HAS 222d/253e Intro to Energy and Environment (Life under the pale sun)
notes on mid-term quiz   May 2007

1.  Burning of ethanol. Main stumbling block is careful counting of bonds and noting that the C-O bond on the left side is single, not double, as there is an H atom also bonded to the C. On the right side of the reaction the CO₂ has each oxygen atom bonded singly to the carbon atom, so the bonds are double, C=O.

2.  Temperature, by Wien’s law governs the wavelength of the peak of the radiation spectrum
  Igloolik is sending heat radiation upward at 11.9 μm, and Death Valley at 8.7 μm.

3.  Electricity is cheap in Washington state: about $0.06 per kWh..kilowatt-hour. Converting gasoline’s cost per gallon gives $0.088 per kWh  ($3.00/gal x 1/2.8 gal/kg x 1/44x10⁶ kg/J x 3.6x10⁶ J/kWh), thus it is 1.5 times the cost of electricity.
  Furthermore electric motors are 80% to 90% efficient, while gasoline motors are ~20% efficient. This gives a cost advantage of roughly 6 for electricity (which is why you hear about the ‘effective 100 mpg gas mileage of an electric car’. Gasoline lawn mowers are notoriously bad generators of pollutants..2 cycle engines especially, which mix oil with gas, and have no separate lubrication system (the blue-smoke machines). Of course one has to weigh this against the pollutant output from the electricity generating plant which is itself running at about 33% efficiency in converting coal to electricity. Something like 10% is then lost in transmitting the electricity to you. But still we win by a factor of 6. Economies of scale. Hydropower is cleaner, unless you talk with the salmon.

4.  The heat engine cycle is in the notes, with a discussion of the cycle drawn as a pressure-volume diagram. Work is force F x Δ distance traveled by the forced object; with pressure = force/area of the piston and Δ volume = Δ distance x area, we see pΔv is indeed F Δd, the work done by the heat engine, if averaged over the whole cycle. So the area on the Pv diagram enclosed by the cyclic curve is equal to the mechanical work done by the heat engine. Note that no energy is lost...heat flows through the system and some is shunted off as mechanical energy..the efficiency of such a simple heat engine cannot exceed the ideal Carnot efficiency, (T₂ –T₁)/T₁, where these T’s are the cold and hot endpoint temperatures of the cycle.
  On the Pv diagram, the equation of state tells us what curves of constant temperature look like, and also show that a greater temperature difference in the cycle will lead to more work done.

essay a:  In the quiz there was not time for you to write extensively, yet some deep issues are involved, and many of them came up in some of the essays. Here is some more discussion.
  The transition from local pollution to global is a part of the nearly exponential upward sweeping curve of human population, inventiveness (technology), wealth and global coverage. We are everywhere, and our inventions amplify our footprints. Energy is a key..as McNeill says, cheap, available energy and human reaction to it defines the environmental history of the 20th C.
  Other factors affect the increasing reach of pollution. For example Arctic natives, being small populations without diverse natural resources or long-distance transportation, did not develop sophisticated technology. They never found the coal on Svalbard, which was developed by a Mr. Longyear from Boston. They burnt small quantities of seal- and whale oil in lamps, and this along with their somatic heat kept their sleeping tents and igloos very warm.
  Another aspect of this transition is that technology outstrips environmental science: CFCs are in use everywhere before we realize what they are doing (they were thought to be chemically inert, unreactive).
Specific examples worth invoking are the Industrial Revolution in England and Europe, CFCs, carbon and fossil fuels. The ‘coal cities’ and the Ruhr and the London smogs are poignant examples. An accompanying idea is that medicine has been slow to understand the damage done to the human body by small quantities of foreign chemicals, or even obvious amounts of dust and smog. Smoking is a serious form of pollution. (Spherical cow question: estimate the number of cigarettes produced in the world each year, You will be amazed.)

Global warming is currently all abuzz. Suddenly the world cares. Science cannot dictate, nor even, like technology, beguile. But it can hold up a mirror to society, showing to it, with clarity, what the world is becoming, and let people decide whether to take corrective action.

McNeill and McKibben are worth comparing. Both seem to me very human centered, indeed McNeill states this as a goal of the historian (he will not comment on ecosystems outside of our own). McKibben, a sort of modern day Henry Thoreau, lives in relative isolation and sees nature through his own comfort and discomfort. But he also has a keen scientific understanding and philosophical bent that McNeill seems to lack. Bring nature to the foreground of our vision is what he can do, sometimes in a single sentence (‘the rain has changed…’). Even though his empathy for the global ecosystem is very limited in 1989, it has grown and I think he is now more of a ‘Gaian’, a believer in the value of the Earthly organism beyond human concerns.

essay b: Science removes the fear of nature. It is especially ironic that Sverdrup would hold this idea. He came from the 1st World War, where technology plus military stupidity were killing millions of soldiers and civilians of the developed, scientifically capable world. He arrived at a frozen, pristine world, a small community isolated and at peace. So they should want his science? Guns, sugar, tobacco and alcohol, and trade opportunities that took them from their traditional economy, arrived with him and after him, and ended their way of life.

Admiration for their skills and endurance and even temper are underlying themes of Sverdrup’s writing. As some of you suggested, the natives have an immense store of knowledge, passed down by oral tradition, parental training, perhaps some sort of cultural evolution too. This is their ‘science’. The depth of their understanding of their environment and their enormous fortitude has to be judged by its success or failure. The Greenland natives have been resident for at least 6000 years (though not continuously) and the Chukchi natives likely longer. Our modern western societies are measured in centuries rather than millennia.

Sverdrup’s discussion is neither emotional nor judgmental (he is Norwegian!). But he says enough about the difficult winters (moss in the forests being unavailable to the reindeer...who are big animals...how much moss each day would one such animal need to eat?)...about the reliance on one animal for all their needs, about uncertain weather and storms, about the unpredictable sea ice that locked them in place for most of 6 years, about traditions of fire embers and certain trees, enough to illustrate the natives’ cause for fear. “He may fear illness for which he knows no cure except the chanting and drumming of the medicine man.”

But a key part of their fear and that of the Greenland natives seems to be the connection with moral failure. They are being punished by storms or disease. They think there are people among them who can cause storms. They have superstitions, or more kindly we might say beliefs, in a nature that aims its weapons at men and women and can hold a grudge.

Seeing Sverdrup in this setting we can imagine a little bit of the arrogance of western civilization, the same attitude that extinguished the indigenous people of almost every land mass on Earth, when Europeans found them. But Sverdrup was very kindly and you have to realize how far
ahead he is of his contemporaries in his sympathy for these people. After all, this is just a few decades after the ‘winning of the West’ in our country, or the final extermination of the aboriginal people of Tasmania, or the subjugation of the Maori of New Zealand. In fact Sverdrup shows admiration for the skill of the natives, humbling his sense of the sophisticated scientist. The teacher ends up learning. The Arctic natives must have learned to fear Europeans whom they saw bring disease that could wipe out entire villages, as well as their seductive trade, sugar, alcohol, guns.

It is interesting to compare Sverdrup, one of the greatest of oceanographers later in life, with Ehrlich, the artist-writer-tourist in Greenland. One has to respect the gifts of each and their ability to bring to us a sense of ‘their newly found people’.

In the end, the key question is: does Sverdrup’s science lead to a better world, for both its people and the global ecosystem? Has science misled us? Is it better for our longevity to be a smart human than a stupid beetle or slime mold?