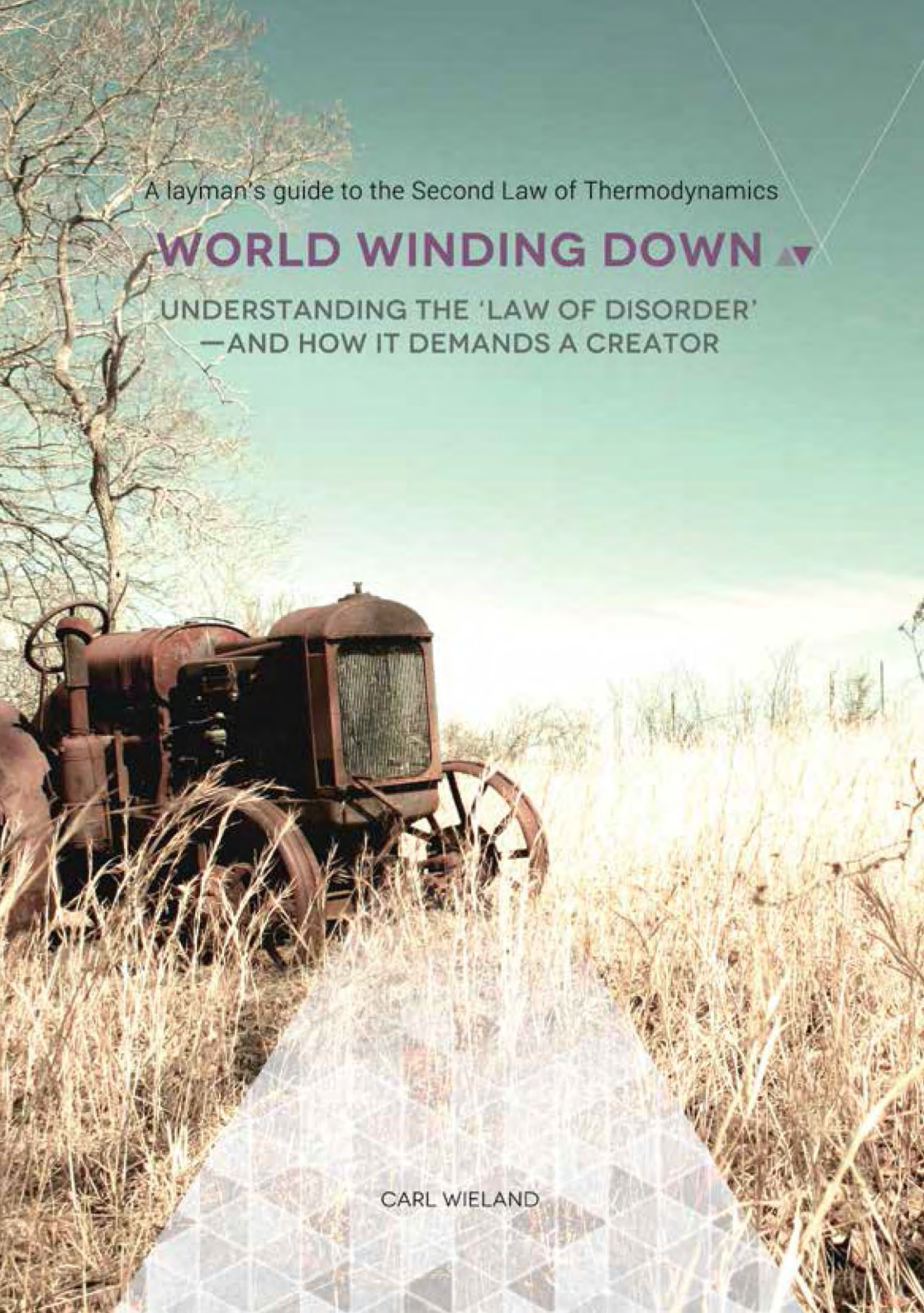
A layman's guide to the Second Law of Thermodynamics
WORLD WINDING DOWN
UNDERSTANDING THE 'LAW OF DISORDER'
—AND HOW IT DEMANDS A CREATOR
CARL WIELAND

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And my particular gratitude to CMI-US scientist Dr Jonathan Sarfati, a physical chemist, for not only checking for scientific accuracy but adding many special touches and flourishes, mostly to be found in the footnotes for the more technically minded. They have made me look a lot more knowledgeable than I am.

