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The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Atoms are the basic building blocks of everything in the world.Learning about atoms helps us understand the world and its makeup better. Everything in the world consists of atoms, so it's good to know something about them. Here are 10 interesting and useful atom facts.There are three parts to an atom. Protons have a positive electrical charge and are found together with neutrons (no electrical charge) in the nucleus of each atom. Negatively charged electrons orbit the nucleus.Atoms are the smallest particles that make up elements. Each element contains a different number of protons. For example, all hydrogen atoms have one proton while all carbon atoms have six protons.Some matter consists of one type of atom (e.g., gold), while other matter is made of atoms bonded together to form compounds (e.g., sodium chloride).Atoms are mostly empty space. The nucleus of an atom is extremely dense and contains nearly all of the mass of each atom. Electrons contribute very little mass to the atom (it takes 1,836 electrons to equal the size of a proton)and orbit so far away from the nucleus that each atom is 99.9% empty space. If the atom was the size of a sports arena, the nucleus would be the size of a pea. Although the nucleus is much denser compared with the rest of the atom, it too consists mainly of empty space.There are over 100 different kinds of atoms. About 92 of them occur naturally, while the remainder are made in labs. The first new atom made by man was technetium, which has 43 protons.New atoms can be made by adding more protons to an atomic nucleus. However, these new atoms (elements) are unstable and decay into smaller atoms instantaneously. Usually, we only know a new atom was created by identifying the smaller atoms from this decay.The components of an atom are held together by three forces. Protons and neutrons are held together by the strong and weak nuclear forces. Electrical attraction holds electrons and protons. While electrical repulsion repels protons away from each other, the attracting nuclear force is much stronger than electrical repulsion. The strong force that binds together protons and neutrons is 1,038 times more powerful than gravity, but it acts over a very short range, so particles need to be very close to each other to feel its effect.The word "atom" comes from the Greek word for "uncuttable" or "undivided." The name comes from the 5th century BCE Greek philosopher Democritus, who believed matter consisted of particles that could not be cut into smaller particles. For a long time, people believed atoms were the fundamental "uncuttable" unit of matter. While atoms are the building blocks of elements, they can be divided into still smaller particles. Also, nuclear fission and nuclear decay can break atoms into smaller atoms.Atoms are very small. The average atom is about one-tenth of abillionth of a meter across. The largest atom (cesium) is approximately nine times bigger than the smallest atom (helium).Although atoms are the smallest unit of an element, they consist of even tinier particles called quarks and leptons. An electron is a lepton. Protons and neutrons consist of three quarks each.The most abundant type of atom in the universe is the hydrogen atom. Nearly 74% of the atoms in the Milky Way galaxy are hydrogen atoms.You have around 7 billion billion billion atoms in your body, yet you replace about 98% of them every yeara fascinating fact abut atoms! Take an Atom Quiz LumenLearning Atoms are made up of particles called protons, neutrons, and electrons, which are responsible for the mass and charge of atoms. Discuss the electronic and structural properties of an atomAn atom is composed of two regions: the nucleus, which is in the center of the atom and contains protons and neutrons, and the outer region of the atom, which holds its electrons in orbit around the nucleus.Protons and neutrons have approximately the same mass, about 1.67 10-24 grams, which scientists define as one atomic mass unit (amu) or one Dalton.Each electron has a negative charge (-1) equal to the positive charge of a proton (+1).Neutrons are uncharged particles found within the nucleus.atom: The smallest possible amount of matter which still retains its identity as a chemical element, consisting of a nucleus surrounded by electrons.proton: Positively charged subatomic particle forming part of the nucleus of an atom and determining the atomic number of an element. It weighs 1 amu.neutron: A subatomic particle forming part of the nucleus of an atom. It has no charge. It is equal in mass to a proton or it weighs 1 amu.An atom is the smallest unit of matter that retains all of the chemical properties of an element. Atoms combine to form molecules, which then interact to form solids, gases, or liquids. For example, water is composed of hydrogen and oxygen atoms that have combined to form water molecules. Many biological processes are devoted to reassembling molecules into different, more useful molecules.Atomic ParticlesAtoms consist of three basic particles: protons, electrons, and neutrons. The nucleus (center) of the atom contains the protons (positively charged) and the neutrons (no charge). The outermost regions of the atom are called electron shells and contain the electrons (negatively charged). Atoms have different properties based on the arrangement and number of their basic particles.Elements, such as helium, depicted here, are made up of atoms. Atoms are made up of protons and neutrons located within the nucleus, with electrons in orbitals surrounding the nucleus.The hydrogen atom (H) contains only one proton, one electron, and no neutrons. This can be determined using the atomic number and the mass number of the element (see the concept on atomic numbers and mass numbers).Atomic MassProtons and neutrons have approximately the same mass, about 1.67 10-24 grams. Scientists define this amount of mass as one atomic mass unit (amu) or one Dalton. Although similar in mass, protons are positively charged, while neutrons have no charge. Therefore, the number of neutrons in an atom contributes significantly to its mass, but not to its charge.Electrons are much smaller in mass than protons, weighing only 9.11 10-28 grams, or about 1/1800 of an atomic mass unit. Therefore, they do not contribute much to an elements overall atomic mass. When considering atomic mass, it is customary to ignore the mass of any electrons and calculate the atoms mass based on the number of protons and neutrons alone.Electrons contribute greatly to the atoms charge, as each electron has a negative charge equal to the positive charge of a proton. Scientists define these charges as +1 and -1. In an uncharged, neutral atom, the number of electrons orbiting the nucleus is equal to the number of protons inside the nucleus. In these atoms, the positive and negative charges cancel each other out, leading to an atom with no net charge.Both protons and neutrons have a mass of 1 amu and are found in the nucleus. However, protons have a charge of +1, and neutrons are uncharged. Electrons have a mass of approximately 0 amu, orbit the nucleus, and have a charge of -1.Exploring Electron Properties: Compare the behavior of electrons to that of other charged particles to discover properties of electrons such as charge and mass.Volume of AtomsAccounting for the sizes of protons, neutrons, and electrons, most of the volume of an atomgreater than 99 percentis, in fact, empty space. Despite all this empty space, solid objects do not just pass through one another. The electrons that surround all atoms are negatively charged and cause atoms to repel one another, preventing atoms from occupying the same space. These intermolecular forces prevent you from falling through an object like your chair.Atomic Number and Mass NumberThe atomic number is the number of protons in an element, while the mass number is the number of protons plus the number of neutrons. Determine the relationship between the mass number of an atom, its atomic number, its atomic mass, and its number of subatomic particlesNeutral atoms of each element contain an equal number of protons and electrons.The number of protons determines an elements atomic number and is used to distinguish one element from another.The number of neutrons is variable, resulting in isotopes, which are different forms of the same atom that vary only in the number of neutrons they possess.Together, the number of protons and the number of neutrons determine an elements mass number.Since an elements isotopes have slightly different mass numbers, the atomic mass is calculated by obtaining the mean of the mass numbers for its isotopes.mass number: The sum of the number of protons and the number of neutrons in an atom.atomic number: The number of protons in an atom.atomic mass: The average mass of an atom, taking into account all its naturally occurring isotopes.Atomic NumberNeutral atoms of an element contain an equal number of protons and electrons. The number of protons determines an elements atomic number (Z) and distinguishes one element from another. For example, carbons atomic number (Z) is 6 because it has 6 protons. The number of neutrons can vary to produce isotopes, which are atoms of the same element that have different numbers of neutrons. The number of electrons can also be different in atoms of the same element, thus producing ions (charged atoms). For instance, iron, Fe, can exist in its neutral state, or in the +2 and +3 ionic states.Mass NumberAn elements mass number (A) is the sum of the number of protons and the number of neutrons. The small contribution of mass from electrons is disregarded in calculating the mass number. This approximation of mass can be used to easily calculate how many neutrons an element has by simply subtracting the number of protons from the mass number. Protons and neutrons both weigh about one atomic mass unit (amu). Isotopes of the same element will have the same atomic number but different mass numbers.Carbon has an atomic number of six, and two stable isotopes with mass numbers of twelve and thirteen, respectively. Its relative atomic mass is 12.011.Scientists determine the atomic mass by calculating the mean of the mass numbers for its naturally-occurring isotopes. Often, the resulting number contains a decimal. For example, the atomic mass of chlorine (Cl) is 35.45 amu because chlorine is composed of several isotopes, some (the majority) with an atomic mass of 35 amu (17 protons and 18 neutrons) and some with an atomic mass of 37 amu (17 protons and 20 neutrons).Given an atomic number (Z) and mass number (A), you can find the number of protons, neutrons, and electrons in a neutral atom. For example, a lithium atom (Z=3, A=7 amu) contains three protons (found from Z), three electrons (as the number of protons is equal to the number of electrons in an atom), and four neutrons (7 3 = 4).IsotopesIsotopes are various forms of an element that have the same number of protons, but a different number of neutrons. Discuss the properties of isotopes and their use in radiometric datingIsotopes are atoms of the same element that contain an identical number of protons, but a different number of neutrons.Despite having different numbers of neutrons, isotopes of the same element have very similar physical properties.Some isotopes are unstable and will undergo radioactive decay to become other elements.The predictable half-life of different decaying isotopes allows scientists to date material based on its isotopic composition, such as with Carbon-14 dating.isotope: Any of two or more forms of an element where the atoms have the same number of protons, but a different number of neutrons within their nuclei.half-life: The time it takes for half of the original concentration of an isotope to decay back to its more stable form.radioactive isotopes: an atom with an unstable nucleus, characterized by excess energy available that undergoes radioactive decay and creates most commonly gamma rays, alpha or beta particles.radiocarbon dating: Determining the age of an object by comparing the ratio of the [latex]^{14}\text{C}[/latex] concentration found in it to the amount of [latex]^{14}\text{C}[/latex] in the atmosphere.What is an Isotope?Isotopes are various forms of an element that have the same number of protons but a different number of neutrons. Some elements, such as carbon, potassium, and uranium, have multiple naturally-occurring isotopes. Isotopes are defined first by their element and then by the sum of the protons and neutrons present.Carbon-12 (or [latex]^{12}\text{C}[/latex]) contains six protons, six neutrons, and six electrons; therefore, it has a mass number of 12 amu (six protons and six neutrons).Carbon-14 (or [latex]^{14}\text{C}[/latex]) contains six protons, eight neutrons, and six electrons; its atomic mass is 14 amu (six protons and eight neutrons).While the mass of individual isotopes is different, their physical and chemical properties remain mostly unchanged.Radiocarbon DatingCarbon is normally present in the atmosphere in the form of gaseous compounds like carbon dioxide and methane. Carbon-14 ([latex]^{14}\text{C}[/latex]) is a naturally-occurring radioisotope that is created from atmospheric [latex]^{14}\text{N}[/latex] (nitrogen) by the addition of a neutron and the loss of a proton, which is caused by cosmic rays. This is a continuous process so more [latex]^{14}\text{C}[/latex] is always being created in the atmosphere. Once produced, the [latex]^{14}\text{C}[/latex] often combines with the oxygen in the atmosphere to form carbon dioxide. Carbon dioxide produced in this way diffuses in the atmosphere, is dissolved in the ocean, and is incorporated by plants via photosynthesis. Animals eat the plants and, ultimately, the radiocarbon is distributed throughout the biosphere.In living organisms, the relative amount of [latex]^{14}\text{C}[/latex] in their body is approximately equal to the concentration of [latex]^{14}\text{C}[/latex] in the atmosphere. When an organism dies, it is no longer ingesting [latex]^{14}\text{C}[/latex], so the ratio between [latex]^{14}\text{C}[/latex] and [latex]^{12}\text{C}[/latex] will decline as [latex]^{14}\text{C}[/latex] gradually decays back to [latex]^{14}\text{N}[/latex]. This slow process, which is called beta decay, releases energy through the emission of electrons from the nucleus or positrons.After approximately 5,730 years, half of the starting concentration of [latex]^{14}\text{C}[/latex] will have been converted back to [latex]^{14}\text{N}[/latex]. This is referred to as its half-life, or the time it takes for half of the original concentration of an isotope to decay back to its more stable form. Because the half-life of [latex]^{14}\text{C}[/latex] is long, it is used to date formerly-living objects such as old bones or wood. Comparing the ratio of the [latex]^{14}\text{C}[/latex] concentration found in an object to the amount of [latex]^{14}\text{C}[/latex] in the atmosphere, the amount of the isotope that has not yet decayed can be determined. On the basis of this amount, the age of the material can be accurately calculated, as long as the material is believed to be less than 50,000 years old. This technique is called radiocarbon dating, or carbon dating for short.The age of carbon-containing remains that are less than about 50,000 years old, such as this pygmy mammoth, can be determined using carbon dating. (credit: Bill Faulkner, NPS)Other elements have isotopes with different half lives. For example, [latex]^{40}\text{K}[/latex] (potassium-40) has a half-life of 1.25 billion years, and [latex]^{235}\text{U}[/latex] (uranium-235) has a half-life of about 700 million years. Scientists often use these other radioactive elements to date objects that are older than 50,000 years (the limit of carbon dating). Through the use of radiometric dating, scientists can study the age of fossils or other remains of extinct organisms.OpenStax College, Biology. October 16, 2013.Provided by: OpenStax CNX.Located at: BY: AttributionSunil Kumar Singh, Fundamental Force Types. October 27, 2013.Provided by: OpenStax CNX.Located at: CC BY: Attributionneutron.Provided by: Wiktionary.Located at: CC BY-SA: Attribution-ShareAlikeelectron.Provided by: Wiktionary.Located at: CC BY-SA: Attribution-ShareAlikeatom.Provided by: Wiktionary.Located at: CC BY-SA: Attribution-ShareAlikeproton.Provided by: Wiktionary.Located at: CC BY-SA: Attribution-ShareAlikeOpenStax College, Biology. October 30, 2013.Provided by: OpenStax CNX.Located at: BY: AttributionOpenStax College, Atoms, Isotopes, Ions, and Molecules: The Building Blocks. 