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Day 27 Apr 30 Entropy, energy transfer.
Consumer products. Wrap up.

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27.0.A Daily Outline

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Purpose:

- The quality of energy, efficiency of using heat to produce work, and the Second Law of Thermodynamics
- Lavoisier and combustion (and other things)
- Fun videos involving energy
- Q/A

Board

- Sit anywhere
- Grab your eye protection
- Find instructions at table: organize and start Task 1

Info:

- Poster evaluation scores (excluding abstracts) ranged from 15 to 23 out of 23. Average 20. Quite good overall.

DON'T FORGET TO CLAP

Materials

- Ice, Dewar bowl, liquid nitrogen, little motor – have ice ready to go, microwave in front, have liquid nitrogen already in bowl Dewar enough to acclimate before class starts, have liquid nitrogen in a tall Dewar for easier pouring
- Piece of metal from thermal transfer kit
- Little motor

Returns

Distributions

- One copy of materials at each table

Starting Comments _____ 1 minute max

- Select someone to clap

Task 1: Inspect the consumer product or products at your table.

Test them out. Propose a suggestion for how they work. Useful information will likely be provided on the containers.

Items include: ammonium nitrate cold pack; calcium chloride hot pack
-- ampules in water pouch
And iron powder in air permeable cloth bag

Each group will report on their product. Then the items can be passed around.

Task 2: Asimov's "The Last Question"

This the the last day, so appropriate to discuss "The Last Question"

In your groups, take 5 minutes to discuss this short story. In particular,

- What does it have to do with heat and energy?
- Other insights

Eavesdrop, then ask for report out – something from each group.

SET UP THE DEMO

Then do the demonstration -- talk through

Then refer to handout on "second law" (1 copy at table)

Any engine (mechanical energy) that draws energy from heat is limited in % of energy conversion. Heat moves from hot body to cold body: insert something that captures that.

Better designs avoid converting potential energy directly to heat.

Convert to mechanical motion (this demo; hydroelectric), increase chemical potential energy (what ATP does: energy from that exothermic reaction drives other endothermic reactions but by adjustments in structure and bonds, or electrical current (batteries).

Less waste heat, but not 100%.

2nd law can be stated in a number of ways

- The entropy of the universe always increases.
- The degree of disorder (disorganization) in universe always increases.
- Matter and energy in universe always moving to complete dissipation -- thermal and positional equilibrium. (Since space is expanding .. lead to infinite dissipation)
- Heat can't be totally converted to useful work.
- The ability and opportunity to do work decreases as the temperature decreases (less colder things to deliver heat to).

Asimov's story follows that time line to end of universe. What happens next? Cosmology

How does life exist?

Life (organized matter) requires work to exist – work is energy. Energy source is potential energy of food chemicals (relative to CO₂ and water and poop). Energy is used to drive ENERGY INCREASING (uphill) and ENTROPY DECREASING (organizing) processes.

Questions?

Task 3: Lavoisier

In your groups, list up to 5 things of significance he was responsible for, and why those things were important.

5 minutes

Let them talk.

Report out from group: round robin style:

- 1) chemical nomenclature: ferric, ferrous sodium chloride
- 2) conservation of mass in chemical reactions
- 3) chemical nature of water (as combination of oxygen and hydrogen)
- 4) elements (not earth, air, fire, water); but substances that could not be further broken down (list on one of handout pages)
- 5) animals produce heat by internal combustion

-- considered head as an imponderable substance, although he threw off phlogiston (which was an imponderable substance)

Lost his head. Wife very important in publishing his materials. Count Rumford married her.

Task 4: Make ice cream

Meanwhile, set up videos. Then eat, watch, talk.

Videos: write reactions on board



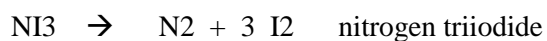
Hydrogen balloon – test

Hindenberg d

3 hydrogen oxygen balloons

Live leak -- big balloon

Space shuttle



Nitroglycerin then 40 mL



Ammonium nitrate and texas plant explosion

Raw footage

Ping Pong Balls

Science Experiment: Liquid nitrogen

Combustion

Task 5

General Q & A Opportunity to ask anything. Take a minute. Chat at table about what you want to ask about:

AT 4:55

Thank students for participation and willingness to be on camera and mic the whole time.

Julia and I move to editing mode, and to figure out how to convert action to usable set of materials.

I will be making grade decisions by the weekend. I will deliver that info to you via an email and a personal evaluation comment.

Demonstration

Prepare mug of ice slush – filled to near top

Prepare near boiling water in microwave – put in mug filled to near top

Prepare and set aside the Dewar of liquid nitrogen

Set ice water mug

If I put this piece of aluminum metal in like this, what will happen?

Heat transfer by conduction. Energy is moving but not doing anything useful.

Use this device instead. Two pieces of metal separated by a slab of material that conducts heat but at the same time creates a voltage difference, like a battery.

That voltage can be used to do work.

Put the device in – the blades eventually spin.

Similar principal in coal and oil combustion to make electricity

Combustion heats water into steam, steam which expands through a turbine (causing it to spin) and at the same time lowering the temperature of the steam (or condensing it to water). So, energy is released by the steam-to-water T drop and condensation, and that energy spins the turbine, and the turbine is connected to a generator to produce electricity.

Way back at start of semester I asked whether cold things have heat? How did you show that?

Looked for conduction of heat from something cold to something colder.

Does ice water have heat? Needs to conduct to something colder. Liquid nitrogen

Set it up. If the blades spin, then heat is being conducted.

Does liquid nitrogen have heat?

Need something colder.

Can we keep making this argument? Absolute zero say no.

Ability to turn heat into work requires having a warmer body and a colder body so that as heat moves warmer to colder, some of that can be converted into mechanical or electrical work (or potential energy). You can't capture all of the heat as work. That would require a cold body at absolute zero. But if you deliver heat to absolute zero, it's not at absolute zero anymore.