# DOWNLOAD PDF WEIGHT AND WEIGHTLESSNESS

## Chapter 1 : SparkNotes: SAT Physics: Weightlessness

*Weight and Weightlessness is well worth the hunt for a surviving used copy. Complement it with Isaac Asimov on the value of space programs, an illustrated chronicle of the Space Race, and Neil deGrasse Tyson's moving Senate testimony on the spirit of space exploration.*

Zero Gravity What do you think about weightlessness? Weightlessness is just a state of unopposed motion under gravity. All you need to do to create weightlessness is drop something. When you do that, you remove all of those opposing forces and the object falls. Weightlessness comes from this conflation of these two slightly different ideas. On the one hand, you have the weight you learn about in school, as a gravitational attraction. You have the slightly subtle idea of weight as something you experience and feel. Before discussing weightlessness, we have to know, what is weight? Weight is nothing but the force due to gravity. So, it always has to point in a distinct way. When there is no opposing force, an object will fall and this, in fact, has a special state or name in physics. The object is in free fall as long as gravity is the only force move on it that means no opposing force from the ground, no air resistance so not falling at terminal velocity. Just need rest accelerating due to gravity without any other forces acting like this fellow as an example. So object orbiting the earth happen to be in freefall like the space shuttle in the image which as you can see always very fast. Weightlessness and why it happens? Weightlessness sense exist when all connecting forces are discarded. These senses are ordinary to any condition in which you are provisionally in a condition of free fall. When in free fall, the single force acting upon your body is the force of gravity which is a non-contact force. So, the force of gravity cannot be noticed without any other opposite forces, you have no feeling of it. You would notice weightless when in a state of free fall. If you go any amusement parks for riders of roller coasters and different rides in which riders are provisionally airborne and scoop out of their seats. Assume that you were raised in the top of a very high tower and then your chair was instantly drop out. As you and your chair drop towards the ground, you both accelerate at the same rate - g. The chair is movable, falling at the same rate as you, it is incompetent to push upon you. Standard forces only result from contact with steady, assisting surfaces. Gravitational force is the single force acting upon your body. There are no outermost objects touching your body and applying a force. As such, you would practice a weightless sensation. You would consider as much as you always do yet you would not have any feeling of this weight. Weightlessness is not only a feeling but also an unreal fit to separate who has lost weight. As you are free falling on a roller coaster ride in an amusement park, you have not directly lost your weight. Weightlessness has very small to do with weight and mainly to do with the existence of contact forces. Weightlessness in Physics I think physicists would normally say weightlessness is a consequence of freefall, but maybe with this view of weight, it would be better to say that freefall is a consequence of weightlessness. As soon as you stop exerting other forces on an object, it has no choice. Now suppose somebody cuts the elevator cable what I will see on the scale in my free fall down the elevator shaft. So, to say it as simply as I can any time you were able to move freely in response to gravity. It means there is nothing to restrain you from accelerating or decelerating. You are weightless or experiencing microgravity. The reason behind astronauts feel weightlessness In the early days of space exploration, NASA developed a technique to recreate zero gravity. The notorious vomit comet because the weightless effect of microgravity is nothing more than a continuous free fall. The thing is that the moon orbits the earth due to gravitational attraction. Actually the space station is only about kilometers away. But does it make sense that the big gravitational force is on you. The truth is the force on the astronauts is almost as much as the force on you. Then why are they floating while you are stuck here? So, as a result of that gravitational pull that they can actually keep orbiting the earth. There is some more assumption related to it astronauts in the space shuttle feel weightless because: It will cause the space shuttle to stay in orbit around the earth. Now while it weaker than on the surface it is not all that much weaker at the altitude of the space shuttle the gravity is about 8. Of course, if we are going to Jupiter or something then this would be closer to the correct answer. The astronauts are falling at the same rate of the shuttle. This is, in fact, the correct answer. If you are falling at the same rate as an object you are inside at that means there is no opposing force to let you feel your own weight, which means they have a sensation of weightlessness. We can also state that in which condition the net or a plain effect of gravity which is a gravitational force is zero. It is possible for a body to be completely weightless when it falls freely in a uniform gravitational field. This is because the weight is felt due to the contact force exerted by the surface on which the body is placed. During free fall this contact force becomes zero. For Example, this weightlessness can be felt while going down in an elevator or a roller coaster.

