DOWNLOAD PDF HOW IS PHYSICS RELATED TO SCIENCE

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For example, atomic and nuclear physics studies matter on the smallest scale at which chemical elements can be identified. The physics of elementary particles is on an even smaller scale since it is concerned with the most basic units of matter; this branch of physics is also known as high-energy physics because of the extremely high energies necessary to produce many types of particles in particle accelerators. On this scale, ordinary, commonsense notions of space, time, matter, and energy are no longer valid. Classical mechanics approximates nature as continuous, while quantum theory is concerned with the discrete nature of many phenomena at the atomic and subatomic level and with the complementary aspects of particles and waves in the description of such phenomena. The theory of relativity is concerned with the description of phenomena that take place in a frame of reference that is in motion with respect to an observer; the special theory of relativity is concerned with relative uniform motion in a straight line and the general theory of relativity with accelerated motion and its connection with gravitation. Both quantum theory and the theory of relativity find applications in all areas of modern physics. Loosely speaking, the laws of classical physics accurately describe systems whose important length scales are greater than the atomic scale and whose motions are much slower than the speed of light. Outside of this domain, observations do not match predictions provided by classical mechanics. Albert Einstein contributed the framework of special relativity , which replaced notions of absolute time and space with spacetime and allowed an accurate description of systems whose components have speeds approaching the speed of light. Later, quantum field theory unified quantum mechanics and special relativity. General relativity allowed for a dynamical, curved spacetime , with which highly massive systems and the large-scale structure of the universe can be well-described. General relativity has not yet been unified with the other fundamental descriptions; several candidate theories of quantum gravity are being developed. Mathematics and ontology are used in physics. Physics is used in chemistry and cosmology. Prerequisites Mathematics provides a compact and exact language used to describe the order in nature. This was noted and advocated by Pythagoras , [48] Plato , [49] Galileo , [50] and Newton. Physics uses mathematics [51] to organise and formulate experimental results. From those results, precise or estimated solutions are obtained, quantitative results from which new predictions can be made and experimentally confirmed or negated. The results from physics experiments are numerical data, with their units of measure and estimates of the errors in the measurements. Technologies based on mathematics, like computation have made computational physics an active area of research. The distinction between mathematics and physics is clear-cut, but not always obvious, especially in mathematical physics. Ontology is a prerequisite for physics, but not for mathematics. It means physics is ultimately concerned with descriptions of the real world, while mathematics is concerned with abstract patterns, even beyond the real world. Thus physics statements are synthetic, while mathematical statements are analytic. Mathematics contains hypotheses, while physics contains theories. Mathematics statements have to be only logically true, while predictions of physics statements must match observed and experimental data. The distinction is clear-cut, but not always obvious. For example, mathematical physics is the application of mathematics in physics. Its methods are mathematical, but its subject is physical. Every mathematical statement used for solving has a hard-to-find physical meaning. The final mathematical solution has an easier-to-find meaning, because it is what the solver is looking for. Physics is also called "the fundamental science" because the subject of study of all branches of natural science like chemistry, astronomy, geology, and biology are constrained by laws of physics, [53] similar to how chemistry is often called the central science because of its role in linking the physical sciences. Structures are formed because particles exert electrical forces on each other, properties include physical characteristics of given substances, and reactions are bound by laws of physics, like conservation of energy, mass, and charge. Physics is applied in industries like engineering and medicine. An applied physics curriculum usually contains a few classes in an applied discipline, like geology or electrical engineering. It usually differs from engineering in that an applied physicist may not be designing something in particular, but rather is using physics or conducting physics research with the aim of developing new technologies or solving a problem. The approach is similar to that of applied mathematics. Applied physicists use physics in scientific research. For instance, people working on accelerator physics might seek to build better particle detectors for research in theoretical physics. Physics is used heavily in engineering. For example, statics , a subfield of mechanics , is used in the building of bridges and other static structures. The understanding and use of acoustics results in sound control and better concert halls; similarly, the use of optics creates better optical devices. An understanding of physics makes for more realistic flight simulators , video games , and movies , and is often critical in forensic investigations. With the standard consensus that the laws of physics are universal and do not change with time, physics can be used to study things that would ordinarily be mired in uncertainty. It also allows for simulations in engineering which drastically speed up the development of a new technology. Research Scientific method Physicists use the scientific method to test the validity of a physical theory. By using a methodical approach to compare the implications of a theory with the conclusions drawn from its related experiments and observations, physicists are better able to test the validity of a theory in a logical, unbiased, and repeatable way. To that end, experiments are performed and observations are made in order to determine the validity or invalidity of the theory.