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October 16, 2013.Provided by: OpenStax CNX.Located at: CC BY: AttributionThis chapter is an adaptation of the chapter The Structure of the Atom in Boundless Chemistry by LumenLearning and is licensed under a CC BY-SA 4.0 license.definitionThe smallest possible amount of matter that still retains its identity as a chemical element, now known to consist of a nucleus surrounded by electrons.Positively charged subatomic particle forming part of the nucleus of an atom and determining the atomic number of an element. It weighs 1 amu.A subatomic particle forming part of the nucleus of an atom. It has no charge. It is equal in mass to a proton or it weighs 1 amu.The sum of the number of protons and the number of neutrons in an atom.The number, equal to the number of protons in an atom, that determines its chemical properties. Symbol: ZThe average mass of an atom, taking into account all its naturally occurring isotopes.Any of two or more forms of an element where the atoms have the same number of protons, but a different number of neutrons within their nuclei.The time it takes for half of the original concentration of an isotope to decay back to its more stable form.an atom with an unstable nucleus, characterized by excess energy available that undergoes radioactive decay and creates most commonly gamma rays, alpha or beta particles.Determining the age of an object by comparing the ratio of the 14C concentration found in it to the amount of 14C in the atmosphere. Written By Pavithra VG Last Modified 22-06-2023 Anything that has mass and occupies space is called matter. The matter is made up of atoms. Atomic structure is the structure of an atom that consists of a nucleus (the centre), protons (positively charged), and neutrons (neutral). The electrons are negatively charged particles that orbit the nucleuss centre. Democritus came up with the concept that matter is composed of atoms. John Dalton, in 1800 proposed the first scientific theory of atomic structure. In the article. We will learn the structure of an atom, subatomic particle, discovery, properties with some examples. Atoms are the building blocks of matter. Therefore, the existence of different kinds of matter around us is due to atoms present. The idea of the relativity of matter was considered run back in India around \(500\,{\rm{BC}}\). The Indian philosopher Maharshi Kanad postulated that if we go on the dividing matter (padarth), we get smaller and smaller particles. Ultimately, we will get the smallest particle, which cannot be divided further. He named these ultimate particles parmanu. The ancient Greek philosophers like Leucippus, Democritus and Epicurus suggested that subdivision of matter is possible. If we go on dividing the matter, a stage will come when particles cannot be further divided. They called these indivisible particles atoms. The word atom comes from a Greek word, something which cannot be split, i.e., indivisible. The first evidence-based theory on the structure of the atom was given by John Dalton, known as Daltons Atomic theory, in the year \(1808\). According to this theory, the smallest and the ultimate particle of matter is an atom. However, towards the end of the \({19^{{\rm{th}}}}\)century and at the beginning of the \(20{\rm{th}}\)century, scientists like J.J. Thomson, Goldstein, Rutherford, Chadwick, Bohr and many more, as a result of their researchers, established that the atom is not as simple as suggested by Dalton. Atom is made up of \(36\) subatomic particles, out of which the most important are the electrons, protons, and neutrons. These three particles are called elementary fundamental particles of an atom because these are essential constituents of atoms. The particles are held within the atom by one of the four fundamental forces- gravity, electromagnetic force, strong force, and weak force. An atom consists of two parts. These are the nucleus and extranuclear portions. The nucleus is present in the centre of the atom and is surrounded by the extranuclear portions. The radius of the nucleus of an atom is nearly \({10^{ 15}}\;{\rm{m}}\), while that of the atom is \({10^{ 10}}\;{\rm{m}}\). The mass of the atom is mainly due to the nucleus, i.e., the atomic mass number is equal to the number of protons and neutrons present in the nucleus. Protons and neutrons together are called nucleons. The nucleus is positively charged since the protons are positively charged and the neutrons are neutral. All the electrons are present in extranuclear space around the nucleus, revolve in well-defined circular paths known as orbits. The orbits are also called energy levels or energy shells, and these are designated as \({\rm{K}}\,,\,{\rm{L}}\,,\,{\rm{M}}\,,\,{\rm{N}}\,,\,{\rm{O}}\,,\, \ldots \) The order of the energy of these energy shells is \({\rm{K}} < {\rm{L}} < {\rm{M}} < {\rm{N}} < {\rm{O}}\,, \ldots \) Electrons when revolving around the nucleus do not lose or gain energy. Thus, the energy of electrons remains stationary. The total positive charge of the nucleus is due to the presence of protons is the same as that of the negative charge of electrons present in the extranuclear space, therefore, the atom as a whole is electrically neutral. The smallest particle of an atom that has a negative charge on it is called electrons. It revolves around the nucleus in a circular path in an atom and is represented by \({{\rm{e}}^ }\). In the \(1897\), the electron was discovered by J.J Thomson through his cathode ray experiment. The mass of an electron is \(\frac{1}{{1837}}\), the mass of a hydrogen atom or equal to \(9.1 \times {10^{ 31}}\;{\rm{kg}}\).An electron carries a unit negative charge with a magnitude of \(1.602 \times {10^{ 19}}\)coulombs.The radius of the electron is extremely small, i.e., less than \({10^{ 15}}\;{\rm{m}}\). The particles of an atom, which is present in the nucleus having a positive charge on them, are called protons. It is presented as \({{\rm{p}}^{\rm{ + }}}\). Goldstein discovered a positively charged particle, but the credit for the discovery of protons is given to Ernest Rutherford. The mass of the proton is the same as that of a hydrogen atom, i.e., \(1837\) times the mass of an electron, i.e., \(1.672 \times {10^{ 27}}\;{\rm{kg}}\).A proton carries a unit positive charge with a magnitude of \(1.602 \times {10^{ 19}} {\rm{C}}\).The proton is present in the nucleus of an atom. The particles of an atom without any charge are called neutrons, and it resides in the nucleus of an atom. The mass of the neutron is almost equal to the mass of the proton. It is usually represented by \({\rm{n}}\) or \({{\rm{n}}^{\rm{0}}}\). In the year (1932), Chadwick discovered new particles without any charge, on bombarding light nuclei atom-beryllium with alpha particles and were thus named neutrons. These do not have any charge on them and are thus named neutrons.Neutrons are neutral molecules, hence does not deflected by an electric or magnetic field.Its mass is equal to \(1.675 \times {10^{ 27}}\;{\rm{kg}}\). The nitrogen \(\left({\rm{N}} \right)\) is made of \(7\) protons, \(7\) electrons and \(7\) neutrons. Electrons are revolving around the central nucleus in the circular path. Since the number of protons is equal to the number of neutrons, the nitrogen atom is electrically neutral. The hydrogen \(\left({\rm{H}} \right)\) is made of \(1\) proton and \(1\) electron. Electrons revolve around the central nucleus in the circular path. The oxygen \(\left({\rm{O}} \right)\) is made of \(8\) protons, \(8\) electrons and \(8\) neutrons. Electrons are revolving around the central nucleus in the circular path. Since the number of protons is equal to the number of neutrons, the oxygen atom is electrically neutral. The carbon \(\left({\rm{C}} \right)\) is made of \(6\) protons, \(6\) electrons and \(6\) neutrons. Electrons are revolving around the central nucleus in the circular path. Since the number of protons is equal to the number of neutrons, the carbon atom is electrically neutral. The atomic structure of hydrogen, oxygen and nitrogen are represented as follows: Following are the different types of atoms. Stable: Atoms with protons, electrons, and neutrons in balance are stable atoms.Isotopes: Elements with the same number of protons but different neutrons are called isotopes. It is also defined as elements with the sameatomic number but with different mass numbers.Example: Isotopes of hydrogen are protium\(\left({_1^1{\rm{H}}} \right)\), deuterium \(\left({_1^2{\rm{H}}} \right)\), and tritium \(\left({_1^3{\rm{H}}} \right)\).Radioactive: An atomis unstable due to too many neutrons, and isradioactive in nature.Example: UraniumAntimatter: These are atoms with a twin anti-particle with an oppositeelectric charge. It is very rare and fragile.Ions: Atoms with less or a greater number of electronsthan that of protons,forms ions. In this article, the structure of an atom, you have understood what an atom is, the parts of a bit, the properties of the fundamental particles of an atom, i.e., protons, electrons, and neutrons. With examples of carbon-nitrogen provided on this page, you can explain the structure of an atom. This article is also helping in recollecting the different types of atoms and their meaning. Q.1. What do you mean by the structure of an atom?Ans: An atom consists of two parts: the nucleus and extranuclear portions. The nucleus is present in the centre of the atom and is surrounded by the extranuclear portions. Protons and neutrons reside in the nucleus and are together called nucleons. The nucleus is positively charged since the proton is positively charged and the neutron is neutral. The electrons are negatively charged and present in extranuclear space around the nucleus. Electrons revolve in well-defined circular paths known as orbits. Q.2. What are the structures and properties of an atom?Ans: Structure of atom: An atom consists of two parts. These are the nucleus and extranuclear portions. The nucleus is present in the centre of the atom and is surrounded by the extranuclear portions. Protons and neutrons reside in the nucleus. The electrons are present in extranuclear space around the nucleus. Electrons revolve in well-defined circular paths known as orbits. Properties of Atom:1. An atom consists of three elementary subatomic particles, i.e., protons, electrons, and neutrons.2. Protons and neutrons reside in the nucleus and are together called nucleons.3. The nucleus is positively charged since the proton is positively charged and the neutron is neutral.4. The electrons are negatively charged.5. Atoms areneutral asa whole. Q.3. How do you know the structure of an atom?Ans: The structure of an atom can be known by the atomic number and mass number. The atomic number is equal to the number of protons, and the number of protons is equal to the number of electrons in a neutral atom. The mass number gives the number of neutrons and protons in an atom. The mass number is equal to the sum of the number of protons and neutrons. Q.4. What are the twoparts of an atom?Ans: An atom consists of the following parts, i.e., nucleus, extranuclear portions. The nucleus consists of protons and neutrons. All the electrons are present in extranuclear space around the nucleus, revolve in well-defined circular paths known as orbits. Q.5. What are the fourtypes of atoms?Ans: The four types of atoms are stable atoms, isotopes, radioactive atoms and antimatter. We hope this article on the structure of an atom has helped you. If you have any queries, drop a comment below and we will get back to you. Learning ObjectivesDescribe the three main subatomic particles.State how the subatomic particles are arranged in atoms. There have been several minor but important modifications to Daltons atomic theory. For one thing, Dalton considered atoms to be indivisible. We know now that atoms not only can be divided but also are composed of three different kinds of particles with their own properties that are different from the chemical properties of atoms. The first subatomic particle was identified in 1897 and called the electron. It is an extremely tiny particle, with a mass of about 9.109 1031 kg. Experiments with magnetic fields showed that the electron has a negative electrical charge.By 1920, experimental evidence indicated the existence of a second particle. A protonhas the same amount of charge as an electron, but its charge is positive, not negative. Another major difference between a proton and an electron is mass. Although still incredibly small, the mass of a proton is 1.673 1027 kg, which is almost 2,000 times greater than the mass of an electron. Because opposite charges attract each other (while like charges repel each other), protons attract electrons (and vice versa).Finally, additional experiments pointed to the existence of a third particle. Evidence produced in 1932 established the existence of the neutron, a particle with about the same mass as a proton but with no electrical charge.We understand now that all atoms can be broken down into subatomic particles: protons, neutrons, and electrons. Table 2.4 Properties of the Subatomic Particles lists some of their important characteristics and the symbols used to represent each particle.ParticleSymbolMass (kg)Relative Mass (proton = 1)Relative Chargeprotonp+1.673 10271+1neutronn01.675 102710electrone9.109 10310.000551 How are these subatomic particles arranged? Between 1909 and 1911, Ernest Rutherford, a Cambridge physicist, and his associates Hans Geiger and Ernest Marsden performed experiments that provided strong evidence concerning the internal structure of an atom. They took a very thin metal foil, such as gold or platinum, and aimed a beam of positively charged particles (called alpha particles, which are combinations of two protons and two neutrons) from a radioactive source toward the foil. Surrounding the foil was a detectoreither a scintillator (a material that glows when hit by such particles) or some unexposed film (which is exposed where the particles hit it). The detector allowed the scientists to determine the distribution of the alpha particles after they interacted with the foil. Figure 2.3 The Geiger-Marsden Experimental Setup shows a diagram of the experimental setup.Figure 2.3 The Geiger-Marsden Experimental Setup. Experiments using this setup were used to investigate the structure of atoms.Most of the particles traveled straight through the foil, but some alpha particles were deflected off to one side. Some were even deflected back toward the source. This was unexpected. Rutherford once said, It was almost as incredible as if you fired a 15-inch shell at a piece of tissue paper and it came back and hit you.Rutherford proposed the following model to explain these experimental results. Protons and neutrons are concentrated in a central region he called the nucleus(plural, nuclei) of the atom. Electrons are outside the nucleus and orbit about it because they are attracted to the positive charge in the nucleus. Most of the mass of an atom is in the nucleus, while the orbiting electrons account for an atoms size. As a result, an atom consists largely of empty space. Rutherford called his description the planetary model of the atom. Figure 2.4 Rutherfords Metal-Foil Experiments shows how this model explains the experimental results.Figure 2.4 Rutherfords Metal-Foil Experiments. Rutherford explained the results of the metal-foil experiments by proposing that most of the mass and the positive charge of an atom are located in its nucleus, while the relatively low-mass electrons orbit about the nucleus. Most alpha particles go straight through the empty space, a few particles are deflected, and fewer still ricochet back toward the source. The nucleus is much smaller proportionately than depicted here. The planetary model of the atom replaced the plum pudding model, which had electrons floating around aimlessly like plums in a pudding of positive charge.Rutherfords model is essentially the same model that we use today to describe atoms but with one important modification. The planetary model suggests that electrons occupy certain specific, circular orbits about the nucleus. We know now that this model is overly simplistic. A better description is that electrons form fuzzy clouds around nuclei. Figure 2.5 A Modern Depiction of Atomic Structure shows a more modern version of our understanding of atomic structure.Figure 2.5 A Modern Depiction of Atomic Structure. A more modern understanding of atoms, reflected in these representations of the electron in a hydrogen atom, is that electrons occupy regions of space about the nucleus; they are not in discrete orbits like planets around the sun. (a) The darker the color, the higher the probability that an electron will be at that point. (b) In a two-dimensional cross section of the electron in a hydrogen atom, the more crowded the dots, the higher the probability that an electron will be at that point. In both (a) and (b), the nucleus is in the center of the diagram.Concept Review ExercisesWhat are the charges and the relative masses of the three subatomic particles?Describe the structure of an atom in terms of its protons, neutrons, and electrons.Key TakeawaysAtoms are composed of three main subatomic particles: protons, neutrons, and electrons.Protons and neutrons are grouped together in the nucleus of an atom, while electrons orbit about the nucleus. Which is smalleran electron or a helium atom?Which is largera proton or an atom of lead?Which subatomic particle has a positive charge? Which subatomic particle has a negative charge?Which subatomic particle is electrically neutral? Does it exist inside or outside the nucleus?Protons are among the (most, least) massive subatomic particles, and they are found (inside, outside) the nucleus.Electrons are among the (most, least) massive subatomic particles, and they are found (inside, outside) the nucleus.Describe why Rutherford used the term planetary model to describe his model of atomic structure.Why is the planetary model not an appropriate way to describe the structure of an atom?What happened to most of the alpha particles in Rutherfords experiment? Explain why that happened.Electrons account for the (majority, minority) of the (mass, volume) of an atom. Atoms are tiny particles that form the basic building blocks of all matter in the universe, whether solid, liquid, or gas. All living organisms and nonliving objects found on Earth are made of trillions and trillions of atoms. The smaller particles that make up an atom are known as subatomic particles. Parts of an Atom Diagram The term atom was derived from the Greek word atomos, meaning indivisible. The ancient Greek and Indian philosophers were the first to think atom as the basic unit of all matter in the universe. In the early 19th century, scientists started understanding the atoms structure with their inner parts in more detail. In 1926, Erwin Schrodinger proposed the current atomic model that we still use today. There are many different atoms, each having its name, size, mass, and number of subatomic particles. They are known as elements. Thus, an atom can also be defined as the simplest structural unit of an element that retains all its properties. There are 94 natural elements and 24 artificial elements that exist today. An atoms size is tiny, with a diameter of 0.1 to 0.5 nanometers (1 1010 to 5 1010 m). Thus, they cannot be seen with our naked eye. A layer of an atom is somewhat similar to a sheet of paper. Atomic Structure All atoms except hydrogen contain three basic subatomic particles: 1) electrons, 2) protons, and neutrons. Neutrons and protons are found at the center of the atom within a dense region called the nucleus. In contrast, electrons are found outside the nucleus in a region called the electron cloud or electron shell. They are negatively charged particles that revolve around the nucleus in a fixed orbit. Unlike protons and neutrons, electrons are fundamental particles much smaller (almost 1800 times) in size than protons and neutrons. The standard symbol used for an electron is e or e. British physicist J.J. Thomson discovered it in 1897. Electrons move so fast around the nucleus that their exact location within an atom cannot be accurately determined. When the number of negatively charged electrons equals the number of positively charged protons, the atom is neutral in charge. Protons are positively charged particles found within a dense region at the center of the atom called the nucleus. They were discovered by Ernest Rutherford in the year 1917 and are denoted by the symbol p or p+. Protons consist of even smaller particles called quarks and gluons. Found tightly packed with the nucleus, they make up virtually all of the mass of an atom, along with the neutrons. They are also found within the nucleus along with the protons in a tightly packed manner. Neutrons, similar to protons, are made of quarks and gluons. They were discovered by James Chadwick in the year 1932 and are denoted by the symbol n or n0. Neutrons are neutral particles with no charge but have a substantial size and mass similar to a proton. Below is a table showing the charge, mass, and location of the three sub-atomic particles: Name of the ParticleSymbolRelative ChargeLocation in the Atom1. Protonp/p++1Nucleus2. Neutronn/n00Nucleus3. Electrone/e-1Shell or Orbit Quarks: They are fundamental subatomic particles that makeup protons and neutrons. They were independently discovered by Murray Gell-Mann and George Zweig in 1964. However, their exact position in an atom cannot be accurately measured. Quarks are of six different types: up, down, top, bottom, charm, and strange. A proton contains three quarks (two up quarks and one down quark), whereas a neutron contains (two down quarks and one up quark). Gluons: Also found within protons and electrons, they act as exchange particles that help transfer strong force between quarks. John Ellis and his fellow