## Chapter 2 : Weightlessness | physics | calendrierdelascience.com

*Weightlessness is the complete or near complete absence of the sensation of calendrierdelascience.com is also termed zero-g, although the term is more correctly "zero g-force."It occurs in the absence of any contact forces upon objects including the human body.*

In the right half, it is in a uniform gravitation field. In Newtonian mechanics the term "weight" is given two distinct interpretations by engineers. Under this interpretation, the "weight" of a body is the gravitational force exerted on the body and this is the notion of weight that prevails in engineering. Near the surface of the earth, a body whose mass is 1 kg has a weight of approximately 9. Weightlessness in this sense can be achieved by removing the body far away from the source of gravity. It can also be attained by placing the body at a neutral point between two gravitating masses. Weight can also be interpreted as that quantity which is measured when one uses scales. What is being measured there is the force exerted by the body on the scales. In a standard weighing operation, the body being weighed is in a state of equilibrium as a result of a force exerted on it by the weighing machine cancelling the gravitational field. This force is called weight2. The force is not gravitational. Typically, it is a contact force and not uniform across the mass of the body. If the body is placed on the scales in a lift an elevator in free fall in pure uniform gravity, the scale would read zero, and the body said to be weightless i. This describes the condition in which the body is stress free and undeformed. This is the weightlessness in free fall in a uniform gravitational field. The situation is more complicated when the gravitational field is not uniform, or, when a body is subject to multiple forces which may, for instance, cancel each other and produce a state of stress albeit weight2 being zero. To sum up, we have two notions of weight of which weight1 is dominant. This is the intended sense of weightlessness in what follows below. A body is stress free, exerts zero weight2, when the only force acting on it is weight1 as when in free fall in a uniform gravitational field. Without subscripts, one ends up with the odd-sounding conclusion that a body is weightless when the only force acting on it is its weight. An apple weighs approximately 1 newton. This is the weight1 of the apple and is considered to be a constant even while it is falling. During that fall, its weight2 however is zero: When it hits Newton, the sensation felt by Newton would depend upon the height from which the apple falls and weight2 of the apple at the moment of impact may be many times greater than 1 N. It was great enoughâ€”in the storyâ€”to make the great man invent the theory of gravity. It is this weight2 which distorts the apple. On its way down, the apple in its free fall does not suffer any distortion as the gravitational field is uniform. Stress during free fall[ edit ] In a uniform gravitational field: Consider any cross-section dividing the body into two parts. Both parts have the same acceleration and the force exerted on each is supplied by the external source of the field. There is no force exerted by one part on the other. Stress at the cross-section is zero. In a non-uniform gravitational field: Under gravity alone, one part of the body may have a different acceleration from another part. This would tend to deform the body and generate internal stresses if the body resists deformation. Weight2 is not 0. Throughout this discussion on using stress as an indicator of weight, any pre-stress which may exist within a body caused by a force exerted on one part by another is not relevant. The only relevant stresses are those generated by external forces applied to the body. An object in a straight free fall, or in a more complex inertial trajectory of free fall such as within a reduced gravity aircraft or inside a space station , all experience weightlessness, since they do not experience the mechanical forces that cause the sensation of weight. Force fields other than gravity[ edit ] As noted above, weightlessness occurs when no resultant force acts on the object uniform gravity acts solely by itself. For the sake of completeness, a 3rd minor possibility has to be added. An electrically charged body, uniformly charged, in a uniform electric field is a possible example. Electric charge here replaces the usual gravitational charge. Such a body would then be stress free and be classed as weightless. Various types of levitation may fall into this category, at least approximately. Weightlessness and proper acceleration[ edit ] A body in free fall which by definition entails no aerodynamic forces near the surface of the earth has an acceleration approximately equal to 9. If the body is in a freely falling lift and subject to no pushes or pulls from the lift or its contents, the acceleration with respect to the lift would be zero. If on the other hand, the body is subject to forces exerted by other bodies within the lift, it will have an acceleration with respect to the freely falling lift. This acceleration which is not due to gravity is called " proper acceleration ". On this approach, weightlessness holds when proper acceleration is zero. How to avoid weightlessness[ edit ] Weightlessness is in contrast with current human experiences in which a non-uniform force is acting, such as: In cases where an object is not weightless, as in the above examples, a force acts non-uniformly on the object in question. Aero-dynamic lift, drag, and thrust are all non-uniform forces they are applied at a point or surface, rather than acting on the entire mass of an object , and thus create the phenomenon of weight. Tidal forces[ edit ] Two rigid cubes joined by an elastic string in free fall near a black hole. The string stretches as the body falls to the right. Tidal forces