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Chapter 1 : Physical chemistry - Wikipedia

Key concepts[edit] The key concepts of physical chemistry are the ways in which pure physics is applied to chemical problems. One of the key concepts in classical chemistry is that all chemical compounds can be described as groups of atoms bonded together and chemical reactions can be described as the making and breaking of those bonds. Predicting the properties of chemical compounds from a description of atoms and how they bond is one of the major goals of physical chemistry. To describe the atoms and bonds precisely, it is necessary to know both where the nuclei of the atoms are, and how electrons are distributed around them. Another set of important questions in chemistry concerns what kind of reactions can happen spontaneously and which properties are possible for a given chemical mixture. This is studied in chemical thermodynamics , which sets limits on quantities like how far a reaction can proceed, or how much energy can be converted into work in an internal combustion engine , and which provides links between properties like the thermal expansion coefficient and rate of change of entropy with pressure for a gas or a liquid. To a limited extent, quasi-equilibrium and non-equilibrium thermodynamics can describe irreversible changes. Which reactions do occur and how fast is the subject of chemical kinetics , another branch of physical chemistry. A key idea in chemical kinetics is that for reactants to react and form products , most chemical species must go through transition states which are higher in energy than either the reactants or the products and serve as a barrier to reaction. A second is that most chemical reactions occur as a sequence of elementary reactions , [7] each with its own transition state. Key questions in kinetics include how the rate of reaction depends on temperature and on the concentrations of reactants and catalysts in the reaction mixture, as well as how catalysts and reaction conditions can be engineered to optimize the reaction rate. The fact that how fast reactions occur can often be specified with just a few concentrations and a temperature, instead of needing to know all the positions and speeds of every molecule in a mixture, is a special case of another key concept in physical chemistry, which is that to the extent an engineer needs to know, everything going on in a mixture of very large numbers perhaps of the order of the Avogadro constant , 6 x of particles can often be described by just a few variables like pressure, temperature, and concentration. The precise reasons for this are described in statistical mechanics , [8] a specialty within physical chemistry which is also shared with physics. Statistical mechanics also provides ways to predict the properties we see in everyday life from molecular properties without relying on empirical correlations based on chemical similarities. History of chemistry Fragment of M. Modern physical chemistry originated in the s to s with work on chemical thermodynamics , electrolytes in solutions, chemical kinetics and other subjects. Together with Svante August Arrhenius , [11] these were the leading figures in physical chemistry in the late 19th century and early 20th century. All three were awarded the Nobel Prize in Chemistry between â€” Developments in the following decades include the application of statistical mechanics to chemical systems and work on colloids and surface chemistry , where Irving Langmuir made many contributions. Another important step was the development of quantum mechanics into quantum chemistry from the s, where Linus Pauling was one of the leading names. Theoretical developments have gone hand in hand with developments in experimental methods, where the use of different forms of spectroscopy , such as infrared spectroscopy , microwave spectroscopy , electron paramagnetic resonance and nuclear magnetic resonance spectroscopy , is probably the most important 20th century development. Further development in physical chemistry may be attributed to discoveries in nuclear chemistry , especially in isotope separation before and during World War II , more recent discoveries in astrochemistry , [12] as well as the development of calculation algorithms in the field of "additive physicochemical properties" practically all physicochemical properties, such as boiling point, critical point, surface tension, vapor pressure, etc.

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Chapter 2 : Quantum mind - Wikipedia

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Astronomy and astrophysics[edit] Main article: List of unsolved problems in astronomy Astrophysical jet: Why do only certain accretion discs surrounding certain astronomical objects emit relativistic jets along their polar axes? Why are there quasi-periodic oscillations in many accretion discs? What is responsible for the numerous interstellar absorption lines detected in astronomical spectra? Are they molecular in origin, and if so which molecules are responsible for them? How do they form? What is the origin of the M-sigma relation between supermassive black hole mass and galaxy velocity dispersion? Rotation curve of a typical spiral galaxy: Can the discrepancy between the curves be attributed to dark matter? Why is the observed energy of satellites flying by Earth sometimes different by a minute amount from the value predicted by theory? Is dark matter responsible for differences in observed and theoretical speed of stars revolving around the centre of galaxies, or is it something else? What is the exact mechanism by which an implosion of a dying star becomes an explosion? What astrophysical process is responsible for the nucleogenesis of these rare isotopes? Why is it that apparently some cosmic rays emitted by distant sources have energies above the Greisenâ€"Zatsepinâ€"Kuzmin limit? What is the origin of magnetar magnetic field? Is the universe at very large scales anisotropic , making the cosmological principle an invalid assumption? The number count and intensity dipole anisotropy in radio, NRAO VLA Sky Survey NVSS catalogue [38] is inconsistent with the local motion as derived from cosmic microwave background [39] [40] and indicate an intrinsic dipole anisotropy. The same NVSS radio data also shows an intrinsic dipole in polarization density and degree of polarization [41] in the same direction as in number count and intensity. There are several other observation revealing large-scale anisotropy. The optical polarization from quasars shows polarization alignment over a very large scale of Gpc. Why is space roar six times louder than expected? What is the source of space roar? Ageâ€"metallicity relation in the Galactic disk: Is there a universal ageâ€"metallicity relation AMR in the Galactic disk both "thin" and "thick" parts of the disk? Although in the local primarily thin disk of the Milky Way there is no evidence of a strong AMR, [49] a sample of nearby "thick" disk stars has been used to investigate the existence of an ageâ€"metallicity relation in the Galactic thick disk, and indicate that there is an ageâ€"metallicity relation present in the thick disk. Why is there a discrepancy between the amount of lithium-7 predicted to be produced in Big Bang nucleosynthesis and the amount observed in very old stars? Transient radio pulses lasting only a few milliseconds, from emission regions thought to be no larger than a few hundred kilometres, and estimated to occur several hundred times a day. While several theories have been proposed, there is no generally accepted explanation for them. The only known repeating FRB emanates from a galaxy roughly 3 billion light years from Earth. What are the phases of strongly interacting matter, and what roles do they play in the evolution of cosmos? What is the detailed partonic structure of the nucleons? What does QCD predict for the properties of strongly interacting matter? What determines the key features of QCD, and what is their relation to the nature of gravity and spacetime? Do gluons acquire mass dynamically despite having a zero rest mass , within hadrons? Do gluons saturate when their occupation number is large? Do gluons form a dense system called Colour Glass Condensate? Nuclei and nuclear astrophysics: Why is there a lack of convergence in estimates of the mean lifetime of a free neutron based on two separate- and increasingly precise- experimental methods? What is the nature of the nuclear force that binds protons and neutrons into stable nuclei and rare isotopes? What is the nature of exotic excitations in nuclei at the frontiers of stability and their role in stellar processes? What is the nature of neutron stars and dense nuclear matter? What is the origin of the elements in the cosmos? What are the nuclear reactions that drive stars and stellar explosions? Atomic, molecular and optical physics[edit] Abrahamâ€"Minkowski controversy: What is the momentum of light in optical media? How do we rigorously prove the existence of Boseâ€"Einstein

