

This Week: The Meaning of Life

There are three main concepts for today's class:

- 1. Energy. What ever happens, energy is involved. It's always conserved, in all cases. It always stays the same.
- Entropy. It is, literally, a measure of *disorder*—a lack of order. And it always increases.
 Time. What's the difference
- between the future and the past?
- So, what does all this have to do with life? We'll talk.







The Arrow of Time The Meaning of Life The End of the World



Viewing the World Through the Lens of Energy

Energy is conserved. It cannot be created or destroyed. It can only be converted from one form to another.

This is a law of nature that is universal: It applies in all places at all times, absolutely.

Types of Energy
Energy of motion. If something is moving, it has kinetic energy. Moving faster means more kinetic energy.
If something is up high, it has a lot; if something is down low, it doesn't.
Stored in springs, or in springy materials. More stretch means more energy.
The energy of light and other waves, like microwaves.
The energy of moving charges in circuits.
Energy stored in the form of chemical: Food, fuel and the like.
Energy stored in the nuclei of atoms.
When something is hot, it has a lot; when it is cold, it has a little.



Explain the operation in terms of forms of energy.







It's not working hard. It's working mindfully.





Entropy: A measure of disorder. But in a pretty specific manner.

Messy, but not high entropy.





Ordered There is a temperature difference, so you can distinguish between the two sides. Low entropy

Disordered The energy is spread out evenly, so you can't distinguish between the two sides. High entropy





















"Waste Heat"

A 560 MW coal-fired plant uses thermal energy from burning coal to heat steam to 370 $^\circ C$ to run a turbine.The plant is cooled by water in a nearby river at 10 $^\circ C.$

- a. What is the minimum power that the plant must deposit energy in the river?
- b. Keeping a modest-sized house comfortable in the cool seasons in a temperate climate takes an average of about 3000 W. How many homes could the "waste" heat supply?



Berlin Spandau Heat and Power Station

Stations that provide homes with both heat and electricity are becoming more common in Europe.

440 MW

140,000

See if you and your neighbors can come up with a definition. What is time?





During the time it takes for a signal to travel from your retina to your brain, a fastball travels about 3 feet. You don't see the ball where it is. You see the ball where it was.



Until Thermal Energy Enters the Picture, Everything Is Reversible.





This is the only basic law of nature that has a time direction.









Life is about entropy.

You are an agent of entropy increase.

So is all life.

Ecosystems too.

Living systems have much more entropy than those that don't support life.



temperature between day and night than Earth—meaning less entropy. Why? Because Earth has life.







The difference in temperature causes the exchange of radiant energy that permits life to exist on our planet.



It is differences, literally, that make life possible.