Of course, the responsibility for any deficiencies remains mine.

INTRODUCTION

Sometimes called the 'Law of Disorder', or 'Law of Decay', the Second Law of Thermodynamics[1] (2LT) may be one of the most misunderstood (and often misused) concepts in the creation/evolution debate—by both creationists and evolutionists alike.

Simply put, the argument from the creationist side has commonly been as follows. There is a universal law that says that all things are continually running downhill, becoming more disorderly. This seems to directly contradict the evolutionary belief that today's highly ordered universe, including all living things, has made itself by moving in precisely the opposite direction. Starting from an initial disorder, things have supposedly become progressively more ordered. Gas and dust have become stars, galaxies and planets; lifeless chemicals have, by their own processes and properties, allegedly become self-reproducing machines; these one-celled microbes have in turn become millipedes, mice, magnolias, mammoths—and even microbiologists—over time.

The Law of Disorder does indeed have something to say in all this, though it is often not quite in the way that those who wield it maintain. The aim of this booklet, which was almost going to be called 'Understanding the Law of Decay', is to help readers of many different backgrounds and educational levels fully grasp this law, one of the most basic, powerful and universal scientific concepts in existence. And to be able to use it, and the issues and principles that lie behind it, with confidence in discussions.

But along with that, it is deliberately intended to correct 'in passing' many mistaken ideas about the Second Law.

1. Sometimes also the 'Law of Entropy'.

Surprisingly, perhaps, these misconceptions are not infrequently held, on both sides of the creation/evolution divide, by those who think they 'know it all'—and/or whose qualifications suggest they should know better. But then, as I can attest from my university days, passing an exam on something is not the same as truly grasping it.

Wrongly applied, the use of this law can be an embarrassment to the cause of sound biblical apologetics. This is why on creation.com (the website of our ministry, *Creation Ministries International*) we have in our 'Arguments Not To Use' section (creation.com/dontuse) long advised great caution in its use.[2] The one wielding it as an argument in the creation/evolution debate without 'getting it right' can all too often—and with good reason—be readily 'shot down in flames'. Then again, many of the objections raised by anti-creationists, including those with qualifications that would indicate they should know better, are equally based on misunderstandings of this Law. In addition, of course, it is always a waste of everyone's time when people talk past each other in ignorance of the facts.

Properly understood and applied, however, understanding this law and, perhaps even more importantly, the principles that lead to the outcomes it describes, represents an important and powerful addition to the biblical creationist arsenal. It is exciting, too, to know that one can, in the process, educate even skeptical scientists in the realities of the world. One can show how these scientific principles are powerfully consistent with what I call the Bible's 'Genesis big picture'.

But don't think that this will be some complicated thing that will be difficult to grasp. It won't involve a bunch of hard-to-

2. We have suggested instead mostly sticking to what is a really a subset of the Second Law argument, the information issue in biology—see later in this booklet. This is because of the great confusion surrounding the 2LT. Hopefully, it will be less necessary to avoid getting into Second Law issues as the straightforward information in this work becomes more widely absorbed.

follow equations or a host of graphs (I promise to use only one graph—and only three equations in the main text, that all boil down to only one anyway. All of them are very straightforward). You see, something that I get excited about and aim for (and I sometimes mention it at the beginning of a talk on some subjects) is for as many as possible in the audience to reach what I call an 'aha' point. As in: "Aha, I get it. Now I *really get it*". In other words, not just giving some vague mental assent, or taking my word for it as some sort of authority figure.

