# TIME FOR A CHANGE?

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## ABSTRACT

This work was inspired by Hughes' book The Binary Universe, which proposes a unique theory about the nature of time and its dominance over phenomena since as gravity and electromagnetic radiation. While Hughes treats time as variable and time dilation as a real phenomenon, I divert while retaining much of Hughes' proposals to speculate that time is immutable and equivalent to change, albeit progressing at a fixed rate analogous to the fastest proposed by Hughes – the Planck time interval.

Keywords:  Time (dilation), Planck time, absolute zero, zero point energy, kinetic energy, Bohr hydrogen atom

## 1. INTRODUCTION

In his book The Binary Universe, Hughes strives "to provide a more accurate, simpler and realistic view of relativity and to encourage QM [Quantum Mechanics] physicists to review and re-assess the relationship between QM and the Special and General [Relativity] theories.  The book focuses firstly on the macro universe and takes a logical, deductive approach to investigating the nature of space-time and gravity … [W]e focus down to the quantum scale and an in-depth analysis of the nature of time itself is presented … I offer here an alternative theory for gravitation … Finally, … I present the inevitable conclusions about the nature of time and of the universe itself from the Planck scale upwards …" *[1]*  I find much with which to agree in Hughes' theories, in particular, the following:

> *Time is independent of the physical void since there is no known cause or effect, or suggested mechanism that links the two ... Quantum Mechanical Theory recognizes that there is more to the vacuum than simply empty void ... Space, the void (or volume), or anything within the void, cannot "exist" without the passage of time.  If time does not pass within the void, then space never did exist, it does not exist now and it never will exist because there is no past, present or future ... [I]t is the passage of time which "creates" [the void] ... Just because we label time as a "dimension" does not make it the same type of entity as the other three physical dimensions ... So, the pre-requisites for existence are the three physical dimensions of the void, and the passage of time ... The proposed theory disagrees with General Relativity and postulates that we cannot distort space itself within space-time ... Time is not a dimension.  It is an objective phenomenon throughout the void! ... [1]*

With the utmost respect for Hughes' theories, my point of departure is his belief in the *absolute* nature of time dilation, i.e., my disagreement that time dilation is a *real* phenomenon.  Hughes contends "that it is only the rate of passage of time which can vary with position or with speed … [T]his presents us with a universe of a variable time rate field in a Euclidean 'flat' space … Time rate variations are caused by either the greater speed of an entity relative to a 'less accelerated' frame of reference, or by the proximity to a massive object with its varying field of time dilation … Space cannot be compressed or otherwise distorted; only time can vary with position or with speed and this time dilation is absolute, it is not just relative …" *[1]*  Later in this paper my view on time dilation being an illusion will be presented.  For now, I review the main reasons why Hughes contends that time dilation is both real and absolute, then present my bases for disagreement.

## 2. HUGHES' BASES FOR REALITY OF TIME DILATION

Consistent with mainstream physics, Hughes considers time dilation to be a real phenomenon, citing three observations/experiments as definitive proof: (1) gravitationally-induced time dilation as demonstrated via the Global Positioning System (GPS), (2) motion-induced time dilation as demonstrated in the 1971 Hafele-Keating experiment using jet-transported atomic clocks, and (3) reduction in the decay rate of atmospherically-created muons reaching the earth's surface due to motion-induced time slowing. In my studies, I have found enough skepticism regarding these being "definitive proofs" of time dilation, including some analyses of my own. Let us examine Hughes' contentions and my disagreements.

GPS is based on gravitationally-induced time dilation

Hughes contends that "we can see the proof of motion induced and gravitationally induced time dilation today from our activities in space exploration and from the corrections which are necessary to keep the GPS in operation …" [1]  Here are two citations by other scientists that refute the role of time dilation in the GPS.

