Without Math

A personal introduction

My parents had been divorced already for years when I finished primary school. This lasted eight years in Hungary and it was usually followed by four years high school or "gimnázium" as they called it there. Actually there were two variations of this, namely the "humán" or the "reál". The first usually involved latin and more theoretical subjects to prepare one for a university choice, while the second more real-istic subjects but still weren't enough to get a job, rather to enter technical colleges or apprenticeship. My older brother, Péter was exactly four years older, while the other, Gábor was four years younger, so the schools we went reflected perfectly our age differences. Péter learnt building radios from my father and was determined to become an electrical engineer. My mother was hoping for a change of interest in him. Her family was killed in Auschwitz and they were all doctors, pharmacists and dentists. So Péter went to the humán gimnázium and struggled with latin. Still, finished quite well and got into the technical university's electrical engineering faculty.
Of course, this was the time I began my story, that is finished elementary school and had to choose where to go next. Unlike four years earlier for my brother, by this time there were alternatives because big changes were planned in the secondary education system. One was the opening of specific technical high schools that gave actual job opportunities right after finishing. The other tendency was that elementary schools extended their education for extra four years and they were called twelve year schools. This was pushed by the primary schools so that their teachers could get better pay, but the ministry of education was trying to hinder this tendency, being afraid that these extended four years would not match a real high school and neither provide job readiness.
I was an average student, not excelling in anything except grammar but bad even in languages. In first grade my teacher aunty Etelka made me stand in the corner because I was bad and while I was standing at the list of the Hungarian alphabet, I was thinking about the illogical usage of altered vowels. The accents are sometimes used to alter sounds like a to á or e to é but at o and u just to prolong them to ó and ú. So, I extended the alphabet in a more "logical" way with a colored chalk. The result was detention to clean up the mess. My third-fourth grade teacher was the one who observed my "talent" in grammar and when he was tutoring the kids in his home free of charge, I was explaining the grammar to the others. Before I even went to third grade we already heard about this teacher. Gyuriács was his name, but the kids just called him "chair-leg", because it was rumored that he uses one to beat the kids in the toilet. As it turned out, it was true. It was also true that he took half of the class on weekends for excursions. His wife was baking waffles at home to supplement their income.
I was raised without religion. In our bedroom, pictures of the communist leaders were framed. Once I asked my teacher and his wife in their home about the huge black cross on the wall and they told me about Jesus. It's funny how we don't remember the details of discussion, yet the dignity and moral stand of people remain in us forever.
Unfortunately, in the upper grades (4-8) I had a really bad math teacher. We called her "Laci-Mama" because her last name was Laszlo though it's usually a first name with Laci as its nickname. Strangely, when I went to a private daycare for the afternoons, the owner, a very strong willed and strange woman who had the nickname "I-Mama" (from her name Irene) was friend with my math teacher and paid her to tutor the kids in the afternoons. So, I got double dose of this ignorant woman. But there were even stranger things. My principal, Laszlo Bellai wrote all the math textbooks for Hungarian elementary schools, but he himself was not teaching. The only encounter I had with him was earlier when I attended the school's afternoon care. A teacher, or rather guard wanted to force me to eat the jam covered bread, which I hated. I got a written permission from my mother to be excused from meals, but when I showed this she made fun of me and so I called her a fucking whore. She sent me to the principal who smacked me. I felt lucky because it was rumored that usually he was using one of the wooden floor pieces.

The husband of I-Mama was an old fashioned engineer and when he was at home he helped the kids with their homeworks too. Once he was looking at my math book and asked, “who the hell wrote this stupidity”, I said that our principal. “Well, he’s an idiot”, he said and explained why the book was faulty, but I don’t remember anything about the details. There was only one more memory of my principal. In a physics class, that was held in the lab, we heard a horrifying shout from the backroom. My teacher ran in and gave first aid to the principal, who spilt some liquid nitrogen on himself.

In the last half year of elementary school, my math teacher, Laci-Mama, was sick. I think she had cancer and I had a replacement teacher. His name was Kozalik. I don’t remember why, but he said that I have a good head for math and I could have much better grades if I wanted. This minute encounter became vital.

Before making the choice of high school I went to see my father who suggested that I should go to a textile technical school because, “it has good future”. My mother was very opposed to the idea and wanted me to go to humán gimnázium just as my brother did. But we both agreed that not to the same one. Meantime, the primary school announced that they would become twelve year school so kids could stay. The only special classes were Russian language and I was really bad in it, but reluctantly decided to stay in the school. My mother learnt that a new special math class will open in a nearby formerly girl’s high school. First I didn’t even want to go for the orientation day, but just a day before it, it turned out that the ministry wouldn’t allow the twelve year change of the elementary school. I also remember what my replacement teacher said, so I decided to go after all. Most of the kids who applied were ones that couldn’t get into the three famous special math high school, but were still excelling in primary school. Probably I had the worst interview but the school was desperate to open the special class and didn’t get enough students in these last minutes, so I got in. As I said, it was a girl’s school and it opened for boys only for this special math class. So about fifteen boys in a girl’s school was pretty exciting after an all boy elementary school.

The first day, my teacher Laszlo Bánhegyi explained his philosophy about how mathematics is the most democratic subject where a child can beat a professor because only the here and now really counts. He also said that if someone is good he can get two fives (highest grade) at once. As an example for unusual solutions he asked a question from the class that came up when a famous Hungarian geometry professor Hajos visited Russia recently. The problem was to subtract x from every letter of the alphabet and to multiply them. That is, to calculate:

$(a - x)\ (b - x)\ (c - x)\ \ldots$ The kids in my class obviously already multiplied such expressions, but I never. In fact, how limited my algebra was is shown by the fact that I raised my hand and gave the following solution: The result is 0 because the last letter of the alphabet is x and so $(x - x) = 0$ annihilates all the previous ones. I got two fives. Probably my teacher didn’t realize my point fully. Of course, x is not the last letter of the alphabet in Hungarian either and $(y - x)\ (z - x)$ still follows the $(x - x) = 0$. I knew the alphabet better than math and why I claimed that x is the last letter, I don’t know. But I also believed that 0 must be the last in the product in order to get 0. My stupidity remained my secret but I got a boost and studied all nights.

After the first semester, I won the Hungarian Mathematical Journal’s problem competition. Before this, my mother didn’t know how I was doing in school because I didn’t tell anything. After two months, there was a parent-teacher meeting and Bánhegyi called my mother aside to talk to her. She was afraid to hear bad news again but my teacher asked her if she is aware of that I was the most exceptional math talent he met.

While I was on “track”, my brother Péter was struggling with math at the university. His professor was a woman, namely the wife of one of my future professors Ákos Chászár. This idiotic woman obviously wanted to show that she requires just as high level of math from the electrical engineers as her husband from the pure mathematicians. I was using my brother’s math books to extend my knowledge in analysis and didn’t realize what a tragic injustice is happening to him. He was already building electrical organ, remote controlled car but these didn’t impress my theoretical mind.

Péter had to visit a tutor, namely a university teacher who just freshly returned from Russia. I remember he was excited because this guy called Czách, could explain everything much better and Péter also mentioned that he was living in a small flat but women's stockings are all over the place. So he must be a big womanizer though was short and bald. Later, I was lucky to have Czách as my lecturer of analysis instead of Császár. This gave me further influence on my road against formalism.

I was complaining to everybody, when started attending university about why we don't start with set theory and logic. Why do we have to comb through the classical math in the old fashioned ways and then at the end the last year learn the foundations. Czách opened his lecture with saying that analysis is applied set theory and logic, so he has to teach the basics. He was writing everything on the blackboard, in fact he was the only lecturer who actually explained the stuff he required us to know. The girls and foreign students loved him, while the stuck up "talents" mocked him.

I admired him and regarded as the third biggest influence on me after Gyuriács and Bánhegyi. To show how right he and I were when stressing the need for logic preparation in analysis, I can only repeat his example from the first lecture. In analysis we always use the typical sentence: If for every ε surrounding, there is an n number that . . . and so on. To know what this means of course, we have to know what it means when it's not true. So to know the opposite of the combinations of "every" and "there is" is the very substance of analysis. And just to show how unprepared people are with these, he started to sing an old Hungarian song: "there is a moment in every women's life when she would like to do what is not allowed . . .". Then he asked what is the opposite of this. Of course some students said stupid things like: "there are no women . . ." or "everything is allowed . . .". But finally everybody agreed that the correct solution is the very unpoetic: "There are women in whom's life there are no moments when they would like to do what is not allowed".

Back in first and second year high school if I knew what Richard Feynmann wrote about the problems of math education for physics students then maybe I would have felt more empathy for my brother. He had to leave the university, but still became an electrical engineer without a university degree. I was too ignorant bathing in my success and following stupid fashionable things with it. I had no idea that I will also be a mathematician without a degree. One of the fashionable things was to ridicule physics as primitive and subordinate to math. Our well intended but less than impressive physics teacher in high school didn't help the situation either. In fact, how much this was so, is reflected by the fact that I didn't even tell my physics teacher when I sent letters to a few noble prize winner physicists. English was already the international language of science, but we were taught German and even that very badly, so I couldn't use it either. It was a dark afternoon in a suburb of Budapest when I gave my few pages to an English interpreter to translate it. I knew he wouldn't conceive the "importance of my discovery". But I didn't know that "Nonstandard Analysis" was already discovered and in an epilogue Robinson was offering it to physicists to be used for a new theory. Anyway, only Heisenberg replied, but he did so in three days.

So I continued on my ignorant ways to be intoxicated by premonitions of "forcing", "random sequences" and other exotic subjects. The lack of literature in Hungarian helped in digging deeper on my own and so later when I realized that everything has already been solved, I also had to realize that nothing is really solved, the deepest questions are still there hidden. To become conscious of this big tendency that hides, doesn't want to explain or contemplate, I had to go much further from math.