This passion to transmit understanding in a straightforward way may be because I've always felt it important to be able not just to know *what* happens in the world around us, but also to understand *why*. And graphs and equations were never something that did that for me. When I studied first-year university physics as part of my medical training, I could pass the exam on issues to do with the Second Law. In spite of that, though, in hindsight I didn't really 'get it'. The equations (including ones more complex than in the main text of this book) were things I learned, but it had not 'clicked' properly. Nor, I might add, did that seem to matter much to those in charge—so long as I knew what to write on the exam paper at year's end. 'Entropy' (see later) was mostly just an impressive-sounding word with a mathematical symbol. Neither it nor the Second Law related to the world all around me in the way it now does. In short, the penny had not dropped, as they say.[3]

In any case, the Second Law of Thermodynamics seemed to only be important if one was going to be an engineer messing around with heat and power (that's where the name comes from, by the way; Greek *thermē* = heat, *dynamis* = power). I was

3. If this has been your experience, too, you may be heartened by the following comment from a major work on mathematics: "Every mathematician knows it is impossible to understand an elementary course in thermodynamics." (V.I. Arnold, in *Proceedings of the Gibbs Symposium*, D. Caldi and G. Mostow, eds., American Mathematical Society, 1990, p. 163.)

headed in a different career direction, for which the examination in physics was just a stepping stone. So that made it easier to put any dissatisfaction at lack of insight to one side.

It was only years later, when I was reading arguments based on this Law in relation to the creation/evolution issue, that my instinct for needing to understand things more deeply resurfaced. Both the arguments for creation using the Second Law, and the evolutionists' rebuttals, made me realize that there was more to it than dry numbers and tables. And it went to the heart of powerful, eternally significant worldview issues.

Also, some things did not seem right about a few of the arguments I was reading. For instance, some would argue that the Second Law of Thermodynamics absolutely precluded the evolution of microbe to man, because things naturally went downhill. But then when confronted with the fact that seeds naturally grow into plants, they would start talking about exceptions to the Second Law. Evolutionists would sometimes claim that evolution itself was an exception to the Second Law. But there *are no* exceptions to scientific laws, or else one could not call them laws, period. Biological systems like our bodies are, just like steam engines, real physical systems of matter and energy. They are therefore subject to exactly the same physical laws.

But—more later. Suffice to say that, to the extent I am now able to transmit some of my own excitement about understanding this aspect of reality, it is through having needed to wrestle with the issue from a non-physicist's perspective myself. It is from reaching what I hope many readers will also come to share—a non-technical but deeply satisfying, broad understanding of this important aspect of reality.[4] For those who unlike myself are

4. Of course, there are many with far more profound understanding, including at the mathematical level. What is meant here is an understanding that is satisfying because it not only accurately reflects macroscopic reality, it helps us to grasp and explain all sorts

inclined to a more mathematical treatment, there are occasional forays like this in some of the footnotes. These can, however, be skipped without missing the overall point.

Non-technical does not need to imply inaccurate or misleading, of course. I recall giving a talk on the subject in 1990 at a creationist conference held at Sydney University in Australia. In the brief question time afterwards, a man (not on the creationist side at that point at least, though friendly enough) stood up and said he was a lecturer[5] in physics at that university. He said it had been the best, most easily understandable yet totally accurate presentation of the Second Law he had ever experienced. He indicated that he now understood that it was a big problem for evolutionary belief.[6] That was provided not for 'pat-on-the-back' reasons (OK, I admit it felt good to write ☺) but to help give you confidence in the validity and accuracy of the straightforward facts to come.

For further reassurance: I gave a talk on the material in this book at a major US creationist conference in 2012.[7] Also in attendance, along with a good number of other scientists of many disciplines, were a Ph.D. physical chemist and a Ph.D. nuclear physicist, both colleagues in creation ministry. And both were delighted with the validity, ease of understanding and

---

of things that we had previously not seen in that light—as well as being able to correctly and effectively use this Law and the principles it is based on in creation/evolution discussions.

5. In the US system, he would have been termed a professor, which in British-based systems generally refers to a higher level of attainment, including heads of departments.

6. In his question, he politely wondered whether God's involvement might not have caused evolution after all, despite it 'going against' His own laws. (Such is the sway evolution holds over minds today.) But this would involve a far greater outpouring of the miraculous, over eons, than 6-day creation. Plus, God would be deceiving us—by manipulating things to go one way behind the scenes when all physical observation indicated the opposite. Not to mention that it contradicts God's record of what really happened. See creation.com/theistic for more problems.