> GPS engineers had realized that clocks at higher altitude tick faster than clocks on Earth's surface, and it is not caused by gravity, but caused by air density of atmosphere. That's why the GPS engineers reset the clock rates, slowing them down before launch, and then proceed at the same rate as ground clocks … In the 1990's, Van Flandern worked as a special consultant to the GPS … Van Flandern goes on to discuss GPS clocks, which are often cited as being proof positive of Einstein's relativity. It may surprise you, but the GPS system doesn't actually use Einstein's field equations … [A] paper by the U.S. Naval Observatory tells us that … the system itself doesn't rely on them at all … "The Operational Control System (OCS) of the GPS does not include the rigorous transformations between coordinate systems that Einstein's general theory of relativity would seem to require." [2]

> When the velocity of light is measured with the GPS we find that it is (c-v) or (c+v), in which v is the rotation velocity of the Earth where the cities are located.  We know that the Lorentz transformations and special relativity are unable to provide a realistic physical explanation of the behavior of matter and light … [A]ll these phenomena can be explained using Newton's physics and mass-energy conservation, without space contraction or time dilation … The GPS determines that after clock µ moves away from clock α in New York, toward clock ß in San Francisco, its display accumulates an extra 14 ns (approximately) with respect to clock ß.  We know that due to the Earth rotation, between N.Y. and S.F. clock µ moves at velocity (v-e), which is the velocity of rotation of the Earth "v" minus the velocity of the truck "e."  Therefore 14 ns are subtracted to its display at its arrival in order to give a correct synchronization of time on clock ß in S.F. … This correction is the same as the one programmed automatically in the GPS. [3]

Hafele-Keating proved reality of motion-induced time dilation

With regard to this famous 1971 experiment, Hughes finds that "[f]rom the Hafele and Keating [H & K] experiment we must conclude: Time dilation due to motion is a proven, real effect, for the entity which accelerates and moves, relative to the initial, less accelerated frame …" [1]  Again, my studies have found sufficient skepticism to seriously doubt the results of this experiment as "proof" of time dilation, as exemplified by the following two citations.

> It is generally considered that one of the most crucial experiments in support of the special theory of relativity is the Hafele-Keating experiment … However, the original paper did not publish the raw data.  Dr. Keating has been kind enough to permit us to analyze the raw data.  We have found

*that an entirely different interpretation of the experimental data ... Thus, one of the essential experimental supports of the relativistic theory of time dilation is shown to be invalid. Instead, the original data provide additional strong support of the reality of the universal time postulate on the velocity of light.* [4]

*The H & K tests prove nothing. The accuracy of the clocks would need to be two orders of magnitude better to give confidence in the results. The actual test results, which were not published, were changed by H & K [to] give the impression that they confirm the theory. Only one clock (447) had a fairly steady performance over the whole test period; taking its results gives no difference for the Eastward and the Westward tests.* [5]

Slowing of decay rate of atmospherically-created muons reaching earth's surface due to time dilation

Consistent with mainstream physics' often-cited "proof" of time dilation, Hughes states that "[m]uons travelling close to the speed of light seem to slow down their decay when traveling through the Earth's atmosphere because of the red shift [slowing of time rate] in the moving frame ... [T]hrough the atmosphere they travel much further than their natural rate of decay should allow ... [M]ore muons than predicted actually reach the surface ..." [1] The following citation refutes the observed abundance of muons reaching the earth's surface as indicative of any time dilation.

*Why are we adamant that we know everything about the muon and controlled all the factors which could affect its speed and life span? Relativists propose time dilation as if our knowledge about the life span and the speed of muons is perfect and absolute. Under certain conditions (gravity, energy state, environment, etc.), why not a muon [that can] travel faster or live longer before it decays into the smaller particles. Muon's time dilation is only a calculated/predicted effect from the mathematics of relativity and hence can't be accepted as a proof of relativity. Muon's time dilation is what we would propose in the given scenario if the theory of relativity is correct. Relativists resort to circular logic here, i.e., they believe that relativity is true, so they imagine time dilation as really happening for the muons and then they claim their imagination of time dilation as proof of relativity — like this they keep going in circles in every scenario that they claim as proof of relativity. Why not [suppose that] the muons produced in the laboratory experience the same time dilation and length contraction if their speed was same as that of the cosmic ray muons? And if they did, why haven't we seen the laboratory muons travel the same 16000 meters as their cosmic counter parts? And if they travelled 16000 meters distance in their life span of 2 microseconds, what would be their speed?* [6]

I performed my own analysis based on the assumption of muon creation throughout the atmosphere to render it plausible that there is no time dilation involved in the observed abundance of muons reaching the earth's surface.