Chapter 2 : energy | Definition, Types, & Examples | calendrierdelascience.com

Physics is the most fundamental and all-inclusive of the sciences, and has had a profound effect on all scientific development. In fact, physics is the present-day equivalent of what used to be called natural philosophy, from which most of our modern sciences arose.

Good times for physicists in making mainstream newspapers, it would seem. Physicists come in many different guises, and what excites one may leave another cold. So let me lay my credentials on the table. I am a soft matter-cum-biological physicist and what excites me is the world around me, the soft squidgy stuff that turns up ubiquitously scattered around our houses in food, cosmetics, paint and ointments, in bulk plastics and novel materials for renewable energy devices; but also, pervasively, in the tissues of our own bodies and the rest of the animal kingdom. Yes, physics and biology can sometimes collide and when they do, it can produce something entirely new. More than half a century ago, physics and biology came together in the work of Crick and Watson â€" working at my own place of work, the Cavendish Laboratory in Cambridge â€" with Franklin and Wilkins from Kings College, London. The structure of the DNA double helix was solved by bringing the then relatively new technique of X-ray diffraction to bear on the structure of carefully grown DNA crystals. Out of this and related work grew the whole field of molecular biology and, although physicists often migrated to work in this field, it became divorced from physics as a discipline. For many years after that mainstream physics concentrated on "simple" systems which could be fully understood and modelled. Biology tended to be seen as messy and complicated, not a fit subject for a physicist as a senior departmental colleague once made very clear to me as I made my initial forays into the field , and few individuals in physics departments braved the untidy world of biological organisms. As a result, those whose tastes remained biological would more likely be found in some form of biology department calling themselves biophysicists, or perhaps working as medical physicists in a hospital. But times change and so do the attitudes of physicists towards messy systems. Complexity and emergent phenomena are most definitely now seen as proper domains for a physicist. Emergent phenomena cover processes where the outcome is more than the sum of the component parts, and something new emerges from collective behaviour that could not be predicted by looking at any contributing entity in isolation. This applies to superconductivity in certain complicated inorganic compounds, but also to the synchronised beating of heart cells. There was, in the past, one way that did seem acceptable for a physicist to enter the biological arena and that was by providing a service, typically imaging of some sort. Medical imaging has made great strides during the past decades â€" MRI, CAT scans and ultrasound being familiar to many from hospital visits, often transforming diagnostics and treatment â€" and much of their development work can be directly attributed to physicists and engineers. My own interest in biological physics stems from my earlier research on synthetic polymers, the long-chain molecules very familiar from the polyethylene of polythene bags or in double glazing made from uPVC short for unplasticised polyvinyl chloride. Long chain molecules behave in a particular way simply because they are long chains; they can get tangled up in a way small molecules cannot and this means their motion is severely restricted. It also means they can interact at different places along their length to form both specific and non-specific junctions. In these cases it seems the native structure is lost just because the control mechanisms in our brain can break down over the years. The physicist can apply the same basic principles and insights to these two very different situations, and maybe cast new light by looking for universalities rather than the specifics arising from the particular amino acid sequence each different protein possesses. That at least is the hope. There are two drawbacks of working at this interface with biology. Firstly, there is the challenge of finding space to teach it in the undergraduate curriculum. Curricula are always overfull, and no one wants their pet topic to be ousted to make way for something new. The absence of any exposure of many undergraduates to these exciting new topics has been noted, however, and various reports have highlighted that something needs to be done about it for instance, the EPSRC International Review of Physics remarked upon it, as did the RCUK Wakeham Review of Physics. In order to help departments who perhaps lack researchers confident to tackle it, the Institute of Physics is preparing new material , which can be slotted in as and when a department feels able to do so. Secondly, because this field is inherently interdisciplinary it can struggle for funding, and may fall down the cracks between research councils. Yet the excitement is precisely in bringing the different fields together so that, just as with emergent phenomena, the sum is more than its parts and two apparently "unoriginal" components can add up to something truly innovative and exciting. It certainly comes in considerably cheaper than hunting the Higgs. I aim to write not only about my science, but about the world I inhabit as a professor in a research-intensive university and the issues that affect me, my colleagues and the students we teach:

Chapter 3 : Comparison of chemistry and physics - Wikipedia

Physics is the science of the motions and actions of physical bodies conceived in terms of cause and effect. Moral philosophy (or, more accurately, psychology) is the detailed study of "the passions and perturbations of the mind"â€"that.