arise when the gravitational field is not uniform and gravitation gradients exist. Such indeed is the norm and strictly speaking any object of finite size even in free-fall is subject to tidal effects. These are impossible to remove by inertial motion, except at one single nominated point of the body. The Earth is in free fall but the presence of tides indicates that it is in a non-uniform gravitational field. This non-uniformity is more due to the moon than the sun. The total gravitational field due to the sun is much stronger than that of the moon but it has a minor tidal effect compared with that of the moon because of the relative distances involved. But its state of stress and deformation, represented by the tides, is more due to non uniformity in the gravitational field of the nearby moon. When the size of a region being considered is small relative to its distance from the gravitating mass the assumption of uniform gravitational field holds to a good approximation. Thus a person is small relative to the radius of Earth and the field for a person at the surface of the earth is approximately uniform. The field is strictly not uniform and is responsible for the phenomenon of microgravity. Objects near a black hole are subject to a highly non-uniform gravitational field. Inside the frame for example, inside an orbiting ship or free-falling elevator , unforced objects keep their velocity relative to the frame. Objects not in contact with other objects "float" freely. If the inertial trajectory is influenced by gravity, the reference frame will be an accelerated frame as seen from a position outside the gravitational attraction, and seen from far away the objects in the frame elevator, etc. As noted, objects subject solely to gravity do not feel its effects. Weightlessness can thus be realised for short periods of time in an airplane following a specific elliptic flight path, often mistakenly called a parabolic flight. It is simulated poorly, with many differences, in neutral buoyancy conditions, such as immersion in a tank of water. Zero-g, "zero gravity", accelerometers[ edit ] Zero-g is an alternative term for weightlessness and holds for instance in a freely falling lift. Zero-g is subtly different from the complete absence of gravity, something which is impossible due to the presence of gravity everywhere in the universe. Accelerometers can only detect g-force i. They cannot detect the acceleration associated with free fall. Humans experience their own body weight as a result of this supporting force, which results in a normal force applied to a person by the surface of a supporting object, on which the person is standing or sitting. In the absence of this force, a person would be in free-fall, and would experience weightlessness. In the pose adopted in the accompanying illustration, the shoulders carry the weight of the outstretched arms and are subject to a considerable torque. A common misconception[ edit ] A common conception about spacecraft orbiting the earth is that they are operating in a gravity free environment. A geostationary satellite above a marked spot on the Equator. An observer on the marked spot will see the satellite remain directly overhead unlike the other heavenly objects which sweep across the sky. Spacecraft are held in orbit by the gravity of the planet which they are orbiting. In Newtonian physics, the sensation of weightlessness experienced by astronauts is not the result of there being zero gravitational acceleration as seen from the Earth , but of there being no g-force that an astronaut can feel because of the free-fall condition, and also there being zero difference between the acceleration of the spacecraft and the acceleration of the astronaut. Space journalist James Oberg explains the phenomenon this way: It keeps satellites from flying straight off into interstellar emptiness. Satellites stay in space because of their tremendous horizontal speed, which allows themâ€"while being unavoidably pulled toward Earth by gravityâ€"to fall "over the horizon. Speed, not position or lack of gravity, keeps satellites in orbit around the earth. A geostationary satellite is of special interest in this context. Unlike other objects in the sky which rise and set, an object in a geostationary orbit appears motionless in the sky, apparently defying gravity. In fact, it is in a circular equatorial orbit with a period of one day. Thus, in the point of view or frame of the astronaut or orbiting ship, there actually is nearly-zero proper acceleration the acceleration felt locally , just as would be the case far out in space, away from any mass. It is thus valid to consider that most of the gravitational field in such situations is actually absent from the point of view of the falling observer, just as the colloquial view suggests see equivalence principle for a fuller explanation of this point. However, the gravity nevertheless is considered to be absent. Rather, objects tend to follow geodesic paths in curved space-time, and this is "explained" as a force, by "Newtonian" observers who assume that space-time is "flat," and thus do not have a reason for curved paths i. In the theory of general relativity, the only gravity which remains for the observer following a falling path or "inertial" path near a gravitating body, is that which is due to non-uniformities which remain in the gravitational field, even for the falling observer. This non-uniformity, which is a simple tidal effect in Newtonian dynamics, constitutes the " microgravity " which is felt by all spacially-extended objects falling in any natural gravitational field that originates from a compact mass. The reason for these tidal effects is that such a field will have its origin in a centralized place the compact mass , and thus will diverge, and vary slightly in strength, according to distance from the mass. It will thus vary across the width of the falling or orbiting object.