7. The CMI-US 2012 Superconference at Asheville, North Carolina. My illustrated presentation was subsequently made into a DVD *Understanding the Law of Decay*, available at creation.com/store.

usefulness of the material and the arguments presented (one of them has also double-checked this booklet prepublication, as has a research professor of physics at an Australian university).

I mention all that because experience indicates that it is not beyond some anti-creationists to try to neutralize powerful arguments for Scripture by whatever means are at hand, scrupulous or otherwise. One of those is the timeworn 'argument from authority'; if such an argument was made, using the excuse that the issue was 'too complicated for the layman to understand', a mere medical doctor (who even admits he is not comfortable with equations and graphs) would be easily outgunned in a 'war of relevance of qualifications'. (Which is one reason why *Creation Ministries International* (CMI) globally[8] probably hires more Ph.D. scientists than any other Christian ministry I know of—though I am not one of them.) So if that tactic is tried on you in regard to the matters in this booklet, that may help you call their bluff— graciously, I trust.

Don't worry if you miss the full significance of some of the early explanations, as it will likely 'come together' for you as you move along. And if not, the beauty of a written explanation like this, as opposed to a talk, is that you can flick back as often as you need to in order to check the foundations of the argument, as it were, to ensure that your understanding is solidly constructed.

With all that preamble, you may be relieved to know that really 'getting' the Second Law of Thermodynamics will likely be a whole lot easier than you imagined. If you have had formal teaching on the subject, you may even have found difficulty in the past in following the necessarily technical way it's presented in certain courses. Despite this, through the use of multiple

8. We consist of a Federation (CMI-Worldwide) of autonomous offices in several countries, bound together by a co-operative charter which also protects the interests of supporters to each office. We share the same publications, the same non-denominational doctrinal platform, the same website (creation.com), and so on.

everyday examples, making similar points in different ways, it will almost certainly make very good sense for you after all.

Finally, to those who think they *do* know it all—maybe you do. But maybe not. You may just be surprised by the realization that it wasn't all quite 'together' after all. Whether so or not, I trust you may still gain some fresh insights—or, at the very least, new ways to explain it to others.

THE 2LT, ORDER AND DISORDER

As alluded to earlier, the study of 'thermodynamics' arose in the early 19th century as people started investigating the concepts of work, heat, and power, and the relationships between them.[9] This was especially important in the days in which steam power was revolutionizing industry and changing the world. But the 2LT is actually a much more universal law than that. Before covering the many categories of things it explains or predicts, let us emphasize that it truly is a *law* of science—there simply is no escape hatch, no 'out'.

Consider these well-known quotations. The Russian thermodynamicist and physicist Ivan Bazarov said in his textbook *Thermodynamics*:

> The second law of thermodynamics is, without a doubt, one of the most perfect laws in physics. Any reproducible violation of it, however small, would bring the discoverer great riches as well as a trip to Stockholm [to collect the Nobel Prize—CW]. The world's energy problems would be solved at one stroke. It is not possible to find any other law … for which a proposed violation would bring more scepticism than this one. Not even Maxwell's laws of electricity or Newton's law of gravitation are so sacrosanct … .[10]

The great physicist Eddington regarded the 2LT as holding "the supreme position among the laws of Nature." He said:

> … if your theory is found to be against the second law of thermodynamics I can give you no hope; there is nothing for it but to collapse in deepest humiliation.[11]

9. Including Sadi Carnot (1796–1832), William Rankine (1820–1872), Rudolf Clausius (1822–1888), William Thomson (Lord Kelvin, 1824–1907), and Josiah Willard Gibbs (1839–1903).