In fact, physics is the present-day equivalent of what used to be called natural philosophy, from which most of our modern sciences arose. Students of many fields find themselves studying physics because of the basic role it plays in all phenomena. In this chapter we shall try to explain what the fundamental problems in the other sciences are, but of course it is impossible in so small a space really to deal with the complex, subtle, beautiful matters in these other fields. Lack of space also prevents our discussing the relation of physics to engineering, industry, society, and war, or even the most remarkable relationship between mathematics and physics. Mathematics is not a science from our point of view, in the sense that it is not a natural science. The test of its validity is not experiment. We must, incidentally, make it clear from the beginning that if a thing is not a science, it is not necessarily bad. For example, love is not a science. So, if something is said not to be a science, it does not mean that there is something wrong with it; it just means that it is not a science. Historically, the early days of chemistry dealt almost entirely with what we now call inorganic chemistry, the chemistry of substances which are not associated with living things. Considerable analysis was required to discover the existence of the many elements and their relationshipsâ€"how they make the various relatively simple compounds found in rocks, earth, etc. This early chemistry was very important for physics. The interaction between the two sciences was very great because the theory of atoms was substantiated to a large extent by experiments in chemistry. The theory of chemistry, i. All these rules were ultimately explained in principle by quantum mechanics, so that theoretical chemistry is in fact physics. On the other hand, it must be emphasized that this explanation is in principle. We have already discussed the difference between knowing the rules of the game of chess, and being able to play. So it is that we may know the rules, but we cannot play very well. It turns out to be very difficult to predict precisely what will happen in a given chemical reaction; nevertheless, the deepest part of theoretical chemistry must end up in quantum mechanics. There is also a branch of physics and chemistry which was developed by both sciences together, and which is extremely important. This is the method of statistics applied in a situation in which there are mechanical laws, which is aptly called statistical mechanics. In any chemical situation a large number of atoms are involved, and we have seen that the atoms are all jiggling around in a very random and complicated way. If we could analyze each collision, and be able to follow in detail the motion of each molecule, we might hope to figure out what would happen, but the many numbers needed to keep track of all these molecules exceeds so enormously the capacity of any computer, and certainly the capacity of the mind, that it was important to develop a method for dealing with such complicated situations. Statistical mechanics, then, is the science of the phenomena of heat, or thermodynamics. Inorganic chemistry is, as a science, now reduced essentially to what are called physical chemistry and quantum chemistry; physical chemistry to study the rates at which reactions occur and what is happening in detail How do the molecules hit? Which pieces fly off first? The other branch of chemistry is organic chemistry, the chemistry of the substances which are associated with living things. For a time it was believed that the substances which are associated with living things were so marvelous that they could not be made by hand, from inorganic materials. This is not at all trueâ€"they are just the same as the substances made in inorganic chemistry, but more complicated arrangements of atoms are involved. Organic chemistry obviously has a very close relationship to the biology which supplies its substances, and to industry, and furthermore, much physical chemistry and quantum mechanics can be applied to organic as well as to inorganic compounds. However, the main problems of organic chemistry are not in these aspects, but rather in the analysis and synthesis of the substances which are formed in biological systems, in living things. This leads imperceptibly, in steps, toward biochemistry, and then into biology itself, or molecular biology. In the early days of biology, the biologists had to deal with the purely descriptive problem of finding out what living things there were, and so they just had to count such things as the hairs of the limbs of fleas. After these matters were worked out with a great deal of interest, the biologists went into the machinery inside the living bodies, first from a gross standpoint, naturally, because it takes some effort to get into the finer details. There was an interesting early relationship between physics and biology in which biology helped physics in the discovery of the conservation of energy, which was first demonstrated by Mayer in connection with the amount of heat taken in and given out by a living creature. If we look at the processes of biology of living animals more closely, we see many physical phenomena: It is interesting how that happens. In their study of nerves, the biologists have come to the conclusion that nerves are very fine tubes with a complex wall which is very thin; through this wall the cell pumps ions, so that there are positive ions on the outside and negative ions on the inside, like a capacitor. This in turn affects it farther along, etc. This wave is somewhat analogous to a long sequence of vertical dominoes; if the end one is pushed over, that one pushes the next, etc. Of course this will transmit only one message unless the dominoes are set up again; and similarly in the nerve cell, there are processes which pump the ions slowly out again, to get the nerve ready for the next impulse. So it is that we know what we are doing or at least where we are. Of course the electrical effects associated with this nerve impulse can be picked up with electrical instruments, and because there are electrical effects, obviously the physics of electrical effects has had a great deal of influence on understanding the phenomenon. The opposite effect is that, from somewhere in the brain, a message is sent