But first I had to go into math. Even into real math, into the reality of life. First, reality is always exciting and getting a job as a mathematician without a degree was very exciting. I saw the university life from the library at Stanford where I helped for being allowed to stay on the campus. I just wanted to see Paul Cohen but he was in England. When he returned, I saw that I was right because he was different, but that didn't change anything. So this job opportunity at the small company Cintra Physics International that started to build table top computers seemed fantastic.

They warned me not to talk to people from the opposition just across the street. “Those Hewlett-Packard people live in the past” my boss explained to me because they were using Polish notation on the computers while ours was pure math. So I wrote the application programs and went through surveying, E.C.G. analysis and all possible fields of applied math. The company went bankrupt and Tektronix the big oscilloscope factory bought it. I was one of the few who were offered a job. I wrote songs about “Portland rain”, “waiting in Washington Park” and had my first big love. And still I stayed a mathematician. One afternoon I realized something. Here is a huge factory that manufactures “TV screens” and now ventures into computers that use Telex and IBM electric typewriter as in and output. So why don’t we put our programs on the screen of a TV and then we can see at once what’s going on. I asked for a meeting with my boss and he wasn’t impressed. A friend told me that there is a group nearby in Seattle that works on new directions with computers. But I didn’t want to stay in this business or any business at all.

So it was back to California, but first I almost died because I fell asleep at the wheel. Luckily, the soft snow saved me and my car without a scratch. My two best friends from high school were not so far away. One in Toronto fighting with his family because he didn’t want to sell insurance, the other in Chicago continuing his math studies. They were called just like my brothers Péter and Gábor. Gábor Fencsik was very good in languages even in Russian. We were supposed to go to university in Russia together but after meeting a couple that just returned, I changed my mind in the last minute. Gábor went alone and wrote sad letters. After two years, Péter Éliás, my other friend convinced me to leave Hungary. We were in Rome, somebody was knocking at our door and there was Gábor practically in the same clothes that he swam the Adriatic Sea to Italy. Strange and weird events happened, but even more were ahead of us.

Gábor moved from Chicago to Berkeley and drove down to L.A. to visit me. The little VW was dusty and Gábor so full of questions about what was happening with me. I was full of answers but couldn’t explain. How could you when a pill just changed your whole world? He probably thought that I was lost when in fact I was just found. I still remained a mathematician. I was ignorant so many times but I knew now that I will never accumulate new ignorance. I was obnoxious when we went first time to Yugoslavia in high school. A big box filled with cocoa powder took up my whole backpack. My family was poor, but we loved hot cocoa. Then later I left him to go alone to Russia. Then again I left everything without telling him. So he has a lot to forgive me. I still remember my first forgiveness. An electric shock went through me and I lied on the bed for seconds. Gábor looked scared and shook my head. He forgot to turn off the electricity when I was fixing something. Nothing happened to me. That’s how we journey alone leaving the old friends and getting new ones.

Family is the only thing that keeps together by customs rather than necessity. And indeed, why couldn’t the family be your friend. So I try to be friend to my daughter and my son. My son Danny, will type these lines into his computer and twenty years ago, my daughter Timea started to handwrite in a little notebook in Hungarian the simple explanations of how “matter works”. Then a few years ago, I started to explain the same things to Danny, but now in English and it became a small book. It got bigger and bigger and we entitled it What’s the Matter. Then, I went into finishing my math books titled, Non Formalist Math. This is half way but now I realized that first I should finish an other similar physics book as What’s the Matter that deals with the opposite deductive method of physics. This in fact, will be the first book titled Now You See it, Now You Don’t. It’s strange that this more basic and also more important book came only as an instantaneous clarification in my mind. It’s even stranger that a theoretical mathematician should write a physics book without math and the previous personal ramblings probably didn’t help to clarify my reasons either. So, I just have to state my reasons as an end result:

Math versus Physics

Alfred Nobel, the discoverer of dynamite became a rich man and in his will he founded the Nobel Prize. The careful selection process is done by the Swedish Academy and the good job is reflected by the fact that by today, the Nobel Prize became identical with excellence. The different fields, determined by Nobel, were the obvious science disciples of Physics, Chemistry, Biology and Medicine, plus Literature and Peace. Strangely, in 1969 Economics was added by the Bank of Sweden. Psychology is not awarded and if we think about all the disagreement among psychologists, then it is better this way. The really surprising thing is though, that Mathematics, the oldest science was not chosen by Nobel on purpose. Some of course would say that Mathematics is not a science, because not only itself but its subject also is merely a human creation and doesn't have to correspond to reality. One might even go further and claim that Mathematics is a mind game. One thing is sure! While Chemistry, Biology and Medicine are obvious narrowing applications of Physics, we couldn't place Mathematics in the beginning and say that Physics is an application of this. Not only the applied quantity of Math is extremely minute compared to the full body of Mathematics, but it is qualitatively very specific too. Reality filters out exactly the crucial and hardest problems and only a very narrow shadow of Mathematics is used in Physics. But we can be even more specific and without accepting that Mathematics is merely a mind game, still have to agree that derivability is the fundamental feature of mathematical truth. With the new Math, that is with Set Theory and Logic, this became even self-conscious. Computers might seem as a new reality that uses Math in a different way than Physics, but they are definitely not a door to mathematical reality. In fact, the missing Psychology is more close to this. So we have a "messy", or in my opinion a mysterious jungle, even behind the formal categories of subjects. If Nobel was paranoid against Mathematics, then we can say that mathematicians are neurotic against Physics. Mathematicians are usually smarter than "normal" scientists. Whatever a physicist can know, a mathematician knows it better, in wider perspective. This however doesn't mean that mathematicians can find new laws in Physics too. In fact, Newton was the last mathematician and physicist in one. This is so, because only after him did separate the two subjects. Since then the orientation to become a mathematician or physicist diversed radically. This doesn't mean that mathematicians can't take an interest in Physics, only that in spite of their smartness something is missing from them. Best example is the Poincare-Einstein controversy. Even if we accept the wildest exaggeration, that Poincare discovered Special Relativity before Einstein, it would seem amazing that he didn't go further to General Relativity, which involved much more Math, especially fields close to Poincare. The truth is that Poincare didn't grasp the new reality, while Einstein did! In spite of this, he needed the help of mathematicians to find his final equations. So Einstein had a very clear concept of his beliefs without the Math involved. This makes it sound as if he could have stated his theory without Math. But this is not so either! It is the mathematical formulas that bring about the predictable details! And only these predictable details can be verified by experiments and thus judged to be true and honored by a Nobel Prize. So, there is a basic, non mathematical but speculative stage in Physics, that creates the possible theories. Then the despised and unhonored Mathematics is exactly that selects from these wild possibilities, the real and honorable ones. I don't think that Nobel was aware of this, but there is a much bigger paradox too: Mathematics not only provides the thin shadow that helps to formulate equations and thus predictions, so that then experiments and thus verification can bring Nobel Prizes, but it also casts a much darker shadow on physical theories themselves. But this shadow is even wider than the whole science and Math, in fact it is wider than Psychology because it roots in the social mind, at the very essence of human existence.

This shadow is Formalism! It took my whole life to recognize this force behind all evil that penetrates not only our lives but also our most intimate thoughts and feelings. The faceless bureaucrat, the patronizing, self-assured judges, cops, teachers, the insensitive doctors are all full size figurines of the same force that makes the education and life itself dead. Because, the meaning of life is learning, while Formalism makes learning a tool for life.

I was already hating Formalism in Mathematics when I was still in total blindness about its scope and thus was a slave to it myself. So for me, Mathematics was the window through which the biggest lie was unmasked. But this was not a simple window. I skipped through this in the previous, Personal Introduction but I wanted to go back from life, from applied Mathematics, to the theory, to UCLA, when a coincidence brought LSD to me and made me fully conscious of my own part in recreating formalism. So right from the beginning, even when I admired Timothy Leary for unmasking the "Establishment", I had a deeper unmasking and I still had Mathematics too. That is the reason that I, unlike all other ex-hippies I met, never deterred from the path. My path was different; it was and still is the unmasking of Formalism. The social lies crystallize into unavoidable contradictions in science and education. While the economy of real life can justify a lot and wash away the critical revolutionary edge, if someone remains a child, then his possessions and lies remain infantile too. This is a worth sacrifice to remain sane and not to fall under the spell of Formalism. After these sentences I don't have to stress how much more is the shadow than something in Math or Physics. Still we have to return to that minute but undeniable contradiction and hope that some of the readers will use it for the only worth cause, to learn about himself or herself.

In Math, Formalism is the obsession with derivation! The critical word of course, is obsession. We might even say that it is an inappropriate word because derivation is such a positive thing so how could it be misused. And indeed, it's not what is found in the derivations but rather what is missing that reflects the obsession. To see it better lets remember that mathematical logic already made totally precise what the derivations are. In fact, even computers could verify if a derivation is correct or not. This doesn't mean that computers could find the derivations. They can only check what a talented mathematician found by inner feelings or hunches. It is similar as in the relationship of a chess play. A very simple computer can watch two people play and check if they step according to the rules. This has nothing to do with playing against a computer. The computer can't play by feelings, so it simply has to try out all possible reactions to the opponent and choose the "best" according to some pre-programmed value like loss of pieces and so on. But then, returning to a derivation, we see at once a big contradiction, namely that it only tells the end result and not how one obtained it. That's what happens at chess too! The opponent only realizes what we were about to do when he loses a piece or the game. In fact, a non-professional player, like me, could easily lose against a champion without even realizing what went wrong, what was his plan. Of course, if I recorded the play and analyze it repeatedly then sooner or later I have to learn from it. So as we see, learning is a different process than following the rules and accepting the loss. The bad Math books and education in general, simply play chess with the kids. It presents them with their stupidity. No wonder they hate it. Of course, the formalists could say that if a kid wants to learn then he should analyze the proofs or information in general. Go back, try, repeat and then facts will turn into learning. So there is no contradiction! Learning is a private process and education can only help, but not replace the will and patience of the individual. This sounds very convincing, because I made it so but if I am such a fanatic anti-formalist as I claimed, then there has to be a deeper contradiction. And indeed, there is. It's true, information can be turned into learning by the student and we can even evaluate a book by how much information it provides and thus how much learning it can induce. So in this sense there can be better or worse formalist books and a very good formalist book is still very good. As I mentioned in the Personal Introduction, I was a working a few weeks in the Stanford Math library. That's where I found Shoenfield's Mathematical Logic. A quite small sized book with incredible amount of information. A Formalist classic, a masterpiece. I also threw it to the wall many times. Then I picked it up, followed the details on paper and shouted: "Why didn't you tell this you bastard!" When somebody is so precise like him, then you can even accept that he didn't tell the tricks on purpose, for you to find out. But not all tricks are in the details, and not all formalist books are precise. When somebody pretends to explain but does it badly then it's worse that not explaining at all. This brings about the bigger tendency for the formalists: Not to explain, just to look precise.

