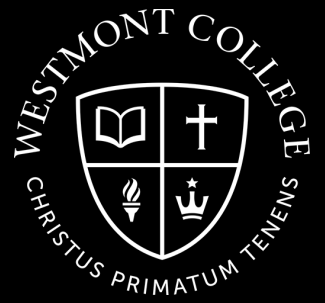
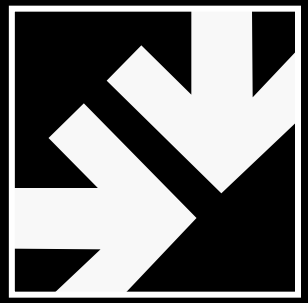
“Does the Second Law of Thermodynamics Contradict the Theory of Evolution?”

Michael A. Everest





Your Background

Your Background

- Secular College/University

Your Background

- Secular College/University
- Very Christian College/University

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- Very Christian College/University
- Nominal Christian College/University

Your Background

- Secular College/University
- Very Christian College/University
- Nominal Christian College/University
- Scientist at Industry/Government Lab

Your Background

- Secular College/University
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- Scientist at Industry/Government Lab
- Non-Scientist

Your Background

Your Background

- Chemistry

Your Background

- Chemistry
- Physics

Your Background

- Chemistry
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- Geology

Your Background

- Chemistry
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- Biology

Your Background

- Chemistry
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- Mind/Social Science

Your Background

- Chemistry
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- Engineering

Your Background

- Chemistry
- Physics
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- Mind/Social Science
- Engineering
- Other Science

Your Background

- Chemistry
- Physics
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- Mind/Social Science
- Engineering
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- Theology/Ministry

My Background

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- Background: chemical reaction dynamics

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- Currently: interfacial chemistry

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- Currently: interfacial chemistry
- Teach undergraduate physical chemistry

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- *Not* a specialist in thermodynamics

My Background

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- Currently: interfacial chemistry
- Teach undergraduate physical chemistry
- *Not* a specialist in thermodynamics
- Primarily an *Educator*

My Context

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- Westmont College

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- 1200 students on campus

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- 12 Chemistry majors/yr

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- 40% YEC background

Some Science: What is the Second Law?

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It is not possible to move heat from a cold place to a hot place without something else happening.

Some Science: What is the Second Law?

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It is not possible to convert 100 Joules of heat into 100 Joules of work.

Some Science: What is the Second Law?

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Etc.

More Science: What is Entropy?

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- Two definitions

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- “Thermodynamic”
  - How much heat added at what temperature?

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$$dS = \frac{dq_{\text{rev}}}{T}$$

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  - How much heat added at what temperature?
- "Statistical"
  - How many ways can it happen?

More Science: What is Entropy?

$$dS = \frac{dq_{\mathrm{rev}}}{T}$$

$$S = k_{\mathrm{B}} \ln \Omega$$

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- "Thermodynamic"
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- Only one way to get all heads. Lots of ways to get half heads and half tails.

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- Two definitions
- "Thermodynamic"
  - How much heat added at what temperature?
- "Statistical"
  - How many ways can it happen?
- Only one way to get all heads. Lots of ways to get half heads and half tails.
- Occasionally "disorder" or "randomness"

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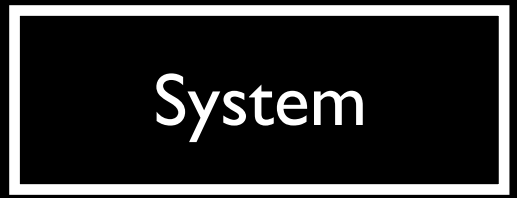

More Science: What is the Second Law?

The entropy of an isolated system can only stay the same or increase.

The entropy of the universe tends toward a maximum.

System

Surroundings

More Science: What is the Second Law?

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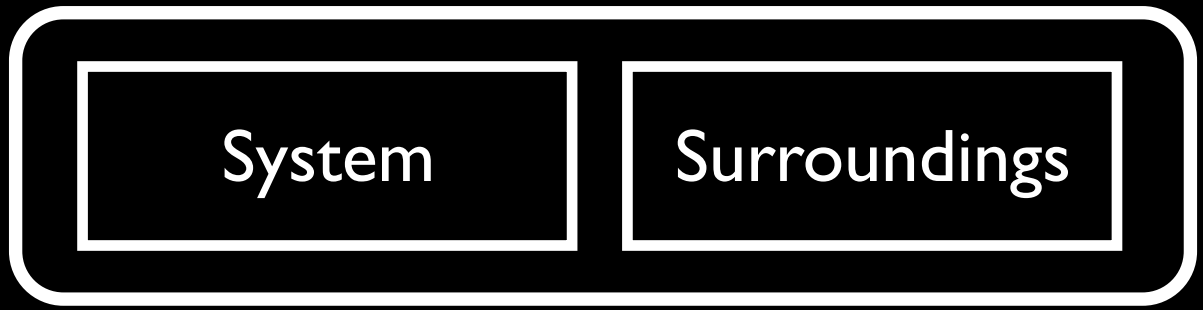

Last Science: What is Evolution?