out along a nerve. What happens at the end of the nerve? There the nerve branches out into fine little things, connected to a structure near a muscle, called an endplate. For reasons which are not exactly understood, when the impulse reaches the end of the nerve, little packets of a chemical called acetylcholine are shot off five or ten molecules at a time and they affect the muscle fiber and make it contractâ€"how simple! What makes a muscle contract? A muscle is a very large number of fibers close together, containing two different substances, myosin and actomyosin, but the machinery by which the chemical reaction induced by acetylcholine can modify the dimensions of the muscle is not yet known. Thus the fundamental processes in the muscle that make mechanical motions are not known. Biology is such an enormously wide field that there are hosts of other problems that we cannot mention at allâ€"problems on how vision works what the light does in the eye , how hearing works, etc. The way in which thinking works we shall discuss later under psychology. Now, these things concerning biology which we have just discussed are, from a biological standpoint, really not fundamental, at the bottom of life, in the sense that even if we understood them we still would not understand life itself. But you can have life without nerves. Plants have neither nerves nor muscles, but they are working, they are alive, just the same. So for the fundamental problems of biology we must look deeper; when we do, we discover that all living things have a great many characteristics in common. The most common feature is that they are made of cells, within each of which is complex machinery for doing things chemically. In plant cells, for example, there is machinery for picking up light and generating glucose, which is consumed in the dark to keep the plant alive. When the plant is eaten the glucose itself generates in the animal a series of chemical reactions very closely related to photosynthesis and its opposite effect in the dark in plants. In the cells of living systems there are many elaborate chemical reactions, in which one compound is changed into another and another. To give some impression of the enormous efforts that have gone into the study of biochemistry, the chart in Fig. Here we see a whole series of molecules which change from one to another in a sequence or cycle of rather small steps. It is called the Krebs cycle, the respiratory cycle. Each of the chemicals and each of the steps is fairly simple, in terms of what change is made in the molecule, butâ€"and this is a centrally important discovery in biochemistryâ€"these changes are relatively difficult to accomplish in a laboratory. If we wanted to take an object from one place to another, at the same level but on the other side of a hill, we could push it over the top, but to do so requires the addition of some energy. Thus most chemical reactions do not occur, because there is what is called an activation energy in the way. In order to add an extra atom to our chemical requires that we get it close enough that some rearrangement can occur; then it will stick. However, if we could literally take the molecules in our hands and push and pull the atoms around in such a way as to open a hole to let the new atom in, and then let it snap back, we would have found another way, around the hill, which would not require extra energy, and the reaction would go easily. Now there actually are, in the cells, very large molecules, much larger than the ones whose changes we have been describing, which in some complicated way hold the smaller molecules just right, so that the reaction can occur easily. These very large and complicated things are called enzymes. They were first called ferments, because they were originally discovered in the fermentation of sugar. In fact, some of the first reactions in the cycle were discovered there. In the presence of an enzyme the reaction will go. An enzyme is made of another substance called protein. Enzymes are very big and complicated, and each one is different, each being built to control a certain special reaction. The names of the enzymes are written in Fig. Sometimes the same enzyme may control two reactions. We emphasize that the enzymes themselves are not involved in the reaction directly. They do not change; they merely let an atom go from one place to another. Having done so, the enzyme is ready to do it to the next molecule, like a machine in a factory. Of course, there must be a supply of certain atoms and a way of disposing of other atoms. Take hydrogen, for example: For example, there are three or four hydrogen-reducing enzymes which are used all over our cycle in different places. It is interesting that the machinery which liberates some hydrogen at one place will take that hydrogen and use it somewhere else. The most important feature of the cycle of Fig. So, GTP has more energy than GDP and if the cycle is going one way, we are producing molecules which have extra energy and which can go drive some other cycle which requires energy, for example the contraction of muscle. The muscle will not contract unless there is GTP. An enzyme, you see, does not care in which direction the reaction goes, for if it did it would violate one of the laws of physics. Physics is of great importance in biology and other sciences for still another reason, that has to do with experimental techniques. In fact, if it were not for the great development of experimental physics, these biochemistry charts would not be known today. The reason is that the most useful tool of all for analyzing this fantastically complex system is to label the atoms which are used in the reactions. They are different isotopes. We recall that the chemical properties of atoms are determined by the number of electrons, not by the mass of the nucleus. But there can be, for example in carbon, six neutrons or seven neutrons, together with the six protons which all carbon nuclei have. Now, we return to the description of enzymes and proteins. Not all proteins are enzymes, but all enzymes are proteins. There are many proteins, such as the proteins in muscle, the structural proteins which are, for example, in cartilage and hair, skin, etc. However, proteins are a very characteristic substance of life: Proteins have a very interesting and simple structure.