workers discovered them in 1979.Neutrino: They are similar to electrons formed from nuclear reactions. Neutrino has no charge but travels at a very high speed, similar to the speed of light, and can pass through any solid object. The tremendous energy of the sun, which is obtained by nuclear fusion, releases trillions of neutrinos every second. Q1. How many atoms are there in the universe? Ans. There are roughly between 1078 and 1082 atoms present in the universe. Q2. How are atoms and elements related? Ans. An element is made entirely of only one type of atom. In other words, an element is made of multiple atoms that are of the same type. Q3. How are molecules different from atoms? Ans. An atom is the smallest unit of an element, whereas a molecule consists of two or more atoms. Q4. What happens when an atom loses an electron? Ans. When an atom loses an electron, it becomes a positive ion. Article was last reviewed on Thursday, February 29, 2024 Atoms are the basic building blocks of everything in the world.Learning about atoms helps us understand the world and its makeup better. Everything in the world consists of atoms, so it's good to know something about them. Here are 10 interesting and useful atom facts.There are three parts to an atom. Protons have a positive electrical charge and are found together with neutrons (no electrical charge) in the nucleus of each atom. Negatively charged electrons orbit the nucleus.Atoms are the smallest particles that make up elements. Each element contains a different number of protons. For example, all hydrogen atoms have one proton while all carbon atoms have six protons.Some matter consists of one type of atom (e.g., gold), while other matter is made of atoms bonded together to form compounds (e.g., sodium chloride).Atoms are mostly empty space. The nucleus of an atom is extremely dense and contains nearly all of the mass of each atom. Electrons contribute very little mass to the atom (it takes 1,836 electrons to equal the size of a proton)and orbit so far away from the nucleus that each atom is 99.9% empty space. If the atom was the size of a sports arena, the nucleus would be the size of a pea. Although the nucleus is much denser compared with the rest of the atom, it too consists mainly of empty space.There are over 100 different kinds of atoms. About 92 of them occur naturally, while the remainder are made in labs. The first new atom made by man was technetium, which has 43 protons.New atoms can be made by adding more protons to an atomic nucleus. However, these new atoms (elements) are unstable and decay into smaller atoms instantaneously. Usually, we only know a new atom was created by identifying the smaller atoms from this decay.The components of an atom are held together by three forces. Protons and neutrons are held together by the strong and weak nuclear forces. Electrical attraction holds electrons and protons. While electrical repulsion repels protons away from each other, the attracting nuclear force is much stronger than electrical repulsion. The strong force that binds together protons and neutrons is 1,038 times more powerful than gravity, but it acts over a very short range, so particles need to be very close to each other to feel its effect.The word "atom" comes from the Greek word for "uncuttable" or "undivided." The name comes from the 5th century BCE Greek philosopher Democritus, who believed matter consisted of particles that could not be cut into smaller particles. For a long time, people believed atoms were the fundamental "uncuttable" unit of matter. While atoms are the building blocks of elements, they can be divided into still smaller particles. Also, nuclear fission and nuclear decay can break atoms into smaller atoms.Atoms are very small. The average atom is about one-tenth of abillionth of a meter across. The largest atom (cesium) is approximately nine times bigger than the smallest atom (helium).Although atoms are the smallest unit of an element, they consist of even tinier particles called quarks and leptons. An electron is a lepton. Protons and neutrons consist of three quarks each.The most abundant type of atom in the universe is the hydrogen atom. Nearly 74% of the atoms in the Milky Way galaxy are hydrogen atoms.You have around 7 billion billion billion atoms in your body, yet you replace about 98% of them every yeara fascinating fact abut atoms! Take an Atom QuizLearning Objectives State the modern atomic theory. Learn how atoms are constructed. The smallest piece of an element that maintains the identity of that element is called an atom. Individual atoms are extremely small. It would take about fifty million atoms in a row to make a line that is 1 cm long. The period at the end of a printed sentence has several million atoms in it. Atoms are so small that it is difficult to believe that all matter is made from atomsbut it is. The concept that

abundance (%)Atomic mass (amu)Chlorine-\(35\)\(75.53\)\(34.97\)Chlorine-\(37\)\(24.47\)\(36.97\)Step 1: For each isotope, multiply the atomic mass by its percentage abundance.\[\begin{align*}\textrm{Chlorine-35} & = \textrm{percentage abundance}\times\textrm{atomic mass}\\& = 75.53\textrm{%}\times34.97\textrm{ amu}\\& = 26.41\textrm{ amu}\end{align*}\] \[\begin{align*}\textrm{Chlorine-37} & = \textrm{percentage abundance}\times\textrm{atomic mass}\\& = 24.47\textrm{%}\times36.97\textrm{ amu}\\& = 9.047\textrm{ amu}\end{align*}\]Step : Find the sum of the values calculated in Step 1.\[\begin{align*}\textrm{Atomic mass of chlorine} & = 26.41\textrm{ amu}+9.047\textrm{ amu}\\& =35.46\textrm{ amu}\end{align*}\]Your turn atomic structureTest yourself on your understanding of atomic structure. Images on this page by RMIT, licensed under CC BY-NC 4.0 Science Physics Matter & Energy Rutherford gold-foil experimentIn 1909 Rutherford disproved Sir J.J. Thomson's model of the atom as a uniformly distributed substance. Because only very few of the alpha particles in his beam were scattered by large angles after striking the gold foil while most passed completely through, Rutherford knew that the gold atom's mass must be concentrated in a tiny dense nucleus. Rutherford overturned Thomsons model in 1911 with his famous gold-foil experiment, in which he demonstrated that the atom has a tiny, massive nucleus. Five years earlier Rutherford had noticed that alpha particles beamed through a hole onto a photographic plate would make a sharp-edged picture, while alpha particles beamed through a sheet of mica only 20 micrometres (or about 0.002 cm) thick would make an impression with blurry edges. For some particles the blurring corresponded to a two-degree deflection. Remembering those results, Rutherford had his postdoctoral fellow, Hans Geiger, and an undergraduate student, Ernest Marsden, refine the experiment. The young physicists beamed alpha particles through gold foil and detected them as flashes of light or scintillations on a screen. The gold foil was only 0.00004 cm thick. Most of the alpha particles went straight through the foil, but some were deflected by the foil and hit a spot on a screen placed off to one side. Geiger and Marsden found that about one in 20,000 alpha particles had been deflected 45 or more. Rutherford asked why so many alpha particles passed through the gold foil while a few were deflected so greatly. It was almost as incredible as if you fired a 15-inch shell at a piece of tissue paper, and it came back to hit you, Rutherford said later. On consideration, I realized that this scattering backwards must be the result of a single collision, and when I made calculations I saw that it was impossible to get anything of that order of magnitude unless you took a system in which the greater part of the mass of the atom was concentrated in a minute nucleus. It was then that I had the idea of an atom with a minute massive centre carrying a charge. Rutherford atomic modelPhysicist Ernest Rutherford envisioned the atom as a miniature solar system, with electrons orbiting around a massive nucleus, and as mostly empty space, with the nucleus occupying only a very small part of the atom. The neutron had not yet been discovered when Rutherford proposed his model, which had a nucleus consisting only of protons.Many physicists distrusted the Rutherford atomic model because it was difficult to reconcile with the chemical behaviour of atoms. The model suggested that the charge on the nucleus was the most important characteristic of the atom, determining its structure. On the other hand, Mendeleyevs periodic table of the elements had been organized according to the atomic masses of the elements, implying that the mass was responsible for the structure and chemical behaviour of atoms. Henry Gwyn Jeffreys Moseley, a young English physicist killed in World War I, confirmed that the positive charge on the nucleus revealed more about the fundamental structure of the atom than Mendeleyevs atomic mass. Moseley studied the spectral lines emitted by heavy elements in the X-ray region of the electromagnetic spectrum. He built on the work done by several other British physicistsCharles Glover Barkla, who had studied X-rays produced by the impact of electrons on metal plates, and William Bragg and his son Lawrence, who had developed a precise method of using crystals to reflect X-rays and measure their wavelength by diffraction. Moseley applied their method systematically to measure the spectra of X-rays produced by many elements. Moseley found that each element radiates X-rays of a different and characteristic wavelength. The wavelength and frequency vary in a regular pattern according to the charge on the nucleus. He called this charge the atomic number. In his first experiments, conducted in 1913, Moseley used what was called the K series of X-rays to study the elements up to zinc. The following year he extended this work using another series of X-rays, the L series. Moseley was conducting his research at the same time that Danish theoretical physicist Niels Bohr was developing his quantum shell model of the atom. The two conferred and shared data as their work progressed, and Moseley framed his equation in terms of Bohrs theory by identifying the K series of X-rays with the most-bound shell in Bohrs theory, the N = 1 shell, and identifying the L series of X-rays with the next shell, N = 2. Moseley presented formulas for the X-ray frequencies that were closely related to Bohrs formulas for the spectral lines in a hydrogen atom. Moseley showed that the frequency of a line in the X-ray spectrum is proportional to the square of the charge on the nucleus. The constant of proportionality depends on whether the X-ray is in the K or L series. This is the same relationship that Bohr used in his formula applied to the Lyman and Balmer series of spectral lines. The regularity of the differences in X-ray frequencies allowed Moseley to order the elements by atomic number from aluminum to gold. He observed that, in some cases, the order by atomic weights was incorrect. For example, cobalt has a larger atomic mass than nickel, but Moseley found that it has atomic number 27 while nickel has 28. When Mendeleyev constructed the periodic table, he based his system on the atomic masses of the elements and had to put cobalt and nickel out of order to make the chemical properties fit better. In a few places where Moseley found more than one integer between elements, he predicted correctly that a new element would be discovered. Because there is just one element for each atomic number, scientists could be confident for the first time of the completeness of the periodic table; no unexpected new elements would be discovered. Science Physics Matter & Energy The concept of the atom that Western scientists accepted in broad outline from the 1600s until about 1900 originated with Greek philosophers in the 5th century bce. Their speculation about a hard, indivisible fundamental particle of nature was replaced slowly by a scientific theory supported by experiment and mathematical deduction. It was more than 2,000 years before modern physicists realized that the atom is indeed divisible and that it is not hard, solid, or immutable. Leucippus of Miletus (5th century bce) is thought to have originated the atomic philosophy. His famous disciple, Democritus of Abdera, named the building blocks of matter atomos, meaning literally indivisible, about 430 bce. Democritus believed that atoms were uniform, solid, hard, incompressible, and indestructible and that they moved in infinite numbers through empty space until stopped. Differences in atomic shape and size determined the various properties of matter. In Democrituss philosophy, atoms existed not only for matter but also for such qualities as perception and the human soul. For example, sourness was caused by needle-shaped atoms, while the colour white was composed of smooth-surfaced atoms. The atoms of the soul were considered to be particularly fine. Democritus developed his atomic philosophy as a middle ground between two opposing Greek theories about reality and the illusion of change. He argued that matter was subdivided into indivisible and immutable particles that created the appearance of change when they joined and separated from others. The philosopher Epicurus of Samos (341270 bce) used Democrituss ideas to try to quiet the fears of superstitious Greeks. According to Epicuruss materialistic philosophy, the entire universe was composed exclusively of atoms and void, and so even the gods were subject to natural laws. Most of what is known about the atomic philosophy of the early Greeks comes from Aristotles attacks on it and from a long poem, De rerum natura (On the Nature of Things), which Latin poet and philosopher Titus Lucretius Carus (c. 9555 bce) wrote to popularize its ideas. The Greek atomic theory is significant historically and philosophically, but it has no scientific value. It was not based on observations of nature, measurements, tests, or experiments. Instead, the Greeks used mathematics and reason almost exclusively when they wrote about physics. Like the later theologians of the Middle Ages, they wanted an all-encompassing theory to explain the universe, not merely a detailed experimental view of a tiny portion of it. Science constituted only one aspect of their broad philosophical system. Thus, Plato and Aristotle attacked Democrituss atomic theory on philosophical grounds rather than on scientific ones. Plato valued abstract ideas more than the physical world and rejected the notion that attributes such as goodness and beauty were mechanical manifestations of material atoms. Where Democritus believed that matter could not move through space without a vacuum and that light was the rapid movement of particles through a void, Aristotle rejected the existence of vacuums because he could not conceive of bodies falling equally fast through a void. Aristotles conception prevailed in medieval Christian Europe; its science was based on revelation and reason, and the Roman Catholic theologians rejected Democritus as materialistic and atheistic. De rerum natura, which was rediscovered in the 15th century, helped fuel a 17th-century debate between orthodox Aristotelian views and the new experimental science. The poem was printed in 1649 and popularized by Pierre Gassendi, a French priest who tried to separate Epicuruss atomism from its materialistic background by arguing that God created atoms. Soon after Italian scientist Galileo Galilei expressed his belief that vacuums can exist (1638), scientists began studying the properties of air and partial vacuums to test the relative merits of Aristotelian orthodoxy and the atomic theory. The experimental evidence about air was only gradually separated from this philosophical controversy. Boyle's lawDemonstration of Boyle's law showing that for a given mass, at constant temperature, the pressure times the volume is a constant.Anglo-Irish chemist Robert Boyle began his systematic study of air in 1658 after he learned that Otto von Guericke, a German physicist and engineer, had invented an improved air pump four years earlier. In 1662 Boyle published the first physical law expressed in the form of an equation that describes the functional dependence of two variable quantities. This formulation became known as Boyles law. From the beginning, Boyle wanted to analyze the elasticity of air quantitatively, not just qualitatively, and to separate the particular experimental problem about airs spring from the surrounding philosophical issues. Pouring mercury into the open end of a closed J-shaped tube, Boyle forced the air in the short side of the tube to contract under the pressure of the mercury on top. By doubling the height of the mercury column, he roughly doubled the pressure and halved the volume of air. By tripling the pressure, he cut the volume of air to a third, and so on. This behaviour can be formulated mathematically in the relation PV = PV, where P and V are the pressure and volume under one set of conditions and P and V represent them under different conditions. Boyles law says that pressure and volume are inversely related for a given quantity of gas. Although it is only approximately true for real gases, Boyles law is an extremely useful idealization that played an important role in the development of atomic theory. Soon after his air-pressure experiments, Boyle wrote that all matter is composed of solid particles arranged into molecules to give material its different properties. He explained that all things are made of one Catholick Matter common to them all, anddiffer but in the shape, size, motion or rest, and texture of the small parts they consist of. In France Boyles law is called Mariottes law after physicist Edme Mariotte, who discovered the empirical relationship independently in 1676. Mariotte realized that the law holds true only under constant temperatures; otherwise, the volume of gas expands when heated or contracts when cooled. Forty years later Isaac Newton expressed a typical 18th-century view of the atom that was similar to that of Democritus, Gassendi, and Boyle. In the last query in his book Opticks (1704), Newton stated: All these things being considered, it seems probable to me that God in the Beginning formd Matter in solid, massy, hard, impenetrable, moveable Particles, of such Sizes and Figures, and with such other Properties, and in such Proportion to Space, as most conduced to the End for which he formd them; and that these primitive Particles being Solids, are incomparably harder than any porous Bodies compounded of them; even so very hard, as never to wear or break in pieces; no ordinary Power being able to divide what God himself made one in the first Creation. By the end of the 18th century, chemists were just beginning to learn how chemicals combine. In 1794 Joseph-Louis Proust of France published his law of definite proportions (also known as Prousts law). He stated that the components of chemical compounds always combine in the same proportions by weight. For example, Proust found that no matter where he obtained his samples of the compound copper carbonate, they were composed by weight of five parts copper, four parts oxygen, and one part carbon. Science Physics Matter & Energy atomsHow atoms can be seen.See all videos for this articleatom, the basic building