

Energy: No Such Thing as a Free Lunch

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Fermilab

First: some acknowledgements

- Donna Askins
 - This originally started as a proposed guest lecture for a class she was going to give at a local community college
- Prof. Janet Conrad
 - For letting me try this lecture the first time at Columbia University.
- Prof. Bob Park
 - For writing “Voodoo Science”
 - and a lifetime spent at the thankless task of trying to educate the public about science
- Eric Krieg
 - Catalogs free energy claims and scams as a public service
- Carl Hays
 - For inviting me to give this lecture
- Google and Wikipedia!!!

Outline

- Introduction and motivation
- A brief history of perpetual motion
- The science of perpetual motion
- Some case studies
 - John Keely: the father of the free energy scam
 - Joseph Newman: patent-ly absurd
 - Tom Bearden: the power of technobabble
 - Cars the run on water: people never learn
 - Genesis World Energy: yes, people really are *that* stupid.
- Getting it wrong:
 - How honest people convince themselves and others of crazy things.
- Good science gone bad
 - Cold fusion
- The point?

Why give this lecture?

- Education
 - The concepts of work and energy are central to our understanding of nature, and it's good for everyone to have some knowledge of them.
 - Some seemingly arcane (and boring) principles turn out to be very important.
 - You can learn a lot about good science by studying *bad* science.
- Public Service
 - Maybe I can prevent you or one of your relatives from losing money in some energy based investment scam or wasting their lives on a quixotic search for something that doesn't exist.
- Reality Check
 - Energy is likely “The Big Issue” of the 21st century
 - Availability
 - Impact
 - *As long as people believe there's a magic technology just around the corner, they will avoid addressing these problems!*

Why now?

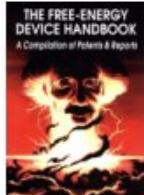
- Unless you get your science from “Fox News”
 - The energy consumption of the human race is increasing.
 - Soon, the developing world will pass the US and Western Europe in energy usage.
 - Our reliance on fossil fuels is impacting our environment, perhaps catastrophically.
 - Fossil fuels will run out – maybe in 10 years, maybe in 100, but they will run out.
- The current emphasis on “going green” has raised the stakes for alternative energy sources:
 - This fact will not be lost on the con men.

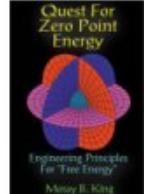
Evidence: Amazon search "free energy"

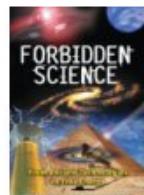
Top 5:

 **Free Energy Pioneer: John Worrell Keely** by Theo Pajmans (**Paperback** - Sep 2004)
[Buy new: \\$19.95 \\$14.96](#) [26 Used & new from \\$9.26](#)
Get it by **Monday, April 21** if you order in the next **11 minutes** and choose one-day shipping.
Eligible for **FREE** Super Saver Shipping.
 (8)
Other Editions: [Paperback](#)

 **Free Energy Generation Circuits & Schematics** by Tom Bearden and John Bedini (**Paperback** - 2006)
[1 Used & new from \\$59.99](#)

 **The Free-Energy Device Handbook: A Compilation of Patents & Reports (Lost Science Series)** by David Hatcher Childress (**Paperback** - Nov 1994)
[Buy new: \\$46.95 \\$13.22](#) [31 Used & new from \\$6.45](#)
Get it by **Monday, April 21** if you order in the next **11 minutes** and choose one-day shipping.
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 **Quest for Zero Point Energy Engineering Principles for Free Energy** by Moray B. King (**Paperback** - Jan 30, 2002)
[Buy new: \\$14.95 \\$10.17](#) [39 Used & new from \\$9.06](#)
Get it by **Monday, April 21** if you order in the next **11 minutes** and choose one-day shipping.
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 **Forbidden Science: From Ancient Technologies to Free Energy** by J. Douglas Kenyon (**Paperback** - Feb 22, 2008)
[Buy new: \\$18.00 \\$12.24](#) [22 Used & new from \\$9.75](#)
Get it by **Tuesday, April 22** if you order in the next **51 hours** and choose one-day shipping.
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Definition: How free is "free"?

- For the purposes of this discussion, “free energy” refers to transformative technologies that:
 - Can be implemented on an individual basis
 - i.e. non-centralized
 - Will enable dramatic reduction in domestic and/or transportation energy expenses
 - say, a factor of four or more
 - Do not require a lifestyle change
 - Involve only modest capital costs
 - pay for themselves in less than a year or two
- Some examples which do NOT qualify:
 - Trading in your Hummer for a motorcycle
 - Lifestyle change
 - Converting your home to 100% solar
 - Takes many years to recover the cost

Types of “free energy”

- Perpetual Motion: A device which produces useable output energy with no input energy or fuel.
 - To the extent science declares anything “impossible”, this is impossible.
- Dramatically improved efficiency in utilizing an existing power source.
 - A legitimate idea, but there limits
- A new source of energy or radically different way of tapping an established source of energy
 - Examples: cold fusion, zero point energy, hydrinos, etc.

In many cases, claims of the second two types really imply the first

Science: Definition

- The Good:
 - Make observations and measurements
 - Develop a model to explain these with the fewest possible variables and assumptions (must also be consistent with all other scientific data).
 - Investigate the predictions and consequences of this model.
- The Bad
 - Like good science in principle, but lack of rigor and/or bias (intentional or unintentional) lead to erroneous conclusions.
- The Ugly
 - Propose theories or claim experimental results which cannot possibly be reconciled with significant body of real world data.
 - Can be the product of profound ignorance or deliberate fraud.
 - Aka “Crackpot Science”, “Voodoo Science”, etc

Most free energy resides solidly here

Science: Myth vs. Reality

- Myth



- Independent
- Maverick
- Makes lots of important discoveries in career
- Results come quickly

Society loves this...

- Reality



- Systematic and meticulous
- Often work in large groups
- Results take time!!
- One significant discover = Nobel Prize!

... but benefits from this

But what about Jobs and Wozniac?

- It's important to make a distinction between "science" and "technology"
 - Science concerns the fundamental rules of nature
 - Technology is the application of these rules.
- Science and technology are closely intertwined, but they are still distinct.
 - New science enables new technology
 - New technology is used to push the boundaries of science.
- Although we live in a time of amazing technological advances, fundamental scientific advances are still few and far between.
 - Last new source of energy was nuclear power (early 20th century)

"Voodoo Science"

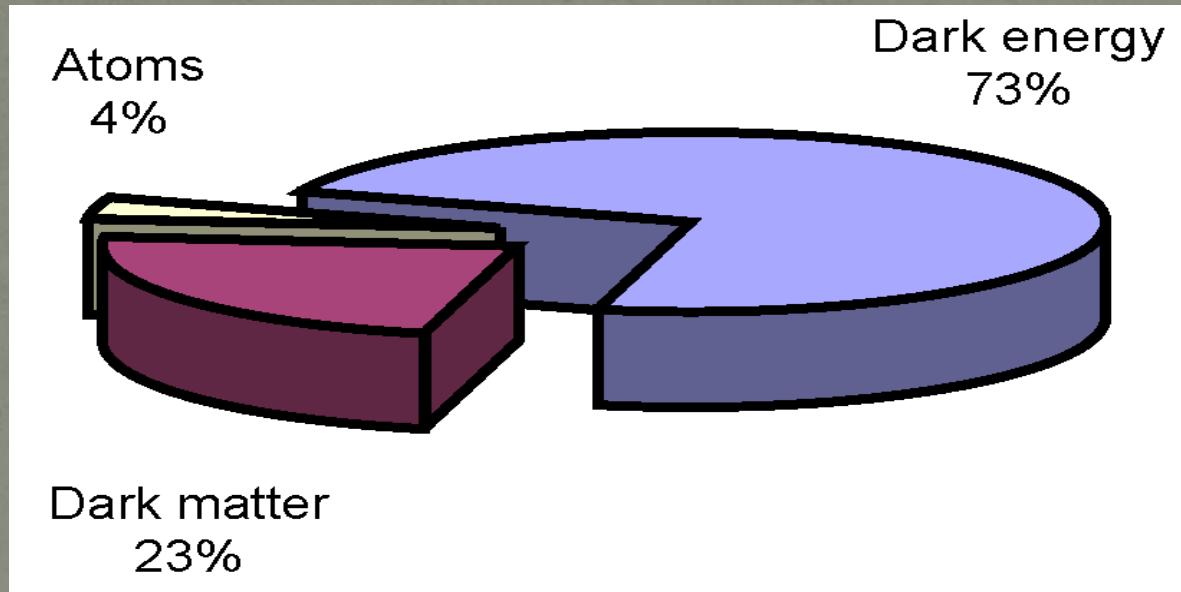
- Bob Park's seven warning signs
 1. Discoverers make their claims *directly to the popular media*, rather than to fellow scientists.
 2. Discoverers claim that a *conspiracy* has tried to suppress the discovery.
 3. The claimed effect appears so weak that observers can hardly distinguish it from noise. *No amount of further work increases the signal.*
 4. *Anecdotal evidence* is used to back up the claim.
 5. True believers cite *ancient traditions* in support of the new claim.
 6. The discoverer or discoverers work *in isolation* from the mainstream scientific community.
 7. The discovery, if true, would require a *change in the understanding of the fundamental laws of nature.*

"Voodoo Science" (cont'd)

- Eric's extra three warning signs
 8. Relying on *overly complex* demonstrations and protocols.
 9. Claims are often *vague and contradictory*.
 10. Claims have *profound and obvious consequences*, which are not addressed.

How can we be so sure of ourselves?

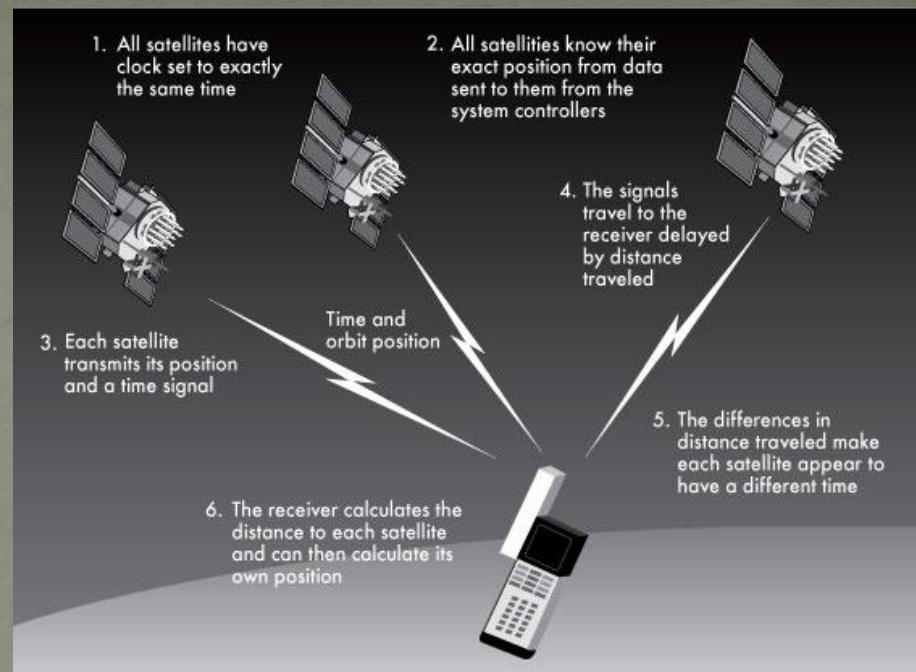
- After all, we only know what 4% of the universe is made of.