Chapter 4 : Physics - Scientific American

Lattice thermal conductivity strongly affects the applications of materials related to thermal functionality, such as thermal management, thermal barrier coatings and thermoelectrics. In order to.

Mechanics Mechanics is generally taken to mean the study of the motion of objects or their lack of motion under the action of given forces. Classical mechanics is sometimes considered a branch of applied mathematics. It consists of kinematics , the description of motion, and dynamics , the study of the action of forces in producing either motion or static equilibrium the latter constituting the science of statics. The 20th-century subjects of quantum mechanics, crucial to treating the structure of matter, subatomic particles , superfluidity , superconductivity , neutron stars , and other major phenomena, and relativistic mechanics , important when speeds approach that of light, are forms of mechanics that will be discussed later in this section. Thus in the first approximation even objects as large as the Earth and the Sun are treated as pointlikeâ€”e. In rigid-body dynamics , the extension of bodies and their mass distributions are considered as well, but they are imagined to be incapable of deformation. The mechanics of deformable solids is elasticity ; hydrostatics and hydrodynamics treat, respectively, fluids at rest and in motion. The three laws of motion set forth by Isaac Newton form the foundation of classical mechanics, together with the recognition that forces are directed quantities vectors and combine accordingly. The first law, also called the law of inertia , states that, unless acted upon by an external force , an object at rest remains at rest, or if in motion, it continues to move in a straight line with constant speed. Uniform motion therefore does not require a cause. Accordingly, mechanics concentrates not on motion as such but on the change in the state of motion of an object that results from the net force acting upon it. Taken together, these mechanical laws in principle permit the determination of the future motions of a set of particles, providing their state of motion is known at some instant, as well as the forces that act between them and upon them from the outside. From this deterministic character of the laws of classical mechanics, profound and probably incorrect philosophical conclusions have been drawn in the past and even applied to human history. Lying at the most basic level of physics, the laws of mechanics are characterized by certain symmetry properties, as exemplified in the aforementioned symmetry between action and reaction forces. Other symmetries, such as the invariance i. The symmetry properties of the theory can be shown to have as mathematical consequences basic principles known as conservation laws , which assert the constancy in time of the values of certain physical quantities under prescribed conditions. The conserved quantities are the most important ones in physics; included among them are mass and energy in relativity theory, mass and energy are equivalent and are conserved together , momentum , angular momentum , and electric charge. The study of gravitation This field of inquiry has in the past been placed within classical mechanics for historical reasons, because both fields were brought to a high state of perfection by Newton and also because of its universal character. No further principles are required to understand the principal aspects of rocketry and space flight although, of course, a formidable technology is needed to carry them out. By measuring the transmission of laser signals between the spacecraft essentially a giant Michelson interferometer in space , scientists hope to detect and accurately measure gravity waves. The modern theory of gravitation was formulated by Albert Einstein and is called the general theory of relativity. Completed in , the theory was valued for many years mainly for its mathematical beauty and for correctly predicting a small number of phenomena, such as the gravitational bending of light around a massive object. Only in recent years, however, has it become a vital subject for both theoretical and experimental research. Curved space-timeThe four dimensional space-time continuum itself is distorted in the vicinity of any mass, with the amount of distortion depending on the mass and the distance from the mass. The study of heat , thermodynamics, and statistical mechanics Heat is a form of internal energy associated with the random motion of the molecular constituents of matter or with radiation. Temperature is an average of a part of the internal energy present in a body it does not include the energy of molecular binding or of molecular rotation. An isolated body eventually reaches uniform temperature, a state known as thermal equilibrium , as do two or more bodies placed in contact. The formal study of states of matter at or near thermal equilibrium is called thermodynamics ; it is capable of analyzing a large variety of thermal systems without considering their detailed microstructures. First law The first law of thermodynamics is the