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Earth with *no* biosphere →

Last Science: What is Evolution?

Earth with *no* biosphere → Earth *with* a biosphere

The Assignment: Intro

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- Imagine that …

The Assignment: Intro

- Imagine that …
- They want to know…

The Assignment: Intro

- Imagine that …
- They want to know…
- They have asked you for…

The Assignment: Details

The Assignment: Details

- …at least two possible approaches

The Assignment: Details

- …at least two possible approaches
- Your recommendation

The Assignment: Details

- …at least two possible approaches
- Your recommendation
- At least five sources.

The Assignment: My Goals

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- Encourage faith/science reflection

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  - “contribution” vs. “integration”

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- Encourage irenic thinking about a "controversial" issue

The Assignment: My Goals

- Encourage faith/science reflection
  - "contribution" vs. "integration"
- Encourage service to the church
- Encourage irenic thinking about a "controversial" issue
- Direct them to the literature

Answers: The Obvious

Does the Second Law of Thermodynamics contradict the Theory of Evolution?

Answers: The Obvious

Does the Second Law of Thermodynamics contradict the Theory of Evolution?

- No.

Answers: The Obvious

Does the Second Law of Thermodynamics contradict the Theory of Evolution?

- No.
- The Sun is an essentially limitless source of energy, so the Earth is not an isolated system.

Answers: The Obvious

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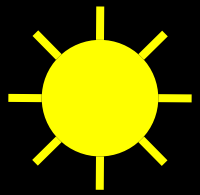

CO_2, H_2O

Answers: The Obvious

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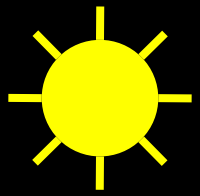

CO_2, H_2O

Answers: What Students Find

Does the Second Law of Thermodynamics contradict the Theory of Evolution?

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Does the Second Law of Thermodynamics contradict the Theory of Evolution?

- A few books and websites say, "Yes"

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- Lots of physics articles say, "No"

Answers: What Students Find

Does the Second Law of Thermodynamics contradict the Theory of Evolution?

- A few books and websites say, "Yes"
- Lots of physics articles say, "No"
  - Different reasons!

Answers: What Students Miss

Does the Second Law of Thermodynamics contradict the Theory of Evolution?

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Does the Second Law of Thermodynamics contradict the Theory of Evolution?

- No. Evolution provides a pathway that maximizes the rate of entropy production!

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Does the Second Law of Thermodynamics contradict the Theory of Evolution?

- No. Evolution provides a pathway that maximizes the rate of entropy production!
- No. No step in the mechanism for evolution violates the Second Law, so the whole thing can't.

Answers: What Students Miss

Does the Second Law of Thermodynamics contradict the Theory of Evolution?

- No. Evolution provides a pathway that maximizes the rate of entropy production!
- No. No step in the mechanism for evolution violates the Second Law, so the whole thing can't.
- Not really. Entropy of the surroundings is so big, anything can happen.

Answers: Not Really?

Does the Second Law of Thermodynamics contradict the Theory of Evolution?

Answers: Not Really?

Does the Second Law of Thermodynamics contradict the Theory of Evolution?

- One estimate…

Answers: Not Really?

Does the Second Law of Thermodynamics contradict the Theory of Evolution?

- One estimate…
- Entropy of biosphere *decreases* by 300 J/K per second.

Answers: Not Really?

Does the Second Law of Thermodynamics contradict the Theory of Evolution?

- One estimate…
- Entropy of biosphere *decreases* by 300 J/K per second.
- Entropy involved in our having a sun is 420×10^{12} J/K!

Answers: Not Really?

Does the Second Law of Thermodynamics contradict the Theory of Evolution?

- One estimate…
- Entropy of biosphere *decreases* by 300 J/K per second.
- *E*ntropy involved in our having a sun is 420×10^{12} J/K!
- Is he saying evolution *does not* obey the Second Law, but is within the expected range of fluctuations?

Take-Home Messages

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- Faith-Integration assignments can be scientifically rigorous

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- Faith-Integration assignments can be scientifically rigorous
- You might learn something, too