- Can't there be some sort of energy source in the other 96%?
- Maybe, but even if we don't know what 96% is, we know a lot about what it *isn't*.

Consider the GPS

- For a GPS to work, we have to understand
 - The chemistry of the fuel
 - The dynamics of the launch and orbit
 - The physics of the onboard atomic clocks
 - The E&M involved in generating and transmitting the signal
 - The Special and General Relativity corrections required
 - $38 \mu\text{sec} = 11.4 \text{ km/day}$ error without them!
 - And then there's all the physics needed to put that much computing in your hand.
 - None of this would work if unknown particles and forces interacted significantly with ordinary matter.

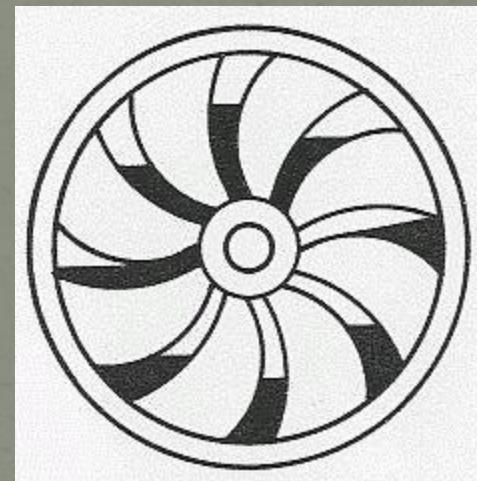
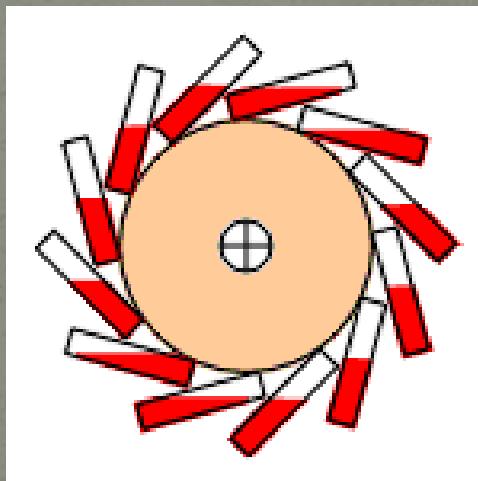


Perpetual motion: a brief history



Early perpetual motion machines

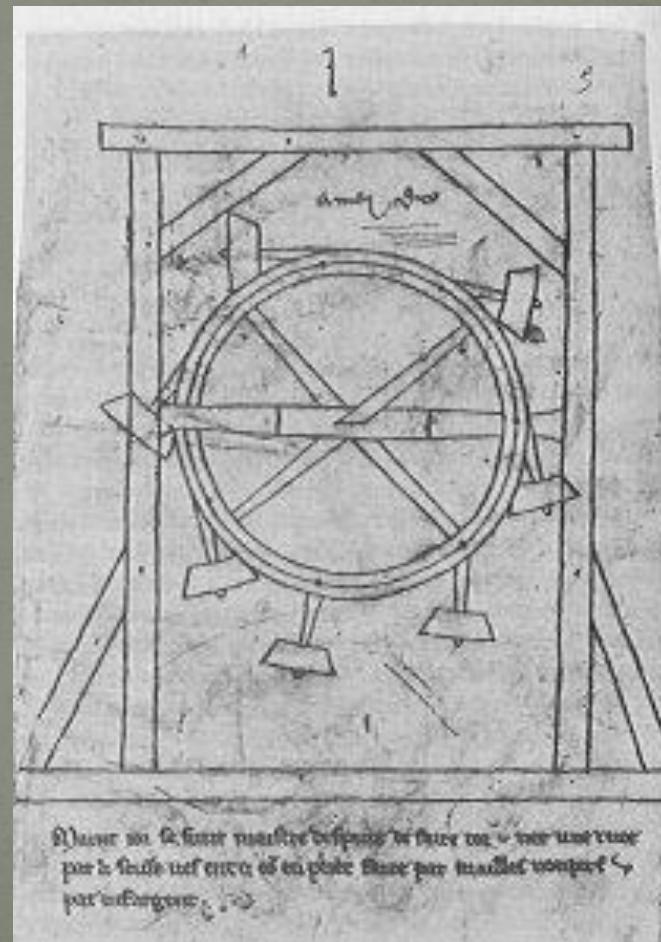
- The first recorded perpetual motion machines were documented by the Indian author Bhaskara (c. 1159), who made sketches of something called the “Persian Wheel”



- This device used flowing water (or sand) to create a “perpetual imbalance”

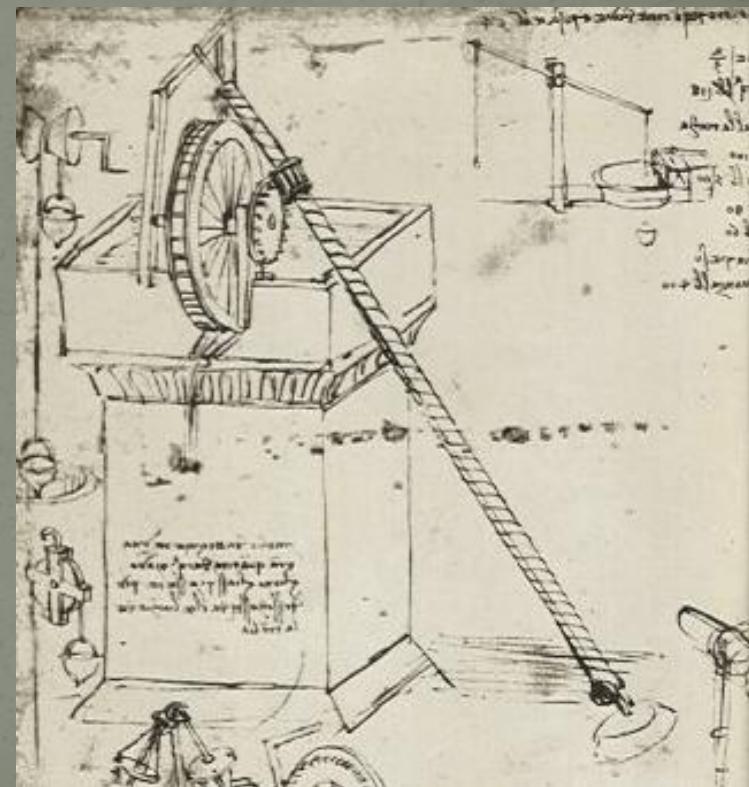
Perpetual motion in the West

- The first sketch of a perpetual motion machine in the Western world was made by Villard de Honnecourt (c. 1250).
- The principle was similar to the “Persian Wheel”, but it relied on levers and weights to achieve imbalance.
- Over the next several centuries, a number of conceptual machines were designed along these lines.



Leonardo da Vinci

- Historians like to point out that Leonardo da Vinci spent a lot of time debunking things like Honnecourt's wheel.
- They usually leave out that he personally believed that the key to perpetual motion was some combination of a water wheel and an Archimedes screw.
- Of course, there was no reason to believe this wouldn't work – then
 - In fact, can you prove it now?



Perpetual motion and physics

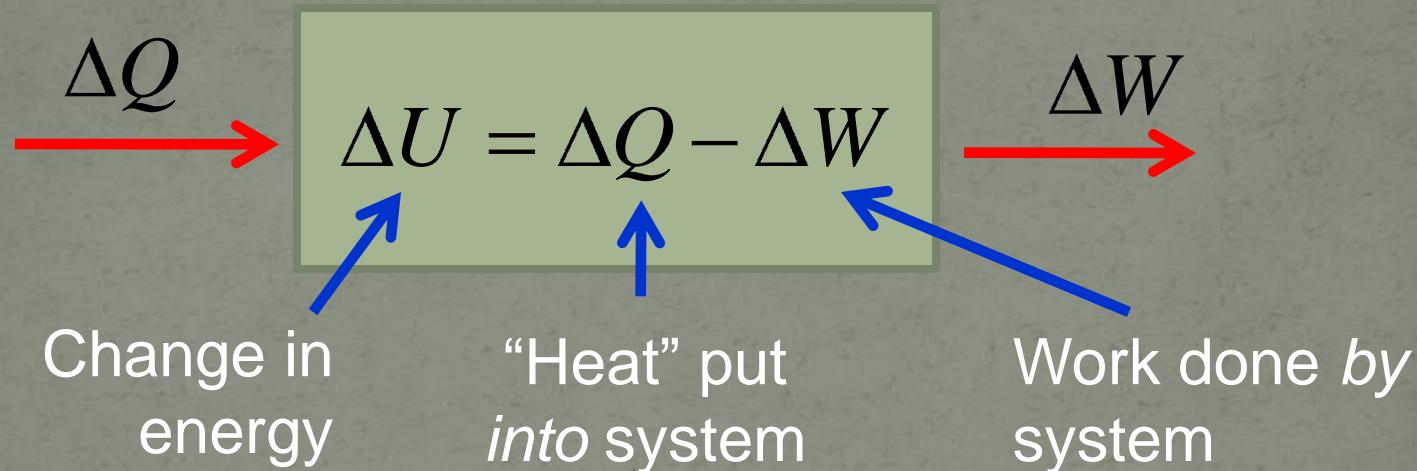
- We need to examine these early claims in the context of the time.
- Because there was no theoretical framework to rule out these machines, these people were behaving as good scientists.
 - The fact they didn't work was an important piece of experimental evidence.
- All of this changed with Newton
 - $F=ma$ and the “universal law of gravitation” held the mathematical key to ruling out all of these “imbalance” type perpetual motion machines in one fell swoop.