energy conservation principle of mechanics i. Second law The second law of thermodynamics asserts that heat will not flow from a place of lower temperature to one where it is higher without the intervention of an external device e. The concept of entropy involves the measurement of the state of disorder of the particles making up a system. For example, if tossing a coin many times results in a random-appearing sequence of heads and tails, the result has a higher entropy than if heads and tails tend to appear in clusters. Another formulation of the second law is that the entropy of an isolated system never decreases with time. Third law The third law of thermodynamics states that the entropy at the absolute zero of temperature is zero, corresponding to the most ordered possible state. Statistical mechanics The science of statistical mechanics derives bulk properties of systems from the mechanical properties of their molecular constituents, assuming molecular chaos and applying the laws of probability. Regarding each possible configuration of the particles as equally likely, the chaotic state the state of maximum entropy is so enormously more likely than ordered states that an isolated system will evolve to it, as stated in the second law of thermodynamics. Such reasoning, placed in mathematically precise form, is typical of statistical mechanics , which is capable of deriving the laws of thermodynamics but goes beyond them in describing fluctuations i. An example of a fluctuation phenomenon is the random motion of small particles suspended in a fluid , known as Brownian motion. Left Random motion of a Brownian particle; right random discrepancy between the molecular pressures on different surfaces of the particle that cause motion. Quantum statistical mechanics plays a major role in many other modern fields of science, as, for example, in plasma physics the study of fully ionized gases , in solid-state physics, and in the study of stellar structure. Particles with electric charge interact by an electric force , while charged particles in motion produce and respond to magnetic forces as well. Many subatomic particles, including the electrically charged electron and proton and the electrically neutral neutron, behave like elementary magnets. On the other hand, in spite of systematic searches undertaken, no magnetic monopoles, which would be the magnetic analogues of electric charges, have ever been found. The field concept plays a central role in the classical formulation of electromagnetism, as well as in many other areas of classical and contemporary physics. The field describing the electric force between a pair of charged particles works in the following manner: Classical electromagnetism is summarized by the laws of action of electric and magnetic fields upon electric charges and upon magnets and by four remarkable equations formulated in the latter part of the 19th century by the Scottish physicist James Clerk Maxwell. The latter equations describe the manner in which electric charges and currents produce electric and magnetic fields, as well as the manner in which changing magnetic fields produce electric fields, and vice versa. The light to which the human eye is sensitive is but one small segment of an electromagnetic spectrum that extends from long-wavelength radio waves to short-wavelength gamma rays and includes X-rays , microwaves , and infrared or heat radiation. Radio waves, infrared rays, visible light, ultraviolet rays, X-rays, and gamma rays are all types of electromagnetic radiation. Radio waves have the longest wavelength, and gamma rays have the shortest wavelength. Optics Because light consists of electromagnetic waves, the propagation of light can be regarded as merely a branch of electromagnetism. However, it is usually dealt with as a separate subject called optics: More recently, there has developed a new and vital branch, quantum optics , which is concerned with the theory and application of the laser , a device that produces an intense coherent beam of unidirectional radiation useful for many applications. Spectrum of white light by a diffraction grating. With a prism, the red end of the spectrum is more compressed than the violet end. The formation of images by lenses , microscopes , telescopes , and other optical devices is described by ray optics, which assumes that the passage of light can be represented by straight lines, that is, rays. The subtler effects attributable to the wave property of visible light, however, require the explanations of physical optics. One basic wave effect is interference , whereby two waves present in a region of space combine at certain points to yield an enhanced resultant effect e. Another wave effect is diffraction , which causes light to spread into regions of the geometric shadow and causes the image produced by any optical device to be fuzzy to a degree dependent on the wavelength of the light. Optical instruments such as the interferometer and the diffraction grating can be used for measuring the wavelength of light precisely about micrometres and for measuring distances to a small fraction of that length.