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## Chapter 3 : Weightlessness - Wikipedia

*Weight & Weightlessness Worksheet Your weight is the force of earth's gravity acting on you. Your apparent weight is the weight you "feel". weight will be.*

What is the difference between mass and weight? Mass is the size of an object and weight is the amount offorce gravity has on an object. Mass is an intrinsic property of a body, as it remains the sameeverywhere in the uniâ€¦verse. Weight is variable due to change in the magnitude of thegravitational force applied by the earth. Mass is scalar and has no direction dependency Weight is vector and is directed towards the center of the earth Mass is constant all the time. It is measured in kilograms kg. Weight is mass X gravity, so on Earth 1 gram equals 10 Newtons themeasure of Weight. Weight depends on gravity. So both mass and weight will typically usekilograms. Mass is a property of matter, it is a measure of how much stuff is in a lump of matter A lump of matter has the same mass, no matter where it is in the universe. Mass gives matter its inertia and the inertia of a lump of matter is the same, no matter where it is in the universe. Weight is a measure of the heaviness of an object - which is the result of the force of attraction between to lumps of matter mass. When a lump of matter is placed in a gravity field it will be pulled towards the centre of that gravity field and the force of that pull is the weight of that matter gravity and mass are related. However its weight will be different in different gravity fields. Therefore weight is a measure of the attraction of the earth gravity for a given mass, and mass is the amount of matter that an object contains. Without gravity, as in outer space or in free fall , any mass has negligible weight. Mass is the amount of matter in an object. Weight is the degree to which gravity affects an object. Weight depends on both the mass of the object and the strength of gravity in its location. Weight is a function of gravity, thus in zero gravity or microgravity, a person is weightless. Mass is an intrinsic property of matter and independent of gravity. This affects things like momentum a massive object in zero gravity is weightless, but still takes the same effort to start moving, change directions, or stop. Thus, you have a different weight on Earth, the Moon, or Mars, but the same mass. Weight is how much gravity is pulling you to the center of the earth and mass is how much is in you. Mass the amount of matter stuff an object is made of. In the case of living objects, it could also depend on how much the object eats over a period of time. Weight is the force of gravity between two masses. It depends on the amount of mass in both masses, and how far apart they are. Mass is the matter you are made of. It stays the same wherever you are Weight is the force of an object from gravity. Weight changes depending on where you are. What are the differences between weight and mass? Mass relates to the amount of matter in an object and is measured in grams and kilograms as well as many other units. Mass - is the amount of matter in an object Weight - the magnitude of gravitational force acting on an object How they are measured: Mass - balance Weight â€¦- scale Unit of measurement: Mass - grams g and kilograms kg Weight - newtons N.