block of all matter and chemistry. Atoms can combine with other atoms to form molecules but cannot be divided into smaller parts by ordinary chemical processes.A simplified look into the structure of an atomExplore an atom's interior to discover the layout of its nucleus, protons, and electrons.See all videos for this articleMost of the atom is empty space. The rest consists of three basic types of subatomic particles: protons, neutrons, and electrons. The protons and neutrons form the atoms central nucleus. (The ordinary hydrogen atom is an exception; it contains one proton but no neutrons.) As their names suggest, protons have a positive electrical charge, while neutrons are electrically neutralthey carry no charge; overall, then, the nucleus has a positive charge. Circling the nucleus is a cloud of electrons, which are negatively charged. Like opposite ends of a magnet that attract one another, the negative electrons are attracted to a positive force, which binds them to the nucleus. The nucleus is small and dense compared with the electrons, which are the lightest charged particles in nature. The electrons circle the nucleus in orbital paths called shells, each of which holds only a certain number of electrons.Investigate varying electron configurations in electron shells around an atom's nucleusAtomic model of electron configurations.See all videos for this articleAn ordinary, neutral atom has an equal number of protons (in the nucleus) and electrons (surrounding the nucleus). Thus the positive and negative charges are balanced. Some atoms, however, lose or gain electrons in chemical reactions or in collisions with other particles. Ordinary atoms that either gain or lose electrons are called ions. If a neutral atom loses an electron, it becomes a positive ion. If it gains an electron, it becomes a negative ion. These basic subatomic particlesprotons, neutrons, and electronsare themselves made up of smaller substances, such as quarks and leptons.More than 90 types of atoms exist in nature, and each kind of atom forms a different chemical element. Chemical elements are made up of only one type of atomgold contains only gold atoms, and neon contains only neon atoms--and they are ranked in order of their atomic number (the total number of protons in its nucleus) in a chart called the periodic table. Accordingly, because an atom of iron has 26 protons in its nucleus, its atomic number is 26 and its ranking on the periodic table of chemical elements is 26. Because an ordinary atom has the same number of electrons as protons, an elements atomic number also tells how many electrons its atoms have, and it is the number and arrangement of the electrons in their orbiting shells that determines how one atom interacts with another. The key shell is the outermost one, called the valence shell. If this outermost shell is complete, or filled with the maximum number of electrons for that shell, the atom is stable, with little or no tendency to interact with other atoms. But atoms with incomplete outer shells seek to fill or to empty such shells by gaining or losing electrons or by sharing electrons with other atoms. This is the basis of an atoms chemical activity. Atoms that have the same number of electrons in the outer shell have similar chemical properties.shell atomic modelIn the shell atomic model, electrons occupy different energy levels, or shells. The K and L shells are shown for a neon atom.This article opens with a broad overview of the fundamental properties of the atom and its constituent particles and forces. Following this overview is a historical survey of the most influential concepts about the atom that have been formulated through the centuries. Facts You Should Know: The Periodic Table Quiz Most matter consists of an agglomeration of molecules, which can be separated relatively easily. Molecules, in turn, are composed of atoms joined by chemical bonds that are more difficult to break. Each individual atom consists of smaller particlesnamely, electrons and nuclei. These particles are electrically charged, and the electric forces on the charge are responsible for holding the atom together. Attempts to separate these smaller constituent particles require ever-increasing amounts of energy and result in the creation of new subatomic particles, many of which are charged. As noted in the introduction to this article, an atom consists largely of empty space. The nucleus is the positively charged centre of an atom and contains most of its mass. It is composed of protons, which have a positive charge, and neutrons, which have no charge. Protons, neutrons, and the electrons surrounding them are long-lived particles present in all ordinary, naturally occurring atoms. Other subatomic particles may be found in association with these three types of particles. They can be created only with the addition of enormous amounts of energy, however, and are very short-lived. All atoms are roughly the same size, whether they have 3 or 90 electrons. Approximately 50 million atoms of solid matter lined up in a row would measure 1 cm (0.4 inch). A convenient unit of length for measuring atomic sizes is the angstrom (), defined as 1010 metre. The radius of an atom measures 12 . Compared with the overall size of the atom, the nucleus is even more minute. It is in the same proportion to the atom as a marble is to a football field. In volume the nucleus takes up only 1014 metres of the space in the atomi.e., 1 part in 100,000. A convenient unit of length for measuring nuclear sizes is the femtometre (fm), which equals 1015 metre. The diameter of a nucleus depends on the number of particles it contains and ranges from about 4 fm for a light nucleus such as carbon to 15 fm for a heavy nucleus such as lead. In spite of the small size of the nucleus, virtually all the mass of the atom is concentrated there. The protons are massive, positively charged particles, whereas the neutrons have no charge and are slightly more massive than the protons. The fact that nuclei can have anywhere from 1 to nearly 300 protons and neutrons accounts for their wide variation in mass. The lightest nucleus, that of hydrogen, is 1,836 times more massive than an electron, while heavy nuclei are nearly 500,000 times more massive. The single most important characteristic of an atom is its atomic number (usually denoted by the letter Z), which is defined as the number of units of positive charge (protons) in the nucleus. For example, if an atom has a Z of 6, it is carbon, while a Z of 92 corresponds to uranium. A neutral atom has an equal number of protons and electrons so that the positive and negative charges exactly balance. Since it is the electrons that determine how one atom interacts with another, in the end it is the number of protons in the nucleus that determines the chemical properties of an atom. ,the free encyclopedia that anyone can edit.112,025 active editors 7,010,731 articles in EnglishIan Carmichael (18June 1920 5February 2010) was an English actor who had a career that spanned seventy years. Born in Kingston upon Hull, he trained at the Royal Academy of Dramatic Art, but his studiesand the early stages of his careerwere curtailed by the Second World War. After initial success in revue and sketch productions, he was cast by the film producers John and Roy Boulting to star in a series of satires, starting with Private's Progress in 1956 through to I'm All Right Jack in 1959. In the mid-1960s he played Bertie Wooster for BBC Television for which he received positive reviews, including from P.G. Wodehouse, the writer who created the character of Wooster. In the early 1970s he played another upper-class literary character, Lord Peter Wimsey, the amateur but talented investigator created by Dorothy L. Sayers. Carmichael was often typecast as an affable but bumbling upper-class innocent, but he retained a disciplined approach to training and rehearsing. (Fullarticle...)Recently featured: Russet sparrowEmmy NoetherThe Combat: Woman Pleading for the VanquishedArchiveBy emailMore featured articlesAboutPallas Athena... that Pallas Athena (pictured) marked Gustav Klimt's transition to his iconic "golden phase" style?... that a legislator, a civil servant, and a soldier led the campaign for a new district on Sumba Island?... that the cover for Brazilian supergroup Tribalistas' debut album used chocolate syrup to illustrate the trio?... that Jeremy Crawshaw was the only punter selected in the 2025 NFL draft?... that HMSSheffield earned twelve battle honours during World WarII?... that a South African library was named after American economist Elizabeth Ellis Hoyt in recognition of her work in Africa?... that the Five Domains model seeks to ensure that animals have a "life worth living"?... that Taylor Swift compared the metaphors in her song "...Ready for It?" to those in the novel Crime and Punishment?... that Ralph Riggs made his professional stage debut when he was a baby?ArchiveStart a new articleNominate an articleMelissa HortmanIn the US state of Minnesota, state representative Melissa Hortman (pictured) is assassinated and state senator John Hoffman is injured.Former president of Nicaragua and first elected female president in the Americas Violeta Chamorro dies at the age of 95.Israel launches multiple airstrikes across cities in Iran, killing various nuclear scientists and military officials, including IRGC commander-in-chief Hossein Salami.Air India Flight 171 crashes in Ahmedabad, India, killing 279 people.Ongoing: Gaza warRussian invasion of UkrainetimelineSudanese civil wartimelineRecent deaths: Stella ChenFranzo Grande StevensSly StoneMohammad BagheriFereydoon AbbasiStu WilsonNominate an articleJune 18: Autistic Pride DayCadaver Tomb of Ren of Chalon1898 The Cadaver Tomb of Ren of Chalon (pictured) in Bar-le-Duc, France, was designated a monument historique.1958 English composer Benjamin Britten's one-act opera Noye's Fludde was premiered at the Aldeburgh Festival.1967 American musician Jimi Hendrix burned his guitar on stage at the end of a performance at the Monterey International Pop Festival in California.1981 The Lockheed F-117 Nighthawk, the first operational aircraft to be designed around stealth technology, made its maiden flight.1994 The Troubles: Ulster Volunteer Force members attacked a crowded bar in Loughinisland, Northern Ireland, with assault rifles, killing six people.Rogier van der Weyden (d.1464)Ambrose Philips (d.1749)Lou Brock (b.1939)Stephanie Kwolek (d.2014)More anniversaries: June 17June 18June 19ArchiveBy emailList of days of the yearAboutThe Garni Temple is a classical colonnaded structure in the village of Garni, in central Armenia, around 30km (19mi) east of Yerevan. Built in the Ionic order, it is the best-known structure and symbol of pre-Christian Armenia. It has been described as the "easternmost building of the Greco-Roman world" and the only largely preserved Hellenistic building in the former Soviet Union. It is conventionally identified as a pagan temple built by King TiridatesI in the first century AD as a temple to the sun god Mihr (Mithra). It collapsed in a 1679 earthquake, but much of its fragments remained on the site. Renewed interest in the 19th century led to excavations in the early and mid-20th century. It was reconstructed in 196975, using the anastylosis technique. It is one of the main tourist attractions in Armenia and the central shrine of Hetanism (Armenian neopaganism). This aerial photograph shows the Garni Temple in the winter.Photograph credit: YerevantsiRecently featured: Igor StravinskySabella pavoninaMagna Carta (An Embroidery)ArchiveMore 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 nynorskShqipSlovenina Retrieved from " 2Calendar yearYearsMillennium2ndmillenniumCenturies18thcentury19thcentury 20thcenturyDecades1870s1880s1890s 1900s1910sYears1895189618971898 189919001901vte1898 by topicHumanitiesAnimationArchaeologyArchitectureArtFilmLiteraturePoetryMusicBy countryAustraliaBelgiumBrazilBulgariaCanadaChinaDenmarkFranceGermanyItalyNew ZealandNorwayPhilippinesPortugalRussiaSouth AfricaSpainSwedenUnited KingdomUnited StatesVenezuelaOther topicsRail transportScienceSportsLists of leadersSovereign statesSovereign state leadersTerritorial governorsReligious leadersLawBirth and death categoriesBirthsDeathsEstablishments and disestablishments categoriesEstablishmentsDisestablishmentsWorks categoryWorksvte1898 in various calendarsGregorian calendar1898MDCCCXCVIIIAb urbe condita2651Armenian calendar1347 Assyrian calendar6648Bah calendar5455Balinese saka calendar18191820Bengali calendar13041305Berber calendar2848British Regnal year61Vict.162Vict.1Buddhist calendar2442Burmese calendar1260Byzantine calendar74067407Chinese calendar (FireRooster)4595 or 4388to (EarthDog)4596 or 4389Coptic calendar16141615Discordian calendar3064Ethiopian calendar18901891Hebrew calendar56585659Hindu calendars- Vikram Samvat19541955- Shaka Samvat18191820- Kali Yuga49984999Holocene calendar11898Igbo calendar898899Iranian calendar12761277Islamic calendar1315316Japanese calendarMeiji 31()Javanese calendar18271828Julian calendarGregorian minus 12 daysKorean calendar4231Minguo calendar14 before ROC14Nanakshahi calendar430Thai solar calendar24402441Tibetan calendar(female Fire-Rooster)2024 or 1643 or 871to(male Earth-Dog)2025 or 1644 or 872Wikimedia Commons has media related to 1898.1898 (MDCCCXCVIII) was a common year starting on Saturday of the Gregorian calendarand a common year starting on Thursday of the Julian calendar, the 1898th year of the Common Era (CE) and Anno Domini (AD) designations, the 898th year of the 2ndmillennium, the 98th year of the 19thcentury, and the 9th year of the 1890s decade. As of the start of 1898, the Gregorian calendar was 12 days ahead of the Julian calendar, which remained in localized use until 1923. Calendar year 1898 world mapJanuary 1 New York City annexes land from surrounding counties, creating the City of Greater New York as the world's second largest. The city is geographically divided into five boroughs: Manhattan, Brooklyn, Queens, The Bronx and Staten Island.January 13 Novelist mile Zola's open letter to the President of the French Republic on the Dreyfus affair, J'Accuse!, is published on the front page of the Paris daily newspaper L'Aurore, accusing the government of wrongfully imprisoning Alfred Dreyfus and of antisemitism.February 12 The automobile belonging to Henry Lindfield of Brighton rolls out of control down a hill in Purley, London, England, and hits a tree; thus he becomes the world's first fatality from an automobile accident on a public highway.[1]February 15 SpanishAmerican War: The USSMaine explodes and sinks in Havana Harbor, Cuba, for reasons never fully established, killing 266 men. The event precipitates the United States' declaration of war on Spain, two months later.February 15: USSMaine is sunk.February 23 mile Zola is imprisoned in France, after writing J'Accuse!.March 1 Vladimir Lenin creates the Russian Social Democratic Labour Party in MinskMarch 14 Association football and sports club BSC Young Boys is established in Bern, Switzerland, as the Fussballclub Young Boys.March 16 In Melbourne the representatives of five colonies adopt a constitution, which will become the basis of the Commonwealth of Australia.[2]March 24 Robert Allison of Port Carbon, Pennsylvania, becomes the first person to buy an American-built automobile, when he buys a Winton automobile that has been advertised in Scientific American.March 26 The Sabie Game Reserve in South Africa is created, as the first officially designated game reserve.April 5 Annie Oakley promotes the service of women in combat situations, with the United States military. On this day, she writes a letter to President McKinley "offering the government the services of a company of 50 'lady sharpshooters' who would provide their own arms and ammunition should war break out with Spain."[3]April 22 SpanishAmerican War: The United States Navy begins a blockade of Cuban ports and the USSNashville captures a Spanish merchant ship.April 23 SpanishAmerican War: A conference of senior Spanish Navy officers led by naval minister Segismundo Bermejo decide to send Admiral Pascual Cervera's squadron to Cuba and Puerto Rico.April 25SpanishAmerican War: The United States declares war on Spain; the U.S. Congress announces that a state of war has existed since April 21 (later backdating this one more day to April 20).In Essen, German company Rheinisch-Westflisches Elektrizittswerk RWE is founded.[4]April 26 An explosion in Santa Cruz, California, kills 13 workers, at the California Powder Works.[5]April 29 The Paris Auto Show, the first large-scale commercial vehicle exhibition show, is held in Tuileries Garden.[6]May 1 SpanishAmerican War Battle of Manila Bay: Commodore Dewey destroys the Spanish squadron, in the first battle of the war, as well as the first battle in the Philippines Campaign.May 2 Thousands of Chinese scholars and Beijing citizens seeking reforms protest in front of the capital control yuan.May 79 Bava Beccaris massacre: Hundreds of demonstrators are killed, when General Fiorenzo Bava Beccaris orders troops to fire on a rally in Milan, Italy.May 8 The first games of the Italian Football Federation are played, in which Genoa played against Torino.May 12 SpanishAmerican War: The Puerto Rican Campaign begins, with the Bombardment of San Juan.May 22 The German Federation football club SV Darmstadt 98 is formed.May 27 The territory of Kwang-Chou-Wan is leased by China to France, according to the Treaty of 12 April 1892, as the Territoire de Kouang-Tchou-Wan, forming part of French Indochina.[7]May 28 Secondo Pia takes the first photographs of the Shroud of Turin and discovers that the image on the Shroud itself appears to be a photographic negative.The original flag of the Philippines as conceived by General Emilio Aguinaldo. The blue is of a lighter shade than the currently mandated royal blue, the sun has eight points as currently but many more rays and it has a mythical face.June 1 The Trans-Mississippi Exposition World's Fair opens, in Omaha, Nebraska.June 7 William Ramsay and Morris Travers discover neon at their laboratory at University College London, after extracting it from liquid nitrogen.[8]June 9 The British government arranges a 99-year rent of Hong Kong from China.June 10 Tuone Udaina, the last known speaker of the Dalmatian language, is killed in an explosion.June 11 The Guangxu Emperor announces the creation of what would later become Peking University.[9][10]June 12 Philippine Declaration of Independence: After 333 years of Spanish dominance, General Emilio Aguinaldo declares the Philippines' independence from Spain.June 13 Yukon Territory is formed in Canada, with Dawson chosen as its capital.June 19 Food processing giant Nabisco is founded in New Jersey.