condensates for general interacting systems? Does the set of initial conditions for which particles that undergo near-collisions gain infinite speed in finite time have measure zero? The mechanism for superconductivity of these materials is unknown. What is the mechanism that causes certain materials to exhibit superconductivity at temperatures much higher than around 25 kelvins? Is it possible to make a material that is a superconductor at room temperature? What is the nature of the glass transition between a fluid or regular solid and a glassy phase? What are the physical processes giving rise to the general properties of glasses and the glass transition? Why does the electron emission in the absence of light increase as the temperature of a photomultiplier is decreased? What causes the emission of short bursts of light from imploding bubbles in a liquid when excited by sound? Is it possible to make a theoretical model to describe the statistics of a turbulent flow in particular, its internal structures? The latter problem is also listed as one of the Millennium Prize Problems in mathematics. In the solar wind and the turbulence in solar flares, coronal mass ejections, and magnetospheric substorms are major unsolved problems in space plasma physics. Is topological order stable at non-zero temperature? Equivalently, is it possible to have three-dimensional self-correcting quantum memory? What mechanism explains the existence of the u.

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Chapter 3 : Representations and constructivism

DOWNLOAD PHYSICS CAT 1 REVIEW QUESTIONS WITH SOLUTIONS CAMBRIDGE CHECKPOINTS physics cat 1 pdf SchrÃƒÂ¶dinger's cat is a thought experiment, sometimes described as a paradox, devised by Austrian.

We also investigate the effect of scaffolded questions according to previous examination performance and school background. Analysis by gender The mock exam mark distribution for the cohort by gender is shown in figure 2 a. We therefore conclude that the paper was set at an appropriate level and marked accordingly. In the subsequent analysis we consider the distributions of first, second and third class degree marks. The class distribution for the whole cohort and by gender is shown in figure 2 b. In figure 2 we observe the phenomenon that prompted our study; the percentage of female students receiving a first This difference in the mean marks by gender corresponds to a 3. Standard image High-resolution image Export PowerPoint slide Each of the two mock examination papers allocated half of the marks to scaffolded questions and the remainder to university style questions. The separate class distributions for the scafolded and university style questions are shown in figure 3 , and illustrates the dramatic differences between the marks achieved in the two different styles of questions, in particular in the extreme degree classifications of first class marks and fails. The average percentage mark achieved for the university style questions In addition, a Standard image High-resolution image Export PowerPoint slide The effect of scaffolding of questions is also considered by gender. The average percentage mark attained by female students for scaffolded questions is This can be compared to 9. For the male students the difference was slightly less marked with We therefore conclude that scaffolding of exam questions is beneficial to all undergraduate students and that the female students benefit preferentially. Analysis by A2-level performance The results presented so far strongly agree with the hypothesis that scaffolding in questions correlates with exam performance. To further support this evidence we make an additional two comparisons. The first is to establish whether the degree classification is correlated to A2-level examination performance. The second is to investigate the correlation between A2-level performance and the scaffolded and university style questions. Figure 4 a shows the correlation between the marks scored at A2-level physics, mathematics and further mathematics and the mock exam. A correlation is observed for all three A2-level subjects. For those students who took both physics and mathematics at A2-level, the correlation between their average A2-level mark and the mark they obtained in the mock exam for the scaffolded and university style questions is shown in figure 4 b. It can be seen that the performance of students depends strongly on the style of exam question, and is apparent for all A2-level marks. For those students who took physics, mathematics and further mathematics at A2-level, the correlation between their average A2-level mark and the mark they obtained in the mock exam for the scaffolded and university style questions is shown in figure 4 c. Once again, it can be seen that the performance of students depends strongly on the style of exam question, and is apparent for all A2-level marks. In addition, there is an indication that the scaffolded style questions partly reduces the correlation between the A2-level mark and the mock exam mark. Distributions of the average mock mark versus the A2-level performance in a physics, mathematics and further mathematics, b university and scaffolded style questions for students who took A2-level physics and mathematics, and c university and scaffolded style questions for students who took A2-level physics, mathematics and further mathematics. Students were sorted into bins of size 20 according to their A2-level mean mark across subjects and the mean mock mark for each bin was then calculated to produce the distributions shown here. Standard image High-resolution image Export PowerPoint slide Analysis by previous education With a large cohort of students we also investigate further diversity and dependencies of the results. In particular, we consider school location, school type and mixed or single-sex schooling. Figure 5 a shows the degree class distribution by gender and by location UK or overseas. It can be seen that the proportion of overseas students attaining a first class mark is higher than that for the UK students. When we further divide the students by gender, we also see a marked difference between the first class marks of male and female students; Standard image

