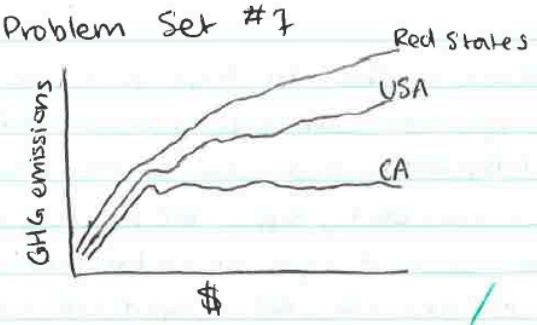
PS#7 Due Monday, March 12

1) Draw and explain the famous California Wealth/Energy use decoupling graph. What is the very very important socio-economic-political message behind that graph regarding GHG reductions? Help?: it shows the per capita electricity use as a function of the year for California and the USA versus the other states and USA as a whole.

Problem Set #7

(1)



This graph shows how that as California has grown economically, it has not increased its energy use and greenhouse emissions. This is largely due to efficiency efforts brought about since the 70's. From this graph, we realize that affluence and energy consumption do not have to be related to one another. Thus, money is decoupled from the increase in CO_2, and the notion that we must emit as a thriving economy is challenged (and basically debunked). It is important to note that in the red states, the average is much higher since reduced emissions is not a priority, and largely because the idea that prosperity is tied to industry / GHG's is still alive and well.

A

? also red states have more carbon rich economies ?

2) You hear some people talking, "Heat pump, Heat engine, refrigerator… are they just all the same thing?" Please distinguish these two things or explain how they are the same.

(2)

Heat Pump → utilizes compression (work) to go against the natural flow or the macrogradient and move ~~air~~ heat from cold → hot. A heat pump makes a localized temperature difference by compressing air that then drives a cycle that moves heat to a certain location very effectively. The ~~heat~~ air then condenses, expands and evaporates before being compressed again, allowing there to still be a flow from hot → cold within the cycle.

Refrigerator → essentially the "cold side" of a heat pump where all the heat is removed from (Basically a heat pump)

Heat Engine → works with the second law of thermodynamics, which operates based on the natural flow of energy from hot → cold. The temperature difference is important because it drives a flow of ~~air~~ heat, which can then be used to turn a turbine and ultimately generate some sort of work output.

A

3) Old freezers didn't have defrost, so they would accumulate ice on the evaporator coils. We can clean off the ice by using a screw driver!
   a) Will removing ice improve the efficiency of the freezer? Why or why not?

b) Why should you ***NEVER*** clean the ice off this way?

a) Yes, because a pipe without frost can remove heat faster, which means (minimize temp. gradient) it takes less time to compress the air, making it more efficient. B

b) Because if the evaporator coils are damaged, the entire refrigerator breaks and it can release CFC's, which are very bad for stratospheric ozone. and are powerful GHG.. ~1400 × CO_2 A

4) OTEC What's the best thing about it? What's the greatest challenge?

(4) OTEC is a great technology because it takes advantage of the massive, untapped, and naturally occuring temp. gradient within our oceans. Also the OTEC facilities are relatively small compared to most power plants, ~~However, the temperature~~ and can conveniently/efficiently supply the majority of the world's population with power because most people live near coasts. However, the major drawbacks of OTEC are that the small temperature differences don't allow for very efficient power generation. ✓

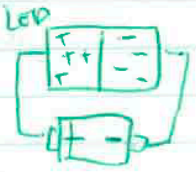
5) You have a wind farm and notice that when the wind blows at about 3 m/s, it generates 20 MW. About what will be the power you generate when the wind blows at 6 m/s? Why?

6) Incandescent, fluorescent, and LED lighting technologies
   a) Explain with a drawing how these three light-producing technologies work
   b) Why do incandescent lights get such bad efficiency?

(5) If $20\,MW = \frac{1}{2}\rho A (3\,m/sec)^3$, then $\rho \times A = 1.5$ and at 6 m/sec winds the power would look like $\frac{1}{2}(\rho \times A)(v)^3 \rightarrow \frac{1}{2}(1.5)(6\,m/sec)^3 =$ 162 MW A

$V \Rightarrow 2V_0$ $P \propto V^3$

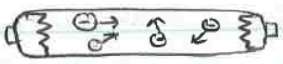
$2^3 = 8$ so $P \Rightarrow P_0(8) = 160\,MW$



(6a) Incandescent

heating up a thin filament until it glows

Fluorescent



burning of a gas in order to make atoms active; as they settle, they release photons (light energy)

LED

Si Si Si Si
Si Si (+) Si
Si (−) Si Si

A

a silicon lattice is "doped" w/ positive and negative charges; as electrons try to fill in the positive "holes," light energy is released

b) Incandescent lights are highly inefficient because a vast majority of the energy they give off is not in the visible light spectrum. The reason why incandescent lights are so hot is because much of their released energy is in the form of infared radiation, which is not very useful. If incandescent lights were more intense and had a lower max wavelength, then they would emit more in the visible light spectrum and become more efficient.