*Could observations of atmospheric muon time dilation be explained by simply assuming muons are created throughout the atmosphere, not just in the upper atmosphere, thereby eliminating the need for "time dilation" as a panacea? ... The trend ... indicates the number of muons vs. altitude rises initially with decreasing altitude as the atmospheric density increases fairly steadily while the cosmic ray intensity decreases sharply but is still at its highest levels. Subsequently the number of muons decreases with decreasing altitude, leveling off when approaching sea level ... as the steady increase in atmospheric density is countered by the leveling off of the decrease in cosmic ray intensity and continued decay of previously created muons ... Therefore, while the relativists will contend that the observations of more than the expected number of muons reaching the surface are explained by relativistic time dilation, dissidents like myself might counter that other non-relativistic explanations are also plausible. Given the extreme simplicity of my model ..., it is easy*

*to imagine ... alignment with observation without resorting to relativistic time dilation as a panacea.* [7]

## 3. CLOCK, BUT NOT TIME, DILATION

Special Relativity (SR) has always equated "time" dilation as evidenced by physical clocks with *time* dilation, i.e., an actual change in the rate of time passage along the fourth dimension of space-time. To his credit, Hughes dismisses time as a distinct dimension from space, acknowledging there are only three dimensions (space), with time as a completely different entity. Nonetheless, he contends that time, as well as clocks, will dilate, although breaking from SR in that time can run both slower and faster in different reference frames.

*The accepted idea in SR is that clocks in the stationary frame will also appear slow to the moving observer. The value of relative velocity is considered by SR to be the same as viewed from either frame ... [I]t does not matter which frame has accelerated ... The new theory proposes that the stationary clock will actually appear fast, or blue shifted, when viewed from the moving frame ... [A]ll events in the stationary frame occur relatively faster than they do in the moving frame ... That means the same speed viewed from the different frames will be different as viewed from each frame, the complete opposite to the assumption made by mainstream relativity ...* [1]

While I cannot agree with Hughes that time itself can dilated, I do acknowledge the ability of clocks to run slower and faster under different circumstances, especially in the case of *accelerated* frames. This idea is expressed by Sprague, as follows.

*Clocks lose time but also gain time ... The clocks in the H & K experiment show both a time loss and a time gain ... [, which] goes against Einstein. However; the clock gain and loss is accurately predicted using Classical Mechanics and ChR [Classical hierarchy Relativity] with relative c ... because ChR specifies that acceleration of a clock will result in a clock change in reading or clock error ... In the case of the accelerating clocks, there isn't any way to interpret the clock gain as confirmation of Einstein that predicts just time loss.* [8]

As above for muons, I performed my own analysis to confirm the plausibility of Sprague's contention.

*... Can accelerating clocks run both faster and slower? ... I endeavored to examine this possibility using three cases considering both speed and directional changes as part of acceleration. As a result, I come to the same conclusion [as Sprague]. This does not imply any belief in the variation of time itself, whether under constant or accelerating velocities, but merely a physical effect on an accelerating "clock."* [9]

Gaede presents a very simple refutation of gravity induced time dilation using simple hourglasses filled with sand. Since each of these represents a physical type of clock, it is obvious that placing one in a stronger gravitational field than another (e.g., Earth surface vs. interplanetary space) will result in the sand from the one in the stronger field draining much faster than the other. Does this mean that time has varied? No, only that gravity can have a physical effect on physical clocks. Time itself remains unaffected. [10] In addition, I have examined the alleged phenomenon of time dilation both without and with an aether, showing it to be an illusion in the first case and purely a physical effect on a macroscopic clock in the second.