Physics and energy

- In the 18th and 19th centuries, a great deal of physics was done, based mathematically on Newton's Laws, which formalized the concepts of work, energy, and conservation laws.
- The 19th century saw the development of thermodynamics
 - Term originally coined by James Joule to describe the science of heat and power
 - Generalized to cover all physical systems
 - Lays out the specifics of the relationship between physical systems and usable energy
- As new types of physics were discovered, they still fit into this paradigm
 - Electricity and Magnetism
 - Relativity
 - Nuclear energy
 - Quantum Mechanics
- To date, no confirmed experimental result has violated conservation of energy or the laws of thermodynamics

First Law of Thermodynamics

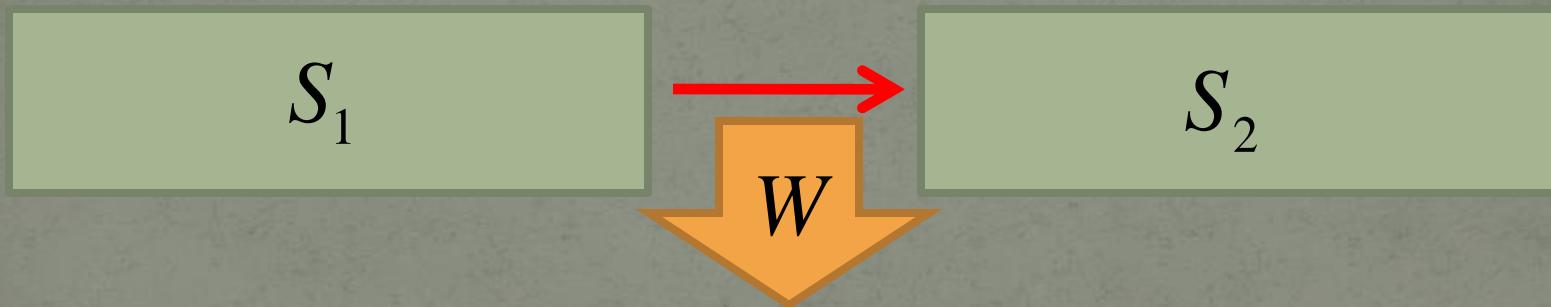
- Every system is characterized by an energy (U)



- This law is also known as “Conservation of Energy”

Second Law of Thermodynamics

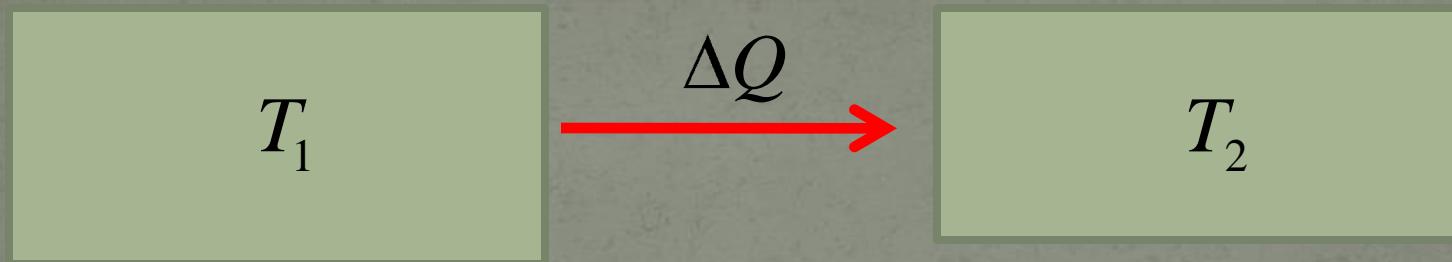
- Not all energy is useable!!
- Every system is characterized by an “entropy” (S)
 - A measure of energy and degree of order
 - Generally “Low entropy” = high energy and high order
- The entropy of a “closed” system can *never* decrease.
- Can only get work out of system in *a transition to a higher entropy state.* ($S_2 > S_1$)



- This law can be generalized to any potential source of energy.

Entropy in classical thermodynamics

- Entropy defined by heat transfer and temperature



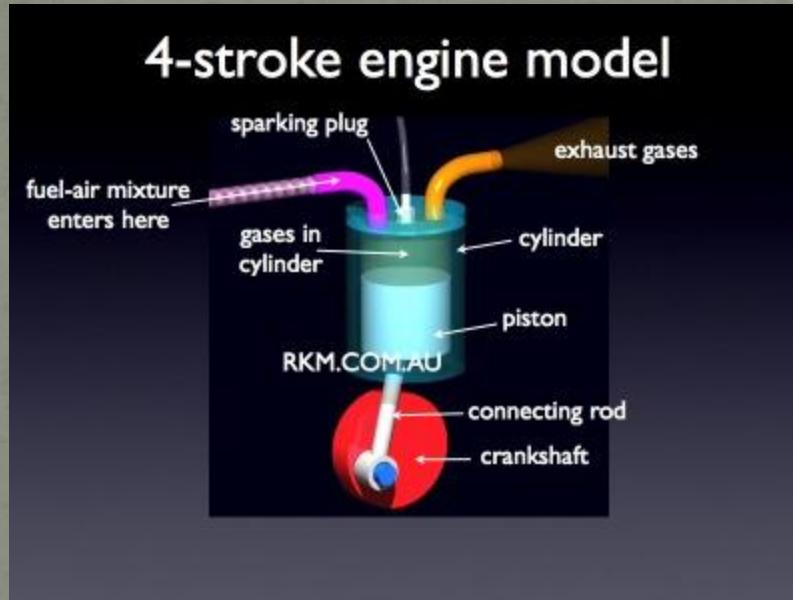
- Classically $\Delta S \equiv \frac{\Delta Q}{T}$
- This means if $T_2 < T_1$, then
$$\Delta S = \Delta S_1 + \Delta S_2 = \frac{-\Delta Q}{T_1} + \frac{\Delta Q}{T_2} > 0$$
- Total entropy has increased, *and we can never decrease it* without doing work on the system.

Second Law and heat

- We can *extract work* when heat flows from *high temperature* to low temperature
- We have to *do work* to move heat from *low temperature* to *high temperature*.

2nd law: getting energy out...

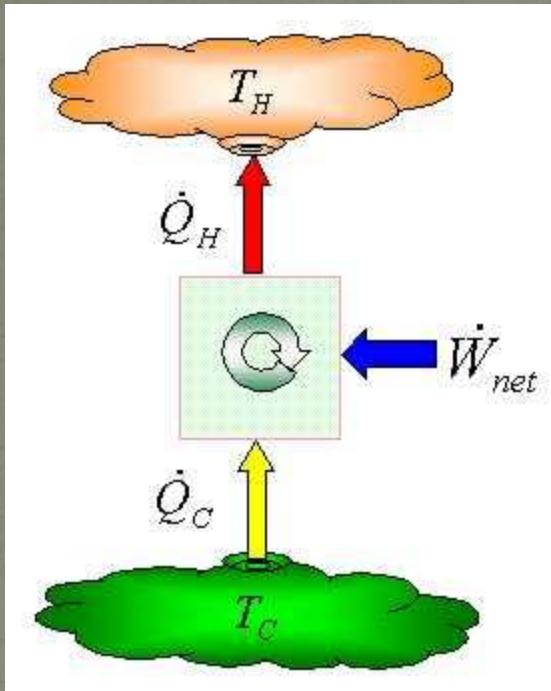
- Internal Combustion Engine



- Hydrocarbons burn in a transition to a higher entropy chemical state (chemical thermodynamics)
- Mechanical work is extracted as hot, compressed gasses (low entropy) go to cool gasses at lower pressure (high entropy)

2nd Law: doing work to move heat

- Air conditioning



Work is done to move heat from inside the house to the radiator unit outside the house.

The heat radiated outside the house is equal to the heat removed from the house *plus* the work it took to move it.

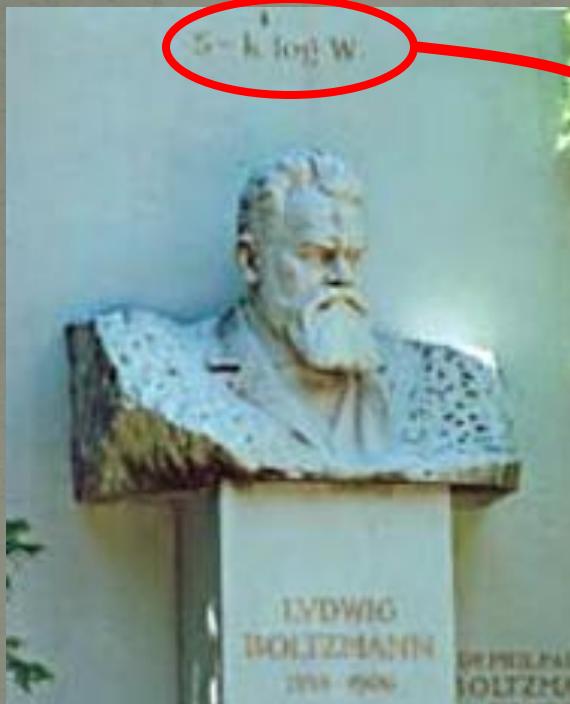
- This is why you can't use your refrigerator to cool your house!

Entropy and "The Arrow of Time"

- It takes WORK to inflate a balloon.
- If I use the pressure from the balloon to power a motor, I can get WORK out of the balloon as it deflates:
 - In a perfectly efficient system, I would get the same work out that I put in
 - The total “entropy” remains constant
- If I pop the balloon, end up with a deflated balloon, BUT
 - I get no work out of the system
 - The work I put in is “lost”, *and I can’t get it back*
 - The total entropy increases.
- Conclusion: The universe is running down!

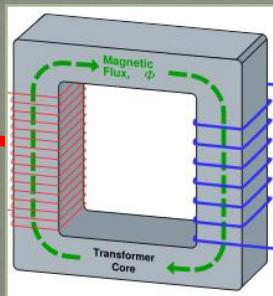
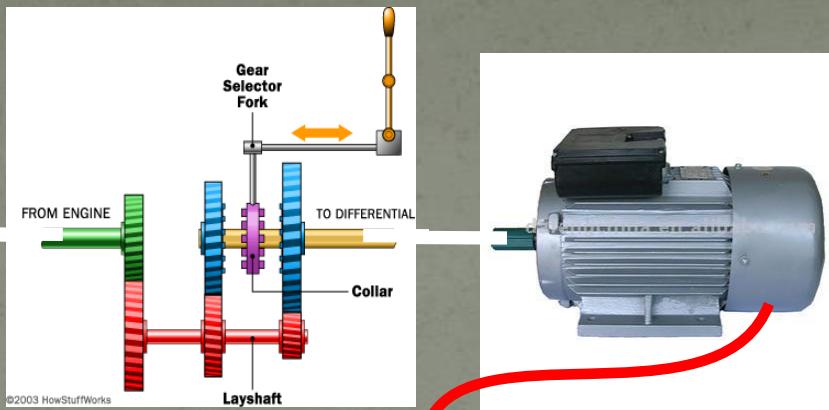
It took a while for entropy to catch on

- In 1906, Ludwig Boltzmann took his own life, partially out of frustration over the reluctance to accept his statistical concept of entropy:



$$S = k \log W$$

Modern Perpetual Motion 101



Start with a motor...
which turns a generator...
which powers the motor...
with perhaps some left over!

Doesn't work??

Try adding some gears...
or maybe a transformer

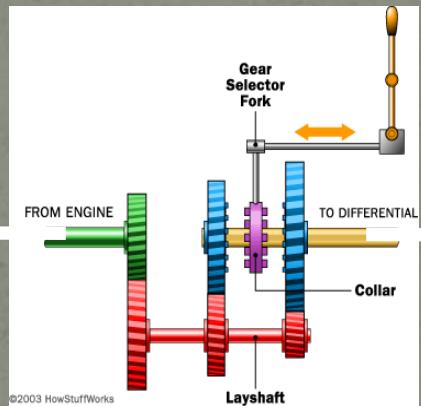
etc, etc, etc...