[pageneeded]June 21 SpanishAmerican War: The United States captures Guam, making it the first U.S. overseas territory.June 28 Effective date of the Curtis Act of 1898 which will lead to the dissolution of tribal and communal lands in Indian Territory and ultimately the creation of the State of Oklahoma in 1907.August 28: Caleb Bradham names his soft drink Pepsi-ColaJuly 1 SpanishAmerican War: Battle of San Juan Hill United States troops (including Buffalo Soldiers and Theodore Roosevelt's Rough Riders) take a strategic position close to Santiago de Cuba from the Spanish.July 3SpanishAmerican War: Battle of Santiago de Cuba The United States Navy destroys the Spanish Navy's Caribbean Squadron.American adventurer Joshua Slocum completes a 3-year solo circumnavigation of the world.July 4 En route from New York to Le Havre, the ocean liner SSLa Bourgogne collides with another ship and sinks off the coast of Sable Island with the loss of 549 lives.July 7 The United States annexes the Hawaiian Islands.July 17 SpanishAmerican War: Battle of Santiago Bay. Troops under United States General William R. Shafter take the city of Santiago de Cuba from the Spanish.July 18 "The Adventures of Louis de Rougemont" first appear in The Wide World Magazine, as its August 1898 issue goes on sale.[11]July 25 SpanishAmerican War: The United States invasion of Puerto Rico begins, with a landing at Gunica Bay.August 12 SpanishAmerican War: Hostilities end between American and Spanish forces in Cuba.August 13 SpanishAmerican War: Battle of Manila By prior agreement, the Spanish commander surrenders the city of Manila to the United States, in order to keep it out of the hands of Filipino rebels, ending hostilities in the Philippines.August 20 The Gornergrat railway opens, connecting Zermatt to the Gornergrat in Switzerland.August 21 Clube de Regatas Vasco da Gama is founded in Rio de Janeiro.August 23 The Southern Cross Expedition, the first British venture of the Heroic Age of Antarctic Exploration, sets sail from London.August 24 Chickasaw and Choctaw tribes sign the Atoka Agreement, a requirement of the Curtis Act of 1898.August 25 700 Greeks and 15 Englishmen are slaughtered by the Turks in Heraklion, Greece, leading to the establishment of the autonomous Cretan State.August 28 American pharmacist Caleb Bradham names his soft drink Pepsi-Cola.September 2 Battle of Omdurman (Mahdist War): British and Egyptian troops led by Horatio Kitchener defeat Sudanese tribesmen led by Khalifa Abdullah al-Taashi, thus establishing British dominance in the Sudan. 11,000 Sudanese are killed and 1,600 wounded in the battle.[12]September 10 Italian anarchist Luigi Lucheni assassinates Empress Elisabeth of Austria in Geneva, as an act of propaganda of the deed.September 18 Fashoda Incident: A powerful flotilla of British gunboats arrives at the French-occupied fort of Fashoda on the White Nile, leading to a diplomatic stalemate, until French troops are ordered to withdraw on November 3.September 21Empress Dowager Cixi of China engineers a coup d'tat, marking the end of the Hundred Days' Reform; the Guangxu Emperor is arrested.Geert Adriaans Boomgaard of Groningen in the Netherlands becomes the world's first validated supercentenarian.October 1 The Vienna University of Economics and Business is founded, under the name K.u.K. Exportakademie.October 3 Battle of Sugar Point: Ojibwe tribesmen defeat U.S. government troops, in northern Minnesota.October 6 The Sinfonia Club, later to become the Phi Mu Alpha Sinfonia fraternity, is founded at the New England Conservatory of Music in Boston by Ossian Everett Mills.October 15 The Fork Union Military Academy is founded, in Fork Union, Virginia.[13]October 21 General Leonard Wood, the U.S. military governor of Cuba, issues a proclamation guaranteeing personal rights to the Cuban people.[14]October 22 In a race riot near Harperville, Mississippi in the U.S., 14 African-Americans and one white person are killed.[14]October 23 An anarchist, suspected of plotting the assassination of Germany's Kaiser Wilhelm II, is arrested in Egypt at Alexandria.[14]October 24 The last Spanish soldiers in Puerto Rico, led by General Ortega, depart on ships to return to Spain.[14]U.S. President William McKinley extends the deadline for all Spanish troops to leave Cuba. Set to expire on December 1, the last day to depart is extended to January 1, 1899.[14]Chinese soldiers attack a party of British engineers at the Marco Polo Bridge on the Beijing to Hankou railway.[14]October 26 A collision between two Japanese steamers at sea kills 60 Japanese sailors.[14]The U.S. begins the release and repatriation of Spanish Navy sailors who had been taken as prisoners of war in the Philippines, and sends them back to Spain.[14]October 27 The Court of Cassation in Paris hears arguments from lawyers regarding a new trial in the Dreyfus case.[14] The Court grants the request on October 29.October 29 France's Court of Cassation grants a rehearing on the Dreyfus case.[14]Kaiser Wilhelm II of Germany and his wife arrive at Jerusalem in Ottoman-ruled Palestine and visit the Church of the Holy Sepulchre.[14]October 30 The Imperial Russian government announces that the leaders of the world's major nations have accepted the invitation of the Tsar to take part in a proposed conference on disarmament.[14]October 31 The Lutheran Church of the Redeemer, Jerusalem, is dedicated after the Sultan of the Ottoman Empire presents the area, said to be the site of the Virgin Mary's home, to Germany's Roman Catholics.[14]Count kuma Shigenobu, Japan's Prime Minister, announces his resignation along with that of his cabinet of ministers.[14]November 1 Charles Dupuy forms a new government as Prime Minister of France following the resignation of Henri Brisson.[14]November 3 With increasing violence threatened by rebels in China, the Russian fleet at Port Arthur and the British warships at Wei-Hai-Wei are readied for battle.[14]November 5 Negros Revolution: Filipinos on the island of Negros revolt against Spanish rule and establish the short-lived Republic of Negros.[14]In China, an admiral of the Imperial Russian Navy and 40 sailors are denied permission by the Chinese government to proceed from Tientsin to Beijing.In the U.S., the collapse of a theater under construction in Detroit kills 11 workmen.[14]November 6 The Japanese ambassador to China meets with the Emperor and the Empress Dowager at Beijing.[14]November 7 The final meeting of the Cuban Assembly of the Repblica de Cuba en Armas, which had been founded in 1895 during the Cuban War of Independence, is called to order by General Calixto Garca in the city of Santa Cruz del Sur. Domingo Mndez Capote is elected as president of the assembly.November 8 Elections are held in the U.S. for all 357 seats in the House of Representatives, as well as for the governors and state legislature of 25 of the 45 states. With 179 needed for a majority, the Republican Party maintains control with 187 seats, despite losing 19; the Democratic party gains 37 to reach 124 seats; the Populist party losses all but five of its 22 seats, and the other 4 seats are controlled by smaller parties. Among Governors elected are Theodore Roosevelt as Governor of the state of New York.[14]Count Yamagata Aritomo forms a new government as Prime Minister of Japan.[14]November 9 In the U.S., the racial violence in Phoenix, South Carolina, comes to an end after 12 African-Americans had been lynched.[14]November 10 The Wilmington insurrection of 1898 begins as a coup d'tat by the white Democratic Party of the U.S. state of North Carolina against the Republican Mayor of Wilmington. On the first day, a building housing a negro newspaper is burned and eight African Americans are killed.[14]The new United Central American States, a merger of El Salvador, Honduras and Nicaragua, places its capital in the Nicaraguan city of Chinandega.[14]Bartolom Mas, the President of the Repblica de Cuba en Armas that had been founded during the Cuban War of Independence, resigns.[14]November 11 In Wilmington, negro leaders and white republicans are forced to leave the city by new government.[14]November 12 The Earl of Minto takes office as the new Governor General of Canada.[14]November 17 Fighting begins in Pana, Illinois, between striking white coal miners and black miners hired to replace them.[14]November 18 The wreck of the ship Atalanta off the coast of the U.S. state of Oregon kills 28 of the 30 crew aboard.[14]November 19 In U.S. college football, Harvard University defeats Yale University, 17 to 0, to close the season unbeaten.[14]November 21 At the Paris conference to end the Spanish-American War, the U.S. commissioners offer $20,000,000 for purchase of the Philippines from Spain.[15]November 24 Italy sends an ultimatum to the Sultan of Morocco concerning treatmen of Italian residents.[15]November 26 General Ramn Blanco resigns as the spanish Governor-General of Cuba and is replaced by General Adolfo Jimnez Castellanos.[15]A two-day blizzard known as the Portland Gale piles snow in Boston, severely impacting the Massachusetts fishing industry and several coastal New England towns.[15]The U.S. Marines arrive on USS Boston at Tientsin in China in order to guard the American legation at Beijing.[15]November 27 All 115 people aboard the American steamer SS Portland are killed when the ship founders off of the caost of Cape Cod.[15]November 28 The Spanish peace commissioners in Paris announce that they accept the offer of the U.S. to purchase the Philippines.[15]November 30 The United Central American States, a merger of Nicaragua, Honduras and El Salvador, is formally dissolved after the government was unable to suppress a revolution in San Salvador.[15]December 1 President Alfaro of Ecuador suspends the govnerment and assumes a dictatorship over the South American nation.[15]The French government decrees a ban on imports

exert its authority over the Thirteen Colonies became a catalyst for the American Revolution. The 18th century also marked the end of the PolishLithuanian Commonwealth as an independent state. Its semi-democratic government system was not robust enough to prevent partition by the neighboring states of Austria, Prussia, and Russia.In West Asia, Nader Shah led Persia in successful military campaigns. The Ottoman Empire experienced a period of peace, taking no part in European wars from 1740 to 1768. As a result, the empire was not exposed to Europe's military improvements during the Seven Years' War. The Ottoman military consequently lagged behind and suffered several defeats against Russia in the second half of the century.In South Asia, the death of Mughal emperor Aurangzeb was followed by the expansion of the Maratha Confederacy and an increasing level of European influence and control in the region. In 1739, Persian emperor Nader Shah invaded and plundered Delhi, the capital of the Mughal Empire. Later, his general Ahmad Shah Durrani scored another victory against the Marathas, the then dominant power in India, in the Third Battle of Panipat in 1761.[8] By the middle of the century, the British East India Company began to conquer eastern India,[9][8] and by the end of the century, the Anglo-Mysore Wars against Tipu Sultan and his father Hyder Ali, led to Company rule over the south.[10][11]In East Asia, the century was marked by theHigh Qing era, a period characterized by significant cultural and territorial expansion. This period also experienced relative peace and prosperity, allowing for societal growth, increasing literacy rates, flourishing trade, and consolidating imperial power across the vast Qing dynasty's territories. Conversely, the continual seclusion policy of the Tokugawa shogunate also brought a peaceful era called Pax Tokugawa and experienced a flourishment of the arts as well as scientific knowledge and advancements, which were introduced to Japan through the Dutch port of Nagasaki. In Southeast Asia, the KonbaungAyutthaya Wars and the Ty Sn Wars broke out while the Dutch East India Company established increasing levels of control over the Mataram Sultanate.In Africa, the Ethiopian Empire underwent the Zemene Mesafint, a period when the country was ruled by a class of regional noblemen and the emperor was merely a figurehead. The Atlantic slave trade also saw the continued involvement of states such as the Oyo Empire. In Oceania, the European colonization of Australia and New Zealand began during the late half of the century. In the Americas, the United States declared its independence from Great Britain. In 1776, Thomas Jefferson wrote the Declaration of Independence. In 1789, George Washington was inaugurated as the first president. Benjamin Franklin traveled to Europe where he was hailed as an inventor. Examples of his inventions include the lightning rod and bifocal glasses. Tpac Amaru II led an uprising that sought to end Spanish colonial rule in Peru.For a chronological guide, see Timeline of the 18th century.See also: Georgian eraMain articles: 1700s, 1710s, 1720s, 1730s, and 1740sEurope at the beginning of the War of the Spanish Succession, 1700The Battle of Poltava in 1709 turned the Russian Empire into a European power.John Churchill, 1st Duke of Marlborough17001721: Great Northern War between the Russian and Swedish Empires.1701: Kingdom of Prussia declared under King Frederick I.1701: The Battle of Feyiase marks the rise of the Ashanti Empire.17011714: The War of the Spanish Succession is fought, involving most of continental Europe.[12]17021715: Camisard rebellion in France.1703: Saint Petersburg is founded by Peter the Great; it is the Russian capital until 1918.17031711: The Rkczi uprising against the Habsburg monarchy.1704: End of Japan's Genroku period.1704: First Javanese War of Succession.[13]17061713: The War of the Spanish Succession: French troops defeated at the Battle of Ramillies and the Siege of Turin.1707: Death of Mughal Emperor Aurangzeb leads to the fragmentation of the Mughal Empire.1707: The Act of Union is passed, merging the Scottish and English Parliaments, thus establishing the Kingdom of Great Britain.[14]1708: The Company of Merchants of London Trading into the East Indies and English Company Trading to the East Indies merge to form the United Company of Merchants of England Trading to the East Indies.17081709: Famine kills one-third of East Prussia's population.1709: Foundation of the Hotak Empire.1709: The Great Frost of 1709 marks the coldest winter in 500 years, contributing to the defeat of Sweden at Poltava.1710: The world's first copyright legislation, Britain's Statute of Anne, takes effect.17101711: Ottoman Empire fights Russia in the Russo-Turkish War and regains Azov.1711: Bukhara Khanate dissolves as local begs seize power.17111715: Tuscarora War between British, Dutch, and German settlers and the Tuscarora people of North Carolina.1713: The Kangxi Emperor acknowledges the full recovery of the Chinese economy since its apex during the Ming.1714: In Amsterdam, Daniel Gabriel Fahrenheit invents the mercury-in-glass thermometer, which remains the most reliable and accurate thermometer until the electronic era.1715: The first Jacobite rising breaks out; the British halt the Jacobite advance at the Battle of Sheriffmuir; Battle of Preston.1716: Establishment of the Sikh Confederacy along the present-day India-Pakistan border.17161718: Austro-Venetian-Turkish War.1718: The city of New Orleans is founded by the French in North America.17181720: War of the Quadruple Alliance with Spain versus France, Britain, Austria, and the Netherlands.17181730: Tulip period of the Ottoman Empire.1719: Second Javanese War of Succession.[15]1720: The South Sea Bubble.17201721: The Great Plague of Marseille.1720: Qing forces oust Dzungar invaders from Tibet.1721: The Treaty of Nystad is signed, ending the Great Northern War.1721: Sack of Shamakhi, massacre of its Shia population by Sunni Lezgins.1722: Siege of Isfahan results in the handover of Iran to the Hotaki Afghans.17221723: Russo-Persian War.17221725: Controversy over William Wood's halfpence leads to the Drapier's Letters and begins the Irish economic independence from England movement.Mughal emperor Muhammad Shah with the Persian invader Nader Shah.1723: Slavery is abolished in Russia; Peter the Great converts household slaves into house serfs.[16]17231730: The "Great Disaster", an invasion of Kazakh territories by the Dzungars.17231732: The Qing and the Dzungars fight a series of wars across Qinghai, Dzungaria, and Outer Mongolia, with inconclusive results.1724: Daniel Gabriel Fahrenheit proposes the Fahrenheit temperature scale.1725: Austro-Spanish alliance revived. Russia joins in 1726.17271729: Anglo-Spanish War ends inconclusively.1730: Mahmud I takes over Ottoman Empire after the Patrona Halil revolt, ending the Tulip period.17301760: The First Great Awakening takes place in Great Britain and North America.17321734: Crimean Tatar raids into Russia.[17]17331738: War of the Polish Succession.Qianlong Emperor17351739: Austro-Russo-Turkish War.17351799: The Qianlong Emperor of China oversees a huge expansion in territory.17381756: Famine across the Sahel; half the population of Timbuktu dies.[18]17371738: Hotak Empire ends after the siege of Kandahar by Nader Shah.1739: Great Britain and Spain fight the War of Jenkins' Ear in the Caribbean.1739: Nader Shah defeats a pan-Indian army of 300,000 at the Battle of Karnal. Taxation is stopped in Iran for three years.17391740: Nader Shah's Sindh expedition.1740: George Whitefield brings the First Great Awakening to New England17401741: Famine in Ireland kills 20 percent of the population.17411743: Iran invades Uzbekistan, Khwarazm, Dagestan, and Oman.17411751: Maratha invasions of Bengal.17401748: War of the Austrian Succession.1742: Marvel's Mill, the first water-powered cotton mill, begins operation in England.[19]1742: Anders Celsius proposes an inverted form of the centigrade temperature, which is later renamed Celsius in his honor.1742: Premiere of George Frideric Handel's Messiah.17431746: Another Ottoman-Persian War involves 375,000 men but ultimately ends in a stalemate.The extinction of the Scottish clan system came with the defeat of the clansmen at the Battle of Culloden in 1746.[20]1744: The First Saudi State is founded by Mohammed Ibn Saud.[21]1744: Battle of Toulon is fought off the coast of France.17441748: The First Carnatic War is fought between the British, the French, the Marathas, and Mysore in India.1745: Second Jacobite rising is begun by Charles Edward Stuart in Scotland.1747: The Durrani Empire is founded by Ahmad Shah Durrani.1748: The Treaty of Aix-La-Chapelle ends the War of the Austrian Succession and First Carnatic War.17481754: The Second Carnatic War is fought between the British, the French, the Marathas, and Mysore in India.1750: Peak of the Little Ice Age.Main articles: 1750s, 1760s, 1770s, 1780s, 1790s, and 1800s1752: The British Empire adopts the Gregorian Calendar, skipping 11 days from 3 September to 13 September. On the calendar, 2 September is followed directly by 14 September.1754: The Treaty of Pondicherry ends the Second Carnatic War and recognizes Muhammed Ali Khan Wallajah as Nawab of the Carnatic.1754: King's College is founded by a royal charter of George II of Great Britain.