## Chapter 4 : Weight And Weightlessness by Franklyn Mansfield Branley

*Weight is the force of gravity, but we've already seen that gravity decreases the farther you get from the Earth. So the reading on the scale should now be smaller. And yet, if the teleporter was functioning correctly, you haven't changed - there is still the same amount of 'stuff' (matter) in your body as there was previously.*

Written by tutor Thomas L. The concept of weightlessness is one that is easily misunderstood by most people until they have been exposed to introductory physics for the first time. Strictly speaking, this statement would be true if not for the fact that the force of gravity can never be exactly equal to zero see the lesson on gravitation for more details about the formula for the force of gravity. This is because gravity has an effect even over incredibly long distances, despite the fact that it is the weakest of the fundamental forces. So if the force of gravity is never equal to zero, how can anything be considered weightless? The more force I feel from the ground or any other surface , the "heavier" I feel. This force that I feel from a contacting surface is commonly referred to as the normal force. In general, there is usually a force like gravity that pushes or pulls the body toward the surface. In response, the surface pushes back on the body in question. We can determine how hard this surface pushes by looking at the net force. For example, if I am standing on a level surface and not accelerating in any direction, the net force on my body is zero, which implies that the normal force is equal in magnitude to the force of gravity see figure. To summarize, the normal force is responsible for the feeling of weight, and the magnitude of the normal force can depend on the direction and magnitude of the net acceleration. Consider the following scenario: The scale is used to measure how hard the bottom of the elevator is pushing against you. If the elevator is accelerating down negative net acceleration , we get the equation Solving for N gives us which is smaller than your weight on the ground. This is because I can sense that I am moving relative to my surroundings. If we return to the elevator example, I feel weightless in a falling elevator because I can "float" inside the elevator, which is simply because we are both falling at the same speed and have the same net acceleration. Both pushing and pulling forces and relative velocity are interrelated events that occur simultaneously to produce the feeling of weightlessness. Therefore, we can refine our earlier statement about the relative velocity of the object to its surroundings in this way: This concept clearly explains why astronauts in the International Space Station are weightless. Intuitively, many people may say that there is "no gravity in space" or that the strength of gravity in orbit is much smaller. In fact, the opposite is true. Without gravity, satellites would not be able to orbit around the earth and would simply move in straight line into space. The reason why astronauts feel weightless is because they are accelerating toward the earth at the same rate as the vehicle they are in. An ant is sitting on a tennis ball that is thrown directly upwards into the air. Which of the following statements is true? The ant feels weightless between point a and c as the ball rises up. The force of gravity is zero at point b C. The force of gravity is nonzero at point a, gets smaller at point b, and gets bigger at point c D. The ant feels weightless between point b and c as the ball falls down. More than one statement is true F. None of these statements are true The answer is E. Statements A and D are both true because the normal force from the ball acting on the ant is zero as the ball moves up and down. An ant is in a car of mass m that drives over a hill with a radius of curvature r at a constant velocity v. How fast must the car go in order to feel weightless at the top of the hill?

## Chapter 5 : What is the difference between weight and weightlessness

*Weightlessness is the absence of the sensation of weight. Weightlessness can be achieved in one of two ways. Go to a place distant from any object so that the force of gravity is nearly zero -- This is true weightlessness.*