Redefining the problem

- Instead of talking about “perpetual motion”, talk about “over-unity”; that is, gearboxes, transformers, etc, in which the power out is greater than the power in

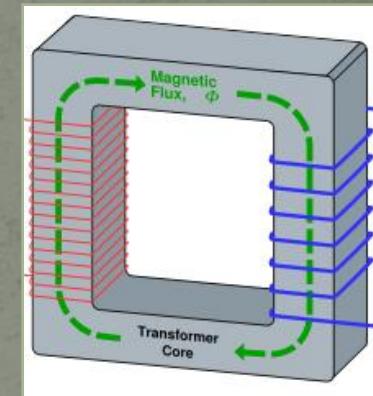
$$P_{in} \equiv \tau_{in} \omega_{in}$$

torque
angular frequency



$$P_{in} \equiv I_{in} V_{in}$$

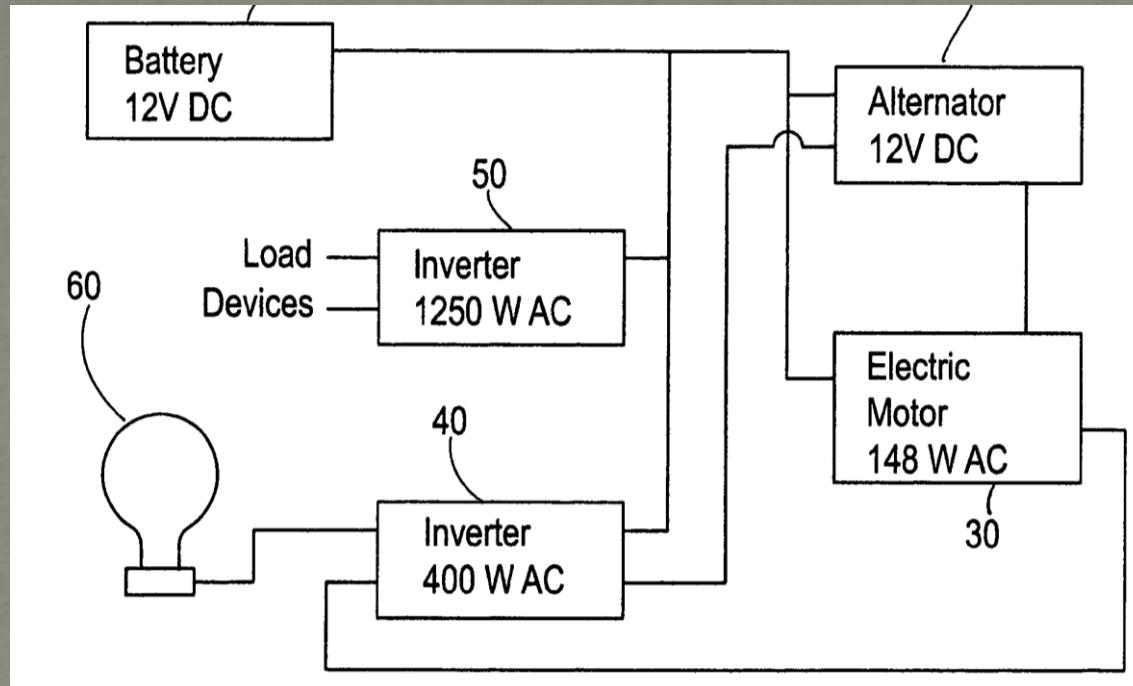
current
voltage



- Physically, $P_{out} \leq P_{in}$ - ALWAYS
- “Over-unity” = “perpetual motion” - PERIOD

In case you thought my example was silly

US Patent #7,095,126: "Internal Energy Generating Power Source" (2006)



ABSTRACT

An external power source such as a battery is used to initially supply power to start an alternator and generator. Once the system has started it is not necessary for the battery to supply power to the system. The battery can then be disconnected. The alternator and electric motor work in combination to generate (sic) electrical power.

Speaking of patents

- A *partial* list of US patents purported to support perpetual motion:
 - 2,006,676: “Electrolytic Carburetor” (Garrett Carburetor)
 - 4,074,153: “Magnetic propulsion device”
 - 4,151,431: “Permanent magnet motor”
 - 4,215,330: “Permanent magnet propulsion system”
 - 6,246,561: “Methods for controlling the path of magnet flux...”
 - 6,362,718: “Motionless electromagnetic generator”
 - More about this one later
 - 6,523,646: “Spring driven apparatus”
 - 6,526,925: “Piston driven rotary engine”
 - 6,962,052: “Energy generation mechanism, device and system”
 - 7,095,126: “Internal energy generating power source”
 - The one we just talked about

Patents and perpetual motion

- The Patent Office has had so much trouble with perpetual motion machine patents, that it's developed special rules.:

“With the exception of cases involving perpetual motion, a model is not ordinarily required by the Office to demonstrate the operability of a device. If operability of a device is questioned, the applicant must establish it to the satisfaction of the examiner”

- 35 U.S.C 101 (Examiners' Handbook)

Translation: “If the Patent Office didn’t ask for a working model, they didn’t believe it was a perpetual motion machine”.

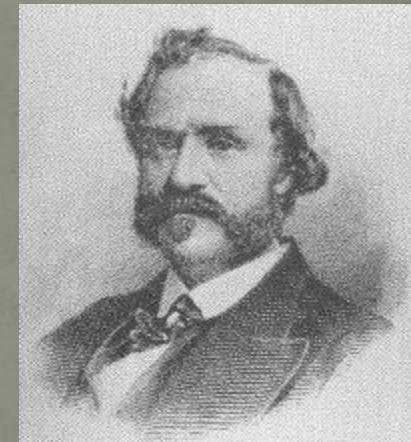
More about patents

- Also from the Examiners' Manual
 - “A rejection under 35 U.S.C. 101 for lack of utility should not be based on grounds that the invention is frivolous, fraudulent or against public policy.”
- In a judicial case involving this statue, the judge ruled
 - “...we find no basis in section 101 to hold that inventions can be ruled unpatentable for lack of utility simply because they have the capacity to fool some members of the public.“

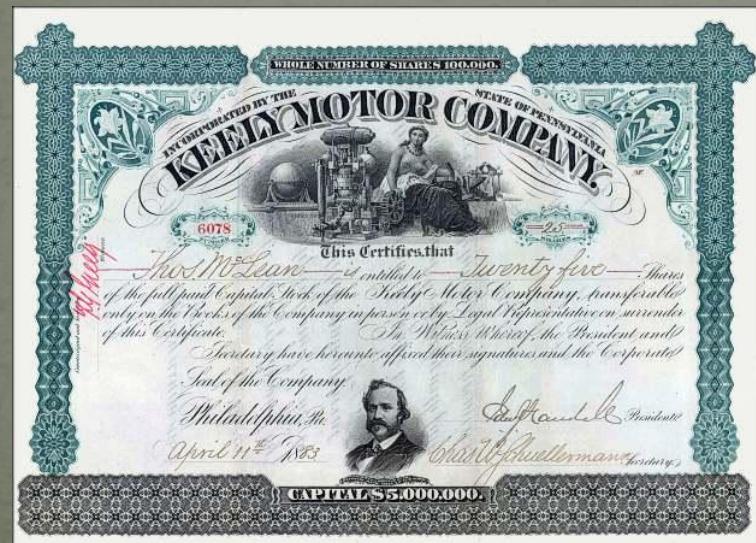
Translation: “The Patent Office will patent things
even if it's clear they will be used to defraud people”

John Keely: the father of the free energy scam

- There were a few claims of perpetual motion machines in the early 19th century, but nothing very big.
- In 1872, John E. Worrel Keely claimed to have discovered a new type of motor, which used some sort of musical resonance to extract energy from the “luminiferous ether”.



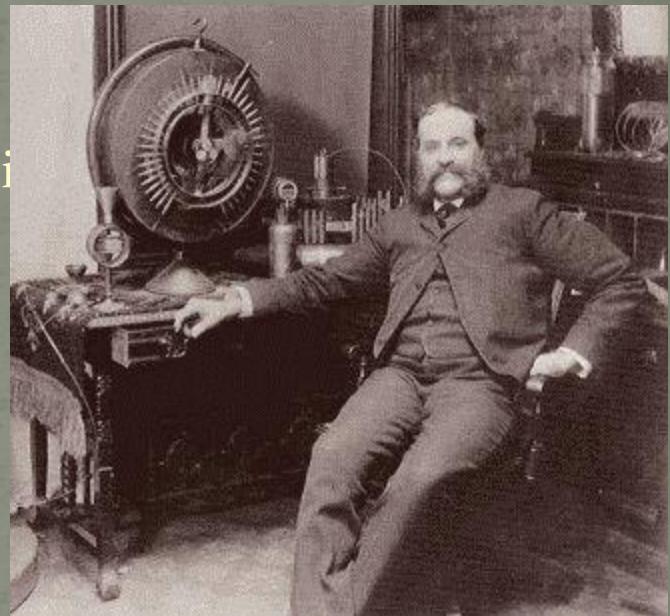
John Worrell Keely



- He formed the “Keely Motor Company”, began giving public demonstrations and selling stock.

Keely and his times

- In the context of the times, Keely's claims were not all that unbelievable:
 - This was before Special Relativity, and “Luminiferous Ether” was the hypothetical fluid through which electromagnetic waves, including light, propagated.
 - This was the golden age of empirical physics, and finding a way to extract energy from this medium was not yet experimentally ruled out.
- Keely's *behavior*, on other hand, should have raised some alarm bells
 - He never published any data regarding the mode of operation of his machine in scientific journals.
 - He never allowed any independent test or even inspection of his machine.

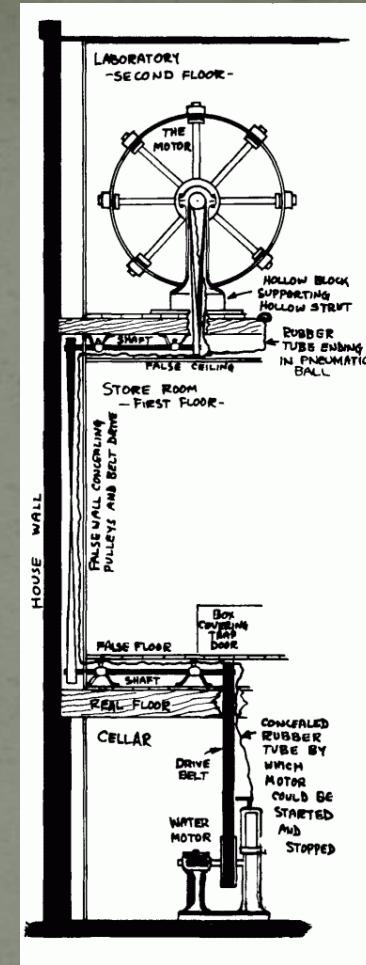


The end of Keely

- After many years of delays, investors were becoming frustrated with Keely's failure to produce a commercial device, and his refusal to allow independent testing.
 - They began withdrawing their investments and advising others to do the same.
- Clara Bloomfield-Moore, a wealth Philadelphia widow, came to the rescue with a large sum of cash and a monthly stipend.
 - which she dramatically reduced after a negative evaluation by the engineer E.A. Scott.
- In 1890, Keely announced a new product, "The Liberator", which would allow a motor to run on water.
 - Few people believed him.
- Keely was hit and killed by a streetcar on November 18, 1898.