*... [T]ime dilation in relativity is an apparent phenomenon only, i.e., when one frame moves relative to another at a constant speed, it only appears that its clock runs slower than the other ... [T]he reputed phenomenon is only an "optical illusion," an appearance of time dilation, but not an actual*

*change in the rate at which time passes. ... [W]hether or not reference frames are moving relative to one another, time does not vary – any such variation is apparent only.* [11]

*"Time Dilation" – Due to "Aether Drag?" "Aether drag," as used here, must not be confused with "dragged aether." The latter is a fairly popular theory that the aether is "dragged" along with Earth during its motion around the sun (and with the sun around the Milky Way, and the Milky Way relative to other galaxies, etc.), with or without accompanying rotation due to Earth's rotation. "Aether drag" is used here in the classical sense of a resistive medium, such as air or water ... Most discussions of relativistic time dilation or mass increase focus on sub-atomic particles, such as those in particle accelerators or atomic clocks ... Although beyond the current capabilities of our technologies to accelerate macroscopic objects toward light speed, it might be instructive to imagine a physical, macroscopic clock at such high speeds, such as a water or pendulum clock, in the presence of air as an analogy with motion relative to an aether ... As these two examples show (substitute a resistive aether for the air), motion can speed up or slow down (or leave unchanged) "clock time" depending not only on the direction by which the "clock time" is measured (e.g., uni-directional [water clock] or oscillatory [bi-directional, pendulum clock]), but also on the direction of motion of the clock relative to the direction by which the "clock time" is measured.* [12]

## 4. TIME FOR A CHANGE

To define his shortest unit of time, Hughes focuses on the atom.

*Now let us consider the atom and in particular the spinning of the electron around the nucleus ... [T]he time rate for the rotating particles will be slower than that of the "stationary" parts of the nucleus. In the case of the electron, its time rate will be measurably slower due to the extreme tangential speed of the electron being around 1/150 of the speed of light[1] ... The kinetic energy of each sub-atomic particle will play its part in producing the atomic time dilation but electron spin is perhaps the major contributor ... The unit of Planck time is a mere 5.391E-44 s... The Planck time is the shortest possible unit of time ... [I]t is impossible for time to "flow" smoothly or continuously ... Time must progress with Planck time steps or jumps ... [T]ime passes in quantum increments rather than in a smooth, continuous way ... [I]t is time that is quantized ...* [1]

This argument for the Planck time being the shortest possible unit, such that time is quantized, appears plausible and forms the basis for the following speculation. Unlike Hughes, my contention is that time is immutable – its rate is fixed regardless of motion, gravity, etc., although these can affect the rate at which clocks show time passage. However, I accept Hughes' contention of a quantized, shortest possible time unit, that being the Planck time.

If one looks at a photograph, time is said to "stand still," or that the photo shows a "moment frozen in time." That is due to there being no change possible in the photograph (other than fading or decomposition as it ages). This would appear to give a rather simple definition for time itself – time is change. However, unlike the photograph, it is impossible to "freeze" time, even at absolute zero where theoretically all motion (and, therefore, change) ceases.

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[1]    Hughes' estimate for electron orbital speed is somewhat lower than one other, but only slightly lower than another. "How high is the tangential velocity of the electron relative to the speed of light? … v = 1.37E+07 m/s … Relative to the speed of light this is v/c = 0.04576 [about 1/22 of the speed of light]" [13]  "… In the simplest case of a hydrogen atom with a single electron spinning around a single proton, the electron moves at about 1/137 of the speed of light." [14]  For the subsequent analysis, Hughes' estimate will be used

