Energy Audit

- Energy Audit Project: Download assignment info sheet from Elms
  - Group project
  - Project Due Dates:
    Assignment #1 - Sept 29
    Assignment #2 - Oct 6
    Assignment #3 - Oct 13
    Assignment #4 - Oct 20
    Assignment #5 (Presentations in Discussion) Oct 21, 24.
- Probably move midterm to Oct 27
- Wednesday 9/28 - Marquee Lecture Series in Science and Technology - Restoring the Chesapeake: Is It Worth It
  - 5pm Biosciences 101
  - Bring your clicker - Extra Credit will be given if you attend at least one of the Marquee Lectures to be given on Sept 28 or Nov 14.
Genetically Modified Fish

- The FDA is considering whether to approve genetically modified fish for human consumption.
- This would allow fish spawned from genetically engineered salmon eggs to be allowed for use as food. These "AquAdvantage® Salmon" grow into full-sized fish in half the time that it would take a regular salmon.
- They combine a growth gene from the Pacific Chinook salmon and genetic material from the ocean pout - a large, eel-like fish - into the fertilized eggs of Atlantic salmon, making the recombined DNA present in cells throughout the body of the fish.
- The Chinook gene promotes the growth to market size, and the pout gene allows the fish to grow in the winter as well as the summer.

The company claims the resultant fish are reproductively sterile due to another genetic alteration - triploidy - that eliminates the possibility of interbreeding amongst themselves or with other native breeds, while maintaining protection over intellectual property.

The company will only sell female eggs and raise the fish within contained, inland systems. However, despite these assurances, the FDA indicates that up to 5% of the eggs may indeed be fertile, and the company's claims in this regard are "potentially misleading."
Would you eat genetically modified salmon?
1. In a heartbeat
2. If the FDA approves it, I guess it’s okay
3. I'll wait a while and see how people fare
4. In a pinch
5. Not on your life

CNN poll results

<table>
<thead>
<tr>
<th>Response</th>
<th>Percentage</th>
<th>Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>In a heartbeat</td>
<td>14.66%</td>
<td>927</td>
</tr>
<tr>
<td>If the FDA approves it, I guess it's okay</td>
<td>9.57%</td>
<td>540</td>
</tr>
<tr>
<td>I'll wait a while and see how people fare</td>
<td>20.41%</td>
<td>1,151</td>
</tr>
<tr>
<td>In a pinch</td>
<td>4.72%</td>
<td>266</td>
</tr>
<tr>
<td>Not on your life</td>
<td>50.66%</td>
<td>2,857</td>
</tr>
</tbody>
</table>

Total Votes: 5,840
Should we be doing this genetic engineering?

1. Yes
2. No
3. Only under very controlled circumstances

Electric Potential

- To move electric charge against an electric force requires work.
  \[- V = \frac{W}{Q}\]
- The electric potential energy difference between two points is the work per Coulomb to move charge between the points and is measured in volts where 1 volt = 1 joule/coulomb

1.5v
**Basic Circuits**

- Current direction is from positive to negative voltages
- Current (I) is the rate charge flows
  - \( I = \frac{\Delta Q}{\Delta t} \)
- Current is measured in AMPERES (AMPS, A)
  - 1 amp = 1 coulomb / s
- Resistance is anything that causes an opposition to the flow of electricity in a circuit.
- Resistance is used to control the amount of voltage and/or amperage in a circuit. Everything in the circuit causes a resistance (even wire).

**Resistance**

- What happens in a “resistor”?
  - Electrons can’t flow freely
  - They run into atoms and transfers energy to the atoms
  - The resistor heats up
- A light bulb is a resistor
  - It gets so hot it glows

http://micro.magnet.fsu.edu/electromag/java/filamentresistance/index.html
Ohm’s Law

- The voltage drop across a resistance is equal to the current times the resistance
  - \( V = IR \)
  - \( R = V/I \)
  - \( I = V/R \)
- Work is \( W = V \times Q \)
  - Power is \( \Delta W/\Delta t = V \times Q/\Delta t \)
  - Power = VI
    - Same power with small current and large voltage or small voltage and large current
  - \( P = VI = I^2R = V^2/R \)
  - Lower resistance more power used

Ohm's Triangle

Cover the variable you want to find and perform the resulting calculation (Multiplication/Division) as indicated.
AC/DC

- **AC** – Alternating Current

  ![AC waveform](image)

- **DC** – Direct Current

  ![DC waveform](image)
The War of the Currents

**VS.**

Thomas Edison (DC)

George Westinghouse and Nikola Tesla (AC)