Keely: postmortem

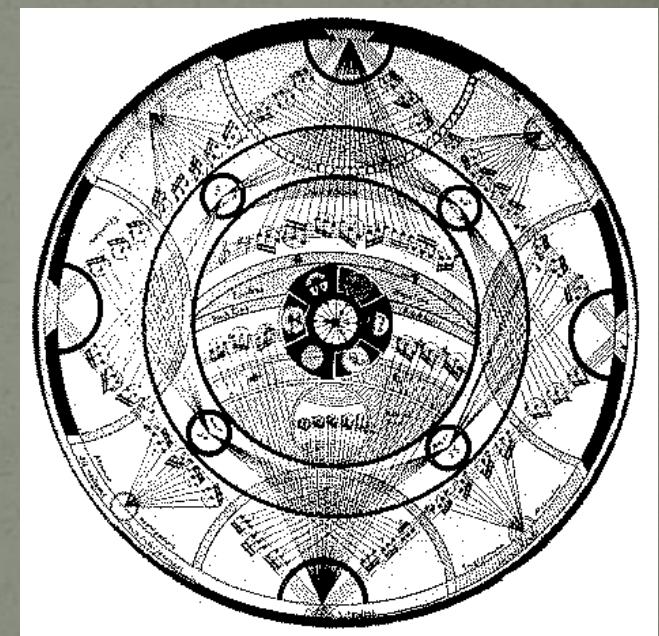
- “Scientific American” had always been skeptical of Keely. Following his death, they inspected his home.
- They discovered an elaborate system of pipes and hoses, connected to his machines through hollowed out legs on the furniture!



- The entire system was powered by a compressed air tank in the basement.

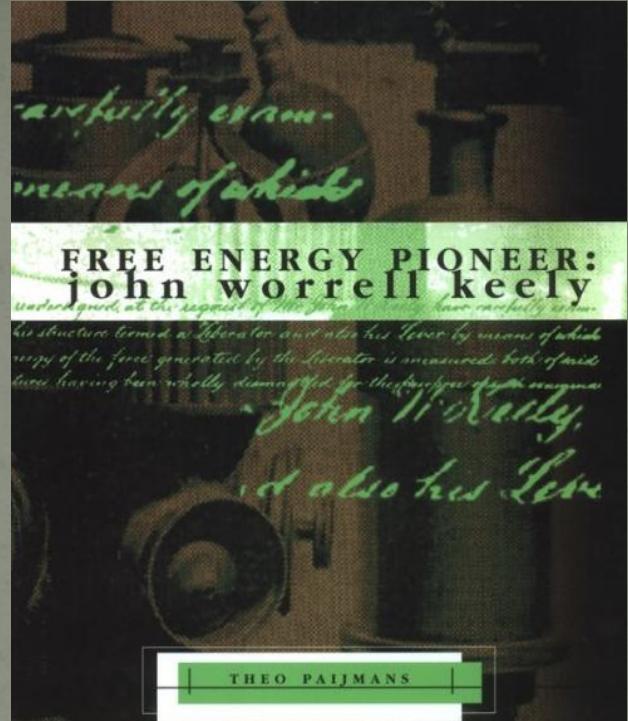
Lessons Keely taught future generations

- Focus on attracting “investors” rather than selling devices or demonstrations.
 - Can only charge so much for a demonstration.
 - Can only sell devices until people realize they don’t work.
 - In contrast, can get significant sums from investors and then keep them away with excuses for months or even years.
- Bring in religion/philosophy
 - Keely tapped into spiritualist/occult beliefs popular in his day, and this trend continued into the early 20th century.
 - Still around today, although many modern free energy gurus favor fundamentalist Christianity.
- Cultivate the “true believers”
 - Many people really want to believe in these technologies.
 - They will be easily convinced.
 - They will continue to believe in spite of all the evidence.



Keely today

- Keely's claims were thoroughly and completely debunked 110 years ago.
- Nevertheless, thousands of people still believe Keely held the key to limitless power and much more.
- Example
 - “Over 100 years ago, John Ernst Worrell Keely (1827-1898), developed an advanced synthesis of science and philosophy. Keely was harnessing Sound, Light, Heart, Mind and Will to operate revolutionary new machinery and to improve Life and health. This is a science based on Natural Law governing Life, hope and Love and not Death, despair and destruction.”
- from the *Sympathetic Vibration Physics* website

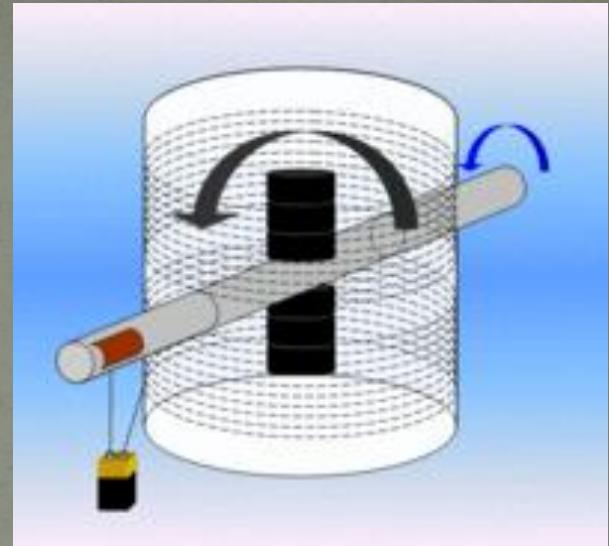


Major classes of modern free energy devices

- Motors that run on permanent magnets
 - Usually find excuses to connect them to batteries
- “Over-unity” transformers that put out more electrical power than they take in.
 - Rather than admit they are selling a perpetual motion machine, they will usually claim to be tapping the “Zero Point Energy” (ZPE)
- Engines that run on water
 - Generally deny being “perpetual motion machines”
 - Instead claim to split water into H and O with “very high efficiency”
- Fancy jars of goo
 - Cold fusion
 - Self-charging batteries
 - Yet more ZPE devices

Joseph Newman: patent-ly absurd

- Joseph Newman is probably not a con man.
- He honestly believes he's created a motor that produces more output power than it takes in.
 - Involves permanent magnets and Copper coils
- He stages elaborate, yet ultimately unimpressive, demonstrations.
 - Has a car which runs powered only by batteries.
at 4 mph
 - Believes his motor is not perpetual motion because it converts the mass of the copper coils into energy.
68
of 250 V each



Joseph Newman's patent attempt

- Newman attempted to patent his motor *as an over unity device.*
 - Application initially rejected out of hand.
 - Under the terms of Patent Code 608.03, Newman supplied a working model.
 - This was evaluated by the National Bureau of Standards, which measured the efficiency at <100%, and the patent application was denied.
 - Newman took the case to court, producing an array of “experts”
 - Court rejected Newman’s challenge.
- Newman ultimately withdrew his US patent application, and turned his attention elsewhere
 - Mexican Patent #MX158113: "MEJORAS A UN SISTEMA Y METODO PARA GENERAR ENERGIA"

Technical jargon can be confusing...



OK, that was a little fun nonsense

Batavia Public Library July 28, 2008

Compare to



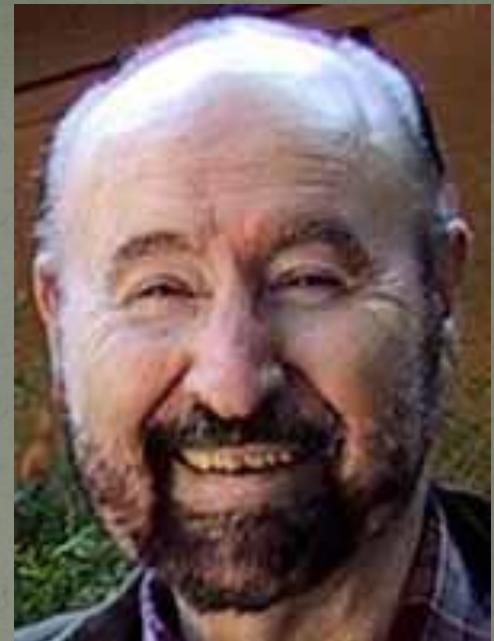
And this guy takes himself seriously!

The (two) claims in the video

- “Standard electrodynamics assumes flat spacetime”
 - WRONG – electrodynamics works fine in curved spacetime, which leads to the bending of light
 - This was predicted by Einstein and experimental verified *almost 90 years ago!*
- Reference to Lee and Yang
 - He seems to be confusing the 1957 Nobel Prize (Lee and Yang) for discovering “handedness” in weak interactions with the 1979 Nobel Prize (Glashow, Weinberg, Salam) for unifying electromagnetic and weak interaction by (among other things) interacting with the vacuum.
 - Of course, neither of these have anything to do with what he’s talking about.
- The point is, there’s no content in this video or any of the dozens of other s Bearden has produced.

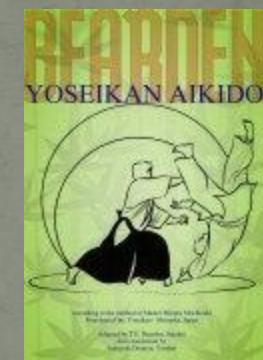
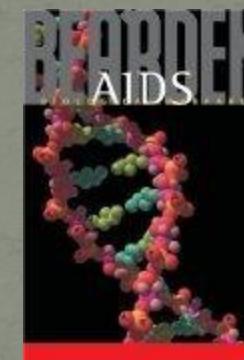
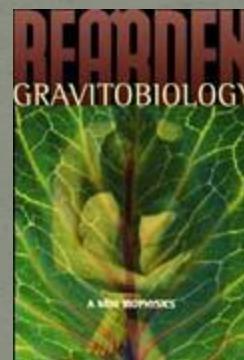
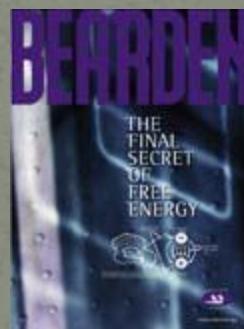
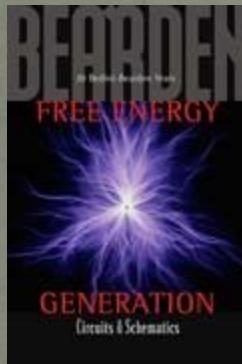
Who is Tom Bearden?