[22]17541763: The French and Indian War, the North American chapter of the Seven Years' War, is fought in colonial North America, mostly by the French and their allies against the English and their allies.1755: The great Lisbon earthquake destroys most of Portugal's capital and kills up to 100,000.1755: The Dzungar genocide depopulates much of northern Xinjiang, allowing for Han, Uyghur, Khalkha Mongol, and Manchu colonization.17551763: The Great Upheaval forces transfer of the French Acadian population from Nova Scotia and New Brunswick.17561763: The Seven Years' War is fought among European powers in various theaters around the world.17561763: The Third Carnatic War is fought between the British, the French, and Mysore in India.1757: British conquest of Bengal.Catherine the Great, Empress of Russia.1760: George III becomes King of Britain.1761: Maratha Empire defeated at Battle of Panipat.17621796: Reign of Catherine the Great of Russia.1763: The Treaty of Paris ends the Seven Years' War and Third Carnatic War.1764: Dahomey and the Oyo Empire defeat the Ashanti army at the Battle of Atakpam.1764: The Mughals are defeated at the Battle of Buxar.1765: The Stamp Act is introduced into the American colonies by the British Parliament.17651767: The Burmese invade Thailand and utterly destroy Attuthaya.17651769: Burma under Hsinbyushin repels four invasions from Qing China, securing hegemony over the Shan states.1766: Christian VII becomes king of Denmark. He was king of Denmark to 1808.17661799: Anglo-Mysore Wars.1767: Taksin expels Burmese invaders and reunites Thailand under an authoritarian regime.17681772: War of the Bar Confederation.17681774: Russo-Turkish War.1769: Spanish missionaries establish the first of 21 missions in California.17691770: James Cook explores and maps New Zealand and Australia.17691773: The Bengal famine of 1770 kills one-third of the Bengal population.1769: The French East India Company dissolves, only to be revived in 1785.1769: French expeditions capture clove plants in Ambon, ending the Dutch East India Company's (VOC) monopoly of the plant.[23]17701771: Famine in Czech lands kills hundreds of thousands.1771: The Plague Riot in Moscow.1771: The Kalmyk Khanate dissolves as the territory becomes colonized by Russians. More than a hundred thousand Kalmyks migrate back to Qing Dzungaria.1772: Gustav III of Sweden stages a coup d'tat, becoming almost an absolute monarch.Encyclopdie, ou dictionnaire raisonn des sciences, des arts et des mtiers17721779: Maratha Empire fights Britain and Raghunathrao's forces during the First Anglo-Maratha War.17721795: The Partitions of Poland end the PolishLithuanian Commonwealth and erase Poland from the map for 123 years.17731775: Pugachev's Rebellion, the largest peasant revolt in Russian history.1773: East India Company starts operations in Bengal to smuggle opium into China.1775: Russia imposes a reduction in autonomy on the Zaporizhian Cossacks of Ukraine.17751782: First Anglo-Maratha War.17751783: American Revolutionary War.1776: Several kongsi republics are founded by Chinese settlers in the island of Borneo. They are some of the first democracies in Asia.17761777: A Spanish-Portuguese War occurs over land in the South American frontiers.1776: Illuminati founded by Adam Weishaupt.1776: The United States Declaration of Independence is adopted by the Second Continental Congress in Philadelphia.1776: Adam Smith publishes The Wealth of Nations.1778: James Cook becomes the first European to land on the Hawaiian Islands.1778: Franco-American alliance signed.1778: Spain acquires its first permanent holding in Africa from the Portuguese, which is administered by the newly-established La Plata Viceroyalty.1778: Vietnam is reunified for the first time in 200 years by the Tay Son brothers. The Ty Sn dynasty has been established, terminating the L dynasty.17791879: Xhosa Wars between British and Boer settlers and the Xhosas in the South African Republic.17791783: Britain loses several islands and colonial outposts all over the world to the combined Franco-Spanish navy.1779: Iran enters yet another period of conflict and civil war after the prosperous reign of Karim Khan Zand.1780: Outbreak of the indigenous rebellion against Spanish colonization led by Tpac Amaru II in Peru.1781: The city of Los Angeles is founded by Spanish settlers.George Washington17811785: Serfdom is abolished in the Austrian monarchy (first step; second step in 1848).1782: The Thonburi Kingdom of Thailand is dissolved after a palace coup.1783: The Treaty of Paris formally ends the American Revolutionary War.1783: Russian annexation of Crimea.17851791: Imam Sheikh Mansur, a Chechen warrior and Muslim mystic, leads a coalition of Muslim Caucasian tribes from throughout the Caucasus in a holy war against Russian settlers and military bases in the Caucasus, as well as against local traditionalists, who followed the traditional customs and common law (Adat) rather than the theocratic Sharia.[24]17851795: The Northwest Indian War is fought between the United States and Native Americans.17851787: The MarathaMysore Wars concludes with an exchange of territories in the Deccan.17861787: Wolfgang Amadeus Mozart premieres The Marriage of Figaro and Don Giovanni.1787: The Tuareg occupy Timbuktu until the 19th century.17871792: Russo-Turkish War.1788: First Fleet arrives in Australia17881790: Russo-Swedish War (17881790).1788: Dutch Geert Adriaans Boomgaard (17881899) would become the first generally accepted validated case of a supercentenarian on record.[25][26]Declaration of the Rights of Man and of the Citizen17881789: A Qing attempt to reinstall an exiled Vietnamese king in northern Vietnam ends in disaster.1789: George Washington is elected the first President of the United States; he serves until 1797.1789: Quang Trung defeats the Qing army.17891799: French Revolution.1789: The Lige Revolution.1789: The Brabant Revolution.1789: The Inconfidncia Mineira, an unsuccessful separatist movement in central Brazil led by Tiradentes1791: Suppression of the Lige Revolution by Austrian forces and re-establishment of the Prince-Bishopric of Lige.17911795: George Vancouver explores the world during the Vancouver Expedition.17911804: The Haitian Revolution.1791: Mozart premieres The Magic Flute.17921802: The French Revolutionary Wars lead into the Napoleonic Wars, which last from 18031815.1792: The New York Stock & Exchange Board is founded.1792: PolishRussian War of 1792.1792: Margaret Ann Neve (17921903) would become the first recorded female supercentenarian to reach the age of 110.[27][28]1793: Upper Canada bans slavery.1793: The largest yellow fever epidemic in American history kills as many as 5,000 people in Philadelphia, roughly 10% of the population.[29]17931796: Revolt in the Vende against the French Republic at the time of the Revolution.17941816: The Hawkesbury and Nepean Wars, which were a series of incidents between settlers and New South Wales Corps and the Aboriginal Australian clans of the Hawkesbury river in Sydney, Australia.1795: The Marseillaise is officially adopted as the French national anthem.Napoleon at the Bridge of the Arcole1795: The Battle of Nuuanu in the final days of King Kamehameha I's wars to unify the Hawaiian Islands.17951796: Iran invades and devastates Georgia, prompting Russia to intervene and march on Tehran.1796: Edward Jenner administers the first smallpox vaccination; smallpox killed an estimated 400,000 Europeans each year during the 18th century, including five reigning monarchs.[30]1796: War of the First Coalition: The Battle of Montenotte marks Napoleon Bonaparte's first victory as an army commander.1796: The British eject the Dutch from Ceylon and South Africa.17961804: The White Lotus Rebellion against the Manchu dynasty in China.1797: John Adams is elected the second President of the United States; he serves until 1801.1798: The Irish Rebellion fails to overthrow British rule in Ireland.17981800: The Quasi-War is fought between the United States and France.1799: Dutch East India Company is dissolved.1799: Austro-Russian forces under Alexander Suvorov liberates much of Italy and Switzerland from French occupation.1799: Coup of 18 Brumaire - Napoleon's coup d'etat brings the end of the French Revolution.1799: Death of the Qianlong Emperor after 60 years of rule over China. His favorite official, Heshen, is ordered to commit suicide.1800: On 1 January, the bankrupt VOC is formally dissolved and the nationalized Dutch East Indies are established.[31]Main articles: Timeline of historic inventions 18th century, and Timeline of scientific discoveries 18th centuryThe spinning jenny1709: The first piano was built by Bartolomeo Cristofori1711: Tuning fork was invented by John Shore1712: Steam engine invented by Thomas Newcomen1714: Mercury thermometer by Daniel Gabriel Fahrenheit1717: Diving bell was successfully tested by Edmond Halley, sustainable to a depth of 55ftc. 1730: Octant navigational tool was developed by John Hadley in England, and Thomas Godfrey in America1733: Flying shuttle invented by John Kay1736: Europeans encountered rubber the discovery was made by Charles Marie de La Condamine while on expedition in South America. It was named in 1770 by Joseph Priestleyc. 1740: Modern steel was developed by Benjamin Huntsman1741: Vitus Bering discovers Alaska1745: Leyden jar invented by Ewald Georg von Kleist was the first electrical capacitor1751: Jacques de Vaucanson perfects the first precision lathe1752: Lightning rod invented by Benjamin Franklin1753: The first clock to be built in the New World (North America) was invented by Benjamin Banneker.1755: The tallest wooden Bodhisattva statue in the world is erected at Puning Temple, Chengde, China.1764: Spinning jenny created by James Hargreaves brought on the Industrial Revolution1765: James Watt enhances Newcomen's steam engine, allowing new steel technologies1761: The problem of longitude was finally resolved by the fourth chronometer of John Harrison1763: Thomas Bayes publishes first version of Bayes' theorem, paving the way for Bayesian probability17681779: James Cook mapped the boundaries of the Pacific Ocean and discovered many Pacific Islands1774: Joseph Priestley discovers "dephlogisticated air", oxygenThe Chinese Putuo Zongcheng Temple of Chengde, completed in 1771, during the reign of the Qianlong Emperor.1775: Joseph Priestley's first synthesis of "phlogisticated nitrous air", nitrous oxide, "laughing gas"1776: First improved steam engines installed by James Watt1776: Steamboat invented by Claude de Jouffroy1777: Circular saw invented by Samuel Miller1779: Photosynthesis was first discovered by Jan Ingenhousz1781: William Herschel announces discovery of Uranus1784: Bifocals invented by Benjamin Franklin1784: Argand lamp invented by Aim Argand[32]1785: Power loom invented by Edmund Cartwright1785: Automatic flour mill invented by Oliver Evans1786: Threshing machine invented by Andrew Meikle1787: Jacques Charles discovers Charles's law1789: Antoine Lavoisier discovers the law of conservation of mass, the basis for chemistry, and begins modern chemistry1798: Edward Jenner publishes a treatise about smallpox vaccination1798: The Lithographic printing process invented by Alois Senefelder[33]1799: Rosetta Stone discovered by Napoleon's troopsMain articles: 18th century in literature and 18th century in philosophy1703: The Love Suicides at Sonezaki by Chikamatsu first performed17041717: One Thousand and One Nights translated into French by Antoine Galland. The work becomes immensely popular throughout Europe.1704: A Tale of a Tub by Jonathan Swift first published1712: The Rape of the Lock by Alexander Pope (publication of first version)1719: Robinson Crusoe by Daniel Defoe1725: The New Science by Giambattista Vico1726: Gulliver's Travels by Jonathan Swift1728: The Dunciad by Alexander Pope (publication of first version)1744: A Little Pretty Pocket-Book becomes one of the first books marketed for children1748: Chushingura (The Treasury of Loyal Retainers), popular Japanese puppet play, composed1748: Clarissa; or, The History of a Young Lady by Samuel Richardson1749: The History of Tom Jones, a Foundling by Henry Fielding1751: Elegy Written in a Country Churchyard by Thomas Gray published17511785: The French Encyclopdie1755: A Dictionary of the English Language by Samuel Johnson1758: Arithmetika Horvatzka by Mihalj ilobod Boli1759: Candide by Voltaire1759: The Theory of Moral Sentiments by Adam Smith17591767: Tristram Shandy by Laurence Sterne1762: Emile: or, On Education by Jean-Jacques Rousseau1762: The Social Contract, Or Principles of Political Right by Jean-Jacques Rousseau1774: The Sorrows of Young Werther by Goethe first published1776: Ugetsu Monogatari (Tales of Moonlight and Rain) by Ueda Akinari1776: The Wealth of Nations, foundation of the modern theory of economy, was published by Adam Smith17761789: The History of the Decline and Fall of the Roman Empire was published by Edward Gibbon1779: Amazing Grace published by John Newton17791782: Lives of the Most Eminent English Poets by Samuel Johnson1781: Critique of Pure Reason by Immanuel Kant (publication of first edition)1781: The Robbers by Friedrich Schiller first published1782: Les Liaisons dangereuses by Pierre Choderlos de Laclos1786: Poems, Chiefly in the Scottish Dialect by Robert Burns17871788: The Federalist Papers by Alexander Hamilton, James Madison, and John Jay1788: Critique of Practical Reason by Immanuel Kant1789: Songs of Innocence by William Blake1789: The Interesting Narrative of the Life of Olaudah Equiano by Olaudah Equiano1790: Journey from St. Petersburg to Moscow by Alexander Radishchev1790: Reflections on the Revolution in France by Edmund Burke1791: Rights of Man by Thomas Paine1792: A Vindication of the Rights of Woman by Mary Wollstonecraft1794: Songs of Experience by William Blake1798: Lyrical Ballads by William Wordsworth and Samuel Taylor Coleridge1798: An Essay on the Principle of Population published by Thomas Malthus(mid18th century): The Dream of the Red Chamber (authorship attributed to Cao Xueqin), one of the most famous Chinese novels1711: Rinaldo, Handel's first opera for the London stage, premiered1721: Brandenburg Concertos by J.S. Bach1723: The Four Seasons, violin concertos by Antonio Vivaldi, composed1724: St John Passion by J.S. Bach1727: St Matthew Passion composed by J.S. Bach1727: Zadok the Priest is composed by Handel for the coronation of George II of Great Britain. It has been performed at every subsequent British coronation.1733: Hippolyte et Aricie, first opera by Jean-Philippe Rameau1741: Goldberg Variations for harpsichord published by Bach1742: Messiah, oratorio by Handel premiered in Dublin1749: Mass in B minor by J.S. Bach assembled in current form1751: The Art of Fugue by J.S. Bach1762: Orfeo ed Euridice, first "reform opera" by Gluck, performed in Vienna1786: The Marriage of Figaro, opera by Mozart1787: Don Giovanni, opera by Mozart1788: Jupiter Symphony (Symphony No. 41) composed by Mozart1791: The Magic Flute, opera by Mozart17911795: London symphonies by Haydn1798: The Pathtique, piano sonata by Beethoven1798: The Creation, oratorio by Haydn first performed^ Volkov, Sergey. 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The development of the economies of continental Europe, 18501914 (1977) onlineThe Wallace Collection, London, houses one of the finest collections of 18th-century decorative arts from France, England and Italy, including paintings, furniture, porcelain and gold boxes. Media related to 18th century at Wikimedia CommonsRetrieved from " 4The following pages link to 18th century External tools(link counttransclusion countsorted list) See help page for transcluding these entriesShowing 50 items.View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500)List of decades, centuries, and millennia (links | edit)Goths (links | edit)Industrial espionage (links | edit)Romania (links | edit)20th century (links | edit)15th century (links | edit)16th century (links | edit)17th century (links | edit)1870s (links | edit)1624 (links | edit)1626 (links | edit)1642 (links | edit)1661 (links | edit)1756 (links | edit)1791 (links | edit)1608 (links | edit)1818 (links | edit)1743 (links | edit)1826 (links | edit)1828 (links | edit)14th century (links | edit)1860s (links | edit)1788 (links | edit)1st century (links | edit)13th century (links | edit)1787 (links | edit)1863 (links | edit)4th century (links | edit)12th century (links | edit)11th century (links | edit)1859 (links | edit)1900 (links | edit)1848 (links | edit)1866 (links | edit)1896 (links | edit)1895 (links | edit)1861 (links | edit)1648 (links | edit)1623 (links | edit)1662 (links | edit)1640s (links | edit)1770s (links | edit)1780s (links | edit)1789 (links | edit)1782 (links | edit)1840 (links | edit)1840s (links | edit)1883 (links | edit)1800s (decade) (links | edit)1801 (links | edit)View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500)Retrieved from " WhatLinksHere/18th_century"CorpuscularismCorpuscularism was a theory proposed by Descartes that all matter was composed of tiny particles.Rene DescartesRene Descartes was a famous mathematician and philosopher of the 16th century who hypothesised the theory of corpuscularism about the atomLusterLuster is a term for a reflective surface that reflects light giving a shiny appearance.Semi conductorsSemi conductors is a term to describe metalloids that are able to conduct a current when electrical energy is applied due to the movement of electrons but the conductivity measurements are not as high as metals due to fewer electrons to carry a charge or a less ordered structure.Ionic compoundAn ionic compound is a bond that forms between metals and non metals to form a large ionic lattice Nuclear FusionNuclear fusion is a process which occurs in. the sun. Hydrogen atoms under a lot of heat and pressure are forced together to make a larger atom of heliumUncertainty PrincipleHeisenbergs uncertainty principle is used to describe the relationship between the momentum and position of an electron. Where by if the exact position of the electron is known the momentum will be uncertain.HeisenbergWerner Heisenberg was a German physicist who was a pioneer in the field of quantum mechanics. He devised the principle of uncertainty relating to the momentum and position of an electron.LobesLobes refers to the shape of electron waves and the area of highest probability of where that electron as a particle would be found.Pauli Exclusion principleThe Pauli Exclusion refers to the theory that each electron can only have a unique set of the 4 quantum numbers and no two electrons can have the same quantum numbersQuantum NumbersQuantum numbers is a term used to describe the assigning of numbers to electrons as a mathematical function to describe their momentum and energy.Bohr ModelThe Bohr model refers to the treatment of electrons as particles that orbit the nucleus.Quantum MechanicsThe term quantum mechanics refers to energy levels and the theoretical area of physics and chemistry where mathematics is used to explain the behaviour of subatomic particles.TroughA trough is the lowest point on a transverse wave.PeakA peak is the highest point on a transverse wave.Vibrational ModesVibrational modes is a term used to describe the constant motion in a molecule. Usually these are vibrations, rotations and translations.Erwin SchrodingerErwin Schrodinger was an Austrian physicist who used mathematical models to enhance the Bohr model of the electron and created an equation to predicted the likelihood of finding an electron in a given position.Alkali MetalThe alkali metals, found in group 1 of the periodic table (formally known as group IA), are so reactive that they are generally found in nature combined with other elements. The alkali metals are shiny, soft, highly reactive metals at standard temperature and pressure.Alkaline Earth