High-resolution image Export PowerPoint slide The dependence of the performance on single-sex versus mixed school education is also analysed, independently of UK or overseas teaching, as shown in figure 5 b. Although, the number of females who received single-sex teaching pre-university 28 is small, the single-sex schooling appears to have a negative effect on the fraction achieving first class marks in the mock exam, even though the average percentage is slightly higher. For the male students there is a small difference in the percentage achieving first class marks and a negligible difference between the average marks. Finally, we consider only those students educated in the UK as a function of school type independent, state, academy and other. Since the numbers of students are small for the academy and other school categories, we consider independent school versus state school background only. The distribution of class marks is shown in figure 5 c. The average percentage mark is 6. Figure 5 d shows that women from an independent school background perform as well, if not better, than their male counterparts. Discussion and implications The structure of the Natural Sciences degree at the University of Cambridge has provided us with unique access to a broad cohort of students who, on entrance, are undecided about their future scientific specialization. The results and experience the students gain in this first year can strongly influence their choices. This study shows that there is a need to help them to bridge the gap between the skills development and assessment they experience at school and that which is expected at university. Our results have shown that providing scaffolding helps both genders achieve better results but builds the confidence of women preferentially. Our future aim therefore will be to help students, throughout the year and through all our avenues of teaching, develop their thinking skills so that they are able to create their own scaffolding and conceptual structure. As students develop their confidence and enjoyment of physics their choice to take physics at the next level with be positively impacted. The Isaac Physics project Warner and Jardine-Wright provides problem solving practice for schools students to positively impact on their experience and confidence enabling them to begin to constructing their own strategy gradually. Through continued support, reinforcement of structure and the identification of concepts we believe that students will not only get better marks but also develop a better understandingâ€”it is difficult to identify a strategy to solve a problem unless you really understand the concepts underpinning that problem. The results presented in this study are limited by one year of data for a cohort who have yet to complete their first year exams. Therefore while we strongly suspect that at the end of the first year the percentage of women achieving firsts will be as reported here and for many years previouslyâ€”but we have yet to track this particular cohort. From previous cohorts we have evidence that as students progress, and specialize in physics, the percentage of women achieving firsts increases and the effect reported here is reduced in years two, three and four. Our future work will include setting a mock exam, in this template, for our first year students and continue to collect data to verify the consistency of these initial findings. A larger sample of data will also enable us to study a statistically significant sample of students who progress to university through examination systems other than A-levels for example, IB, Pre-U. Furthermore, we will be able to test the impact of changes in the support and teaching methodologies we implement to help students self-scaffold and test the hypothesis that if they develop these skills through the first year of physics study and through pre-university intervention the difference in results between scaffolded and university style questions will be minimized. As we in physics collect evidence to support our hypothesis and prove that the students development of strategic thinking impacts positively on their results and understanding that other departments within the university chemistry, mathematics and engineering whose first year gender distributions mirror those of physics will follow our example. Conclusions As part of our Department of Physics activities directed towards gender equality, we have investigated the impact of exam question style on the performance of first year Natural Sciences students who take physics as one of their options. The exam questions are designed to bridge the gap between the traditional scaffolded school style questions and the less-structured style questions commonly encountered as part of the first year assessment procedure. We report a number of key findings: There is no gender bias in the performance of the cohort who took A2-level subjects physics, maths and further maths at school, with the women performing equally well if not better than their male counterparts. The mock exam mark distribution

confirms the same trend as observed in the end of first year exams, with the percentage of women receiving firsts significantly lower than their male counterparts. Scaffolded type questions significantly improve the performance of both men and women from all school backgrounds, with the women benefiting preferentially compared to the men. There exists a correlation between the performance at A2-level physics, maths and further maths and the mock exam. The correlation is less pronounced for the scaffolded questions compared to the university style questions. Students who received their school education overseas or in a mixed education environment are more likely to receive a first class mark in the first year physics exam. Students who received a UK independent school education performed better in the mock exam than those from a state school background, with women from independent schools performing as well as the men from independent schools. These results suggest a mis-match between the problem-solving skills and assessment procedures between school and first year university, and are consistent with the findings of Warner and Hyde and Mertz They will provide key input into the future teaching and assessment of first year undergraduate physics students. Supplementary table of results Summary table of overall mean percentage and standard deviation alongside the percentage of each grouping achieving firsts, second, thirds and who failed.