- In short, he's *the* cult figure in the free energy community:
 - Next to Tesla, of course
- He has a B.S. in Math from Northeastern Louisiana University, and a Master's in Nuclear Engineering from the Georgia Institute Technology.
- He retired from the Army at the rank of Colonel
 - This appears to have been his only real job .
- For a while he identified himself as “Thomas Bearden, PhD”
 - His PhD turned out to be purchased from “Trinity College and University” – a notorious degree mill.
 - He’s back to just “Thomas Bearden” - usually



Bearden's claims

- For decades, Bearden has been making numerous claims involving “over-unity” physics (he avoids the term “perpetual motion”)
 - Claims that these technologies are being suppressed by governments and special interests
- He has written 10 book on free energy, conspiracy theories, AIDS, ... and one on Aikido



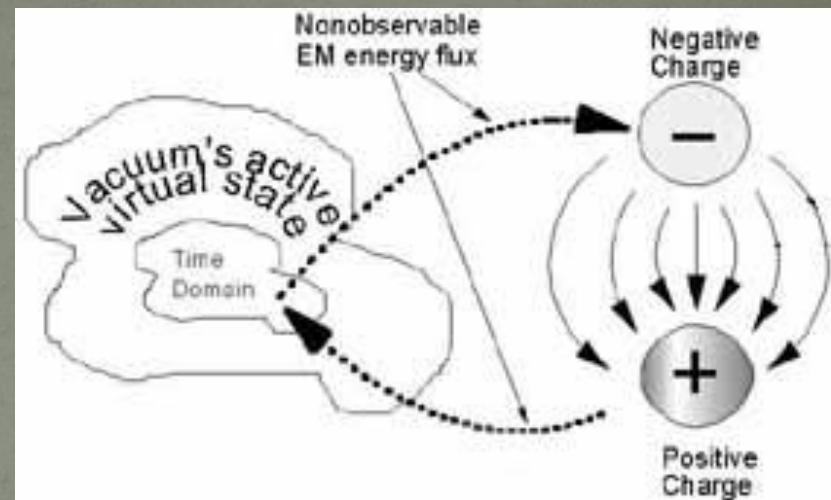
- For example, he believes both the Challenger accident and Chernobyl were triggered by secret “scalar wave” weapons.

The "science" of Tom Bearden

- Bearden supports his claims with a random stream of physics jargon and famous names:
 - “Zero Point energy”, “Scalar waves”, “Nikola Tesla”, “broken symmetry”, “Aharonov-Bohm Effect”, etc, etc, etc.
- One analysis of his theories (by real physicists) described them as:

“full of misconceptions and misunderstandings concerning the theory of the electromagnetic field”

 - Carvalho and Rodrigues, “*The non sequitur mathematics and physics of the New Electrodynamics proposed by the AIAS group*”



The motionless electric generator (MEG)

- Patented in 2002 by a group led by Bearden.
- Purports to be a device for extracting energy from the vacuum (or from “scalar waves”, the explanation is not clear).
- In 2002, Bearden promised a commercial model in “a year or so”
- As of 2005, he claimed he still needed “\$10-\$12 million dollars” to develop the MEG into a commercial product.
 - It’s not clear what the money is for, since he claims it has already produced “100 times more energy than was input”.
- To date, there is still no commercial product.
- Independent analyst essentially describe it as “a fancy transformer”.
- Cited by many as “absolute proof” of “over-unity” physics.



Other claims by Bearden*

- Numerous “over-unity” technologies exist, but are actively suppressed by government or special interests, using means up to and including murder.
- Believes that something called “scalar waves” are being secretly developed as a weapon, and in fact are responsible for:
 - Chernobyl
 - The disintegration of the space shuttle Challenger
 - The 2001 Indonesian tsunami
 - Hurricane Katrina, which was engineered by a combination of the KGB, the Japanese Yakuza, and remaining members of the Aum Shinrikyo cult
- What conclusion would you draw about the guy?

So how can you tell the difference...

- ...between real science, and scientific sounding jargon?
- Answer: *You* can't.
- Science is very complex and specialized. Some things can really only be understood by experts.
- For example, consider the two journal articles

Chang and Georgi,
“Quantum modified mooses”
Nuclear Physics B672 (2003)

Real paper by renowned
physicists in a respected
journal

Ganfornina and Valdes,
“Studies on the Tsagas-
Sourlas-Santilli Isotopology”
Algebras, Groups, and
Geometries (2003)

Nonsense, self-published
by kooks

- You have to rely on the opinion of “the establishment”

Energy from water



Batavia Public Library July 28, 2008

Digression: the popular news media

- With a few exceptions, when it comes to science, news media are awful.
- When it comes to pseudo-science, the media are *godawful*.
- When it comes to free energy con games, news media should arguably be charged as accomplices.
- If you remember nothing else from this lecture, remember this:
 - *No significant scientific result has ever been reported first by the evening news (or a YouTube video)*

What a good reporter might have noticed

- If you could build a car that runs on water, why would you build a “gas-water hybrid”? Nostalgia?
- They used “4 ounces of water”, but *how much gas*?
- Do you have a lot of call to cut through charcoal?
 - Could it be the Oxygen was combining directly with the Carbon and the charcoal was simply burning itself?
- Nothing magic about making a flame with Hydrogen from electrolysis.
 - Particularly with a unit the size of an arc-welder.
- This sort of thing has been tried many times before
 - Google “Brown’s gas”, for example

The "science" of Aquxygen

- Like many free energy scams, Aquxygen claims their product is based on revolutionary new physics.
 - In this case, a new molecular state of Hydrogen and Oxygen (HHO)
- Their website includes a scientific paper by R. Santilli at the “Institute for Basic Research”
- What is the IBR?
 - Well, it has four locations, one for each of its four members:
 - Florida
 - Italy
 - Kazakhstan (and this was before Borat!)
 - Nigeria (OK, should have expected that)
- Basically, they publish scientific sounding nonsense in support of free energy scams.

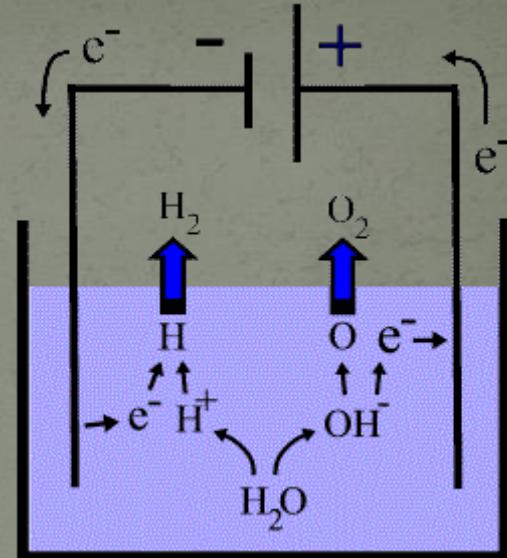
The problem

- Burning Hydrogen and Oxygen produces water.
- Remember the First Law of Thermodynamics
 - An engine that runs on water
 - Starts with water
 - Ends with water (i.e. in the same state)
 - Extracts useable energy

Cars that run on water violate the laws of physics as we know them

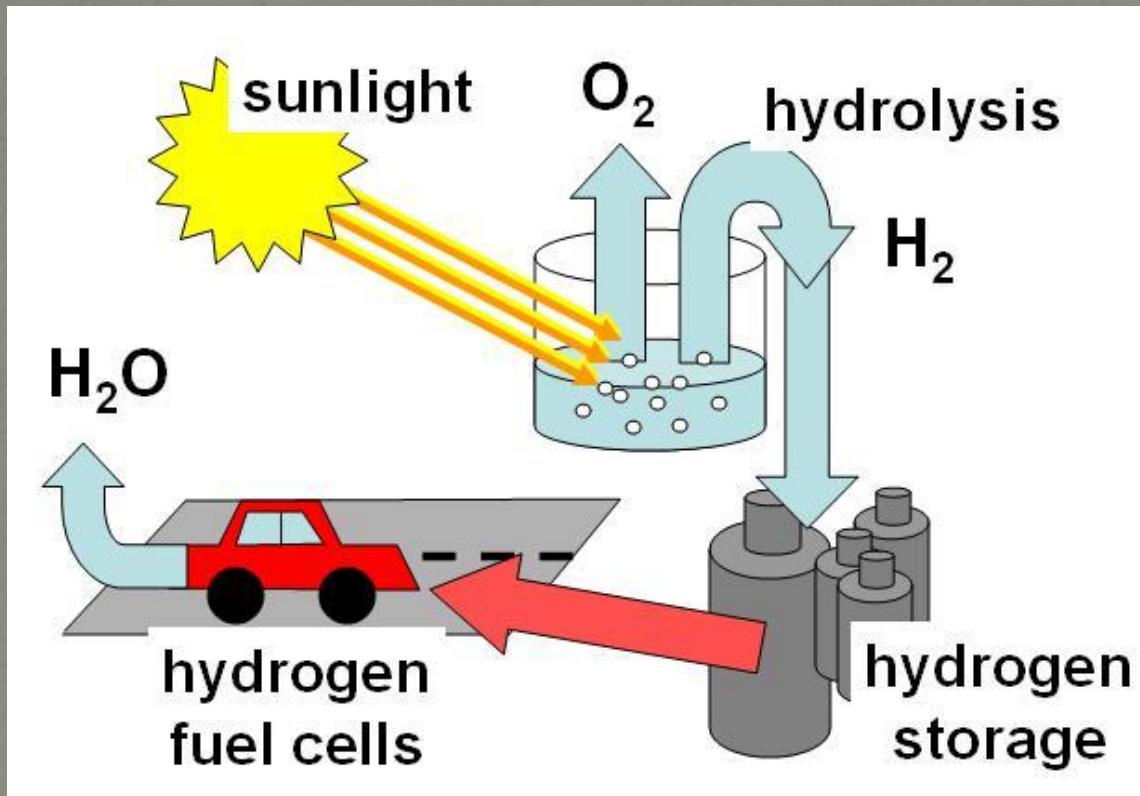
Electrolysis: in the real world

- Electrolysis is the process by which electricity is used to break water into Hydrogen and Oxygen
- Energy is released when the Hydrogen and Oxygen are recombined , which again produces water
- The energy release in recombining the Hydrogen and Oxygen *is always less than the energy used in electrolysis.*



Application of Hydrogen cycle

- Hydrogen can be used to store energy from inherently intermittent sources like wind and solar



- Lots of practical problems to solve, but no problem with the laws of physics

You can fool some of the people all of the time

- No matter how many times the notion of extracting power from water is debunked, *people still believe it.*
- I could fill a whole talk with cars that run on water
- Example: Stan Meyer (look for videos on YouTube)
 - Claimed in 1990 to have a dune buggy that ran on water.
 - Got a lot of news coverage, and took a lot of money from investors.
 - In 1996, Meyer an Ohio court found Meyer guilty of “gross and egregious fraud” and ordered him to repay (some) investors \$25K
 - In 1998, Meyer died suddenly, at the age of 58
 - The coroner ruled that Meyer, who suffered from high blood pressure, died of an aneurism
 - Conspiracy theories persist that he was “killed by big oil”
 - Oddly, *complete plans remain available on the web* – but no one has made them work.
- You’d think people would be done with energy from water...