*Absolute zero is the lowest limit of the thermodynamic temperature scale, a state at which the enthalpy and entropy of a cooled ideal gas reach their minimum value, taken as zero kelvin (0 K, not 0°K). The fundamental particles of nature have minimum vibrational motion, retaining only quantum mechanical, zero-point energy-induced particle motion.* [15] *Zero-point energy (ZPE) is the lowest possible energy that a quantum mechanical system may have.* [16] *Absolute zero is the theoretical point where all molecular motion ceases and they are at complete rest (except for quantum mechanical motion) ... According to kinetic theory, there should be no movement of individual molecules at absolute zero, so any material at this temperature would be solid ... Because of quantum-mechanical effects, the speed at absolute zero is larger than zero and depends, along with the energy, on the volume within which a particle is confined. At absolute zero, the molecules and atoms in a system are all in their ground state, the state of lowest possible energy, and a system has the least amount of kinetic energy allowed by the laws of physics. The lowest possible ZPE for a confined particle in a box, however, is not zero. Rather than being fixed and non-moving ... a particle still has some translational kinetic energy and motion. This is a reflection of Heisenberg's uncertainty principle, which states that one cannot measure values (with arbitrary precision) of certain conjugate quantities (e.g., the position and momentum), which are pairs of observables of a single elementary particle.* [17]

Therefore, there is still some sort of motion, and therefore change, at the (sub-)atomic level even at absolute zero, such that time will still progress forward with Planck time quanta since something will change (positions of subatomic particles) with each quantum. Let us examine this from a classical, not quantum mechanical or relativistic, perspective. In the spirit of Occam's Razor [18], focus on the simplest possible atom, the Bohr hydrogen atom of one proton and one orbiting electron. The electron, with mass = 9.109E-31 kg, orbits the proton, with mass = 1.673E-27 kg, at the Bohr radius of 5.292E-11 m at Hughes' speed = 1/150 that of light, or (2.998E+08 m/s)/150 = 1.999E+06 m/s. [19-21] Therefore, in one unit of Planck time, the electron will have progressed (5.391E-44 s)(1.999E+06 m/s) = 1.077E-37 m along its orbital path of length $2\pi$(5.292E-11 m) = 3.325E-10 m, or (1.077E-37 m)/(5.292E-11 m) = 2.036E-27 radian (1.167E-25 degree). Therefore, there has been a change, namely that in the position of the electron.

Since it is the movement of the atom that is of prime interest, in this case the proton itself, will it have moved over one unit of Planck time? Viewing the Bohr hydrogen atom as a mass "M" (the proton) with a circularly orbiting mass "m" (the electron), between which there is an electrostatic attraction due to their opposite charges, there is a barycentric shift from the center of the proton about which both the proton and electron revolve. This shift is given by d = rm/(M + m), where r = Bohr radius (5.292E-11 m), M = 1.673E-27 kg and m = 9.109E-31 kg, such that d = 2.880E-14 m, a shift of about 0.05% along the radius between the centers of the two particles. While this is miniscule, it implies that the proton itself is not purely stationary, but rather revolves around the barycenter with a speed of $2\pi$(2.880E-14 m)/[(3.325E-10 m)/(1.999E+06 m/s)] = 1,088 m/s. Thus, in one unit of Planck time, the proton will have progressed (5.391E-44 s)(1.088E+03 m/s) = 5.863E-41 m along its orbital path length of $2\pi$(2.880E-14 m) = 1.809E-13 m, or (5.863E-41 m)/(2.880E-14 m) = 2.036E-27 radian (1.167E-25 degree), the same in terms of angular movement as the electron. The movements of both the proton and electron about the mutual barycenter (and that of the electron about the proton center itself) are displayed in Figure 1, as the displacements from positions A to B, greatly exaggerated for clarity (including the barycenter displacement). Can the extremely miniscule rotation of the proton about the barycenter be viewed as the "vibration" of the atom corresponding to ZPE?

Might the kinetic energy associated with the proton motion correspond classically to the concept of ZPE? The kinetic energy is (1.673E-27 kg)(1,088 m/s)$^2$/2 = 9.895E-22 J, or using 1.602E-19 J/ev, 0.006177 ev. From Table 1, this is lower than the lowest value cited (0.026 ev for the average kinetic energy of a gas molecule at room temperature) by a factor of around four. [22] Might this be a plausible classical interpretation of ZPE? On the other hand, if the electron's kinetic energy is also included, the total for the

Bohr hydrogen atom jumps by (9.109E-31 kg)(1.999E+06 m/s)$^2$/2 = 1.819E-18 J, or 11.36 ev, placing it near the energy required to ionize the hydrogen atom in its ground state (13.6 ev).