10. Pergamon, 1964.

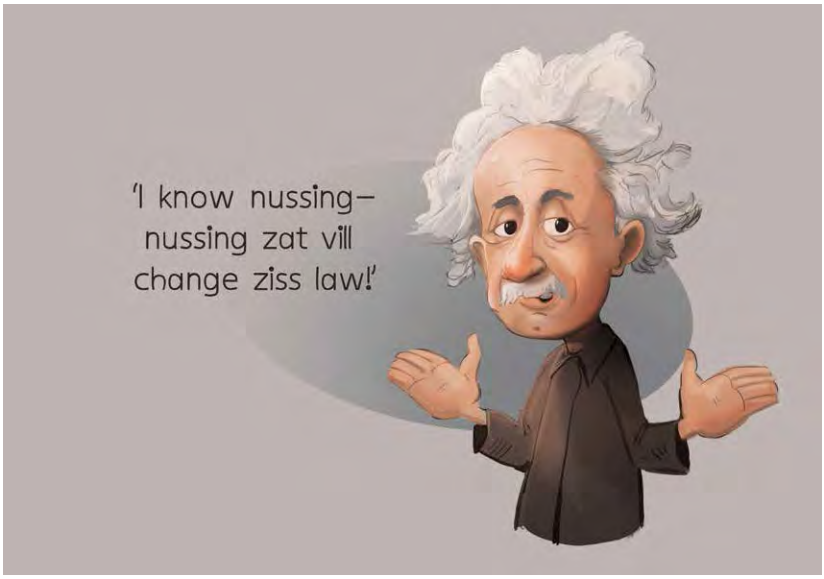
11. Sir Arthur Stanley Eddington, *The Nature of the Physical World*, chapter 4, 1915.

MIT engineering professor Seth Lloyd, writing in *Nature* in 2004, said:

> Nothing in life is certain except death, taxes and the second law of thermodynamics.[12]

Albert Einstein said of it (emphasis added):

> A theory is the more impressive the greater the simplicity of its premises, the more different kinds of things it relates, and the more extended its area of applicability. Therefore the deep impression that classical thermodynamics made upon me. *It is the only physical theory of universal content which I am convinced will never be overthrown*, within the framework of applicability of its basic concepts.[13]



To illustrate Einstein's comments about its breadth of application,

12. *Nature* **430**:971, 26 August 2004; doi:10.1038/430971a

13. Albert Einstein (author), Paul A Schilpp (editor), Autobiographical Notes. A Centennial Edition, Open Court Publishing Company, 1979, p. 31.

here are just some of the many things which the Second Law of Thermodynamics explains or is totally bound up with, as will be shown. The first are two matters which are very familiar to people widely read in the creation/evolution area; namely, the 2LT (or at least the principles which give rise to it, henceforth the 'Second Law principles') explains why things left to themselves naturally become more disordered with time. And why the energy available for work in any system just naturally and spontaneously decreases.

It also explains why certain processes go one way, and not the other; and why in the real world some things are possible and others not. For example, it explains why heat always naturally flows from hot objects to cold ones, never the other way around. (In fact, that's the basis of one of the several definitions of the Second Law,[14] which is why people can find it hard to relate it to things like creation/evolution issues.)

It's also why, if you were to open a bottle of oxygen gas in a room full of nitrogen, the oxygen, if you could see it (e.g. if it were a different colour) would be seen to eventually disperse itself evenly around the room, more or less uniformly mixed with the nitrogen. But you will never see the oxygen go rushing back into the bottle by itself.

THE ARROW OF TIME

This idea of forbidding things to go in certain directions is why the Second Law of Thermodynamics is often called 'time's arrow', because it has been argued that it serves to define the direction of time. If you saw a cup falling off the table and shattering into a million pieces, you wouldn't think there was anything

14. No process is possible in which the sole result is the absorption of heat from a reservoir and its complete conversion into work. Clausius formulated the law as "Heat can never pass from a colder to a warmer body without some other change, connected therewith, occurring at the same time."

weird about that. But if you saw the pieces gathering themselves back into the whole cup and jumping back on the table, you would know that you were seeing something impossible. For it to happen, time would have to flow backwards. This is because you know that as time proceeds in its normal direction, the cup would fall. And the pieces would shatter and scatter, all for reasons that will be covered.[15]

Also, it is the reason why certain kinds of perpetual motion machines are impossible, as we shall see (the kind that would, as Bazarov states, instantly solve the world's energy problems).

The principles that give rise to the Second Law are even the 'real reason' why transmitted messages tend to lose information, not gain it. And this in turn relates to inheritance, the transmission of the information carried by DNA from one generation to the next.

BUT WHY?