MetalsAlkaline earth metals is the second most reactive group of elements in the periodic table. They are found in group 2 of the periodic table (formally known as group IIA).Unknown ElementsUnknown elements (or transactinides) are the heaviest elements of the periodic table. These are meitnerium (Mt, atomic number 109), darmstadtium (Ds, atomic number 110), roentgenium (Rg, atomic number 111), nihonium (Nh, atomic number 113), moscovium (Mc, atomic number 115), livermorium (Lv, atomic number 116) and tennessine (Ts, atomic number 117).Post-Transitional MetalThe post-transition metals are the ones found between the transition metals (to the left) and the metalloids (to the right). They include aluminium (Al), gallium (Ga), indium (In), thallium (Tl), tin (Sn), lead (Pb) and bismuth (Bi).OganessonOganesson (Og) is a radioactive element that has the atomic number 118 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is in Group 18. It has the symbol Og.TennessineTennessine (Ts) is a radioactive element that has the atomic number 117 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is in Group 17. It has the symbol Ts.LivermoriumLivermorium (Lv) is a radioactive element that has the atomic number 116 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is in Group 16. It has the symbol Lv.MoscoviumMoscovium (Mc) is a radioactive metal that has the atomic number 115 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is in Group 15. It has the symbol Mc.FleroviumFlerovium (Fl) is a radioactive metal that has the atomic number 114 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is in Group 14. It has the symbol Fl.NihoniumNihonium (Nh) is a radioactive metal that has the atomic number 112 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is in Group 13. It has the symbol Nh.CoperniciumCopernicium (Cr) is a radioactive metal that has the atomic number 112 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is a Transition metal in Group 11. It has the symbol Rg.RoentgeniumRoentgenium (Rg) is a radioactive metal that has the atomic number 111 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is a Transition metal in Group 11. It has the symbol Rg.DarmstadtiumDarmstadtium (Ds) is a radioactive metal that has the atomic number 110 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is a Transition metal in Group 10. It has the symbol DsMeitneriumMeitnerium (Mt) is a radioactive metal that has the atomic number 109 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is a Transition metal in Group 9. It has the symbol Mt.HassiumHassium (Hs) is a radioactive metal that has the atomic number 108 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is a Transition metal in Group 8. It has the symbol Hs.BohriumBohrium (Bh) is a radioactive metal that has the atomic number 107 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is a Transition metal in Group 7. It has the symbol Bh.SeaborgiumSeaborgium (Sg) is a radioactive metal that has the atomic number 106 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is a Transition metal in Group 6. It has the symbol Sg.DubniumDubnium (Db) is a radioactive metal that has the atomic number 105 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is a Transition metal in Group 5. It has the symbol Db.RutherfordiumRutherfordium (Rf) is a radioactive metal that has the atomic number 104 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is a Transition metal in Group 4. It has the symbol Rf.LawrenciumLawrencium (Lr) is a silvery-white colored radioactive metal that has the atomic number 103 in the periodic table. It is an Actinoid Metal with the symbol Lr.NobeliumNobelium (No) is a radioactive metal that has the atomic number 102 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is an Actinoid Metal with the symbol No.MendeleviumMendelevium (Md) is a radioactive metal that has the atomic number 101 in the periodic table, its appearance is not fully known due to the minuscule amounts produced of it. It is an Actinoid Metal with the symbol Md.FermiumFermium (Fm) is a silvery-white colored radioactive metal that has the atomic number 100 in the periodic table. It is an Actinoid Metal with the symbol Fm.EinsteiniumEinsteinium (Es) is a silvery-white colored radioactive metal that has the atomic number 99 in the periodic table. It is an Actinoid Metal with the symbol Es.CaliforniumCalifornium (Cf) is a silvery-white colored radioactive metal that has the atomic number 98 in the periodic table. It is an Actinoid Metal with the symbol Cf.BerkeliumBerkelium (Bk) is a silvery colored radioactive metal that has the atomic number 97 in the periodic table. It is an Actinoid Metal with the symbol Bk.CuriumCurium (Cm) is a silvery-white colored radioactive metal that has the atomic number 96 in the periodic table. It is an Actinoid Metal with the symbol Cm.AmericiumAmericium (Am) is a silvery colored radioactive metal that has the atomic number 95 in the periodic table. It is an Actinoid Metal with the symbol Am.PlutoniumPlutonium (Pu) is a silvery colored radioactive metal that has the atomic number 94 in the periodic table. It is an Actinoid Metal with the symbol Pu.NeptuniumNeptunium (Np) is a silvery colored radioactive metal that has the atomic number 93 in the periodic table. It is an Actinoid Metal with the symbol Np.ProtactiniumProtactinium (Pa) is a shiny silver colored radioactive metal that has the atomic number 91 in the periodic table. It is an Actinoid Metal with the symbol Pa.ThoriumThorium (Th) is a silvery-white colored radioactive metal that has the atomic number 90 in the periodic table. It is an Actinoid Metal with the symbol Th.ActiniumActinium (Ac) is a silvery colored radioactive metal that has the atomic number 89 in the periodic table. It is an Actinoid Metal with the symbol Ac.RadiumRadium (Ra) is a silvery-white colored metal that has the atomic number 88 in the periodic table. It is an Alkaline earth Metal with the symbol Ra and is located in Group 2 of the periodic table.FranciumFrancium (Fr) is thought to be a gray colored metal that has the atomic number 87 in the periodic table. It is an

the two available states in the lowest shell, producing what is called a filled shell. The next atom is lithium, with three electrons. Because the closest shell is filled, the third electron goes into the next higher shell. This shell has spaces for eight electrons, so that it takes an atom with 10 electrons (neon) to fill the first two levels. The next atom after neon, sodium, has 11 electrons, so that one electron goes into the next highest shell. In the progression thus far, three atomshydrogen, lithium, and sodiumhave one electron in the outermost shell. As stated above, it is these outermost electrons that determine the chemical properties of an atom. Therefore, these three elements should have similar properties, as indeed they do. For this reason, they appear in the same column of the periodic table of the elements (see periodic law), and the same principle determines the position of every element in that table. The outermost shell of electronscalled the valence shelldetermines the chemical behaviour of an atom, and the number of electrons in this shell depends on how many are left over after all the interior shells are filled. The atomic structure refers to the structure of an atom comprising a nucleus (centre) in which the protons (positively charged) and neutrons (neutral) are present. The negatively charged particles called electrons revolve around the centre of the nucleus.Download Complete Chapter Notes of Structure of AtomDownload NowThe history of atomic structure and quantum mechanics dates back to the times of Democritus, the person who first proposed that matter is composed of atoms. The study of the structure of an atom gives a great insight into the entire class of chemical reactions, bonds and their physical properties. The first scientific theory of atomic structure was proposed by John Dalton in the 1800s.Table of Contents The advances in atomic structure and quantum mechanics have led to the discovery of other fundamental particles. The discovery of subatomic particles has been the base for many other discoveries and inventions.What Is Atomic Structure?The atomic structure of an element refers to the constitution of its nucleus and the arrangement of the electrons around it. Primarily, the atomic structure of matter is made up of protons, electrons and neutrons.The protons and neutrons make up the nucleus of the atom, which is surrounded by the electrons belonging to the atom. The atomic number of an element describes the total number of protons in its nucleus.Neutral atoms have equal numbers of protons and electrons. However, atoms may gain or lose electrons in order to increase their stability, and the resulting charged entity is called an ion.Atoms of different elements have different atomic structures because they contain different numbers of protons and electrons. This is the reason for the unique characteristics of different elements.Atomic ModelsIn the 18th and 19th centuries, many scientists attempted to explain the structure of the atom with the help of atomic models. Each of these models had its own merits and demerits and was pivotal to the development of the modern atomic model. The most notable contributions to the field were by the scientists such as John Dalton, J.J. Thomson, Ernest Rutherford and Niels Bohr. Their ideas on the structure of the atom are discussed in this subsection.Daltons Atomic TheoryThe English chemist John Dalton suggested that all matter is made up of atoms, which were indivisible and indestructible.He also stated that all the atoms of an element were exactly the same, but the atoms of different elements differ in size and mass.Chemical reactions, according to Daltons atomic theory, involve a rearrangement of atoms to form products. According to the postulates proposed by Dalton, the atomic structure comprises atoms, the smallest particle responsible for the chemical reactions to occur.The following are the postulates of his theory: Every matter is made up of atoms.Atoms are indivisible.Specific elements have only one type of atom in them.Each atom has its own constant mass that varies from element to element.Atoms undergo rearrangement during a chemical reaction.Atoms can neither be created nor destroyed but can be transformed from one form to another.Daltons atomic theory successfully explained the Laws of chemical reactions, namely, the Law of conservation of mass, the Law of constant properties, the Law of multiple proportions and the Law of reciprocal proportions.Demerits of Daltons Atomic TheoryThe theory was unable to explain the existence of isotopes.Nothing about the structure of the atom was appropriately explained.Later, scientists discovered particles inside the atom that proved the atoms are divisible.The discovery of particles inside atoms led to a better understanding of chemical species; these particles inside the atoms are called subatomic particles. The discovery of various subatomic particles is as follows:Thomson Atomic ModelThe English chemist Sir Joseph John Thomson put forth his model describing the atomic structure in the early 1900s.He was later awarded the Nobel Prize for the discovery of electrons. His work is based on an experiment called the cathode ray experiment. The construction of working of the experiment is as follows:Cathode Ray ExperimentIt has a tube made of glass which has two openings, one for the vacuum pump and the other for the inlet through which a gas is pumped in.The role of the vacuum pump is to maintain a partial vacuum inside the glass chamber. A high-voltage power supply is connected using electrodes, i.e., cathode and anode, which are fitted inside the glass tube.Observations:When a high voltage power supply is switched on, there are rays emerging from the cathode towards the anode. This was confirmed by the Fluorescent spots on the ZnS screen used. These rays were called Cathode Rays.When an external electric field is applied, the cathode rays get deflected towards the positive electrode, but in the absence of an electric field, they travel in a straight line.When rotor Blades are placed in the path of the cathode rays, they seem to rotate. This proves that the cathode rays are made up of particles of a certain mass so that they have some energy.With all this evidence, Thompson concluded that cathode rays are made of negatively charged particles called electrons.On applying the electric and magnetic field upon the cathode rays (electrons), Thomson found the charge-to-mass ratio (e/m) of electrons. (e/m) for electron: 17588 1011 e/bg.From this ratio, the charge of the electron was found by Mullikin through an oil drop experiment. [Charge of e = 1.6 10-16 C and Mass of e = 9.1093 10-31 kg].Conclusions:Based on conclusions from his cathode ray experiment, Thomson described the atomic structure as a positively charged sphere into which negatively charged electrons were embedded.It is commonly referred to as the plum pudding model because it can be visualised as a plum pudding dish where the pudding describes the positively charged atom and the plum pieces describe the electrons.Thomsons atomic structure described atoms as electrically neutral, i.e., the positive and the negative charges were of equal magnitude.Limitations of Thomsons Atomic Structure:Thomsons atomic model does not clearly explain the stability of an atom. Also, further discoveries of other subatomic particles couldnt be placed inside his atomic model.Rutherford Atomic TheoryRutherford, a student of J. J. Thomson, modified the atomic structure with the discovery of another subatomic particle called Nucleus. His atomic model is based on the Alpha ray scattering experiment.Alpha Ray Scattering ExperimentConstruction:A very thin gold foil of 1000 atoms thick is taken.Alpha rays (doubly charged Helium He2+) were made to bombard the gold foil.Zn S screen is placed behind the gold foil.Observations:Most of the rays just went through the gold foil, making scintillations (bright spots) in the ZnS screen.A few rays got reflected after hitting the gold foil.One in 1000 rays got reflected by an angle of 180 (retraced path) after hitting the gold foil.Conclusions:Since most rays passed through, Rutherford concluded that most of the space inside the atom is empty.A few rays got reflected because of the repulsion of its positive with some other positive charge inside the atom.1/1000th of the rays got strongly deflected because of a very strong positive charge in the centre of the atom. He called this strong positive charge nucleus.He said most of the charge and mass of the atom resides in the nucleus.Rutherfords Structure of AtomBased on the above observations and conclusions, Rutherford proposed his own atomic structure, which is as follows.The nucleus is at the centre of an atom, where most of the charge and mass is concentrated.The atomic structure is spherical.Electrons revolve around the nucleus in a circular orbit, similar to the way planets orbit the sun.Limitations of the Rutherford Atomic ModelIf electrons have to revolve around the nucleus, they will spend energy and that too against the strong force of attraction from the nucleus, a lot of energy will be spent by the electrons, and eventually, they will lose all their energy and will fall into the nucleus so the stability of atom is not explained.If electrons continuously revolve around the nucleus, the type of spectrum expected is a continuous spectrum. But in reality, what we see is a line spectrum.Atomic Structure Rutherfords Model, J.J Thomsons Model Subatomic ParticlesProtonsProtons are positively charged subatomic particles. The charge of a proton is 1e, which corresponds to approximately 1.602 10-19The mass of a proton is approximately 1.672 10-24Protons are over 1800 times heavier than electrons.The total number of protons in the atoms of an element is always equal to the atomic number of the element.NeutronsThe mass of a neutron is almost the same as that of a proton, i.e., 1.67410-24Neutrons are electrically neutral particles and carry no charge.Different isotopes of an element have the same number of protons but vary in the number of neutrons present in their respective nuclei.ElectronsThe charge of an electron is -1e, which approximates to -1.602 10-19The mass of an electron is approximately 9.1 10-31.Due to the relatively negligible mass of electrons, they are ignored when calculating the mass of an atom. Atomic Structure of IsotopesNucleons are the components of the nucleus of an atom. A nucleon can either be a proton or a neutron. Each element has a unique number of protons in it, which is described by its unique atomic number. However, several atomic structures of an element can exist, which differ in the total number of nucleons.These variants of elements having a different nucleon number (also known as the mass number) are called isotopes of the element. Therefore, the isotopes of an element have the same number of protons but differ in the number of neutrons.The atomic structure of an isotope is described with the help of the chemical symbol of the element, the atomic number of the element and the mass number of the isotope. For example, there exist three known naturally occurring isotopes of hydrogen, namely, protium, deuterium and tritium. The atomic structures of these hydrogen isotopes are illustrated below.The isotopes of an element vary in stability. The half-lives of isotopes also differ. However, they generally have similar chemical behaviour owing to the fact that they hold the same electronic structures.Atomic Structures of Some ElementsThe structure of an atom of an element can be simply represented via the total number of protons, electrons and neutrons present in it. The atomic structures of a few elements are illustrated below.HydrogenThe most abundant isotope of hydrogen on the planet Earth is protium. The atomic number and the mass number of this isotope are 1 and 1, respectively.Structure of Hydrogen Atom: This implies that it contains one proton, one electron and no neutrons (Total number of neutrons = Mass number Atomic number)CarbonCarbon has two stable isotopes 12C and 13C. Of these isotopes, 12C has an abundance of 98.9%. It contains 6 protons, 6 electrons and 6 neutrons.Structure of Carbon Atom: The electrons are distributed into two shells, and the outermost shell (valence shell) has four electrons. The tetravalency of carbon enables it to form a variety of chemical bonds with various elements.OxygenThere exist three stable isotopes of oxygen 18O, 17O and 16O. However, oxygen-16 is the most abundant isotope.Structure of Oxygen Atom: Since the atomic number of this isotope is 8 and the mass number is 16, it consists of 8 protons and 8 neutrons.6 out of the 8 electrons in an oxygen atom lie in the valence shell.Bohrs Atomic TheoryNeils Bohr put forth his model of the atom in the year 1915. This is the most widely used atomic model to describe the atomic structure of an element which is based on Plancks theory of quantization.Postulates:The electrons inside atoms are placed in discrete orbits called stationery orbits.The energy levels of these shells can be represented via quantum numbers.Electrons can jump to higher levels by absorbing energy and move to lower energy