Weighing grain, from the Babur-namah [9] Discussion of the concepts of heaviness weight and lightness levity date back to the ancient Greek philosophers. These were typically viewed as inherent properties of objects. Plato described weight as the natural tendency of objects to seek their kin. To Aristotle , weight and levity represented the tendency to restore the natural order of the basic elements: He ascribed absolute weight to earth and absolute levity to fire. Archimedes saw weight as a quality opposed to buoyancy , with the conflict between the two determining if an object sinks or floats. The first operational definition of weight was given by Euclid , who defined weight as: As medieval scholars discovered that in practice the speed of a falling object increased with time, this prompted a change to the concept of weight to maintain this cause effect relationship. Weight was split into a "still weight" or pondus, which remained constant, and the actual gravity or gravitas, which changed as the object fell. In the 17th century, Galileo made significant advances in the concept of weight. He proposed a way to measure the difference between the weight of a moving object and an object at rest. Ultimately, he concluded weight was proportionate to the amount of matter of an object, and not the speed of motion as supposed by the Aristotelean view of physics. Weight became fundamentally separate from mass. Mass was identified as a fundamental property of objects connected to their inertia , while weight became identified with the force of gravity on an object and therefore dependent on the context of the object. In particular, Newton considered weight to be relative to another object causing the gravitational pull, e. This allowed him to consider concepts as true position and true velocity. He considered this a false weight induced by imperfect measurement conditions, for which he introduced the term apparent weight as compared to the true weight defined by gravity. Relativity[ edit ] In the 20th century, the Newtonian concepts of absolute time and space were challenged by relativity. This led to an ambiguity as to what exactly is meant by the force of gravity and weight. A scale in an accelerating elevator cannot be distinguished from a scale in a gravitational field. Gravitational force and weight thereby became essentially frame-dependent quantities. This prompted the abandonment of the concept as superfluous in the fundamental sciences such as physics and chemistry. Nonetheless, the concept remained important in the teaching of physics. The ambiguities introduced by relativity led, starting in the s, to considerable debate in the teaching community as how to define weight for their students, choosing between a nominal definition of weight as the force due to gravity or an operational definition defined by the act of weighing. This is a horizontal acceleration of 5. Combined with the vertical g-force in the stationary case the Pythagorean theorem yields a g-force of 5. Several definitions exist for weight, not all of which are equivalent. However, some textbooks also take weight to be a scalar by defining: Sometimes, it is simply taken to have a standard value of 9. A spring scale measures weight, by seeing how much the object pushes on a spring inside the device. On the Moon, an object would give a lower reading. A balance scale indirectly measures mass, by comparing an object to references. On the Moon, an object would give the same reading, because the object and references would both become lighter. Operational definition[ edit ] In the operational definition, the weight of an object is the force measured by the operation of weighing it, which is the force it exerts on its support. So, there exists opposite and equal force by the support on the body. Also it is equal to the force exerted by the body on its support because action and reaction have same numerical value and opposite direction. This can make a considerable difference, depending on the details; for example, an object in free fall exerts little if any force on its support, a situation that is commonly referred to as weightlessness. However, being in free fall does not affect the weight according to the gravitational definition. Therefore, the operational definition is sometimes refined by requiring that the object be at rest. The operational definition, as usually given, does not explicitly exclude the effects of buoyancy , which reduces the measured weight of an object when it is immersed in a fluid such as air or water. As a result, a floating balloon or an object floating in water might be said to have zero weight.

## Chapter 6 : Weightlessness | Define Weightlessness at calendrierdelascience.com

*Former silver-medal boxing champion, sign painter, uranium prospector, and soldier, Paul began college at the age of 27, with the help of the GI Bill.*