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Chapter 4 : Sydney Boydell | Open Library

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Misconceptions constructivists view the prior knowledge as stable alternate conceptions that apply robustly across multiple contexts. Pilot studies demonstrate the feasibility of a full-fledged experimental program to decide which flavor of constructivist describes students more adequately. To spell out my claim, I must distinguish between two flavors of constructivism. I will show that 1 these two frameworks, when fleshed out, lead to different sets of predictions about student behavior, and that 2 pilot studies show the feasibility of a full-fledged experimental program to decide which flavor of constructivism describes students more adequately, and also give us reason to take fine-grained constructivism seriously. So, this paper operationalizes a debate usually conducted on a theoretical plane. But I begin to build a fuller account by spelling out the nature and activation tendencies of one crucial representational knowledge element. Pilot studies demonstrate a method of putting those different sets of predictions to the test. Instead, as students construct a new understanding, their prior knowledge plays a crucial role. Within this broad framework, however, different camps tell different stories about the structure of this prior knowledge and the mechanism of conceptual change. This alternate theory contains the misconception Motion Requires Force, according to which an object in motion requires a force to keep it moving. However, since misconceptions are assumed to be somewhat theory-like, or are at least described in general terms that are not linked to particular contexts, the misconceptions framework cannot make predictions about the contexts in which fluctuations are most likely to occur. When confronted with evidence that contradicts her old conceptions, and when made aware of the difference between her old theory and the scientifically-accepted theory, the student becomes ready to accept the new theory. Maintaining agency [3] is an element of cognitive structure useful for understanding any continuing effect maintained by a continuing cause, such as a light bulb needing a continuous supply of energy to stay lit. Actuating agency is another resource, an element of cognitive structure involved in understanding an effect initiated by a cause, when the effect outlasts the cause, such as the strike of a hammer causing a bell to ring. The desk scenario tends to activate Maintaining agency, and hence, the idea that a continued net forward force is needed to keep the desk moving forward. They are resources that can be activated under various circumstances, sometimes appropriately, sometimes not. Furthermore, whereas the misconception is an element of cognitive structure specifically tied to motion and force, the finer-grained resources also apply to light bulbs, bells, and numerous other situations. In this sense, these resources are finer-grained but more general than misconceptions though some finer-grained resources might be tied more tightly to a particular setting. Within the fine-grained framework, conceptual change is not a matter of replacing bad mini-generalizations with good ones. In Newtonian mechanics, Maintaining Agency merely contributes to an informal heuristic for reasoning about situations involving strong friction or other dissipative forces. They are restructured, not replaced. Consequently, these two flavors of constructivism invite different instructional practices, as Hammer a discusses. Within a misconceptions framework, this is taken to show that students are misreading the velocity graph as a position graph, a mistake the student is likely to make on other velocity graphs; see McDermott et al. By contrast, within a fine-grained framework, the flat horizontal line can be taken to activate Stillness, an element of cognitive structure associated with lack of motion. So, the fine-grained account predicts some context-dependent inconsistencies in whether the student interprets the graph as if it indicates position instead of velocity. Therefore, in the absence of a detailed story about these contextual dependencies, the fine-grained and misconceptions stories do not make empirically distinguishable predictions. They agree that students will sometimes read the velocity graph as if it were a position graph, and that conscious reflection about what the graph represents can help students make fewer such mistakes. A specification of contextual dependencies is what distinguishes fine-grained from misconceptions