The objective of communication must be helping. We are all the same, that's why we can help. Not all communications have the objective of helping though. If a cop stops you for speeding, then he informs you about why you will receive a fine. In a wider picture, he might be helpful to keep speeding down, but in the communication of informing you, he is simply a robot.
He is forced into the position of being a formalist and he might choose the roles of patronizing or skepticism and so on. A judge in his speech is even more entangled in Formalism. Work as a general condition is Formalism inducing or simply lie building. When somebody writes a book, in theory there is no forced Formalism. Everybody is free to write about what and how he wants to. And yet, 99 % of the written books are saying things that already have been said better. People write books for position and money. This already makes the students the losers because the chances of even finding the good Formalist books are negligible. But the situation is even worse because Formalism is different in the non-mathematical fields. We don't have the derivations as backbone so the books are a mere collection of over simplified and contradictory facts. What's worse, the contradictions are hidden. The main tendency is, not to be controversial, not to raise problems, sweep everything under the carpet of a pretend simplicity. But there is a specific actualization of this in Physics: Math is dragged in without its derivations, which is logical, after all it's only applied here. For Physics students, of course it is required to learn Mathematics with derivations. Which is stupid and useless as I mentioned in the Personal Introduction, regarding my brother. I also mentioned the famous Feinmann manifesto against it. But returning to the Physics books, here only the end results of Math is used but in full details for the obvious reason that these final formulas are the verifiable absolute truth. So the juggling of Math becomes mixed up with the physical content. The physicists are simply afraid of writing books totally without Math. Why? Because then, they would have to play with hypothetical theories, with all the problematic possibilities how to see nature, and then only at the end would have to say that from all these we have certain ways, namely mathematical predictions and experiments that choose this or that. So I, a theoretical mathematician, but also a fanatic anti-formalist must do what they can't or afraid to do, namely to write finally a good Physics book. This will also prove that you don't have to know any Math to understand nature. Which to me, only means that we only approached nature so superficially yet, that it can be explained without Math. Or more deeply: Where real Math comes into nature is still the deepest mystery.

First Book: Now You See It, Now You Don't

1.) The problems with "seeing"

We all know the sayings: "Seeing is believing" , "What you see is what you get". These mundane wisdoms were giving much deeper meanings in two sense: Firstly, theoretical educators like Polya, stressed again and again that, "No amount of knowledge can replace the proper visualization of concepts". So not only seeing is believing, but also, seeing is understanding. Secondly, when a survey was done about the thoughts of Nobel Prize winners on their own discoveries, they all stressed the importance of "visual ideas". One of the asked ones was Einstein. He also made a funny remark, that when somebody raised a question at a lecture, he realized that there is one more person added to the handful that understand Relativity. But then, looking at the really primitive introductory book that Einstein wrote with Infeld, we have to wonder why he didn't explain more. We could say that the greatest minds might not have the touch to explain their ideas, so they let this to be done by others. Unfortunately, those who write the textbooks, think that the best is to follow the discoverers in giving as little explanations as possible and stick to the facts. Then of course, we wonder even more why the theoretical educators don't criticize the flood of bad textbooks, one by one, instead of just giving correct guidelines. Obviously, it's easy to say that we have to be visual, but somehow it is difficult to explain visually. All this is part of the big tendency of Formalism that I mentioned in the two introductions. But behind all this problem of seeers not helping others to see, lies an even deeper problem of seeing itself. That's why our title is "Now You See It, Now You Don't". Indeed, not only well-prepared magic tricks, but also nature itself can deceive our eyes. The most obvious deceptions though come from the limitations of our eyes.
If we look up to the sky we don't see how far the stars, moon and sun are because our depth seeing is not working beyond the short, earthly distances. Even here, we use clues to see what we're suppose to and that's why the moon, down close to the horizon seems mush bigger. The opposite, very small distances are again beyond our vision, but there is a much more interesting limitation that we are less conscious of, namely the speeds of moving objects. We all know, how on a freeway we can get use to the high speed and then entering a city we can't believe how "slow" we have to go. But before the high speeds of technology we were already all surrounded with a very natural and daily fast motion, namely with the falling of objects. A well-known trick is to offer somebody a $100 bill, if he can catch it. So we put his two fingers parallel and in between we let the flattened bill fall. Nobody can close their fingers before the bill slides down. Amazingly, if we do the dropping ourselves, then we always catch, because our brain sends a signal to our fingers about our intention at once, while the other person has to see the note falling and then decide to grasp.
Of course, being visual doesn't mean that we have to use actual images. This is exactly where humans go beyond animals and scientific understanding is at the root of this specific human intelligence. So now I'll sketch the basic problems involved with this:
The three directions of intelligence are computer, animal and human.
Computers "live" in a "rigid" reality. One misentered keystroke will completely change the input. Animals, on the other hand, live in a "flexible" reality. What they see is never exactly the same as before, but they are still able to regard the variety of angles and sizes as the same input. Voice and face recognition by computers indicate that they could imitate flexible reactions and then the big question could be, what difference would still remain between the naturally evolved animals and the designed computers. Much more important to see first though the "designer", that is human intelligence. The most common opinion is that our big advantage is communication. Animals also communicate, but only about their own state of mind. This might reflect the outside world, like dangers or opportunities, but the intention of passing these is never present. Humans of course, teach their children about the world. The spoken language is just one particular way for this and not the vital point. Once the child accepts signals referring to the world, this opens up an empty book and all later learnings relate to each other. The human becomes able to live in an "interpreted" reality.

An animal when seeing something from the far, might not get a bigger visual content than would from a closer photograph, so the visual ability is there to recognize something from a photograph.
Yet, it will never happen!!!
Exactly by the good seeing, the photograph is regarded as a new reality and its amazing similarity to a real image is ignored. A little boy, on the other hand, will at once recognize his father from a picture. Not because his seeing is “so good”, neither because it is “so bad”, but simply because he lives in interpreted realities. Connecting images that are similar, not by reality, but by interpretation is the continuous way of existence in the human brain. So, this photograph recognition is a misleading direction because exactly the similarity is emphasized in it though, that is not the cause of it. The cause is interpretation and similarity is just a simplest way of this if the non similarities, like frame and background are ignored. An even more misleading situation is the recognition of mirror images. This, including the recognition of themselves can be achieved by animals. This is not interpreted reality though. A much better direction than similarities is abstraction. Here, the vital difference between human and animal can be pinpointed drastically: Rats are masters of labyrinths. They explore and learn fast. They can even learn a whole set of different labyrinths and remember them all. Yet, if there is a common rule in these labyrinths, it will be completely ignored. So a new labyrinth that follows the rule, must be learnt as a new, that is by exploring. The same is true for dolphins, under water. As a consequence, no rat or dolphin can learn how to play chess. The abstraction that the horse jumps in an L shape, is beyond animals.
Still, just as the evolutionary way of animal flexibility can be imagined to be simulated by designed computers, the same way we could imagine intelligent animals or computers. And indeed, the Planet of the Apes and the Terminator, did exactly this. More importantly, though the size and quality of animal brain is not drastically different from ours and computers could be increased to this level too. So since we can’t pinpoint the fundamental trick how early communications opens up the human brain, we leave this in the shadow, just as we leave the evolutionary development of instincts. One way of Formalism is to ignore mysteries.
Everybody can grasp how natural selection made the giraffe’s neck longer and the tiger’s tooth sharper. To say then that “similarly” the nest building is an obvious result of evolution is Formalism. An over simplification, we might say naïvely, but in fact it is an intentional deceit. Real lies are always aimed to keep the problems hidden, and can be conscious, but most of the time the person is lying to himself too. The professionals do it to be the exclusive knowers, the clowns who entertain the masses do it in ignorance, because they don’t give a damn anyway. So, both the official education and the entertaining popularizations accumulate the lies.
The ancestors of giraffes and tigers had neck and tooth. The better individuals had bigger chances, so longer necked giraffes and sharper toothed tigers became selected. But from what was the exact and perfect sequence of nest building selected? From a meaningless gathering of sticks? It doesn’t make sense. Something is missing. The most important thing is that when a new level of discoveries proves the previous ones, then these mysteries are not solved! The discovery of DNA proved without a shadow of a doubt that changes in the body can not be inherited, so it also proved the existence of evolution. Still, if we look at the details, it made the previous mystery even deeper. Indeed, the DNA describes the protein synthesis and so the building of the body. Firstly, the actual size and shape of the body is still a mystery, so here we have the so called morphological paradox. But much more importantly, the brain is part of the body. It is the most crucial part of the body and it contains the instincts. So does the DNA contain the instincts too? We have the nest building coded in the triplets? That’s even more absurd than before. The over simplified versions of Evolution, Genetics or any knowledge is not to help people, rather it is to keep them from understanding it. That’s the most important reason to fight Formalism. Problems are not hindering knowledge, they are the seeds of knowledge. Formalism wants to destroy these seeds.
The cunning deception and stupid blindness as two ends of the scale is an invalid way of looking at the puppets of Formalism itself. Intentionality is always there, but in multi layers. Not mentioning the main problems is never a forgetful accident.