Energy Relationships for Satellites Astronauts who are orbiting the Earth often experience sensations of weightlessness. These sensations experienced by orbiting astronauts are the same sensations experienced by anyone who has been temporarily suspended above the seat on an amusement park ride. Not only are the sensations the same for astronauts and roller coaster riders , but the causes of those sensations of weightlessness are also the same. Unfortunately however, many people have difficulty understanding the causes of weightlessness. What Do You Believe? The cause of weightlessness is quite simple to understand. Consider the following multiple choice question about weightlessness as a test of your preconceived notions on the topic: Test your preconceived notions about weightlessness: Astronauts on the orbiting space station are weightless because See Answer None of these are appropriate reasons for the weightless sensations experienced by orbiting astronauts. Continue reading this part of Lesson 4 to find out the real reason. If you believe in any one of the above statements, then it might take a little rearrangement and remapping of your brain to understand the real cause of weightlessness. As is the case on many topics in Physics, some unlearning must first be done before doing the learning. So if you do have a preconception or a strong preconception about what weightlessness is, you need to be aware of that preconceived idea. And as you consider the following alternative conception about the meaning of weightlessness, evaluate the reasonableness and logic of the two competing ideas. Contact versus Non-Contact Forces Before understanding weightlessness, we will have to review two categories of forces - contact forces and action-at-a-distance forces. The upward chair force is sometimes referred to as a normal force and results from the contact between the chair top and your bottom end. This normal force is categorized as a contact force. Contact forces can only result from the actual touching of the two interacting objects - in this case, the chair and you. The force of gravity acting upon your body is not a contact force; it is often categorized as an action-at-a-distance force. The force of gravity does not require that the two interacting objects your body and the Earth make physical contact; it can act over a distance through space. Since the force of gravity is not a contact force, it cannot be felt through contact. You can never feel the force of gravity pulling upon your body in the same way that you would feel a contact force. If you slide across the asphalt tennis court not recommended , you would feel the force of friction a contact force. If you are pushed by a bully in the hallway, you would feel the applied force a contact force. If you swung from a rope in gym class, you would feel the tension force a contact force. If you sit in your chair, you feel the normal force a contact force. But if you are jumping on a trampoline, even while moving through the air, you do not feel the Earth pulling upon you with a force of gravity an action-at-a-distance force. The force of gravity can never be felt. Yet those forces that result from contact can be felt. And in the case of sitting in your chair, you can feel the chair force; and it is this force that provides you with a sensation of weight. Since the upward normal force would equal the downward force of gravity when at rest, the strength of this normal force gives one a measure of the amount of gravitational pull. If there were no upward normal force acting upon your body, you would not have any sensation of your weight. Without the contact force the normal force , there is no means of feeling the non-contact force the force of gravity. Weightless sensations exist when all contact forces are removed. These sensations are common to any situation in which you are momentarily or perpetually in a state of free fall. When in free fall, the only force acting upon your body is the force of gravity - a non-contact force. Since the force of gravity cannot be felt without any other opposing forces, you would have no sensation of it. You would feel weightless when in a state of free fall. These feelings of weightlessness are common at amusement parks for riders of roller coasters and other rides in which riders are momentarily airborne and lifted out of their seats. Suppose that you were lifted in your chair to the top of a very high tower and then your chair was suddenly dropped. As you and your chair fall towards the ground, you both accelerate at the same rate - g. Since the chair is unstable, falling at the same rate as you, it is unable to push upon you. Normal forces only result from contact with stable, supporting surfaces. The force of gravity is the only force acting upon your body. There are no external objects touching your body and exerting a force. As such, you would experience a weightless sensation. You would weigh as much as you always do or as little yet you would not have any sensation of this weight. Weightlessness is only a sensation; it is not a reality corresponding to an individual who has lost weight. As you are free falling on a roller coaster ride or other amusement park ride , you have not momentarily lost your weight. Weightlessness has very little to do with weight and mostly to do with the presence or absence of contact forces. When an object is in a state of equilibrium either at rest or in motion at constant speed , these two forces are balanced. The upward force of the scale upon the person equals the downward pull of gravity also known as weight. And in this instance, the scale reading that is a measure of the upward force equals the weight of the person. However, if you stand on the scale and bounce up and down, the scale reading undergoes a rapid change. As you undergo this bouncing motion, your body is accelerating. During the acceleration periods, the upward force of the scale is changing. And as such, the scale reading is changing. Is your weight changing? You weigh as much or as little as you always do. The scale reading is changing, but remember: The scale is only measuring the external contact force that is being applied to your body. Now consider Otis L. Evaderz who is conducting one of his famous elevator experiments. He stands on a bathroom scale and rides an elevator up and down. As he is accelerating upward and downward, the scale reading is different than when he is at rest and traveling at constant speed. When he is accelerating, the upward and downward forces are not equal. But when he is at rest or moving at constant speed, the opposing forces balance each other. Knowing that the scale reading is a measure of the upward normal force of the scale upon his body, its value could be predicted for various stages of motion. The interaction of the two forces - the upward normal force and the downward force of gravity - can be thought of as a tug-of-war. The net force acting upon the person indicates who wins the tug-of-war the up force or the down force and by how much. A net force of N, up indicates that the upward force "wins" by an amount equal to N.

# DOWNLOAD PDF WEIGHT AND WEIGHTLESSNESS

## Chapter 7 : Weightlessness and Satellites | Wyzant Resources

*Gravity, Weightlessness, and Apparent Weight In my classes, I like to bring up the question: Why do astronauts float around in space? The most common response to this question is that they float.*