constructivism. Without going into detail, I will now propose some other intuitive knowledge elements that students might bring to bear when interpreting visual representations. These speculations play no role in my later arguments, but illustrate the fine-grained constructivist framework. In this framework, a misconception can emerge in a particular context, but perhaps not in other contexts, by the mis activation of various fine-grained intuitive knowledge elementsâ€"elements which in other contexts might contribute to productive interpretations. A fine-grained intuitive knowledge element: On a street sign showing a thick curvy line, WYSIWYG contributes to the quickâ€"and in this case, productiveâ€"conclusion that the road curves. Consider this map figure 3 of the central California coastline. Grayscale version of a color map of the middle California coastline The right-hand region is green, while the left-hand region is blue. Like most intuitive knowledge elements in a fine-grained framework, it is neither correct nor incorrect. In other words, children learn to interpret more abstract, less iconic representationsâ€"representations for which WYSIWYG must be put in the background. For example, bigger really does mean bigger in many representations. In some visual representations, one feature or a particular Gestalt involving multiple features quickly draws your attention. Experiments can determine which visual attributes are most compelling in which circumstances. These visual attributes are detected even before the information reaches the visual cortex in the brain. Edges, corners, and motion probably constitute compelling visual attributes in some circumstances and likely contribute to other compelling visual attributes in other circumstances. Therefore, we can reasonably infer that the neuroscience of vision can contribute to our understanding of compelling visual attributes. My claim is that, even though WYSIWYG is not cued strongly in all contexts, it is cued strongly with respect to the compelling visual attribute of a representation: Consider figure 3, the California coastline. Given that the human vision system is hard-wired to detect edges see section 3. So, according to my activation claim, the boundary on the map disproportionately gets interpreted as representing a boundary in real life. This interpretation, of course, is correct. Crucially, because the application of WYSIWYG to the compelling visual attribute leads to a productive interpretation, that pattern of activation tends to get reinforced, as argued below. It may turn out that subjects, quickly and without conscious thought, perceive the overall Gestalt of the figure to be an outward flow from the central dot. If so, the WYSIWYG activation claim says that the diagram is likely to be interpreted as showing an outward flow from the center, which is, indeed, a productive way of viewing the relationship between a charge and its electric field lines. I give one last example. In a high school physics class, students were told to look for a supernova in this galaxy. The students knew that supernovae are extremely compact, bright objects. And indeed, the small bright blob on the image represents a small bright blob in space, a supernova. I now discuss the speculative developmental story underlying my WYSIWYG activation claim, starting with a one-paragraph summary and then going into more detail. Consider a visual attribute that is particularly useful for interpreting the world. Its usefulness causesâ€"or at least favorsâ€"the development of quick and direct interpretative strategies often involving WYSIWYG that are effective and that call attention to themselves, making them compelling. According to this story, biological evolution produced edges as a hard-wired compelling visual attribute partly because they are so useful in functional tasks such as knowing the boundary of an object. Similar reasoning applies to soft-wired perception mechanisms, including representational resources and the connections between them that implement interpretive strategies. The most useful visual attributes become involved in quick and direct interpretive strategies, which are often stronglyâ€"and productivelyâ€"connected to WYSIWYG. By their very nature, these quick-and-direct strategies disproportionately grab attention, making the underlying visual attribute more compelling. Even when other interpretations of the visual scene might be available, compelling attributes are so often useful that they compete effectively for attention and carry along the WYSIWYG interpretive stance. In sum, the usefulness of a visual attribute causes the development of quick and effective interpretive strategies that preferentially call attention to themselves are compelling and for which WYSIWYG is an appropriate default stance. A representation for which WYSIWYG leads to an unproductive interpretation of the compelling visual attribute will fool people, making the representation less usefulâ€"and presumably, less

used by creators of representationsâ€”than it would otherwise be. Partly for this reason, as illustrated by the California coastline and the electric field, consumers of representations experience WYSIWYG as a productive attitude toward compelling visual attributes. In net, repeated experience with representations selected to make productive use of compelling visual attributes reinforces the links between compelling visual attributes and WYSIWYG. For instance, according to this model, within a moment of seeing the California coastline representation, people just think "boundary! Equally unconscious, in all likelihood, is the learning process by which WYSIWYG and compelling visual attributes become strongly paired. In the next section, I put the activation claim to the test. How do the two flavors of constructivism disagree? To highlight why the two flavors of constructivism generate different sets of predictions, I first sketch the general form of my argument. Misconceptions constructivism views conceptual change as a switch from one set of stable conceptions to another. By contrast, the context-dependent cueing of fine-grained constructivism allows stories to be told about the fine structure of these transitions, stories that predict particular patterns of non-randomness in the fluctuations. If enough of those fine-grained predictions turn out to be correct, then we have reason to prefer fine-grained constructivism. By contrast, if fine-grained constructivists cannot predict and detect patterns of non-randomness in the fluctuations, then we have reason to prefer misconceptions constructivism. In this section, I describe two analyses of pilot-study data about which fine-grained constructivismâ€”specifically, the WYSIWYG activation claimâ€”makes a prediction, while misconceptions constructivism makes no prediction. My main point is methodological: Graph for MaRC summer exam question Cars A and B start at the same position and move according to the graph of speed versus time [figure 6]. Is car A going forward or backward? What about car B? What happens at time T1? Circle the correct response. Car B is ahead. Car A is ahead. Neither car is ahead; car B and car A cross each other. I call parts a and b the Direction question and the Crossing question, respectively. Within the misconceptions framework see section 2. Random errors could stem from other causes, as footnote 11 discusses. But nothing more can be said. Misconceptions are generally described as applying robustly across multiple contexts. For this reason, misconceptions constructivism cannot predict whether more errors will occur on Direction or on Crossing. On the Direction question, WYSIWYG applied to the two oppositely-sloped lines on the graph leads to the incorrect conclusion that the cars go in different directions. By contrast, as just explained, misconceptions constructivism gives us no reason to expect more wrong answers on one question than on the other. Fine-grained constructivism makes a specific prediction concerning a distribution of incorrect answers. Misconceptions constructivism makes no such prediction. This empirical difference is the main point of my paper. As it turns out, partly because the class spent little time on velocity graphs, only one student out of nine got both Direction and Crossing right. Two students got both Direction and Crossing wrong, choosing iii on part b.