In the words of the late Professor Julius Sumner Miller, a regular personality on television in my youth: "Why is it so?" Is there a simple-to-understand reason for all these disparate phenomena? Is there some principle, or set of them, from which all these things can be derived? Yes, there is. It is simply that:

> 1) All systems of matter and energy continually strive to reach the most probable state.

(By 'all systems of matter and energy' we're really talking about everything in the material world you care to define as a system. That could be this booklet you are holding, or it could be the

15. In strict philosophical terms, this 'time's arrow' argument is circular—see creation.com/doom. The fact that the direction of entropy increase (a concept we'll come to later in this work) is commonly regarded as a way to define time here highlights the universality of the law. It concerns the things that will or will not happen in the real world, barring supernatural intervention.

room you're in. Or the whole universe—each are examples of a 'system'.)

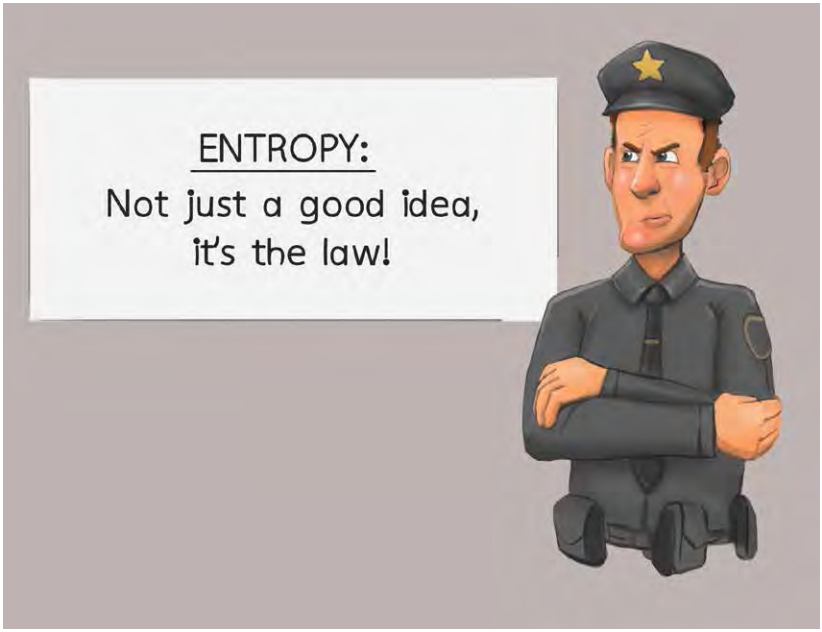
And following on from that, here's the bottom line:

2) Disorder is way, way more probable than order.

We intuitively recognize this by the fact that it's far easier to break something than to make it. That's why even something as simple as the disorderliness in your room is related to the principles that make up this law of science. You have to work hard and repeatedly at keeping it tidy—applying not just energy,

The workers have to eat to get energy, which breaks molecules down from complex to simple, increasing disorder in that way, plus releasing heat which warms the surroundings. As well, the operation of machines burns fuel—either directly if gasoline-powered, or indirectly at the power station if electrically driven. This, plus the movement of the machinery and the workers also heats the air, disordering the universe beyond the house itself.

The same is true for the seed growing into a plant; it can only increase its order in this way at the expense of other processes which disorder the surroundings more than this increase in the 'local' order. Quite simply, there are *no* exceptions to the Second Law. Every process is running down the universe.



And that has some really powerful implications for the creation/evolution debate, including the existence of God. Not just any old god, either, as will become clear.

ENERGY: THE BIG PICTURE

Consider this relentless entropy increase just in terms of the availability of energy, as in the graph below (Fig. 31).[51] This is the only graph in the booklet, as promised. It illustrates what is happening to the universe as far as its energy goes. And it allows us to draw some extremely important and wide-ranging conclusions about the true nature of reality, and more.