## 5.  SUMMARY

No definitive conclusion can be drawn from this exercise, other than speculation as to the true nature of time (time = change) and a possible classical interpretation of the quantum mechanical concept of ZPE. The analysis was inspired by Hughes' book The Binary Universe, with which I find much to agree.  Where there is disagreement, I still find the concepts proposed by Hughes to be sufficiently thought-provoking, satisfying a prime goal of Hughes' effort "to reignite the healthy debate needed to drive scientific progress and which has been largely missing in this field for too long." [1]
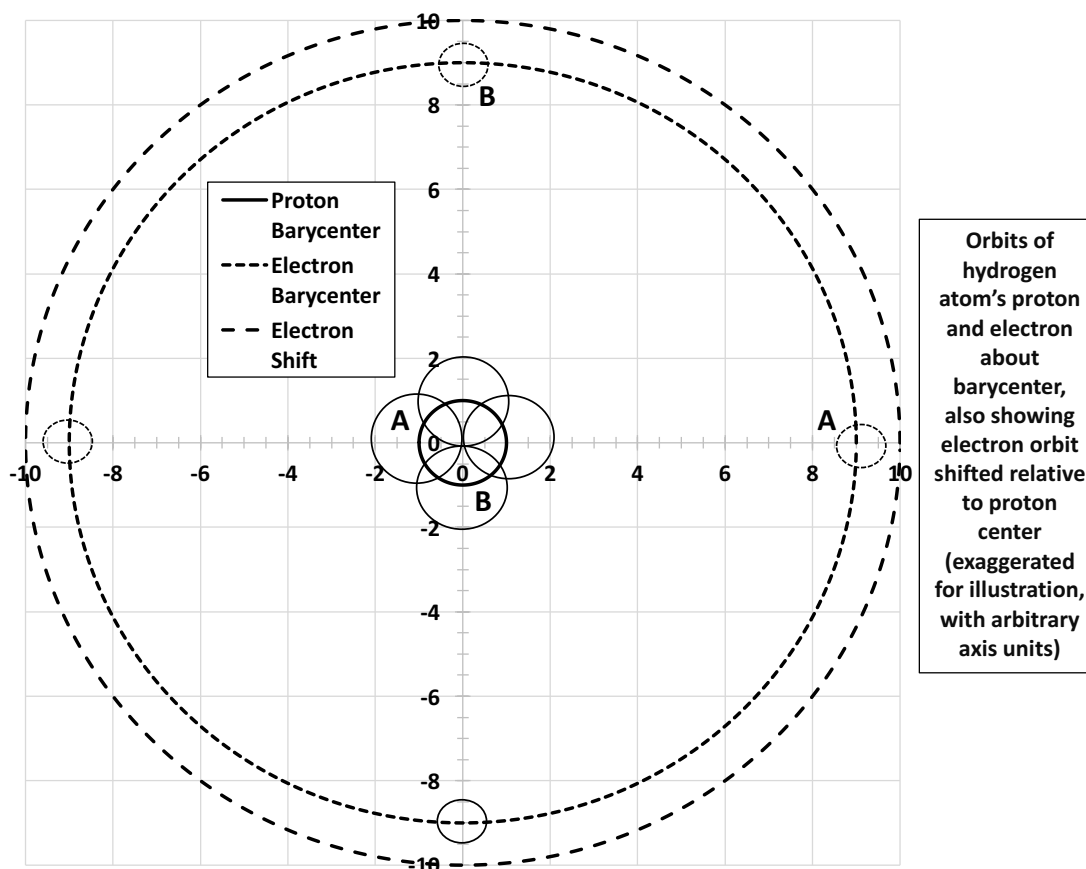