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Chapter 5 : Primary Maths (Grades 4 and 5) - Free Questions and Problems With Answers

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History[edit] Eugene Wigner developed the idea that quantum mechanics has something to do with the workings of the mind. He proposed that the wave function collapses due to its interaction with consciousness. Freeman Dyson argued that "mind, as manifested by the capacity to make choices, is to some extent inherent in every electron. He instead discussed how quantum mechanics may relate to dualistic consciousness. This more fundamental level was proposed to represent an undivided wholeness and an implicate order , from which arises the explicate order of the universe as we experience it. He suggested that it could explain the relationship between them. He saw mind and matter as projections into our explicate order from the underlying implicate order. Bohm claimed that when we look at matter, we see nothing that helps us to understand consciousness. Bohm discussed the experience of listening to music. He believed the feeling of movement and change that make up our experience of music derive from holding the immediate past and the present in the brain together. The musical notes from the past are transformations rather than memories. The notes that were implicate in the immediate past become explicate in the present. Bohm viewed this as consciousness emerging from the implicate order. Bohm saw the movement, change or flow, and the coherence of experiences, such as listening to music, as a manifestation of the implicate order. He held these studies to show that young children learn about time and space because they have a "hard-wired" understanding of movement as part of the implicate order. Bohm never proposed a specific means by which his proposal could be falsified, nor a neural mechanism through which his "implicate order" could emerge in a way relevant to consciousness. Penrose and Hameroff initially developed their ideas separately and later collaborated to produce Orch-OR in the early s. The theory was reviewed and updated by the authors in late According to Bringsjorg and Xiao, this line of reasoning is based on fallacious equivocation on the meaning of computation. If this proves to be the case, then quantum mechanics will be significantly involved in brain activity. Dissatisfied with its randomness, Penrose proposed a new form of wave function collapse that occurred in isolation and called it objective reduction. He suggested each quantum superposition has its own piece of spacetime curvature and that when these become separated by more than one Planck length they become unstable and collapse. Hameroff proposed that these electrons are close enough to become entangled. However, this too was experimentally discredited. The proposed existence of gap junctions between neurons and glial cells was also falsified. The opinions are often based on intuition or subjective ideas about the nature of consciousness. People argue endlessly about that. How do you judge whether a person is conscious or not? Only by the way they act. You apply the same criterion to a computer or a computer-controlled robot. I am claiming that the actions of consciousness are something different. But it usually plays a totally insignificant role. It would have to be in the bridge between quantum and classical levels of behavior â€" that is, where quantum measurement comes in. Daniel Hillis replied, "Penrose has committed the classical mistake of putting humans at the center of the universe. He said, "Well, Roger Penrose has given lots of new-age crackpots ammunition by suggesting that at some fundamental scale, quantum mechanics might be relevant for consciousness. This dialog takes place between the classical and the quantum parts of the brain. He argues from the Orthodox Quantum Mechanics of John von Neumann that the quantum state collapses when the observer selects one among the alternative quantum possibilities as a basis for future action. The collapse, therefore, takes place in the expectation that the observer associated with the state. Such usage is not compatible with standard quantum mechanics because one can attach any number of ghostly minds to any point in space that act upon physical quantum systems with any projection operators. According to Lawrence Krauss, "It is true that quantum mechanics is extremely strange, and on extremely small scales for short times, all sorts of weird things happen. And in fact we can make weird quantum phenomena happen. Conceptual

problems[edit] The idea that a quantum effect is necessary for consciousness to function is still in the realm of philosophy. Penrose proposes that it is necessary. But other theories of consciousness do not indicate that it is needed. There are computers that are specifically designed to compute using quantum mechanical effects. Quantum computing is computing using quantum-mechanical phenomena , such as superposition and entanglement. Whereas common digital computing requires that the data be encoded into binary digits bits , each of which is always in one of two definite states 0 or 1 , quantum computation uses quantum bits , which can be in superpositions of states. One of the greatest challenges is controlling or removing quantum decoherence. This usually means isolating the system from its environment as interactions with the external world cause the system to decohere. Currently, some quantum computers require their qubits to be cooled to 20 millikelvins in order to prevent significant decoherence. Some of the hypothetical models of quantum mind have proposed mechanisms for maintaining quantum coherence in the brain, but they have not been shown to operate. Quantum entanglement is a physical phenomenon often invoked for quantum mind models. This effect occurs when pairs or groups of particles interact so that the quantum state of each particle cannot be described independently of the other s , even when the particles are separated by a large distance. Instead, a quantum state has to be described for the whole system. Measurements of physical properties such as position , momentum , spin , and polarization , performed on entangled particles are found to be correlated. If one of the particles is measured, the same property of the other particle immediately adjusts to maintain the conservation of the physical phenomenon. According to the formalism of quantum theory, the effect of measurement happens instantly, no matter how far apart the particles are. Entanglement is broken when the entangled particles decohere through interaction with the environment; for example, when a measurement is made [70] or the particles undergo random collisions or interactions. According to David Pearce, "In neuronal networks, ion-ion scattering, ion-water collisions, and long-range Coulomb interactions from nearby ions all contribute to rapid decoherence times; but thermally-induced decoherence is even harder experimentally to control than collisional decoherence. In this way, the idea is similar to quantum cognition. This field clearly distinguishes itself from the quantum mind as it is not reliant on the hypothesis that there is something micro-physical quantum mechanical about the brain. Quantum cognition is based on the quantum-like paradigm, [74] [75] generalized quantum paradigm, [76] or quantum structure paradigm [77] that information processing by complex systems such as the brain can be mathematically described in the framework of quantum information and quantum probability theory. For example, quantum cognition proposes that some decisions can be analyzed as if there are interference between two alternatives, but it is not a physical quantum interference effect. Practical problems[edit] The demonstration of a quantum mind effect by experiment is necessary. Is there a way to show that consciousness is impossible without a quantum effect? Can a sufficiently complex digital, non-quantum computer be shown to be incapable of consciousness? Perhaps a quantum computer will show that quantum effects are needed. In any case, complex computers that are either digital or quantum computers may be built. These could demonstrate which type of computer is capable of conscious, intentional thought. Quantum mechanics is a mathematical model that can provide some extremely accurate numerical predictions. Richard Feynman called quantum electrodynamics, based on the quantum mechanics formalism, "the jewel of physics" for its extremely accurate predictions of quantities like the anomalous magnetic moment of the electron and the Lamb shift of the energy levels of hydrogen. Ch1 So it is not impossible that the model could provide an accurate prediction about consciousness that would confirm that a quantum effect is involved. If the mind depends on quantum mechanical effects, the true proof is to find an experiment that provides a calculation that can be compared to an experimental measurement. It has to show a measurable difference between a classical computation result in a brain and one that involves quantum effects. The main theoretical argument against the quantum mind hypothesis is the assertion that quantum states in the brain would lose coherency before they reached a scale where they could be useful for neural processing. This supposition was elaborated by Tegmark. His calculations indicate that quantum systems in the brain decohere at sub-picosecond timescales. Typical reactions are on the order of milliseconds, trillions of