Atomic and chemical physics One of the great achievements of the 20th century was the establishment of the validity of the atomic hypothesis , first proposed in ancient times, that matter is made up of relatively few kinds of small, identical partsâ€"namely, atoms. However, unlike the indivisible atom of Democritus and other ancients, the atom, as it is conceived today, can be separated into constituent electrons and nucleus. Atoms combine to form molecules , whose structure is studied by chemistry and physical chemistry ; they also form other types of compounds , such as crystals , studied in the field of condensed-matter physics. Such disciplines study the most important attributes of matter not excluding biologic matter that are encountered in normal experienceâ€"namely, those that depend almost entirely on the outer parts of the electronic structure of atoms. Only the mass of the atomic nucleus and its charge, which is equal to the total charge of the electrons in the neutral atom, affect the chemical and physical properties of matter. Millikan oil-drop experimentBetween and the American physicist Robert Millikan conducted a series of oil-drop experiments. By comparing applied electric force with changes in the motion of the oil drops, he was able to determine the electric charge on each drop. He found that all of the drops had charges that were simple multiples of a single number, the fundamental charge of the electron. Although there are some analogies between the solar system and the atom due to the fact that the strengths of gravitational and electrostatic forces both fall off as the inverse square of the distance, the classical forms of electromagnetism and mechanics fail when applied to tiny, rapidly moving atomic constituents. Atomic structure is comprehensible only on the basis of quantum mechanics, and its finer details require as well the use of quantum electrodynamics QED. Atomic properties are inferred mostly by the use of indirect experiments. Of greatest importance has been spectroscopy , which is concerned with the measurement and interpretation of the electromagnetic radiations either emitted or absorbed by materials. These radiations have a distinctive character, which quantum mechanics relates quantitatively to the structures that produce and absorb them. It is truly remarkable that these structures are in principle, and often in practice, amenable to precise calculation in terms of a few basic physical constants: Condensed-matter physics This field, which treats the thermal, elastic, electrical, magnetic, and optical properties of solid and liquid substances, grew at an explosive rate in the second half of the 20th century and scored numerous important scientific and technical achievements, including the transistor. Among solid materials , the greatest theoretical advances have been in the study of crystalline materials whose simple repetitive geometric arrays of atoms are multiple-particle systems that allow treatment by quantum mechanics. Because the atoms in a solid are coordinated with each other over large distances, the theory must go beyond that appropriate for atoms and molecules. Thus conductors , such as metals , contain some so-called free electrons, or valence electrons , which are responsible for the electrical and most of the thermal conductivity of the material and which belong collectively to the whole solid rather than to individual atoms. Semiconductors and insulators , either crystalline or amorphous , are other materials studied in this field of physics. Brattain, and William B. Other aspects of condensed matter involve the properties of the ordinary liquid state, of liquid crystals, and, at temperatures near absolute zero , of the so-called quantum liquids. The latter exhibit a property known as superfluidity completely frictionless flow , which is an example of macroscopic quantum phenomena. Such phenomena are also exemplified by superconductivity completely resistance-less flow of electricity , a low-temperature property of certain metallic and ceramic materials. Besides their significance to technology, macroscopic liquid and solid quantum states are important in astrophysical theories of stellar structure in, for example, neutron stars. Nuclear physics This branch of physics deals with the structure of the atomic nucleus and the radiation from unstable nuclei. About 10, times smaller than the atom, the constituent particles of the nucleus, protons and neutrons, attract one another so strongly by the nuclear forces that nuclear energies are approximately 1,, times larger than typical atomic energies. Quantum theory is needed for understanding nuclear structure. Particle tracks from the collision of an accelerated nucleus of a niobium atom with another niobium nucleus. The single line on the left is the track of the incoming projectile nucleus, and the other tracks are fragments from the collision. Courtesy of the Department of Physics and Astronomy, Michigan State University Like excited atoms, unstable radioactive nuclei either naturally occurring or artificially produced can emit electromagnetic radiation. The energetic nuclear photons are called gamma rays. Radioactive nuclei also emit other particles: A principal research tool of nuclear physics involves the use of beams of particles e.

Recoiling particles and any resultant nuclear fragments are detected, and their directions and energies are analyzed to reveal details of nuclear structure and to learn more about the strong force. A much weaker nuclear force, the so-called weak interaction, is responsible for the emission of beta rays. Nuclear collision experiments use beams of higher-energy particles, including those of unstable particles called mesons produced by primary nuclear collisions in accelerators dubbed meson factories. Exchange of mesons between protons and neutrons is directly responsible for the strong force. For the mechanism underlying mesons, see below Fundamental forces and fields. In radioactivity and in collisions leading to nuclear breakup, the chemical identity of the nuclear target is altered whenever there is a change in the nuclear charge.