Just today in a bookstore I glanced into a book on Piaget. Now, how can someone spend a lifetime on "discovering" the details of child development without reflecting on the basic mystery of communication, opening the interpreted realities. When I came home, on the TV, Oprah was asking Dr. Phil to help people cope with the consequences of September 11-th. On one level, we can just get pissed off about how this monster with her million dollar daily income and pampered dogs, could become the spiritual conscience of America. But the real truth is in the details, here again. Naïvely looking for reasons for why people could hate America so much is the best way to ignore the obvious, namely that America is an island of wealth. If this problem is not raised, then of course the more important related question can be ignored too, namely whether this wealth is due to the americans being better or rather due to exploiting the rest of the world. The truth is of course a mixture, but the ignorance doesn't want to cope with any percentage of fate coming from America itself. That we individuals are the cause of what is happening to us, is the most frequently used typically american stupidity, but for America as a whole it is forbidden to be applied. In fact, a religious leader interviewed right after September 11, stated that the killed people died not because of God's will, but the survivors were saved by God. "Sitcom Land Logic" applied in religion! If we dig deeper and deeper, we end up with Jefferson's principle of America being the fair, equal playground of natural inequalities. This honest formulation and the actual freedom in America indeed makes it the fairest playground of the world. The self consciousness of a social system is quite independent of its working. But it's not just the use of rhetoric and politics, it is facing the individuals themselves. This goes not only for America, in fact the number one enemy at present displayed the stupidest denial. Bin Laden said that all this was because of the suffering of palestinians and iraqi children. So not only he wanted to claim more than he intended, namely that the collapse of the buildings was meant to be, which is an obvious lie, but more importantly he claimed much less than his real motivations. He was afraid and unable to pinpoint his real hate of America, so he made phony fix points for it. This always returns as the wider question whether Islam requires an islamic state or not. Both sides try to soften the issue by saying that Islam is peaceful and only the extremists are the problem. The truth of course is, that Islam like all religions are self escalating, always ready to step to a higher totalitarianism. America's true religion is Jeffersonism and that's what keeps all religions under control. This of course also means that there is no religion and indeed, capitalism contradicts religion. In fact, the only good element of religion is the very opposition of capitalism. Marx, who opposed both capitalism and religion with an imaginary "Dialectical Materialism", in truth based his beliefs on a very non-dialectical idealism, namely that the value of something is not merely its market price. Today it's even more true than in his time. The absurdity of share prices dictated by the free market is apparent to anyone with an open mind and especially with open heart. Third world countries, especially farmers are exploited by the very existence of the world wide global markets. After the failure of socialism we have to accept this system and even China does so. This acceptance for the individual is two fold: Firstly, he works in this system so his work is valued by it and secondly, he consumes in it, so he buys at these prices. A new level is when he uses the system, that is invests. Everybody who invests is a capitalist, the old pensioner the same way as a billionaire. This new class definition destroys all of its edge and that's good because there is a different classification that is eternal. Marx, was not only right about believing in the values of things beyond the price, but also in that profit should not be the goal of individuals. While the market price became the most upfront reality of the present, the profit making crawled back into the shadows. How so, we might ask, after all if the share markets are open then making profit by them is also. We can make profit by gambling not only on the share market, but in a casino too. But these risk takers are actually the most honest profiteers only. To use what one has for getting more, here at least is not polluting. Of course, money is not enough to make money in the big picture. Exactly, would the defenders of capitalism say: The investments are turned into factories and jobs, what's more, into better and better products that can be consumed and make our lives better. But consumption doesn't make everybody happy. So some turn to something "deeper", collect books, believe in religions.

Others or even the same still want to be more secure and thus invest. Not only in shares but in values, real estate, houses to rent and so on.
Even our incomes can be increased if we negotiate our values. So lawyers, agents become a web of people living on others. All this boils down to the intentions. Schwarzenegger reflected upon the fact, that five million dollars didn't make him happier than three would have made. What he didn't reflect on was that his fees were negotiated by agents. By using agents our intention is hidden, we want to make more money. Money for nothing, using our advantage, exploiting everybody else. Only actions directed to reveal the truth to others are true giving. Charity is just the cover for exploitation. So the reason why America will be attacked again and again is simple. Because of envy. Now that the internal envy found out how easy it is to cause senseless destruction and how good it feels, it will never stop. The internal terrorism has awakened.
Returning to science, the instant ability of a child to accept interpreted realities, to recognize his father from a picture is the same that enables him to understand nature. Indeed, he can look at a picture taken though a microscope and see beyond the magnification of his eyes. He can look at a drawing of the solar system and see the earth from the outside. Also, he can see in seconds how the earth circles around the sun in a year and see in slow motion, how an apple falls from the tree. Like all second realities, these are automatically interpreted in their full and proper consequences for the individual. In other words, the picture from the microscopic or cosmic world is properly extending the immediate first reality.

2.) Bigger Pictures

In spite of the power of visualization that goes beyond sizes and speeds, the consequences are only interpreted and they don't determine where to look for new visualizations. Going from what we see already and to look at something else is the root of creativity, the extra plus, not inherent in all humans. The something else, of course, must relate to the old and well known, in fact it can put it in a whole new meaning. That's why I called this section the "Bigger Pictures", but I meant it in the abstract sense. Looking at an impressionist painting too closely, we might only see some spots of paints but then from a distance we see a flower, in fact we even feel its details too. But our abstract bigger picture means more like that we saw already a detailed flower from close and then, going to the whole, it turns out that it wasn't a flower but rather just a picture of a flower on a book or something else.

Aristotle collected the philosophical knowledge achieved, but also the scientific mistakes made before him. Actually, he didn't regard himself as seriously as the suppressive Catholic rule of the Middle Ages. The idea that maybe, not the sun goes around the earth, but in reverse is not new. But the first thing we have to see, is that these are not even the proper opposite of each other. Indeed, the sun "goes around" the earth everyday, while the earth goes around the sun every year. So the sun's "circling" around the earth is in reality caused by the spinning of the earth around it's own axis. This axis is a little bit tilted, not totally perpendicular to the plane of circling around the sun and that's why we have different angles of the sun throughout the year and so that's why we have seasons. This would be a very convincing argument for the earth's double motion, that is fast daily spin and slow yearly orbit, but this wasn't the one that brought up again the idea after the middle ages. It was rather the observed motion of the other planets.

Unlike the white stars that "turn around" every night the same, simply because of the spinning of the earth, the yellowish or wondering stars when observed for months or years will follow completely patternless loops and never return into perfect cycles. But all these motions come out nicely if we realize that they simply orbit the sun. The later name "planet" comes from the word "plane" and indeed watching the planets with a telescope we can see their surface. The moon's surface of course can be seen with the naked eye too, but with a telescope we can see the craters and that it is a ball. The exact sizes of the sun, moon and planets were not known but even just by a simple logic, if the planets orbit the sun then it must be much bigger, so why would it orbit our earth. Indeed, Giordano Bruno and Copernicus returned to the sun centered idea mostly by a belief in a simpler reality, though there were some ancient elements of sun worship, a "return to Rae" too. So the church was very upset and we all heard that Galileo was threatened with torture and kept in a house arrest. Less known is that Kepler, who lived in a freeer protestant country, sent letters to Galileo pushing him to step out for the truth. Kepler solved the last errors in a sun centered system by realizing that the orbits of the planets are not circles, but a little bit compressed ellipses. This means slower and faster sections in their paths that can be checked from the tables of planetary motions collected by Kepler's master Tycho Brahe. Galileo's reluctance was finally conquered when he was able to see the moons of jupiter with his primitive telescope. Before the threats, there was a very interesting letter sent from cardinal Bellarmino to father Foscarini, who followed Galileo's views. In this letter, Bellarmino says that the church has no problem with a sun centered mathematical model to describe the planetary motions more correctly. It is only the stubborn commitment to an absolute truth that leads to not only a contradiction with the church, but also to a confusion of simple people. The first part, definitely suggests that a simple idea of Relativity was conscious at the time. And why not? After all when sitting in a merry-go-round we all see how the whole world can turn around us. The deeper question of how to select the absolute reality from the possible mathematical models was not raised yet.

The church didn't care much to protect other mistakes of Aristotle that had no biblical meanings. Most importantly, and the closest to the earth-sun problem was the falling of objects. Aristotle claimed that gravitation, that is weight, is caused by the earth and heavier objects fall faster to the ground. Galileo invited all celebrities to his experiment at the leaning tower of Pisa, proving that a lead and wooden bowl fall together.

