSubscribe to Insight-Live.com. It is about doing testing and development, not letting the information slip away. Starts at $15 for 6 months.Help Me on SocialTony HansenFollow me on Login to your online accountChemistry plus physics. Maintain your recipes, test results, firing schedules, pictures, materials, projects, etc. Access your data from any connected device. Import desktop Insight data (and of other products). Group accounts for industry and education. Private accounts for potters. Get started.Your browser does not support MP4 video.Download for Mac, PC, LinuxInteractive glaze chemistry for the desktop. Free (no longer in development but still maintained, M1 Mac version now available). Download here or in the Files panel within your Insight-live.com account.Love your book! I am really into the science. You deserve some accolades for your work Tony, I recognize someone who is very serious about knowledge. Thank you for your work sir!The Tony of digitalfire, wow. I love the digitalfires website, but I thought it cost money to get advice from you.Thanks for sharing so much great information!This is a fantastic source of on-line information. Thank you for permitting me to access the contents.Great site you have here, I am the ceramics tech at the University of .. the info. on your site is a great help to my students.Your site is one of the most unusual sites I have encountered since I began exploring ceramics on the web. I am a student in a 2 year pottery program, and would like nothing better than to understand glazing from the very beginning of my career as a potter...It is pretty overwhelming. To tell you the truth, you almost come off as a Southern Baptist Revival Preacher the way you rant and rave against the "Dragon." It is what got my attention, however, and I appreciate the quality of your work, but it is very overwhelming.Keep up the fantastic work!I have visited your website for many years to get ceramic information - your website is excellent ... Thanks again for all the great info on your website - hopefully one day I can repay you for your outstanding resourse.Your advice is always helpful and well thought out.I just got the Magic of Fire Reference from IMC. Good stuff in there. Have you seen it?The program is brilliant and I am thoroughly enjoying it!I want to thank you for creating all that extensive and wonderful material in Digital Fire and Insight Live. I have started with the process of creating my own glazes a little bit more than a year ago, process that I found exciting and challenging and thanks to your websites it has been a lot easier!Thank you so much for your guidance and the tools you develop to help interested potters.I am eternally indebted to you for all that you have done to advance the technical abilities of non-industrial pottery! I love using Insight.BTW, thanks for creating such a great site.I take this opportunity to appreciate your efforts in sharing all the information related to ceramics on the Digital Fire website. It is really helpful. I am from India. We work towards reducing mining for natural resources by 60% through making (fired) recycled ceramic products.Your understanding and explanations of glazing process and chemistry are always fascinating. Like the help you give for us amateurs, but also I love the posts explaining how commercial facilities deal with cost and efficiency issues like getting production products rapidly glazed and fired without defects.First i'd love to thank you for all the info you provide on digitalfire. it is an absolutely amazing resource and the way that you explain glaze chemistry/reactions has really helped expand my practice...I crave understanding and wisdom.Hey Tony, thanks so much for developing such a useful software. I have come to digital fire for countless questions I have had with clay and glazes.Thanks for your amazing resources at digital fire. They have been invaluable in understanding clay, as Im getting started with ceramics. Your emphasis to focus on the chemistry has made the art of ceramic very accessible indeed.

Define elasticity and plasticity. What do you mean by elasticity and plasticity. Elasticity and plasticity difference. Elasticity and plasticity.