**Figure 1.  Revolutions of Hydrogen Proton and Electron about Mutual Barycenter**

**Table 1.  Energy Scales Table**

| Phenomenon | Energy |
|---|---|
| **Nuclear, Atomic, and Molecular** | |
| The average kinetic energy of a gas molecule at room temperature (300° Kelvin=27° Celsius=81° Fahrenheit) | 0.026 ev (1 ev = 1x10$^{-19}$ Joules) |
| Van Der Waal bonds | 0.044 ev |
| Hydrogen bonds | ~0.2 ev |
| Ionic bonds | 0.17 to 0.3 ev |

| Phenomenon | Energy |
|---|---|
| Single covalent bond | ~2 to 5 ev |
| Double covalent bond between two carbon atoms in a molecule | 6.6 ev |
| Triple covalent bond between two carbon atoms in a molecule | 8.8 ev |
| Energy required to ionize a Hydrogen atom in its ground state | 13.6 ev |
| Energy required to completely ionize an atom of Uranium | $1.2 \times 10^5$ ev |
| The combined energy of the photons created by the collision of a proton and antiproton | $1.9 \times 10^6$ ev |
| Binding energy of a Deuterium nucleus | $2.2 \times 10^6$ ev |
| Energy of the neutron produced in a Deuterium/Tritium fusion process | $14 \times 10^6$ ev |
| **Biological** | |
| Energy released by a single ATP molecule in ATP hydrolysis | 0.3 to 0.6 ev |
| The energy required for a single neuron to fire | $\sim 10^3$ ev |
| Energy required for a single bacterial cell to replicate | $\sim 10^6$ ev |
| The energy required for a human heart to beat once | 0.5 Joules |
| One gram of sugar | $\sim 1.6 \times 10^3$ Joules |
| Energy expended by 1 day of heavy labor | $10^7$ Joules |
| Energy in the food consumed by the average person in 1 day | $1.2 \times 10^7$ Joules |
| **Technological/Fuel** | |
| Energy stored by a AA battery | $10^3$ Joules |
| Energy required to run a 100 Watt light bulb for 1 hour | $3.6 \times 10^5$ Joules |
| Amount of Solar Energy (visible light) striking 1 meter$^2$ of the U.S. surface in one hour (Sun overhead) | $\sim 4 \times 10^5$ Joules |
| Energy required to run an electric stove for 1 hour | $\sim 4 \times 10^7$ Joules |
| Energy released by the combustion of one gallon of gasoline | $10^8$ Joules |
| Electricity used by an average house for 1 year | $10^{10}$ Joules |
| Energy required to heat an average house for one year | $10^{11}$ Joules |
| Energy required for a one way transatlantic flight by a jet airliner | $10^{12}$ Joules |
| Energy required to place the space shuttle in orbit | $10^{13}$ Joules |
| Energy stored in 1 pound of Uranium 235 | $3.7 \times 10^{13}$ Joules |
| Energy released by a one megaton Hydrogen bomb | $4 \times 10^{15}$ Joules |
| Yearly fuel/electricity consumption of the United States | $7.3 \times 10^{19}$ Joules |
| **Geological/Atmospheric/Oceanographic** | |
| Lightning bolt | $10^{10}$ Joules |
| Total energy released by a magnitude 6.5 earthquake (e.g., 1994 Northridge Earthquake) | $3.2 \times 10^{14}$ Joules |
| Thunderstorm | $10^{15}$ Joules |
| Hurricane | $10^{15}$ Joules |
| Total energy released by a volcano (Krakatoa) | $10^{19}$ Joules |
| Fossil fuel left on Earth | $2 \times 10^{23}$ Joules |
| **Astronomical** | |
| Energy released in the collision of comet Shoemaker with Jupiter | $\sim 10^{23}$ Joules |
| Solar flare | $10^{24}$ Joules |
| Average total energy output of the Sun in a single year | $\sim 10^{34}$ Joules |
| Energy released by a quasar in one second | $\sim 10^{39}$ Joules |
| Energy released by a ("medium sized") supernova | $\sim 10^{45}$ Joules |

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