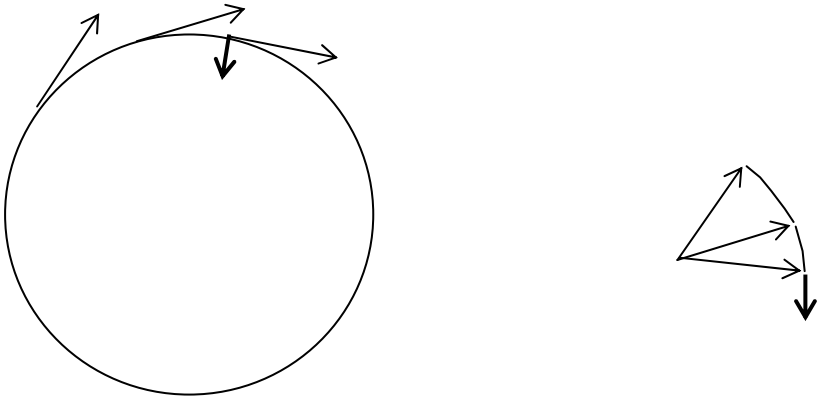
This meant that the heaviness and the falling are not connected so it was also questioning the plausibility that the heaviness as a force moves the falling objects.
He also showed that all objects start to fall slowly and then speed up.
Both of Galileo's experimental results, were proposed by others before him, but by derived arguments. Unfortunately, these arguments don't get into the education system even though they are actually thought experiments that are "bigger pictures" of the reality.
First of all, the second claim that objects speed up can be checked today by slow motion filming, which of course means fast recording, that is hundreds of frames per second and then played back at normal 24 per second. But without such technology we can also argue that objects dropped from higher, do bigger damage, both what is under them and in themselves. This crash must be caused by the speed, so it is bigger and bigger at falling. Lets observe that here the speed became a new effect beyond being a property of the motion. So the speed became physical from mathematical. A convincing way to show the increased speed is to drop a ball on somebody's head from different heights. Even "funnier" is the "proof" why all objects must fall together, because it is indirect, so we'll show an impossibility, namely present a contradiction from the assumption that heavier objects would fall faster. Imagine two twins jump out the window! They fall with equal speeds next to each other, but if they jump holding together they are twice as heavy so would fall faster. If they let go of each other, they slow down, then holding hands speed up again. What is a togetherness anyway? Could touching cause the change of speed? How absurd this is can be seen even more by imagining different objects falling "together" or "aside". For example, a hammer contains the heavy head and a lighter handle, still the full hammer should fall faster than just its head. But if we drop the head and the handle without attached, then the head should fall faster. So the handle stays behind. But then if they are attached, the handle pulls back, slows down the head, so the full hammer should be slower than just the head.
Kepler was a mathematical genius compared to Galileo and found the basic rules of planetary motions. But a genius of even bigger size was needed to combine Galileo's strange separation of weight and falling with Kepler's even stranger God-dictated planetary motions.
The solution is simple! The falling of the objects is the same as the motions of the planets. The planets are falling to the sun, round and round, orbiting it.
First of all, if it's so then why don't objects circle the earth, like planets do the sun?
Well they do! The oldest such object is the moon. If we drop a ball from a cliff but kick it forward too, then it will land much further ahead in the ocean. If we kick it very, very strongly it might fly ahead and disappear beyond the horizon. If we kick it even harder, it should it go around the earth and hit us from behind. But then of course, if we step aside, it is the same as if it were kicked again, so it will orbit the moon. Unfortunately, a ball will be stopped by some mountains. If we go to the highest mountain, Mount Everest, and use a cannon, then our cannon ball still wouldn't orbit because the air slows it down. But if we had a mountain that reaches higher than the atmosphere, it would work. That's how we send satellites from the carrying rockets. On the moon there is no atmosphere so we could launch satellites from cannons. This unification of falling and orbiting is beautiful, except still has nothing to do with neither Galileo's nor Kepler's results. Yes, we have to go into even bigger pictures.
First of all, the falling is caused by gravitation. The weight of the stone is that pulls it down. Yet, Galileo was right, that is falling doesn't depend on the weight.
So the weight causes it but it doesn't depend on the weight?
Yes, it sounds like a contradiction, but it isn't. Lets just look at the bigger picture, literally.
An apple falls from the tree. There is a big round earth, and there is a tiny apple tree on it.
An even tinier apple, is attracted by the earth, that's why it hangs always downwards. When the stem becomes weak enough it breaks, and the earth pulls the apple down to the ground. Our heuristic unification was that the planets are just like apples, and the sun is just like the earth. So then, attraction or gravitation is a common feature of everything. But then, the apple attracts the earth too. Not only, the earth pulls it downwards before the stem breaks, but also the apple pulls the earth up together with the tree, so it pushes the branch that holds it up too. Then, when it becomes free, not only the apple falls down, but the earth with the apple tree goes up too.

This sounds like the craziest proposition because we never experience the earth and apple trees move upwards. We might try an even crazier explanation for this, by saying that we don't see it because we are moving up together with the earth. Of course, this is incorrect because we should still feel the sudden motion. Instead, lets remember that we don't see bacterias either. So maybe while the apple is falling down, the motion of the earth with us and the apple tree, is so small that we simply can't detect it. And indeed, this is the case. Of course, to prove this, we have to know more about how a force moves something. If we push a car or a train, it is not the same. Obviously, a bigger object moves less by the same force. So then eureka! The force pulling down the apple and pulling up the earth is the same but the earth is billion, billion times bigger, so it must move that much slower. So by the time the apple falls down, the earth can only move a billion, billionth of the apple's fall. This is even smaller than a billionth of a bacteria. Still, our earth is continually shaking when around it people are moving and apples are falling. That's beautiful again but how does it solve Galileo's common fall, that is the independence from weight? Very simply! Imagine that a hammer had a ten times heavier head than its handle. This means that ten times bigger force is pulling is down too, but it also means that the head is ten times harder to move. So the head has ten times bigger pulling force and ten times bigger resistance against moving too. These cancel out each other and the end result is the common falling. We might even say that this is a natural phenomenon. Indeed, if a body like a litre water is increased five times, that is we take five litre water, then both its weight and its resistance must increase exactly five times. If however we take water and a five times heavier piece of metal, then this repeatedness argument is not working, in other words, why would a five times heavier, that is more gravitational matter be also five times hard to move? If we assume that all matter is made of one single kind of God Particles then the argument would be again correct, because then the mass of a body would simply be the number of God Particles and the gravitational or the resistance effect would be both proportional with the number of particles. This of course, only if the combination of the God Particles had no effect on the total. The Grand Unification theory still didn't find the God Particle. There, of course, the whole point is how such particle could bring about the diversity of known matter. So by simply assuming one with the feature of gravitation, resistance and addition doesn't really solve the real questions, but gives a fantasy solution to the common fall.

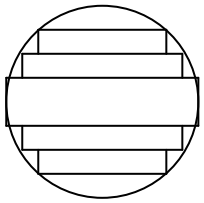
3.) Calculations

The law of common fall as the self canceling effect of gravitation and resistance and the continuous transition from earthly falls to planetary motions are the two most vivid triumphs of Newton's heuristic ideas. But actually, the most crucial step he made was something that seemingly disappeared by his big connection. This is the other law of Galileo beside the common fall, that is the accelerating of falling bodies. It is almost disappearing for the following reason: In the "cannon experiment" as the ball is shot further and further away, it will travel forward or rather around with the constant initial speed until the accelerating drop bumps it into the ground. However, at the final, perfect shot when it returns to the back of the cannon, there is no drop at all and so if we remove the cannon it will orbit forever with the same fixed initial speed. This is a totally false image though and all we have to remember is how Kepler had to go beyond Tycho Brahe. Brahe went halfway, still believing that the earth is the center, but the other planets go around the sun. Knowing Brahe's personality we can be sure that this was not due to a humble obedience to the church. Rather his detailed observations didn't support a simple sun centered picture with all circling planets. Kepler struggled with these anomalies and hit on the big solution that instead of circles, the planets orbit on ellipses. Most of these orbits are very close to circles but still the planets get a bit closer and further from the sun. When they are closer they move faster, when they are further they are also slower. How much this change of speed is, was explicitly stated by Kepler in one of his laws, but the point is that our above over simplified view of the cannonball becoming a satellite does not solve the planetary motions. And indeed, Newton did not over simplify the situation! In fact, he seemingly over complicated it by regarding the circular orbiting also as "acceleration". Of course, the planets go periodically faster and slower, so we need acceleration and deceleration, but we just use the word acceleration for both. At cars, acceleration definitely means speeding up, so it means a "break away" from this image to use it for "brakings" too. Otherwise, we would have to use "change rate of speed" or some other complicated expression. Even though the old fashioned word, acceleration became the general expression for the change rate of speed, the speed itself became generalized and for this a new word became used, namely velocity. The crucial new feature is that velocity includes the direction too! So while speed is just a number, namely the distance traveled under a unit time like second, velocity is a vector, an arrow with the length of the speed but with the direction in which the object would travel if all influence would stop. Hidden in this physical definition of velocity lies the assumption that is regarded as Newton's first law, namely that if a body is left without any influences, that is forces, then it will keep on traveling in the same direction and with the same speed. Today this is a quite natural and plausible law, because we are raised by the images of space travel. But just looking around on earth, we hardly see objects without influences. The gravitation of the earth, the frictions of surfaces or even of the air, influence everything. So at Newton's time, probably this was the biggest initial step, to imagine the empty space. Now if keeping the velocity is the normal and basic state of all things then the planets traveling around the sun and the moons around the planets are not basic even if they go in perfect circles. Indeed, even for circling with the same speed, the direction is always changing, so if the acceleration is the change of velocity, then we have acceleration even here. To include the direction of motion just to be able to say that the accelerated falling is also true for circling planets wouldn't be a real achievement. We have to be able to calculate the new accelerations that include change of velocity directions. This follows the line of logic that was already in the simple speed and acceleration. The speed is how much distance we do in a second. The acceleration is how much more speed we do in every second, so the acceleration is actually the speed of speed. The same way velocity is the change rate of space and the general acceleration is the velocity of the velocity. But above, we only mentioned the physical definition of velocity as the motion that the body keeps if left alone. Strangely, a more realistic definition is the mathematical one because it comes from the real, actual motion. This doesn't have to be on a straight line and with fixed speed, rather can be on a curved path and with speed up and slow down periods.