times longer than sub-picosecond time scales. In this experiment, two different colored lights, with an angular separation of a few degrees at the eye, are flashed in succession. If the interval between the flashes is less than a second or so, the first light that is flashed appears to move across to the position of the second light. Furthermore, the light seems to change color as it moves across the visual field. A green light will appear to turn red as it seems to move across to the position of a red light. Dennett asks how we could see the light change color before the second light is observed. According to David Pearce, a demonstration of picosecond effects is "the fiendishly hard part â€" feasible in principle, but an experimental challenge still beyond the reach of contemporary molecular matter-wave interferometry. Ordinary nerve signals have to be treated classically. For my picture, I need this quantum-level activity in the microtubules; the activity has to be a large scale thing that goes not just from one microtubule to the next but from one nerve cell to the next, across large areas of the brain. We need some kind of coherent activity of a quantum nature which is weakly coupled to the computational activity that Hameroff argues is taking place along the microtubules. There are various avenues of attack. One is directly on the physics, on quantum theory, and there are certain experiments that people are beginning to perform, and various schemes for a modification of quantum mechanics. As Penrose proposes, it may require a new type of physical theory. Ethical problems[edit] Can self-awareness, or understanding of a self in the surrounding environment, be done by a classical parallel processor, or are quantum effects needed to have a sense of "oneness"? This is not automatically excluded or impossible, but it seriously limits the kinds of experiments that can be done. Federal Government funded effort to document the connections of neurons in the brain. An ethically objectionable practice by proponents of quantum mind theories involves the practice of using quantum mechanical terms in an effort to make the argument sound more impressive, even when they know that those terms are irrelevant. Dale DeBakcsy notes that "trendy parapsychologists, academic relativists, and even the Dalai Lama have all taken their turn at robbing modern physics of a few well-sounding phrases and stretching them far beyond their original scope in order to add scientific weight to various pet theories. An ethical statement by a researcher should specify what kind of relationship their hypothesis has to the physical laws. Misleading statements of this type have been given by, for example, Deepak Chopra. Chopra has commonly referred to topics such as quantum healing or quantum effects of consciousness. Just like an electron or a photon is an indivisible unit of information and energy, a thought is an indivisible unit of consciousness.

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Chapter 6 : Thought experiment - Wikipedia