Genesis World Energy:

- On December 5, 2002, Genesis World Energy issued a press release announcing

“a scientific breakthrough that allows consumers to easily access the energy contained within the hydrogen and oxygen molecular structure of ordinary water”
- This technology had reportedly been developed by “more than 400 visionaries from a wide range of disciplines”.
- Oddly, none were named, but we were assured they were very impressive.



More oddities

- In addition to the mysterious “400”, none of the company officers are named, nor does the company appear to have any facilities, or even an address.
- Skeptics point out that the press release specifies the output of their “Edison Device” in “kilowatts per day” – a nonsensical unit.
 - This error is never corrected
- The company releases some pictures, but allows no independent inspections.



The plot thickens

- On March 18, 2003, the company announces that it is poised to invest \$20 billion in manufacturing facilities to begin producing commercial units in 2004, ramping up to 2 million units per day by the end of the year.
- Even assuming they mean per business day, at the stated price of \$3000 for the domestic unit, this translates to \$1.5 trillion in gross annual sales

- $\sim 4 \times$



- $\sim 1 \times$



Beginning to unravel

- On April 23, 2003, still having never produced a commercial product, GWE announces a new automotive technology.
- Many recognize their demonstration device as a child's toy which had been used in a previous free energy scam.
- 2004 comes with no commercial product. In response to nervous investors, GWE releases a report from an unnamed “independent lab”.
 - Skeptics immediately jump on numerous errors – *including the same unit confusion that was in the original press release.*



The end of genesis World Energy

- On September 23, 2005, Patrick Kelly is arrested in Idaho on a New Jersey warrant. Although his name has never appeared in any news releases, Kelly is identified as the president of Genesis World Energy (which had changed its name to Genesis Scientific and United Fuel Cell Technologies by this time).
- On September 31, 2006, Kelly pled guilty to securities fraud and was sentenced to five years in prison and a \$400,000 fine. In sentencing, the judge stated, “the defendant is going to prison because he stole from investors”
 - It’s estimated he took in about \$2.5M in “investments”
- In the end, the “400” turned out to be Kelly and one partner, whose involvement was limited enough that he wasn’t even convicted.

Some Lessons from GWE

- The Good News
 - Kelly went to prison.
 - To the best of my knowledge, no one claims he was framed.
- The Bad News
 - Even in the normally credulous free energy community, there was skepticism about GWE, because of the outlandish marketing claims, not because of the dubious science.
 - In spite of this skepticism, people invested \$2.5M
 - Kelly fell victim to his own greed. There are plenty of equally bogus technologies bilking investors with impunity: Xogen, Aquygen, Black Light Power, etc.

Prosecuting energy con men

- Kelly was convicted for misappropriating corporate funds for personal expenditures (houses, credit cards for his daughter, etc)
 - Only accused of mishandling about 10% of investment money.
 - Ultimately irrelevant that the technology was bogus
- Difficult to prosecute based on scientific claims. Most prove:
 - Technology doesn't work
 - Technology *can't possibly* work
 - The people asking for your money know this
- Most con men are smarter than Kelly
 - Classify investments as “venture capital”
 - Pay themselves a large salary
 - Divert a little money to meaningless “R&D”
 - Continue with impunity

Getting it wrong

- Many of these people are quite sincere in their beliefs.
- How can they get something as simple as conservation of energy so wrong?
- A little knowledge is a dangerous thing.
- One of the most common mistakes is to apply approximate physics formulae to situations where they aren't relevant.

Getting it wrong

- For example, in the power in an electrical circuit at any given time is given by the voltage times the current

$$P = IV$$

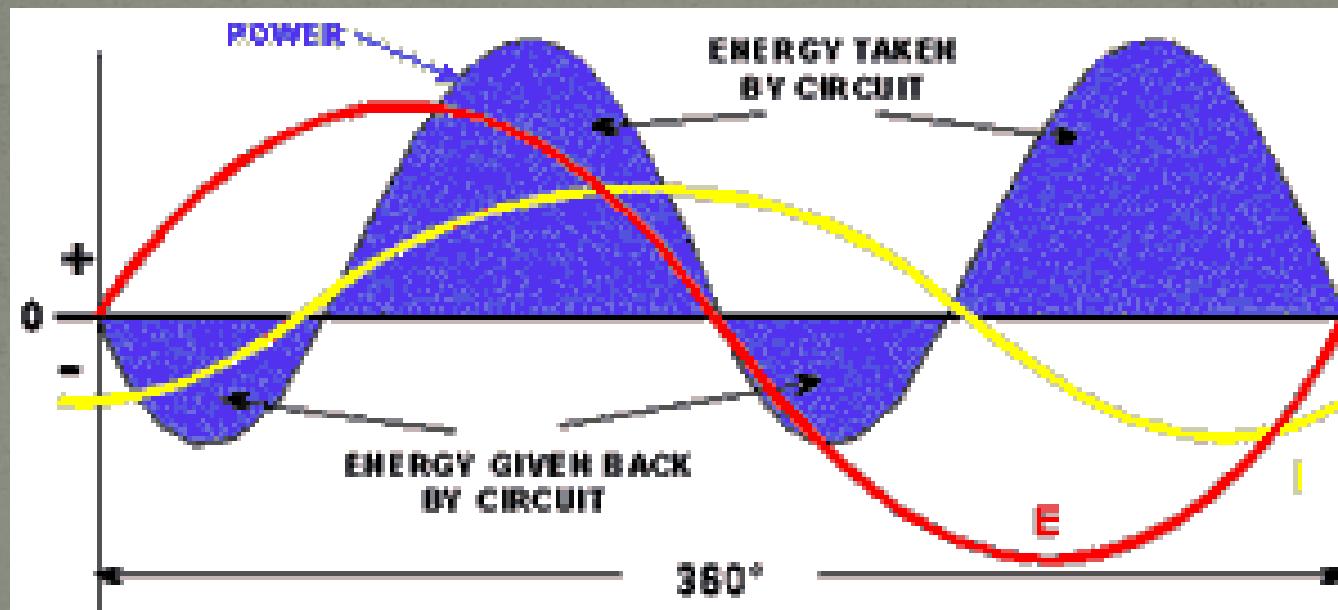
- For a *simple* alternating current (AC) circuit, the average power is

$$P_{ave} = \frac{I_{peak} V_{peak}}{2}$$

- But this is NOT generally true

General AC circuits

- In general AC circuits, power is going into the circuit some of the time and coming out at other times.
- The simple formula *does not work*



Other complications

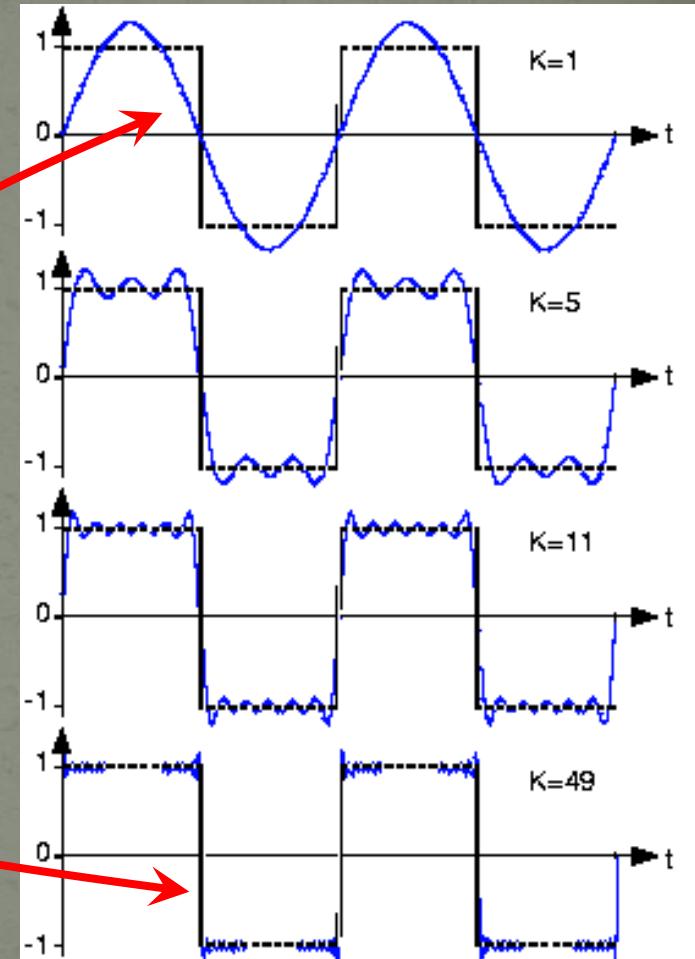
- The formulae we've been discussing apply to sine waves.
- Other wave forms have different relationships
- For example, **sine wave**

$$P_{ave} = \frac{I_{peak} V_{peak}}{2}$$

- but for a **square wave**

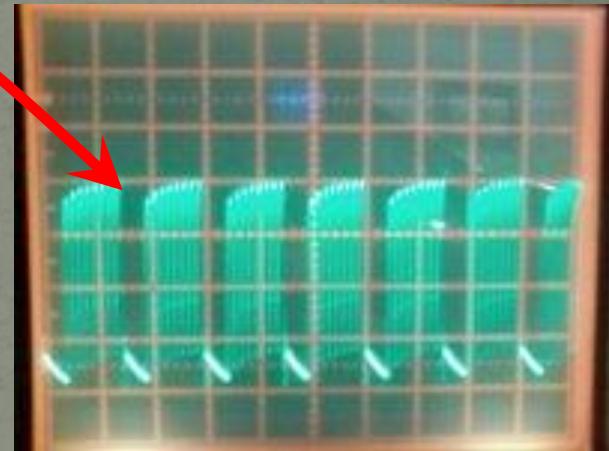
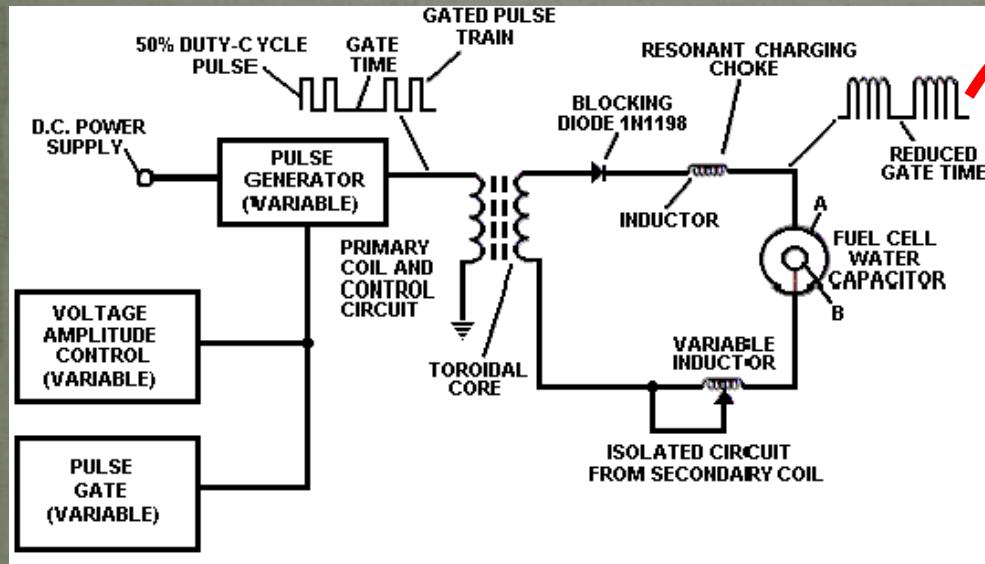
$$P_{ave} = I_{peak} V_{peak}$$

- No simple formula works all the time.