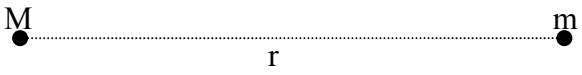
Still if we have perfectly captured a little past or future motion of a body before or after a point of time, then we can tell exactly how it would have traveled if left alone at that time. By "perfect capture", we mean not a 24 or even 1000 frame per second recording, but rather infinite many positions closer and closer to the place at the point of time. If at the investigated place and time, we can go back or forward, then dividing the displacement vector with the elapsed time, we get approximate average velocities around the place. If we have infinite many of these closer and closer to the critical place and time, then their limit is the actual velocity at the place and time. Of course, in reality we don't have infinite frame photography or video, but if the position was given as a function of the time by a mathematical formula then we can calculate infinite many positions and from them, infinite many approximate velocities. The crucial feature is that even though the space and time differences are getting smaller and smaller as we approach a place and time, their ratios, namely the displacement divided by the time difference is approaching a definite value. Even the fact that the direction of the velocity is touching the curve of the path can be seen from this mathematical definition. To work out the exact limits of such ratios in general is the task of the differential calculus. Usually it starts only with ratios of numbers but as we saw, Newton had to apply it at once for vectors. This was the big step that lead to the derivation of the Kepler laws.
In the simplest new meaning of acceleration, that is when the body is circling with a fixed speed, the mathematical formalism is quite simple and can be almost replaced with physical arguments. Indeed, the acceleration is the velocity of the velocity, so all we have to do is measure the velocity vectors from one point.



Since the velocities are the same in length, their arrow ends are on a circle again and so their velocity will be an arrow touching the velocity circle. So the acceleration is perpendicular to the velocity and thus the acceleration of a circular motion is always pointing to the center of the circle. This mathematical result is in perfect accordance with the physical meaning because a force from the center is that changing the direction of the velocities. This force itself can be a rope by which we spin something around or can be gravitation caused by a body around which an other one is orbiting. Even the size of this circular acceleration can be easily obtained from the velocity length, that is the speed and the radius of the circle.
Vector calculus became the essential mathematical field for physics and in text books it replaces the physical thoughts completely. The word calculus is used for differential and integral calculus. The differential direction was mentioned above as the limits of ratios. Integration is an even more basic way to get a limit value from infinite small values. Simplest case of this is calculating the area or volume of a shape that has curved lines or surfaces. All we have to do is cut the whole into more and more little pieces, bordered with lines and thus forming rectangles that can be calculated easily. Using more and more lines, the total of these easily calculable shapes will approach the whole, because we can approach the curved lines and surfaces with straight ones:

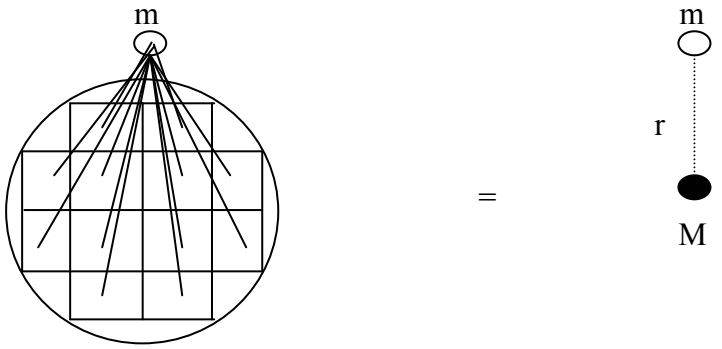


Instead of an area or volume we can integrate other quantities and then it's not just the shape that can make the complication and so even for a simple shape, how the quantity "adds up" or combines can be difficult. In fact, this was the first crucial application for Newton to apply his gravitational law for real planets. He had a simple law, how two masses should attract each other depending on their distance. Obviously if two bodies are further away then they attract less, but the actual law is that twice as far away they will attract four times less. In other words, the distance decreases the gravitation by the square. For two bodies far enough this has an exact meaning:



$$\text{gravitation} = \frac{M\,m}{r^2}$$

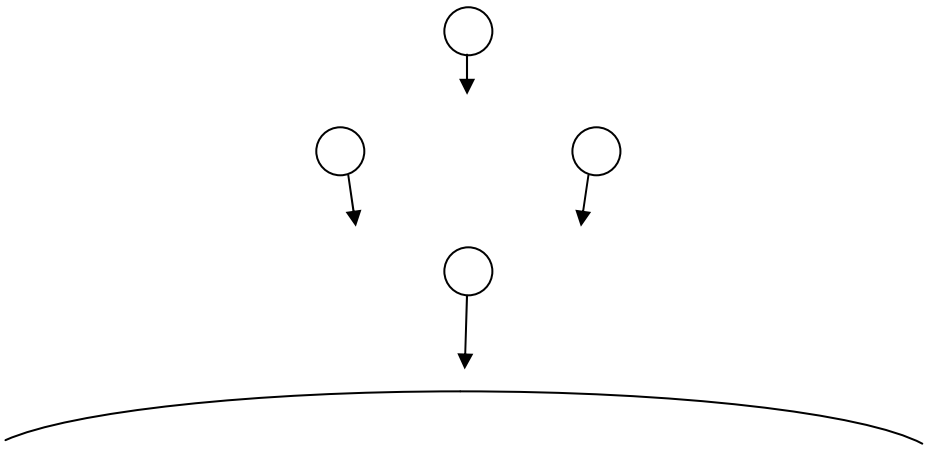
But what if the bodies are big? Or even if just one of them is big, like the earth and the other like an apple is very close to it. What distance is the r in this situation? We might take it for the distance from the surface of the earth, but that's quite stupid because the whole earth is just starting after that distance. The most logical could be the distance from the center of the earth and Newton wanted to prove this. This would mean that if we cut the earth into little bits, apply the simple law to them and somehow combine them, then it would give the same force as placing the whole mass of the earth into its center:



It took years for Newton to integrate the gravitation of a ball, but he succeeded. This of course led to the fantastic result, that the earthly gravitation can be expressed from the earth's mass and radius.

4.) Complications

The successful integration of the gravitational force of a ball might give the false impression, that the whole gravitational interaction between balls is as simple as if they were at their centers. But just because the force can be replaced to one point it doesn't mean that the effect can be too! We can even bring in the law of common fall to justify the common reactions from the parts. But lets remember that common fall simply meant that the fall is independent of the mass, but not of the place. Of course, Galileo dropped two objects next to each other and they fell together. But this was to demonstrate the unimportance of the two masses, not the two places. In fact, since both bodies fell radially towards the center of the earth, they had to get a little bit closer at the bottom of the Pisa tower than they were on the top when let go. Even more complicated is the situation if we drop two objects with a height difference under each other. We might feel that they fall together with keeping the same difference, but they don't. Indeed, the gravitation is bigger closer to the earth and thus the lower body travels a little bit longer distance than the upper under the same time. So strangely the distance between the two falling bodies is increasing. The law of common fall of course is true for more general planetary motions, which means that the masses of planets are immaterial for their motions. So was the cannonball's mass that we shot from Mount Everest. Only the speed determines when it will go around. This also means that if we shoot a space capsule, then the objects inside will travel the same way, in other words they float, just as if they were in empty space, ruled by Newton's first law. That's why this is called artificial weightlessness. We can achieve it closer to the earth for shorter times, for example when falling with an elevator or as they do it in practice, in a falling airplane. But this artificial weightlessness should be called approximate weightlessness, because just as at the two falling bodies above, we always have minute relative motions of the "weightless" bodies. These could only be measured by high tech equipments! Yet these minute forces still reveal that actually we are in a system that only moves together but is not perfectly without external influence. It's a catch-22 that the images I mentioned which we see on TV about weightlessness and thus help accepting Newton's first law are totally different in origin from the real conditions of that law. They should be space travels in really empty deep space, which we don't have yet. The minute forces inside a freefalling or orbiting lab, should be mentioned to get the real picture. Still our everyday Joe gets a better picture of what really happens than Jules Verne tried to give. He falsely thought that when we travel to the moon then only between the critical point will the earth's and moon's attraction cancel and thus lead to weightlessness. In truth the whole trip is in weightlessness and that particular point of true weightlessness is indistinguishable from the artificial weightlessness of the whole trip.
The basic picture of common fall distortions can be seen with four ping pong balls:



Thus, if these ping pong balls are dropped, then the top one falls slower than the lower one and thus their distance is increasing while the two side ones move closer and closer to each other.

But these minute differences of gravitation due to the minute differences of places are not only causing different motions, but also tensions if a body is forced to move together. So, if we connect our four ping pong balls with springs then holding the system in one place without even letting it go, those springs must expand vertically and compress horizontally. The same way every object around the earth is in constant stress. Of course, these internal tensions are so minute that the rigid forces overcome them easily without any effect.

Planets and moons are themselves objects in the gravitation of other planets and the sun. Here the differences of spaces are huge and thus these internal tensions too. But the real everyday experience that reveals the gravitational space differences, is the tides of the oceans. Unlike the imaginary springs that we used above to connect our four ping pong balls, the oceans are kept on the surface of the earth by gravitation itself. This is more flexible than springs, so if an external gravitation is applied to the earth including its oceans, then an obvious bump would form towards the outer body. This outer body is usually the sun or the moon, because the other planets are not big enough or too far away. So for example, if we could hold the earth standing in the sun's gravitational field, then the oceans would form a single tide towards the sun. Then if we'd let the earth go, it would fall towards the sun in "artificial weightlessness", that is the sun's gravitation would seem to disappear. The whole ocean would fall together with the earth according to the law of common fall and so the single tide towards the sun would soon disappear and instead it should be distributed all around according to the gravity of the earth. But as we said the artificial weightlessness is not perfect! The ocean towards the sun is experiencing a bigger gravitation, while on the opposite side a smaller one than the center of the earth. This would remove the oceans from the earth on both sides, but the earth's self gravitation doesn't allow this. So a compromise or equalization of the forces will be achieved by forming two tides, one toward and one opposite to the sun. This double tide would only last until the earth falls into the sun. Now, just as the falling of the cannonball on the earth can gradually change into an orbiting by giving it bigger and bigger "side kick", similarly we can change the straight falling of the earth into an orbiting. The "side kick" wouldn't affect the tides, so we would get an orbiting earth with two tides.

The moon is much smaller than the sun but much closer too and thus it leads to an even bigger tide effect than the sun. Since the moon and the sun are sometimes in the same or opposite direction from the earth, the two tides, the sun's and the moon's are continually increasing or canceling each other. On top of this the earth is spinning, which gives an additional delaying effect, so the actual tides are changing day to day and are not towards the moon or the sun.