Two Competing technologies

- Edison’s DC system was original US standard
- Westinghouse licensed Tesla’s AC systems
- Some bad blood – Tesla had worked for Edison, but felt cheated
- DC had to be generated nearby, AC could go longer distances
- Edison started a campaign to discourage use of AC
  - His technicians publicly electrocuted stray cats and dogs with AC
  - He secretly paid for the construction of the electric chair (AC) (even though he was opposed to capital punishment)
  - They didn’t use a high enough voltage – took two tries
  - “They would have done better using an axe” = Westinghouse
Two Competing technologies

- Ultimate execution
  - Topsy the elephant – a Coney Island circus elephant
  - Had killed 3 people and was sentenced to death
  - Gave it cyanide (to be sure) and electrocuted
    Edison filmed the execution which was widely shown

- Edison tried to get being electrocuted called getting “westinghoused”

- In the end AC won out – easier to transmit over long distances

Why is AC better?

- Remember Ohm’s Law and power dissipated:
  \[ P = I \cdot V = I^2 \cdot R \]

\[ P_{\text{generated}} = P_{\text{loss}} + P_{\text{delivered}} \]

For a given R of the transmission lines, less current means less power lost

- use high V and low I -
Why is AC better?

- It is easy to change the voltage of AC electricity
  - Step-up
  - Step-down

- Use transformers
  - Time varying current generates magnetic fields
  - Time varying magnetic fields generate currents

Typical AC

- US - 60 Hz (cycles/second)
- Europe 50 Hz

- US - 120 V
- Europe - 220 V

- Transmission
  - Around campus - 13,600 V
  - Across country - 115,000 to 500,000 V

Higher V means lower I - less loss!
**Example**

- I need to move 1kW of power for 1 km
  - Say the wire has resistance of 1 ohm
- $P = IV$ so at 100 volts this is $I = P/V = 1000/100 = 10$ amps
  - Power lost in the wire is $IV_{\text{wire}} = I^2R = 100W$
- At 1000V $I = 1$ amp $\rightarrow I^2R = 1W$
**DC is still used**

- Batteries are DC
- Many small devices use DC – look at your chargers
- Do not need high currents, long distance transmission
- Chargers convert 120 V AC into DC (typically 3–15 V)

**How much current does a 1200 W space heater use?**

1. 1/12 Amp
2. 1/2 Amp
3. 5/6 Amp
4. 1 Amp
5. 10 Amp
6. 100 Amp
Thermodynamics

the study of energy utilization and interconversion

"Thermodynamics is a funny subject. The first time you go through it, you don’t understand it at all. The second time you go through it, you think you understand it, except for one or two small points. The third time you go through it, you know you don’t understand it, but by then you are so used to it, it doesn’t bother you any more”

Arnold Sommerfeld

The Zeroth Law of Thermodynamics

- Temperature – if two objects are in thermal equilibrium with a third object (like a thermometer) then they are in thermal equilibrium with each other
- Another way of saying it is that temperature is a measurable quantity and it tells us about the energy content of an object
- this law asserts that we can define a temperature function, or more informally, that we can 'construct a thermometer'
Temperature

What is the coldest temperature you have ever been in?

1. 32°F
2. 20°F
3. 10°F
4. 0°F
5. -10°F
6. -20°F
7. -30°F
8. -40°F
9. -50°F
Heat and Work

- A system can absorb heat (Q) from the surroundings.
  - Q > 0, if heat is absorbed by the system.
  - Q < 0, if heat is evolved from the system to the surroundings.

- Heat appears only at the system boundary.
- Heat appears only during a change of state.

- Strictly speaking, it is incorrect to say that a system "has heat." Rather, it has thermal energy.
- A system can perform work (W) on the surroundings.
  - W > 0, if weights are lifted in the surroundings.
  - W < 0, if weights are lowered in the surroundings.
- Work appears only at the system boundary.
- Work appears only during a change of state.
- Q and W can be thought of as "energy in flux."
Thermal Equilibrium

- if $Q=0$ then we are in “thermal equilibrium”
  - $T_A = T_B$

Hot and Cold
**Microscopic definition of $T$:**

- $\frac{1}{2} mv^2 = \frac{3}{2} k_b T$
- $v$ is average speed, $k_b$ is Boltzmann constant
  - hot means faster motion

- What happens to the motion of molecules/atoms and absolute zero?
- Kelvin scale – $0 \, ^\circ C = 273 \, K$
  - Thermal energy proportional to $K$, not $C$ or $F$!

http://jersey.uoregon.edu/vlab/Thermodynamics/therm1a.html