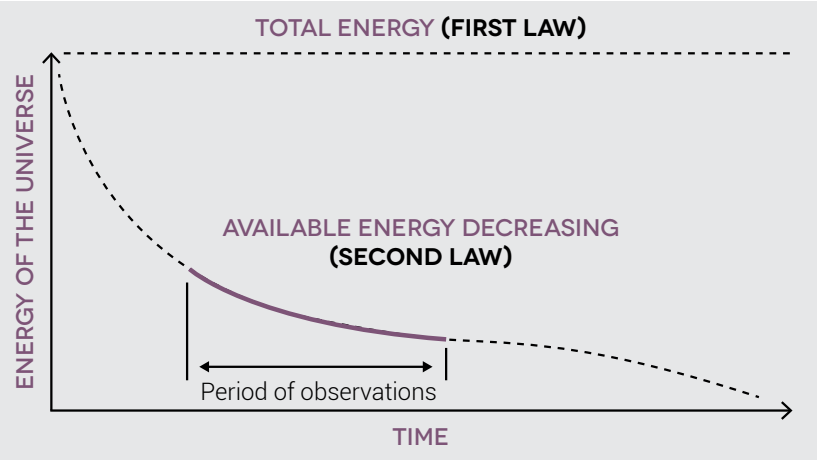


Fig. 31: Graph of the universe's energy

Energy is shown on the 'Y' (upright) axis, and time on the 'X' (horizontal) axis. The dashed line across the top is horizontal, because it represents the total energy of the universe, and this always remains constant. This is because, as you will recall, the First Law of Thermodynamics says that energy can't be created or destroyed, only converted to other forms of energy (including matter). But the lower, descending line represents the energy *available for work*, and, according to the Second Law of Thermodynamics, it is constantly decreasing. It's deliberately shown as an irregular (not straight-line) decrease to signify that

51. This graph is credited to the late Dr Henry M. Morris.

this decrease may not always be at the same rate. (Some things generate entropy faster than others, obviously.)

But however fast this available energy is decreasing at any given point, it's clear from those entropy equations of the Second Law that it's *always* heading downhill, towards a state in which no more energy is available. This is called the future 'heat death' of the universe (see shortly).

THE 2LT POINTS TO A BEGINNING

And here are the implications, the conclusions we can draw from this graph. The universe is running down; *all* natural processes are winding it down inexorably. The first thing that this tells us is that it had to have a beginning—it can't be eternally old, or it would have 'wound down' completely already. Or, to put it another way, trace those two graphs backwards in time, and no matter what angle that lower graph takes, sooner or later, the two would come together at some point. One could not go back further than that without having more energy *available* than

there is in *total*, which is clearly impossible. Now while that might not represent the beginning (the actual beginning could have come at a more recent time, as the universe did not have to start fully wound up, with every single jot of energy available for useful work). But it does mean that it cannot be eternal—it must have had a beginning. The scientific evidence that supports this is overwhelming, so much so that even most of today's atheistic/naturalistic thinkers concede that the universe began in time. They do this in spite of the fact that they would find it much more comfortable to have an eternal universe. (If the universe itself were eternal, it would not need an eternal God to make it.)

Christians can easily get lulled by this into thinking that we should therefore welcome the dominant 'big bang' paradigm, because it, too, postulates just such a beginning. But in addition to the serious scientific problems the 'big bang' involves,[52] there are also its inherent and intractable, massive contradictions to Genesis; the timeframe, for one thing, and the order of events. For example, Genesis makes it clear that the earth was created before the sun; the big bang has it the other way around. Furthermore, leading proponents of the big bang are already confident they have found a way around any implications of a creator God. They have set up sophisticated-sounding theories of how the universe in effect created itself, with almost exquisitely equal amounts of matter and antimatter spontaneously appearing out of nothing, out of 'fluctuations in the quantum vacuum'.[53]

However, this is fundamentally irrational. For one thing, the 'nothing' they postulate is not really nothing, as it presupposes that the laws of quantum mechanics already exist—as well as space and time in which the 'fluctuations' can occur. For another,

52. See Williams, A. and Hartnett, J., *Dismantling the Big Bang*, Master Books, Green Forest, AR, 2005. Also Wieland, C., Secular scientists blast the big bang, *Creation* **27**(2):23–25, 2005, creation.com/bigbangblast.