The oversimplified explanation that the tides are caused because the moon or sun attracts the oceans is bad because it goes back to the pre-newtonian concept of forces. Of course, the sun attracts the oceans, but it attracts the earth too, so they could still be unaffected to each other. The truth is that the sun attracts the different parts of the earth differently and that causes tensions and tides. Most importantly, the oversimplified explanation does not account for the dual tides on the opposite side.

Instead of the gradual change from falling to orbiting, we can explain the tides even better by looking right at the orbiting:

It's quite plausible that if something is closer to the sun it has a bigger gravity and thus orbits faster. So, the ocean water towards the sun should orbit faster than the earth while the ocean water on the opposite side should orbit slower. In order to avoid this, a force is needed to reduce the sun's attraction of the oceans towards it, while a force is needed to increase the sun's attraction on the opposite side. The two tides are doing exactly this! The extra water level gives a gravitational force on these waters towards the earth's center. On the side towards the sun this gravitational force reduces the sun's gravitation, while on the other side it increases it. Thus both tides have the perfect total force to orbit together with the earth.

5.) Practical coincidences

I promised no math and I'll keep it, but now we turn to some very limited calculations.
These are exceptions, in a sense because I will not use them to support the theory, rather give feel of the sizes. Luckily, as if God had designed even this practical side of nature, all the necessary numbers turn out to be close to round values. It's strange that if something is perfectly true then we simply accept it as a law of nature, while if it is only true approximately then we at once regard it as pure coincidence. This is a new "intuitiveness" that wasn't always so, as I will show in the followings. Even more strangely exactly the newest physics of Relativity, gives a more accurate set of laws replacing the old Newton mechanics, so exactly today we could argue that "almost coincidences" might be a more primitive level of laws. But this is not convincing, because there is an other feature involved too, namely that laws describe infinite possibilities, while coincidences are always finite.
For example, our solar system consists nine planets. Four smaller solid ones close to the sun: Mercury, Venus, Earth and Mars. Further away four big gaseous planets are: Jupiter, Saturn, Uranus and Neptune. And finally a very small outmost solid planet is Pluto. In between the four close solid planets and the four gaseous ones lie the asteroid belt that contains a few big pieces. The biggest is Ceres and is famous for two reasons. Firstly, it was predicted by a "coincidence law" I'll mention soon and secondly its exact observable place was calculated by Gauss.
When Kepler discovered his planetary laws, he regarded not only those, but the whole solar system as a "Godly design". He only knew the first six planets, because Uranus, Neptune and Pluto were only discovered later with better telescopes. So beside the earth, there were five planets and already the greeks regarded this as a "logical" necessity, because the five planets plus the sun and the moon gives "exactly" seven moving objects on the sky. By the way, the sun and the moon look almost exactly the same size from the earth making solar eclipses just perfect. Kepler even connected an other old Greek obsession with the five planets, namely the five perfect solids. These are bodies that can be covered with identical symmetrical faces that connect in the same angles everywhere. Simplest is the tetrahedron covered with four triangles. So it's not a pyramid, because pyramids have five faces, the four triangles and the square base. If we put two such pyramids together on their base, we get an eight faced octahedron, with all triangle faces. Strangely, twenty triangles can also be put together in equal angles and this icosahedron has in every corner five faces joining, so to every corner the neighboring ones form a five sided pentagon. Even more strangely, pentagons themselves can be faces, namely twelve of them giving the dodecahedron. Finally, the simplest of the perfect solids, the cube is covered by six squares. The greeks couldn't prove that these five are the only possible perfect solids. Still, they associated the elements with these solids. Kepler hit upon a coincidence that he regarded a law, namely a way that the five solids correlate to the distances between the orbit sizes of the planets. Today, it sounds ridiculous, but we have to realize that even the other three correct laws that he discovered, he regarded only true due to the specific design of the planets. Now we know, thanks to Newton that those laws are true for any solar system that we might design or find. In fact, Kepler's second law is even true for any central motion, like for example a stone spinned around with a rope and then slowly pulled in and thus traveling on a spiral. The main thing is that these laws are regulating infinite possibilities unlike the finite coincidences of planetary distances. Strangely, an even newer "rule" was discovered for the planet distances that became known as Bode's law and it works like this:
Lets form a sequence from 0 and then 3 and its doublings, that is:

0 , 3 , 6 , 12 , 24 , 48 , 96 , 192 , 384

Now add 4 to all and divide them by 10:

.4 , .7 , 1 , 1.6 , 2.8 , 5.2 , 10 , 19.6 , 38.8

Amazingly, if 1 is the distance of the earth from the sun, then:

Mercury	0.4
Venus	0.7
Earth	1
Mars	1.5
Jupiter	5.2
Saturn	9.5
Uranus	19.2
Neptune	30.1
Pluto	39.4

So if we ignore the planet Neptune and the calculated distance 2.8 then the sequence of values give almost exactly the actual planetary distances. When Bode's law was stated, Uranus, Neptune and Pluto was not known yet. But soon Uranus was discovered and this lead to an even stronger belief in the law. So the existence of a 2.8 earth distanced planet from the sun was searched for. And guess what, the asteroid belt fits there and Ceres was indeed discovered later.
The weird coincidences continue if we look around the earth too. I mentioned the greek's obsession with using geometrical shapes for the elements. Earth, Water, Air and Fire were the obvious choices as elements, even though today we know that these are not elements at all, as will be explained in the second book. A fifth or sixth element was usually taken as the more abstract Ether and Life Force.
Air was accepted as some kind of matter in space from quite ancient times. Indeed, wind and breathing already appear as flowing air, but playing with bottles and tubes also showed that we can blow air into or suck out of space. Today, every child rediscovers through bubblegum and lollipop, how positive and negative pressure can be used. Pressure and suction seem similar to hot and cold but there is a vital difference that gives interesting clues too. For a baby, clearly hot and cold are absolute realities, but a bigger child will realize that we people have a temperature and simply the smaller temperatures are felt cold. This more mature relativistic concept of hot and cold still commonly comes in as a thought and even adults when open a fridge and feel the cold rushing out, regard this as reality. Thus the problem is given here by the contradiction of our thoughts and senses. Only further contemplation can solve this by realizing that losing temperature is itself a sensation. So eureka! There is no cold, only heat! Nothing comes out of the fridge! Instead heat rushes into it including from our body that we sense and falsely interpret as cold getting onto it because most sensations indeed come from outside. Now in the case of pressure and suction, the situation is more stubborn because it doesn't depend on us. It's true that the easiest way to create positive or negative pressure is with our mouth or rather lung, but we can also use pumps instead. Strangely, even though pressure is much simpler than heat, the recognition of how negative pressure is just a phantom like cold came quite late. People knew very well that under water there is more and more pressure as we go deeper because diving is an ancient activity. It was also observed that strangely and quite oppositely underwater, everything is lighter. Abstract thinking can make an easy connection between these two though. Indeed, if a body is immersed in water then the pressure at its top is smaller because it's less deep. So when we hold a stone underwater then the pressure all around the stone is not canceling out completely. From the left and right they equal but from the bottom there is a bit more pressure than from the top and this helps us to hold it. The strange thing is that even though the pressure is increasing with depth, this pressure difference is not because it only depends on the size of the body. We can also ask whether the position of the stone is important and first might think that holding a potato shaped stone in the upright position gives more lightening help than holding it on its side. But at once we can find out why this never happens. Indeed, when upright the pressure difference between the top and the bottom is bigger but it applies to a narrower body, while if we keep it sideway then the pressure difference is smaller but the area on which it works is bigger. So by realizing that the force is the product of the pressure and the area, we see that the actual uplifting force can be the same.

Still the perfect compensation of pressure and area is pretty weird and can only be shown by integration. The really amazing thing is though that here unlike at Newton's integration of the ball's gravity we can get the same result that the integration gives with a totally simple argument instantly. All we have to do is imagine that a stone we hold underwater were made of water itself. In other words, lets regard a potato shaped water part in the water! This obviously floats so we don't have to hold it at all regardless if it is positioned upright or lying. But then this means that the water surrounding this water potato gives exactly the uplifting force that compensates its weight. So then a stone potato is exactly lighter with the weight of an identical water potato. In short, every body in a liquid loses as much weight as its weight were if it were made of the liquid. So it's only the volume that counts, but not the position not even the shape and neither the depth. As we see, we not only solved the mystery of these independences but found the exact rule of the uplifting force. If something is lighter than its weight were made of the liquid then this uplifting force will be bigger than the weight, so the body will rise to the surface. In fact, it will rise above the surface of the liquid until the immersed volume compensates the whole weight. That's how a wood floats on water and how iron floats on mercury. The real amazing thing is that iron can float on water too! Indeed, a big empty iron sphere underwater has the uplifting force as the weight if it were made of water. This can be much more than the weight of the thin iron wall, so it will rise and immerse only the volume that gives a water amount equal in weight to the whole sphere. This ball if cut open is exactly a metal ship. Now the really amazing thing is that this whole logic we used for water can be applied to air instead. The two minor differences are that at the surface of the earth we are always at the bottom of the "air ocean" that is, the whole atmosphere is above us and we don't have around any objects that are lighter than air and thus would rise up. Still we have exceptions even for these too. Firstly, if we go up higher mountains we'll get less air pressure because there is less air above us and secondly, we do have some gases that are lighter than air, like helium used for floating balloons. The water-air analogy leads even back to our original theme of coincidences because their weight ratio is quite close to thousand. First of all, obviously water is the heavier and thousand is big enough so that the greeks couldn't measure the weight of air. But, thousand is not such a big number and even more importantly it is ten times ten times ten, so since volume is measured in cubes it only means ten times the edge. In fact, the above "quite close" means about one fifth error, but it goes in favor of the air. So, if we have a cube made of water and then a cube with ten times the edges filled with air then this "empty" cube will be one fifth heavier than the smaller one tenth edge water cube. Now lets remember that a metre is a big arm length while decimetre, its tenth, is about the distance we can hold between our thumb and fingers. One centimetre that is the hundredth of a metre is tenth of a decimetre is about how thick a finger is. Then we can choose the unit of mass by the water and it will make quite easy to calculate the air too. One cubic metre is a lot of water so this is quite heavy, namely a tonne. Instead of this "industrial" size, the one cubic centimetre that is a thimble full of water is called a gram. The in between, practical size is the cubic decimetre which we also call a litre, especially if it's in other shape like a bottle. This volume is obviously thousand times of the cubic centimetre, so this much water weighs thousand grams or in short a kilogram. Similarly, the tonne is thousand times of the kilogram because one cubic metre is a thousand cubic decimetre. For the sake of complicating things we can even tell the tonne in grams by two ways: Since a tonne is thousand kilograms and a kilogram is thousand grams we obviously get that a tonne is thousand times thousand, that is a million grams. But also directly a metre being hundred centimetre, a cubic metre is hundred times hundred times hundred, that is a million cubic centimetre. So regarding this in water a tonne is a million grams. It's quite unbelievable that one cubic metre can contain a million thimbles, in fact if they are allowed to slide into each other we could place even more!