levels by losing or emitting their energy.As long as an electron stays in its own stationery, there will be no absorption or emission of energy.Electrons revolve around the nucleus in these stationary orbits only.The energy of the stationary orbits is quantised.Limitations of Bohrs Atomic Theory:Bohrs atomic structure works only for single electron species such as H, He+, Li2+, Be3+, .When the emission spectrum of hydrogen was observed under a more accurate spectrometer, each line spectrum was seen to be a combination of a number of smaller discrete lines.Both Stark and Zeemans effects couldnt be explained using Bohrs theory.Heisenbergs uncertainty principle: Heisenberg stated that no two conjugate physical quantities could be measured simultaneously with 100% accuracy. There will always be some error or uncertainty in the measurement.Drawback: Position and momentum are two such conjugate quantities that were measured accurately by Bohr (theoretically).Stark effect: Phenomenon of deflection of electrons in the presence of an electric field.Zeeman effect: Phenomenon of deflection of electrons in the presence of a magnetic field.Dual Nature of MatterThe electrons, which were treated to be particles, and the evidence of the photoelectric effect show they also have a wave nature. This was proved by Thomas Young with the help of his double-slit experiment.De-Broglie concluded that since nature is symmetrical, so should light or any other matter wave be.Quantum NumbersPrincipal Quantum Number (n): It denotes the orbital number or shell number of an electron.Azimuthal Quantum Numbers (l): It denotes the orbital (sub-orbit) of the electron.Magnetic Quantum Number: It denotes the number of energy states in each orbit.Spin Quantum number(s): It denotes the direction of spin, S = - = Anticlockwise and = Clockwise.Electronic Configuration of an AtomThe electrons have to be filled in the s, p, d and f in accordance with the following rule.1. Aufbaus principle: The filling of electrons should take place in accordance with the ascending order of energy of orbitals.Lower energy orbital should be filled first, and higher energy levels.The energy of orbital (p + l) value it two orbitals have the same (n + l) value, E nAscending order of energy 1s, 2s, 2p, 3s, 3p, 4s, 3d, . . .2. Paulis exclusion principle: No two electrons can have all four quantum numbers to be the same, or if two electrons have to be placed in an energy state, they should be placed with opposite spies.3. Hunds rule of maximum multiplicity: In the case of filling degenerate (same energy) orbitals, all the degenerate orbitals have to be singly filled first, and then, only pairing has to happen. Frequently Asked Questions on Atomic StructureWhat are subatomic particles?Subatomic particles are the particles that constitute an atom. Generally, this term refers to protons, electrons and neutrons.How do the atomic structures of isotopes vary?They vary in terms of the total number of neutrons present in the nucleus of the atom, which is described by their nucleon numbers.What are the shortcomings of Bohrs atomic model?According to this atomic model, the structure of an atom offers poor spectral predictions for larger atoms. It also failed to explain the Zeeman effect. It could only successfully explain the hydrogen spectrum.How can the total number of neutrons in the nucleus of a given isotope be determined?The mass number of an isotope is given by the sum of the total number of protons and neutrons in it. The atomic number describes the total number of protons in the nucleus. Therefore, the number of neutrons can be determined by subtracting the atomic number from the mass number. the structure of an atom, theoretically consisting of a positively charged nucleus surrounded and neutralized by negatively charged electrons revolving in orbits at varying distances from the nucleus, the constitution of the nucleus and the arrangement of the electrons differing with various chemical elements.the concept of an atom as a central positively charged nucleus consisting of protons and neutrons surrounded by a number of electrons. The number of electrons is equal to the number of protons: the whole entity is thus electrically neutralCollins English Dictionary Complete & Unabridged 2012 Digital Edition William Collins Sons & Co. Ltd. 1979, 1986 HarperCollins Publishers 1998, 2000, 2003, 2005, 2006, 2007, 2009, 2012Origin of atomic structure1First recorded in 18951900Examples have not been reviewed.Understanding the atomic structure of the surface of a functional material is essential for both engineers and chemists.Overall, this research advances our understanding of the atomic structure of glasses, providing new directions for material control and development.Each node is a very small quantum computer, made out of a sliver of diamond that has a defect in its atomic structure called a silicon-vacancy center.After cooling the nodes to close to absolute zero, light is sent through the first node and, by nature of the silicon vacancy center's atomic structure, becomes entangled with it.In this research, the team developed a deep learning AI technique to quantitatively analyze cation mixing using atomic structure images.atomic spectrumatomic theoryBrowse#aabbccddeeffgghhiijjkkllmmnnoopqqrrsttuuvvwwxxyyzzAboutCareersContact usCookies, terms, & privacyHelpFollow usGet the Word of the Day every day! 2025 Dictionary.com, LLC Weve detected that JavaScript is disabled in this browser. Please enable JavaScript or switch to a supported browser to continue using x.com. You can see a list of supported browsers in our Help Center. Help Center Login to create quiz, word search, matching games, or worksheets. If you are not a registered user register here to login. Science Physics Matter & Energy Whereas Avogadros theory of diatomic molecules was ignored for 50 years, the kinetic theory of gases was rejected for more than a century. The kinetic theory relates the independent motion of molecules to the mechanical and thermal properties of gasesnamely, their pressure, volume, temperature, viscosity, and heat conductivity. Three menDaniel Bernoulli in 1738, John Herapath in 1820, and John James Waterston in 1845independently developed the theory. The kinetic theory of gases, like the theory of diatomic molecules, was a simple physical idea that chemists ignored in favour of an elaborate explanation of the properties of gases. Bernoulli model of gas pressureAs conceived by Daniel Bernoulli in Hydrodynamica (1738), gases consist of numerous particles in rapid random motion. He assumed that the pressure of a gas is produced by the direct impact of the particles on the walls of the container.Bernoulli, a Swiss mathematician and scientist, worked out the first quantitative mathematical treatment of the kinetic theory in 1738 by picturing gases as consisting of an enormous number of particles in very fast, chaotic motion. He derived Boyles law by assuming that gas pressure is caused by the direct impact of particles on the walls of their container. He understood the difference between heat and temperature, realizing that heat makes gas particles move faster and that temperature merely measures the propensity of heat to flow from one body to another. In spite of its accuracy, Bernoullis theory remained virtually unknown during the 18th century and early 19th century for several reasons. First, chemistry was more popular than physics among scientists of the day, and Bernoullis theory involved mathematics. Second, Newtons reputation ensured the success of his more-comprehensible theory that gas atoms repel one another. Finally, Joseph Black, another noted British scientist, developed the caloric theory of heat, which proposed that heat was an invisible substance permeating matter. At the time, the fact that heat could be transmitted by light seemed a persuasive argument that heat and motion had nothing to do with each other. Herapath, an English amateur physicist ignored by his contemporaries, published his version of the kinetic theory in 1821. He also derived an empirical relation akin to Boyles law but did not understand correctly the role of heat and temperature in determining the pressure of a gas. Waterstons efforts met with a similar fate. Waterston was a Scottish civil engineer and amateur physicist who could not even get his work published by the scientific community, which had become increasingly professional throughout the 19th century. Nevertheless, Waterston made the first statement of the law of equipartition of energy, according to which all kinds of particles have equal amounts of thermal energy. He derived practically all the consequences of the fact that pressure exerted by a gas is related to the number of molecules per cubic centimetre, their mass, and their mean squared velocity. He derived the basic equation of kinetic theory, which reads P = NMV2. Here P is the pressure of a volume of gas, N is the number of molecules per unit volume, M is the mass of the molecule, and V2 is the average velocity squared of the molecules. Recognizing that the kinetic energy of a molecule is proportional to MV2 and that the heat energy of a gas is proportional to the temperature, Waterston expressed the law as PV/T = a constant. During the late 1850s, a decade after Waterston had formulated his law, the scientific community was finally ready to accept a kinetic theory of gases. The studies of heat undertaken by English physicist James Prescott Joule during the 1840s had shown that heat is a form of energy. This work, together with the law of the conservation of energy that he helped to establish, had persuaded scientists to discard the caloric theory by the mid-1850s. The caloric theory had required that a substance contain a definite amount of caloric (i.e., a hypothetical weightless fluid) to be turned into heat; however, experiments showed that any amount of heat can be generated in a substance by putting enough energy into it. Thus, there was no point to hypothesizing such a special fluid as caloric. At first, after the collapse of the caloric theory, physicists had nothing with which to replace it. Joule, however, discovered Herapaths kinetic theory and used it in 1851 to calculate the velocity of hydrogen molecules. Then German physicist Rudolf Clausius developed the kinetic theory mathematically in 1857, and the scientific world took note. Clausius and two other physicists, James Clerk Maxwell and Ludwig Eduard Boltzmann (who developed the kinetic theory of gases in the 1860s), introduced sophisticated mathematics into physics for the first time since Newton. In his 1860 paper Illustrations of the Dynamical Theory of Gases, Maxwell used probability theory to produce his famous distribution function for the velocities of gas molecules. Employing Newtonian laws of mechanics, he also provided a mathematical basis for Avogadros theory. Maxwell, Clausius, and Boltzmann assumed that gas particles were in constant motion, that they were tiny compared with their space, and that their interactions were very brief. They then related the motion of the particles to pressure, volume, and temperature. Interestingly, none of the three committed himself on the nature of the particles. The first modern estimates of the size of atoms and the numbers of atoms in a given volume were made by German chemist Joseph Loschmidt in 1865. Loschmidt used the results of kinetic theory and some rough estimates to do his calculation. The size of the atoms and the distance between them in the gaseous state are related both to the contraction of gas upon liquefaction and to the mean free path traveled by molecules in a gas. The mean free path, in turn, can be found from the thermal conductivity and diffusion rates in the gas. Loschmidt calculated the size of the atom and the spacing between atoms by finding a solution common to these relationships. His result for Avogadros number is remarkably close to the present accepted value of about 6.022 1023. The precise definition of Avogadros number is the number of atoms in 12 grams of the carbon isotope C-12. Loschmidts result for the diameter of an atom was approximately 108 cm. Much later, in 1908, French physicist Jean Perrin used Brownian motion to determine Avogadros number. Brownian motion, first observed in 1827 by Scottish botanist Robert Brown, is the continuous movement of tiny particles suspended in water. Their movement is caused by the thermal motion of water molecules bumping into the particles. Perrins argument for determining Avogadros number makes an analogy between particles in the liquid and molecules in the atmosphere. The thinning of air at high altitudes depends on the balance between the gravitational force pulling the molecules down and their thermal motion forcing them up. The relationship between the weight of the particles and the height of the atmosphere would be the same for Brownian particles suspended in water. Perrin counted particles of gum mastic at different heights in his water sample and inferred the mass of atoms from the rate of decrease. He then divided the result into the molar weight of atoms to determine Avogadros number. After Perrin, few scientists could disbelieve the existence of atoms. While atomic theory was set back by the failure of scientists to accept simple physical ideas like the diatomic molecule and the kinetic theory of gases, it was also delayed by the preoccupation of physicists with mechanics for almost 200 years, from Newton to the 20th century. Nevertheless, several 19th-century investigators, working in the relatively ignored fields of electricity, magnetism, and optics, provided important clues about the interior of the atom. The studies in electrodynamics made by English physicist Michael Faraday and those of Maxwell indicated for the first time that something existed apart from palpable matter, and data obtained by Gustav Robert Kirchhoff of Germany about elemental spectral lines raised questions that would be answered only in the 20th century by quantum mechanics. Until Faradays electrolysis experiments, scientists had no conception of the nature of the forces binding atoms together in a molecule. Faraday concluded that electrical forces existed inside the molecule after he had produced an electric current and a chemical reaction in a solution with the electrodes of a voltaic cell. No matter what solution or electrode material he used, a fixed quantity of current sent through an electrolyte always caused a specific amount of material to form on an electrode of the electrolytic cell. Faraday concluded that each ion of a given chemical compound has exactly the same charge. Later he discovered that the ionic charges are integral multiples of a single unit of charge, never fractions. On the practical level, Faraday did for charge what Dalton had done for the chemical combination of atomic masses. That is to say, Faraday demonstrated that it takes a definite amount of charge to convert an ion of an element into an atom of the element and that the amount of charge depends on the element used. The unit of charge that releases one gram-equivalent weight of a simple ion is called the faraday in his honour. For example, one faraday of charge passing through water releases one gram of hydrogen and eight grams of oxygen. In this manner, Faraday gave scientists a rather precise value for the ratios of the masses of atoms to the electric charges of ions. The ratio of the mass of the hydrogen atom to the charge of the electron was found to be 1.035 108 kilogram per coulomb. Faraday did not know the size of his electrolytic unit of charge in units such as coulombs any more than Dalton knew the magnitude of his unit of atomic weight in grams. Nevertheless, scientists could determine the ratio of these units easily. More significantly, Faradays work was the first to imply the electrical nature of matter and the existence of subatomic particles and a fundamental unit of charge. Faraday wrote: The atoms of matter are in some way endowed or associated with electrical powers, to which they owe their most striking qualities, and amongst them their mutual chemical affinity. Faraday did not, however, conclude that atoms cause electricity. In 1865 Maxwell unified the laws of electricity and magnetism in his publication A Dynamical Theory of the Electromagnetic Field. In this paper he concluded that light is an electromagnetic wave. His theory was confirmed by German physicist Heinrich Hertz, who produced radio waves with sparks in 1887. With light understood as an electromagnetic wave, Maxwells theory could be applied to the emission of light from atoms. The theory failed, however, to describe spectral lines and the fact that atoms do not lose all their energy when they radiate light. The problem was not with Maxwells theory of light itself but rather with its description of the oscillating electron currents generating light. Only quantum mechanics could explain this behaviour (see below The laws of quantum mechanics). visible solar spectrumThe visible solar spectrum, ranging from the shortest visible wavelengths (violet light, at 400 nm) to the longest (red light, at 700 nm). Shown in the diagram are prominent Fraunhofer lines, representing wavelengths at which light is absorbed by elements present in the atmosphere of the Sun.By far the richest clues about the structure of the atom came from spectral line series. Mounting a particularly fine prism on a telescope, German physicist and optician Joseph von Fraunhofer had discovered between 1814 and 1824 hundreds of dark lines in the spectrum of the Sun. He labeled the most prominent of these lines with the letters A through G. Together they are now called Fraunhofer lines. A generation later Kirchhoff heated different elements to incandescence in order to study the different coloured vapours emitted. Observing the vapours through a spectroscope, he discovered that each element has a unique and characteristic pattern of spectral lines. Each element produces the same set of identifying lines, even when it is combined chemically with other elements. In 1859 Kirchhoff and German chemist Robert Wilhelm Bunsen discovered two new elementscesium and rubidiumby first observing their spectral lines. Johann Jakob Balmer, a Swiss secondary-school teacher with a penchant for numerology, studied hydrogens spectral lines and found a constant relationship between the wavelengths of the elements four visible lines. In 1885 he published a generalized mathematical formula for all the lines of hydrogen. Swedish physicist Johannes Rydberg extended Balmers work in 1890 and found a general rule applicable to many elements. Soon more series were discovered elsewhere in the spectrum of hydrogen and in the spectra of other elements as well. Stated in terms of the frequency of the light rather than its wavelength, the formula may be expressed: Here is the frequency of the light, n and m are integers, and R is the Rydberg constant. In the Balmer lines m is equal to 2 and n takes on the values 3, 4, 5, and 6.

Describe the structure of an atom. Describe the structure of an atom using the atomic theory. Describe the atomic structure of an atom and name all its components. What is the structure of an atom. Describe the structure of an atom in terms of sub atomic particles. Atomic structure chemistry.