Can it be that simple?

- Power circuit from Stan Meyer's “Water Fuel Cell”
 - Electrolysis driving waveform



- All “over-unity” claims regarding Meyer’s cell result from erroneous evaluation of the power in this complex waveform.
- Complicated waveforms are a very common feature of “over-unity” circuits.

Can it really be that simple? (cont'd)

- On a recent Wikipedia discussion, a user who had done extensive experiments that seemed to support Joe Newman's claims posted the following

“Recently I found that AC Power actually is a product of 3 things: The RMS voltage times the RMS current and the power factor of the circuit. The power factor is resistance divided by impedance.”

- In other words, *he had had no concept of basic electronics while doing his tests.*
- This is not that unusual.

Digression: Nikola Tesla

- You won't get far in the “free energy” world, without encountering Nikola Tesla, who's become something of a patron saint.
- Nikola Tesla was a brilliant, iconoclastic inventor at the turn of the (last) century who holds over 300 patents.
- Among his most important contributions was the introduction of AC power for power distribution (something Edison fought against)

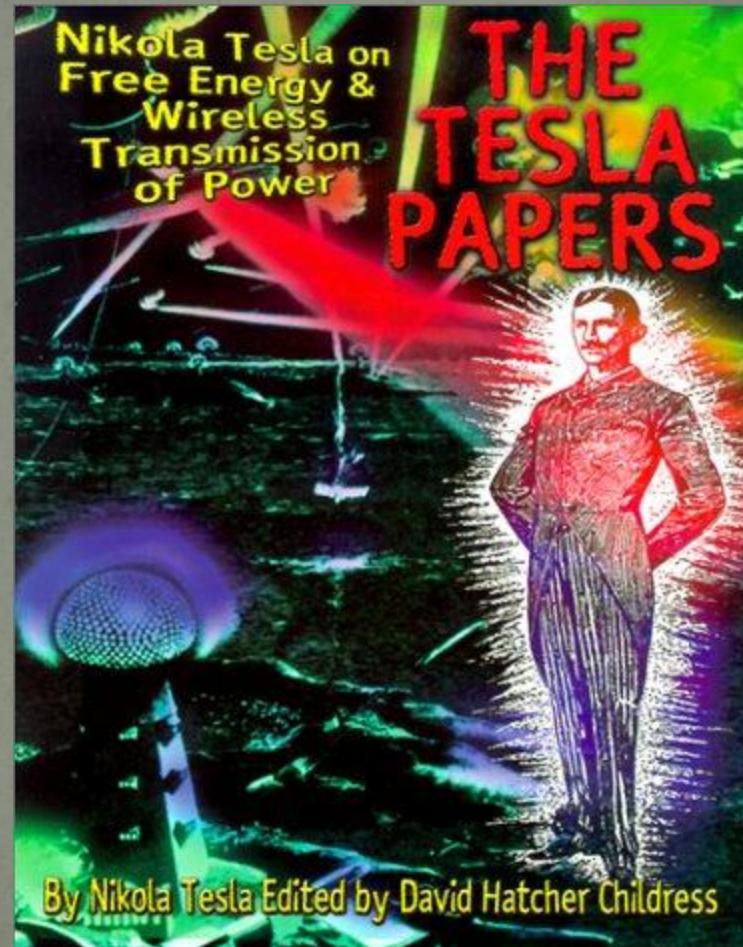
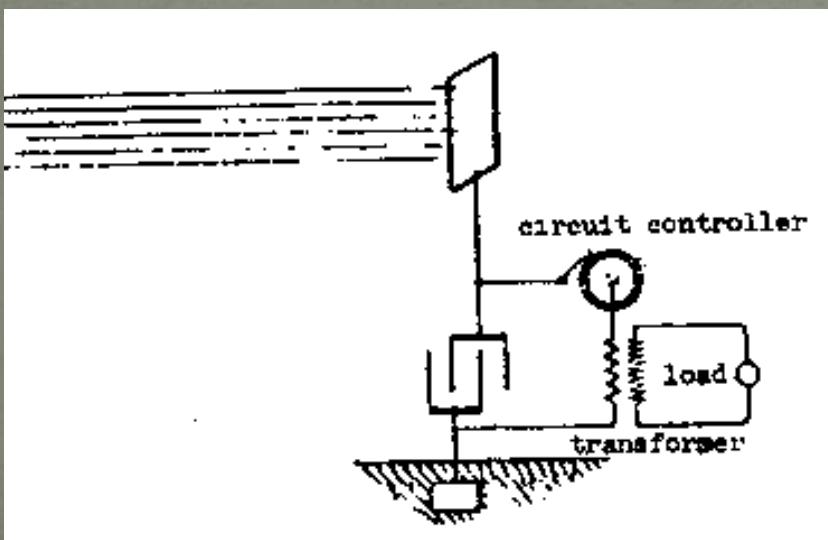


Tesla's later years

- Most historians agree that Tesla really invented (and patented) the radio.
- He became very bitter that Marconi got the public credit, possibly triggering a downward mental slide.
- He began to make increasingly odd statements
 - He claimed he got his ideas from extraterrestrials.
 - He admitted he was developing a fear of “round objects”
 - He claimed to have developed a working “death ray”
 - He also claimed to have patented “free energy devices”

Tesla's free energy

- Tesla had long been pushing a plan to “broadcast” electric power.
- It only works if energy is “too cheap to meter”
- Also patented a “radian energy receiver”



Tesla: the facts

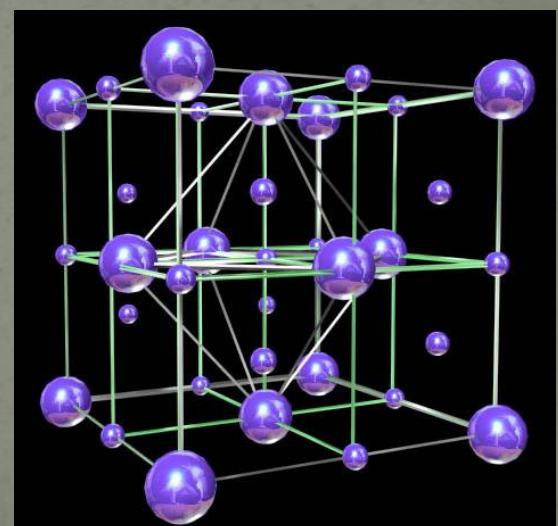
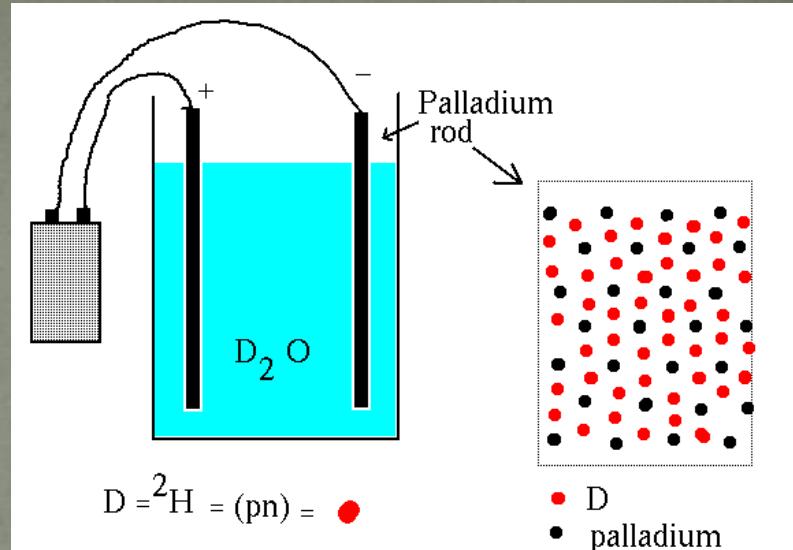
- Tesla was an prolific and innovative inventor, but not a scientist
 - Made no fundamental *scientific* contributions
 - Not even clear he really understood the science behind his inventions.
- All of his inventions were understood in terms of the physics of the time.
- His extreme claims, such as the death ray, simply don't work.
- His “radiant energy device” is just an antenna
 - Would work if the universe were filled with electromagnetic radiation.
 - Unfortunately, it isn't.

Defense of "fringe" science

- It's important to distinguish “crackpot science” from “fringe science”
- “Fringe science” is science that involves measurements or theories which are extremely difficult to reconcile with the prevailing theoretical framework, *but are nevertheless not yet ruled out experimentally.*
 - Fringe science is not only legitimate but vital.
 - Many accepted theories were once “fringe”
 - Plate tectonics
 - Theory of relativity
 - Quantum mechanics
 - Expanding universe
 - Some examples of current fringe experiments include
 - Search for tachyons
 - Gravitational mass of antimatter
 - Unfortunately, unless care is taken, fringe science can easily become crackpot science...

Cold fusion: the revolution that wasn't

- In 1989, two teams announced they had seen evidence for nuclear fusion at room temperature taking place in a Palladium rod which had been loaded with Deuterium from heavy water.
- One team, Pons and Fleischmann, claimed energy release at a level which promised practical application.
- Although difficult to reconcile with solid state physics, there's nothing a priori impossible about the claim, and theorists struggle to accommodate the result.



The road from fallacy to fraud

- At the 1989 APS meeting, no one was able to confirm Pons and Fleischmann's results
- A CalTech chemist offered an explanation for all of their results in terms of sloppy experimental techniques.
 - Pons and Fleischmann did not attend, as they were busy soliciting funds.
- In addition, obvious cross-checks were not done
 - Control test with ordinary water
 - Assay for Helium, the product of fusion
- Cold fusion was dead – scientifically anyway.

And yet...

- Cold fusion is alive and well in the minds of believers



- There are magazines, websites, books, products, and conferences.
- Pons and Fleischmann continue to carry out “research” in France, funded by private investors.

Things to remember from this lecture

- Patents don't prove anything.
- Science isn't announced on the evening news.
- Just because it sounds complicated doesn't mean it's science.
- Cars don't run on water, no matter how many people claim they do.
- People lie. Some people do it for a living.
- They laughed at Einstein, but they also laughed at Bozo.
- If someone really discovers free energy:
 - They don't need complex marketing
 - They don't need you.

Some final comments

- This is just the tip of the iceberg
 - Just go to YouTube and search for
 - Tom Bearden
 - Joe Newman
 - Stan Meyer
 - Bedini Motor
 - Or just “free energy”
 - Watch the videos and *read the comments*
- Perpetual motion is just one facet of our society’s obsession with pseudo-science
 - Compare the Astrology section of B&N with the Science section.
- We will never solve the daunting (and exciting) energy challenges facing us unless we first face reality.