As we saw, regarding air instead of water, we get a fifth more weight when upsizing the edge of a cube. For example, a cubic decimetre, that is a litre air weighs a fifth more than a cubic centimetre water, so it weighs one and a fifth grams. Also, a cubic metre air weighs a fifth more than a cubic decimetre, that is a litre water, so it weighs one and a fifth kilogram.

The roughly thousand ratio between the water's and air's weight is also practical for an other reason, namely makes it very easy to calculate the air's pressure on the surface of the earth. Obviously, we need to know how deep we are at the bottom of the "air ocean", that is how tall the atmosphere is. But unlike water, that is the same dense on the top and the bottom of the ocean, because can hardly be compressed, air gets rapidly thinner as we go higher and higher. Mount Everest, the tallest mountain is less than ten kilometres, that is ten thousand metres. There we can hardly breathe so obviously we have already a considerably thinner air. The atmosphere goes much much further up, but we'll get a quite accurate value of its weight if we only regard it as ten kilometre high, but without thinning and with thousandth of the weight of water. To calculate the pressure we have to choose a unit area and calculate the weight on that. Since air is pretty light lets use the smallest of our above units, namely a square centimetre. Thus, we have a ten kilometre tall column, which is only one square centimetre narrow. To calculate the volume, lets change the base and the height into the same unit, namely decimetre. A centimetre is one tenth of a decimetre, so a square centimetre is one hundredth of a square decimetre. On the other hand a kilometre is thousand metres, one metre is ten decimetres, so ten kilometres is hundred thousand decimetres. Multiplying the base of our column with its height, the one hundredth and the hundred cancel each other, so we get thousand cubic decimetres. But air is thousand times lighter than water so it is about the same weight as one cubic decimetre of water, which is a kilogram. So what we found is that on each square centimetre, the atmosphere is pushing us with a kilogram weight. In water, to get this pressure we only have to go ten metres deep because again one square centimetre is a hundredth square decimetre, but ten metres is exactly hundred decimetres. So a ten metre tall water column gives one cubic decimetre or a litre, weighing a kilogram. Of course, at this ten metre deep we have two kilograms pressure because the water pressure adds to the outside air pressure. Every ten metres we go deeper, we get a new extra kilogram pressure on a square centimetre. At hundred metres deep we'll have eleven, at thousand one hundred and one kilograms. So very deep the air's pressure is negligible to the water's. But this shouldn't fool us because the one kilogram per square centimetre air pressure is an incredible amount already here out of water. Indeed, our body has about ten thousand square centimetre surface so we are always carrying ten thousand kilograms, which is ten tonnes on us. How is this possible? Why aren't we squashed? Because we have the same pressure from the inside! So shouldn't we be crushed even more from both in and out? No, because the pressure goes into all little openings, through the blood, even to our cells. A good way to see this if we regard a simpler case, a soft toilet paper. A few kilograms could compress this into a flatter sheet, yet the hundreds of kilograms of air weight on it doesn't have any effect, why? Because the air goes in between the fluffiness and all the little hairy bits will have pressures from the sides and all around, and at those small sizes these hairy bits are relatively quite strong.

Now we can see how suction or negative pressure is merely a phantom just like coldness. If a pump like a syringe is pushed in completely and we close the opening, then pulling it out feels like we were working against the suction of the vacuum. In fact, nothing is pulling us back, rather the outside air pressure is pushing the barrel back. So, if the syringe is open, then though the hole the barrel has equal pressures on both ends, thus they cancel each other and we can easily slide it. We don't feel the atmospheric pressure! If the hole is closed, then only the back gets the atmospheric pressure and that's what we feel as suction. As we said, the atmospheric pressure is about the same as ten metres tall water pressure. This allows an absolute proof of our explanations. If we make a more than ten say fifteen metres long water container and fill it up with water, then turn it upside down and immerse its opening into the ocean, then the fifteen metres water column will go down to ten metres equalizing the outside pressure. The rest of the five metres will be vacuum. If we make the tube seventeen metres long, we'll have seven metres vacuum. So, the amount of the vacuum is immaterial because it has no effect, its only the ten metres water that counts. To execute this experiment would be extremely difficult, so Toricelli, a good friend of Galileo used mercury instead of water. This is much heavier and so only three quarters of a metre of it can equalize the atmospheric pressure. So a metre long glass tube filled with mercury and then upside down immersed into a tray or mercury will slide back

to three quarters of a metre, leaving a quarter metre vacuum.
As we see, the metre and gram are not only the official theoretical units of physics but are also very practical, so there shouldn't be any excuse not to accept them, yet America is still stuck with inches and pounds!
The units of time are less confusing because division of the day into hours, minutes and seconds, is uniformly accepted. Of course, the twenty-four hours, sixty minutes and sixty seconds are originating from old heritage, but somehow the end result, the second is quite lucky again. In what sense, we may ask, after all what other time do we experience than the day? Actually, we experience three important speeds, the slowest but still quite fast is the falling of bodies, the second is the speed of sound and the third is the speed of light. By the law of common fall, all bodies fall the same way if they are at the same height from the earth and as we saw the little differences in heights are negligible, compared to the radius of the earth. So practically all things fall the same way around us. But we also saw that they fall accelerating, so we can't even talk about speed of fall, only about the acceleration of falls. This means the speed increase in every unit time. So with seconds and metres this is the metre per second increase per second. This value is abbreviated as g from the word gravitation and amazingly its value is almost exactly ten. Thus a falling body increases its speed after every second with ten metres per second. So, if after t second its speed was v metre per second, then after $t + 1$ second it will be $v + g \approx v + 10$. Of course, this increase is continuous, not happening in jumps after every second and the $g \approx 10$ value merely indicates the end result. For example, when we drop something it will start with zero speed. After a second it usually reaches the ground and it never goes to ten metre per second speed. But even if it falls from a window and thus travels a full second, it wouldn't drop ten metres because that is the speed it reaches at the bottom. The actual speed was continually increasing from zero to this final ten. So the average speed was five and thus the falling distance was also five metres. The same way in general if an object falls t seconds, then its final speed is $g\,t \approx 10\,t$ and so its average speed is $5\,t$. Then using this for t seconds it should fall $5\,t\,t = 5\,t^2$. For example, in two seconds, the last speed is $10 \cdot 2 = 20$, the average is 10 and the fall is $10 \cdot 2 = 5 \cdot 2^2 = 20$ metres. In ten seconds the average speed is 50 and the fall is 500 metres, that is half kilometre. So, creating ten seconds of artificial weightlessness with an airplane requires a half kilometre drop. Even though the dropping speeds are quite fast increasing, they usually remain smaller than our above mentioned second basic speed, namely the speed of sound. Indeed, this is about one third of a kilometre in every second and a practical calculation will show how fast this is compared to drops: Suppose we want to measure the depth of a well. We drop a pebble in it and measure how many seconds pass till we hear its splash. Say we counted five seconds! This means 50 end speed, 25 average and thus 125 metres drop. But one may argue that we used an incorrect time because the sound of splash needed also some time to reach us. For the "incorrect" 125 metres this time delay would be less than half a second because a third kilometre is 330 metre in a second and 125 metres is less than half of this.
The third speed, the speed of light is really fast, namely almost a million times faster than sound, so it's not a third kilometre but a third of a million kilometres every second. To get a better idea or an other reference about this, we should remember that the light from the sun reaches the earth in eight minutes.
Both sound and light has a mysterious property that makes the world easy to experience, namely the property of fixed speed. For sound, if the different pitches would travel with different speeds then music from a distance would sound a chaos. Similarly, if different colored lights had different speeds, we would see very weird things. But the fixed speed of light goes far beyond colors. Indeed, in two directions: Firstly, it turned out that heat, radio, TV, X ray and a whole range of waves are all the same as light. Even more, it turned out that these electro-magnetic waves represent a basic speed that is even fix independently of the observer's motion who measures them. Thus to regard this speed as a displacement under certain time is quite misleading and rather space and time are united by this speed itself. The main thing is that this independence of light speed is not conceivable by neither of the previous two speeds, that is of mechanically moving particles or wave in a medium.

In mechanical speed, both the source and the observer play part. If we shoot a bullet from a gun moving forward then the bullet will be faster. If we move against a bullet, it will again seem faster. Sound clearly will not depend on the speed of source because as it leaves the source it travels in the medium like air or water that carries it. The observer can still run against or away from the waves and thus they will seem faster or slower. With light we have both kind of independence. So even if the empty cosmos had a mysterious medium like the ether that carries the light, it wouldn't explain the independence from the observer's motion. The only such explanation could be that the ether influences the observer's instruments to measure always the same speed.