53. 1 in 10^{50} more matter particles than anti-matter particles, so as to end up with a matter-filled universe after self-annihilation of the rest.

the validity of such reasoning is suspect on philosophical grounds. Consider:

> **1)** Since we know from the 2LT that the universe had a beginning, this means that there must have been a time when it did not exist.
>
> **2)** We know from the scientific law of cause and effect that everything that has a beginning has a cause, so the universe must have had a cause.
>
> **3)** Something that does not exist cannot do anything—in particular, it cannot cause anything, including its own future existence.
>
> **4)** *Ergo*, the cause of the universe must be other than itself. So there *has to be* a Creator who is not a part of this universe, i.e., who transcends it.[54]

In addition, such a Creator must be greater than the universe, by virtue of being able to bring it into being, and so would not be prevented from working within it, too.

Our Second Law graph also shows that it becomes more 'wound up' as we go backwards in time, so it must have started in a more wound-up (lower entropy) state—though not necessarily 'fully wound up', as already indicated.

So how did it get to be that way? It has no way of winding itself up, i.e. by natural processes. All natural processes wind it down—increase its entropy—still further. Even an extremely powerful hypothetical being, if that being were part of the universe (like the gods of certain eastern religions), could not wind it up (reduce its total entropy) 'from the inside', as it were—not even a little bit.

The obvious answer is, once more, that it arrived at that beginning state (of low entropy) via the actions of a super-

54. See also Safarti, J., If God created the universe, then who created God?, creation.com/whomadegod.

powerful Creator who was greater than the universe—'outside of it', yet capable of acting within and upon it. Such a being who created the universe in that state would presumably be interested in its destiny as well, and also powerful enough to influence that destiny, too. In their 1971 thermodynamics textbook, Sonntag and Van Wylen drew a very rational and scientific conclusion:

> … the authors see the Second Law of Thermodynamics as man's description of the prior and continuing work of a Creator, who also holds the answer to the future destiny of man and the universe.[55]

This is quite out of step with what is regarded as 'kosher' by the high priests of evolutionary naturalism who dominate the scientific establishment today. In fact, even though nothing in the intervening decades has changed insofar as the science is concerned, it is hard to see the authors being able to get away with that sort of statement in a science textbook today.

All of this fits very well with the biblical description of the infinite personal God of Abraham, Isaac and Jacob; the One who, in the words of the old song, has "got the whole world in His hands".

It doesn't sit well with the quasi-mystical god of the most common variety of theistic evolutionist. Such a god is not remotely similar to the miracle-working Creator God of Genesis and the New Testament Gospels. He—or maybe 'she' or 'it', since there are no biblical constraints to imagination once someone abandons the authority of the text itself—is more akin to a fairly powerless and vague 'force'. Much more like the amorphous god of some eastern pantheistic religions. Such a god is limited to having to sit back and wait for natural processes to allegedly do the creating over billions of years.

55. Van Wylen, Gordon J, and Sonntag, Richard E., *Introduction to Thermodynamics: Classical and Statistical*, John Wiley and Sons, Hoboken, NJ, 1971, p. 281.

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A layman's guide to the Second Law of Thermodynamics

WORLD WINDING DOWN

UNDERSTANDING THE 'LAW OF DISORDER' —AND HOW IT DEMANDS A CREATOR

A powerful yet easy-to-understand weapon in the war to defend Christianity

Much controversy swirls around what is an often misunderstood scientific law, in fact the most fundamental of all such laws—The Second Law of Thermodynamics. Many have used it to show that 'evolution is impossible', only to find themselves 'shot down in flames'. But when properly understood—especially the principles that lead to its outworking—it truly is a potent scientific counter to today's widespread belief that everything made itself, 'from nothing to nature'.

The author's trademark conversational style combines readily with the many everyday examples he provides. This book will undoubtedly 'switch on the lights' for many mystified by obscure terms and equations—without sacrificing scientific accuracy.

"An easy, enjoyable and sometimes humorous read!"

NEIL E. BROWN,
Minister of Pastoral Care,
First Baptist Church Woodstock, Georgia.

"A very clear, concise layman-level description of the most powerful law of physics. The author provides strong arguments from this law why the universe demands a Creator."

JOHN G. HARTNETT PH.D.
ARC DORA research fellow, Institute of Photonics and Advanced Sensing and the School of Chemistry and Physics, University of Adelaide.

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