What is the difference between weight and mass? Why do you weigh less on the moon? If a certain type of physicist were reading that section, I might be in jail by now. At this point, I should placate the purists out there and be a bit more precise about all of these terms. Imagine stepping onto a simple bathroom scale and seeing the little needle turn. First of all, your body is pulled downwards by the gravitational attraction between yourself and the Earth. A coiled spring inside the scale compresses, providing you with more and more upwards force the more it is compressed. The whole thing adjusts itself, with a bit of wobbling, until it stops at a point when the upwards force from the spring is exactly equal to the force of gravity pulling you down. We know from the previous section that objects of greater mass experience a greater force of gravity, so heavier objects will stabilize with a more tightly compressed spring and thus a higher scale reading. It measures the amount a spring compresses, which measures the amount of gravitational force acting on your body. This is the key point: But as we now know, the strength of that force depends on both your own mass and the mass of the Earth, as well as the distance from you to the center of the planet. Now grab the nearest scale and hop into a teleporter which sends you to the top of Mount Everest and stand on the scale again. What do you notice? So the reading on the scale should now be smaller. On Earth, the two words are interchangeable for everyday use, because gravity has about the same strength everywhere on the surface of the planet. If an object has twice the mass, it will have twice the weight. But your weight changes depending on where you are in the universe. This is due to the fact that the moon has a much smaller mass than the Earth does and so exerts a smaller gravitational force on you. Unless you survived only on freeze-dried potatoes and Tang on the way up. Mass is a property of all matter 1. It has two main effects: Today, physicists are actively researching what may seem like an unanswerable question: One part of a possible answer to this question requires the existence of a particle called the Higgs Boson check out a great animation about the Higgs in this previous post! As I write this, scientists in Europe are busily smashing particles together at the Large Hadron Collider, hoping that the Higgs boson might pop out of the resulting collisions. For now, it seems that mass is just something we all have to deal with. The most commonly known of these is the photon, which is the particle that light is made out of. Because photons are not restricted by the limitations of mass, they only ever move at one speed â€” the fastest speed anything can move at, the speed of light. But we do have two ways of experiencing weightlessness, which is entirely different but still a lot of fun. The easiest way to feel weightless is to go into outer space. As we already discussed, once you get far enough from any big planets or moons, there will be no strong gravity forces pulling you in any direction. You will simply float. For example, a series of canals, comprising the vestibular system inside your inner ear, contain a fluid which moves around and tells your brain about how your body is accelerating. Your limbs and inner organs float too, of course â€” even your blood accumulates more in your brain than usual, as I mentioned in the introduction to this chapter. Because the elevator and everything inside it all fall with the same rate of acceleration just like the hammer and the feather from earlier , and because the apple cannot accelerate downwards more quickly than the elevator, the apple will not drop towards the floor. Everything around you and everything in your body is falling at exactly the same rate, and so you feel weightless: To be clear, both you, the apple, and the fluids are not actually weightless â€” there is still a force of gravity pulling everything down. But you have no way to feel or detect this force unless there is a window that shows the outside world zooming past. We can extend this line of thought to a few more related situations. But what about standing in an elevator that is accelerating downwards at some other rate? This accounts for the strange swooping sensation you feel in your stomach when an elevator starts going down. Similarly, when an elevator starts accelerating upwards, you feel a bit heavier. Once an elevator has started to go down, it moves at a constant velocity for most of the time until it stops. But moving downwards at a constant velocity is very different from accelerating downwards: For about 25 seconds during each six-mile-long arc, the passengers move in freefall with the plane and thus feel weightless. Weight is the amount of gravitational force acting on an object. It changes depending on where the object is located. Mass is the amount of matter in an object. It can only change if some mass is added or removed. When a person is accelerating, they feel either heavier or lighter depending on the direction of acceleration. A person in freefall has no sensation of gravity at all. Another possible point of confusion is that the passengers feel weightless even on the upwards part of the arc. Just remember that an object can be accelerating downwards even while moving up.

## Chapter 8 : Mass, Weight, and Weightlessness - Pop Physics

*Weightlessness has very little to do with weight and mostly to do with the presence or absence of contact forces. If by "weight" we are referring to the force of gravitational attraction to the Earth, a free-falling person has not "lost their weight;" they are still experiencing the Earth's gravitational attraction.*

## Chapter 9 : Weight - Wikipedia

*A greater apparent weight results in a heavier or greater sensation of our weight, and vice-versa Weightlessness is a phenomenon experienced by people during free-fall. The term zero gravity is.*