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If then we take two bodies whose natural speeds are different, it is clear that on uniting the two, the more rapid one will be partly retarded by the slower, and the slower will be somewhat hastened by the swifter. Do you not agree with me in this opinion? You are unquestionably right. But if this is true, and if a large stone moves with a speed of, say, eight while a smaller moves with a speed of four, then when they are united, the system will move with a speed less than eight; but the two stones when tied together make a stone larger than that which before moved with a speed of eight. Hence the heavier body moves with less speed than the lighter; an effect which is contrary to your supposition. Thus you see how, from your assumption that the heavier body moves more rapidly than the lighter one, I infer that the heavier body moves more slowly. Strange then, as Cohen says, that philosophers and scientists alike refuse to acknowledge either Galileo in particular, or the thought experiment technique in general for its pivotal role in both science and philosophy. Variety[edit] Thought experiments have been used in a variety of fields, including philosophy , law , physics , and mathematics. In philosophy, they have been used at least since classical antiquity , some pre-dating Socrates. In law, they were well-known to Roman lawyers quoted in the Digest. Much later, Ernst Mach used the term Gedankenexperiment in a different way, to denote exclusively the imaginary conduct of a real experiment that would be subsequently performed as a real physical experiment by his students. Mach asked his students to provide him with explanations whenever the results from their subsequent, real, physical experiment differed from those of their prior, imaginary experiment. However, people had no way of categorizing it or speaking about it. This helps to explain the extremely wide and diverse range of the application of the term "thought experiment" once it had been introduced into English. Uses[edit] Thought experiments, which are well-structured, well-defined hypothetical questions that employ subjunctive reasoning irrealis moods â€" "What might happen or, what might have happened if. In thought experiments we gain new information by rearranging or reorganizing already known empirical data in a new way and drawing new a priori inferences from them or by looking at these data from a different and unusual perspective. In law, the synonym "hypothetical" is frequently used for such experiments. Regardless of their intended goal, all thought experiments display a patterned way of thinking that is designed to allow us to explain, predict and control events in a better and more productive way. Theoretical consequences[edit] In terms of their theoretical consequences, thought experiments generally: However, they may make those theories themselves irrelevant, and could possibly create new problems that are just as difficult, or possibly more difficult to resolve. In terms of their practical application, thought experiments are generally created to: In these cases, the result of the "proxy" experiment will often be so clear that there will be no need to conduct a physical experiment at all. This is a unique use of a scientific thought experiment, in that it was never carried out, but led to a successful theory, proven by other empirical means. Relation to real experiments[edit] The relation to real experiments can be quite complex, as can be seen again from an example going back to Albert Einstein. In this paper, starting from certain philosophical assumptions, [15] on the basis of a rigorous analysis of a certain, complicated, but in the meantime assertedly realizable model, he came to the conclusion that quantum mechanics should be described as "incomplete". These experiments tested the Bell inequalities published in in a purely theoretical paper. The above-mentioned EPR philosophical starting assumptions were considered to be falsified by empirical fact e. Thus thought experiments belong to a theoretical discipline, usually to theoretical physics , but often to theoretical philosophy. In any case, it must be distinguished from a real experiment, which belongs naturally to the experimental discipline and has "the final decision on true or not true", at least in physics. Causal reasoning[edit] The first characteristic pattern that thought experiments display is their orientation in time. Seven types[edit] Temporal representation of a prefactual thought

experiment. Sanna in [22] â€" speculate on possible future outcomes, given the present, and ask "What will be the outcome if event E occurs? Semifactual speculations are an important part of clinical medicine. Prediction[edit] Temporal representation of prediction, forecasting and nowcasting. According to David Sarewitz and Roger Pielke , p , scientific prediction takes two forms: Given that retrodiction is a process in which "past observations, events and data are used as evidence to infer the process es the produced them" and that diagnosis "involve[s] going from visible effects such as symptoms, signs and the like to their prior causes", [51] the essential balance between prediction and retrodiction could be characterized as: It then involves an imaginary moving backwards in time, step-by-step, in as many stages as are considered necessary, from the future to the present to reveal the mechanism through which that particular specified future could be attained from the present. The major distinguishing characteristic of backcasting analyses is the concern, not with likely energy futures, but with how desirable futures can be attained. Backcasting [is] both an important aid in determining the direction technology development must take and in specifying the targets to be set for this purpose. As such, backcasting is an ideal search toward determining the nature and scope of the technological challenge posed by sustainable development, and it can thus serve to direct the search process toward new â€" sustainable â€" technology. In philosophy[edit] In philosophy, a thought experiment typically presents an imagined scenario with the intention of eliciting an intuitive or reasoned response about the way things are in the thought experiment. Philosophers might also supplement their thought experiments with theoretical reasoning designed to support the desired intuitive response. The scenario will typically be designed to target a particular philosophical notion, such as morality, or the nature of the mind or linguistic reference. The response to the imagined scenario is supposed to tell us about the nature of that notion in any scenario, real or imagined. For example, a thought experiment might present a situation in which an agent intentionally kills an innocent for the benefit of others. John Searle imagines a man in a locked room who receives written sentences in Chinese, and returns written sentences in Chinese, according to a sophisticated instruction manual. Here, the relevant question is not whether or not the man understands Chinese, but more broadly, whether a functionalist theory of mind is correct. It is generally hoped that there is universal agreement about the intuitions that a thought experiment elicits. Hence, in assessing their own thought experiments, philosophers may appeal to "what we should say," or some such locution. A successful thought experiment will be one in which intuitions about it are widely shared. But often, philosophers differ in their intuitions about the scenario. Other philosophical uses of imagined scenarios arguably are thought experiments also. In one use of scenarios, philosophers might imagine persons in a particular situation maybe ourselves , and ask what they would do. For example, in the veil of ignorance , John Rawls asks us to imagine a group of persons in a situation where they know nothing about themselves, and are charged with devising a social or political organization. The use of the state of nature to imagine the origins of government, as by Thomas Hobbes and John Locke , may also be considered a thought experiment. He asked his readers to imagine themselves suspended in the air isolated from all sensations in order to demonstrate human self-awareness and self-consciousness , and the substantiality of the soul. Some thought experiments present scenarios that are not nomologically possible. In his Twin Earth thought experiment , Hilary Putnam asks us to imagine a scenario in which there is a substance with all of the observable properties of water e. It has been argued that this thought experiment is not nomologically possible, although it may be possible in some other sense, such as metaphysical possibility. It is debatable whether the nomological impossibility of a thought experiment renders intuitions about it moot. In some cases, the hypothetical scenario might be considered metaphysically impossible, or impossible in any sense at all. David Chalmers says that we can imagine that there are zombies , or persons who are physically identical to us in every way but who lack consciousness. This is supposed to show that physicalism is false. However, some argue that zombies are inconceivable: Others have claimed that the conceivability of a scenario may not entail its possibility. 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