Chapter 5 : Where physics meets biology | Athene Donald | Science | The Guardian

Physics (from Ancient Greek: Ï†Ï…ÏƒÎ¹ÎºÎ® (á¼•Ï€Î¹ÏƒÏ„Î®Î¼Î·), translit. physiká¸— (epistá¸—mÄ“), lit. 'knowledge of nature', from Ï†Ï•ÏƒÎ¹Ï‚ phÃ½sis "nature") is the natural science that studies matter and its motion and behavior through space and time and that studies the related entities of energy and force.

Scope[edit] Physics and chemistry may overlap when the system under study involves matter composed of electrons and nuclei made of protons and neutrons. On the other hand, chemistry is not concerned with other forms of matter such as quarks , mu and tau leptons and dark matter. Although fundamental laws that govern the behavior of matter apply both in chemistry and physics, the disciplines of physics and chemistry are distinct. Physics is concerned with nature from a very large scale the entire universe down to a very small scale subatomic particles. All physical phenomena that are measurable follow some behavior that is in accordance with the most basic principles studied in physics. Physics also deals with the basic principles that explain matter and energy, and may study aspects of atomic matter by following concepts derived from the most fundamental principles. Chemistry focuses on how substances interact with each other and with energy for example heat and light. Chemistry also studies the properties of matter at a larger scale for example, astrochemistry and the reactions of matter at a larger scale for example, technical chemistry , but typically, explanations and predictions are related back to the underlying atomic structure, giving more emphasis on the methods for the identification of molecules and their mechanisms of transformation than any other science. Approach[edit] Although both physics and chemistry are concerned with matter and its interaction with energy, the two disciplines differ in approach. In physics, it is typical to abstract from the specific type of matter, and to focus on the common properties of many different materials. Chemistry, on the other hand, focuses on what compounds are present in a sample, and explores how changing the structure of molecules will change their reactivity and their physical properties. Physics can be divided into experimental and theoretical physics. Historically, theoretical physics has correctly predicted phenomena that were out of experimental reach at the time, and could be verified only after experimental techniques caught up. Training[edit] In a typical undergraduate program for physics majors, required courses are in the sub-disciplines of physics, with additional required courses in mathematics. In a typical undergraduate program for chemistry majors, emphasis is placed on laboratory classes and understanding and applying models describing chemical bonds and molecular structure. Emphasis is also placed in the methods for analysis and the formulas and equations used when considering the chemical transformation. Students take courses in math, physics, chemistry, and often biochemistry. Between the two programs of study, there is a large area of overlap calculus , introductory physics, quantum mechanics , thermodynamics. However, physics places a larger emphasis on fundamental theory with its deep mathematical treatment while chemistry places more emphasis in combining the most important mathematical definitions of the theory with the approach of the molecular models. Laboratory skills may differ in both programs, as students may be involved in different technologies, depending on the program and the institution of higher education for example, a chemistry student may spend more laboratory time dealing with glassware for distillation and purification or on a form of chromatography - spectroscopy instrument, while a physics student may spend much more time dealing with a laser and non-linear optics technology or some complex electrical circuit. Careers in chemistry and physics[edit] According to Bureau of Labor Statistics United States Department of Labor , there are 80, chemists and 17, physicists working in the United States as of May Chemistry is the only science that has an entire industry, the chemical industry , named after it, and many chemists work in this industry, in research and development , production, training, or management. Other industries employing chemists include the petroleum , pharmaceutical, and food industry. While there is no industry named after physics, many industries have grown out of physics research, most notably the semiconductor and electronics industry. Physicists are also employed outside of science, for example in finance, because of their training in modeling complex systems.

Chapter 6 : How the Physics of Football Works | HowStuffWorks

Physics is the study of matter â€” what is it made of? How does it behave? What laws or equations describe it? From subatomic particles, to the Big Bang, modern physicists study matter at a tremendous range of scales.

Chapter 7 : Physics - Wikipedia

This is known as the "Brazil nut effect," and the seemingly mundane phenomenon is actually one of the biggest unsolved mysteries in many-body physics the science that describes large quantities of.

Chapter 8 : The Feynman Lectures on Physics Vol. I Ch. 3: The Relation of Physics to Other Sciences

Scientific American is the essential guide to the most awe-inspiring advances in science and technology, explaining how they change our understanding of the world and shape our lives.

Chapter 9 : Famous Physicists - List of World Famous Physicists

The Abyss is a fantastic film, and though more science fiction than science fact, there's enough realism in the portrayal of the deep sea, and its exploration, to keep the physics fan quite interested.