

Dear P310/510'ers,

I list here key points that occur to me as I sit to compose Test2. You might use this as a kind of check list for your own preparation. Feel free to contact me if you get stuck. BBB (brabson@indiana.edu, Swain West 038, Office Tel: (855-3881); Home Tel: (332-6507).

Selective Surfaces: In general, the absorptivity, $a(\lambda)$ at any wavelength, λ , equals the emissivity $\epsilon(\lambda)$ at that same wavelength. That is, $a(\lambda) = \epsilon(\lambda)$. However, both $a(\lambda)$ and $\epsilon(\lambda)$ are functions of wavelength. One can construct a surface that is an excellent absorber of visible light (one that looks black) and terrible emitter of infrared (shiny to infrared). Such a surface will collect visible energy quite well and emit infrared poorly, thus reaching a higher equilibrium temperature, a desirable result.

Global Energy Balance: $(1 - \text{albedo})(\pi)(R_E^2)I_0 = \sigma\epsilon AT^4$, $\rightarrow T = 254 \text{ K}$, but $\langle T \rangle = 288 \text{ K} \rightarrow$ Greenhouse Effect

* Intensity [Watts/m²] = Power[Watts]/Area[m²]. For example, the solar insolation at the top of the atmosphere = $I_0 = 1367 \text{ Watts/m}^2$.

* Stefan's Law: The Power emitted by a body at temperature T is given by: $P = \sigma\epsilon AT^4$, $\sigma = 5.67 \times 10^{-8} \text{ Watts/m}^2/\text{K}^4$.

* Wien's Law: The maximum wavelength emitted by a body at temperature T is given by the equation:

$$\lambda_{\text{peak}}T = 2.898 \times 10^{-3} \text{ m K}$$

* For all waves of a given frequency we can write: $v = f(\lambda) = \text{frequency} * \text{wavelength}$.

* The greenhouse effect is illustrated by the atmosphere which is largely transparent to visible light but absorbing of infrared light because of molecules like CO₂, H₂O, CH₄, CFC's...

* Volcanic activity changes albedo.

Milankovitch Cycles:

20 K year period = precession of rotational axis.

41 K year period = obliquity of rotational axis - dominated from 3M to 1M years before present.

105 K year period = eccentricity of orbit - dominated for last 800,000 years.

Temperature and CO₂ Measurements, Direct and Proxy:

* Instrumental Temperature records for last 350 years

* The idea of temperature proxies such as tree ring thickness, tree ring density, isotope ratios, etc.

* The temperature proxy, $\delta^{18} = {}^{18}\text{O}/{}^{16}\text{O}$ showing 100,000-year cycles for the last 800,000 years

* Ice core data, T and CO₂ for the last 160,000 years showing the last two interglacial periods on either side of the last (Wisconsin) ice age.

* CO₂ records: Mauna Loa since 1958, Ice Core CO₂ data back to 600,000 ybp.

Global Climate Change:

* Reference: Executive Summary from the recent IPCC 2007 Working Group I. (<http://physics.indiana.edu/~brabson/p310/>)

* Anthropogenic forcings, and their relative importance.

* Carbon cycle - "missing CO₂ sink" ---> The IU Ameriflux project

- * Feedback mechanisms - both positive and negative
- * Rapid transitions in past temperature - (1) Methane hydrates? (2) Fresh water melt into polar seas?
- * Feedback mechanisms
- * Climate Models: GCM's (General Circulation Models) – simple box models, ocean/atmosphere coupling, complexity, nonlinearities, predictions under a CO₂ doubling.

Batteries and Fuel Cells:

- * Relating potential energy and potential: $U = qV$
- * Current: $I = dq/dt$
- * Ohm's Law: $V = IR$
- * Electric power: $P = IV = I^2R = V^2/R$
- * Specific energy, specific power, batteries, and engines
- * Battery processes, Chemical PE → Electrical energy
- * **Plating:** $I \cdot t = Q = (Q/\text{molecule}) \cdot (\text{molecules}/\text{mole}) \cdot (\text{moles})$
- * **Fuel cells**, their operation and use in a hydrogen economy, and the difference between cells exchanging H⁺, OH⁻, and CO₃⁻ ions.

Electromagnetism:

- * Magnetic fields: B[Tesla]
- * $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$, $d\mathbf{F} = I d\mathbf{l} \times \mathbf{B}$ where B = the magnetic field in Tesla. Remember that the magnetic field created by a magnet points away from the north pole and toward the south pole.
- * $\mathcal{E} = \text{Emf} = -d\Phi/dt$, where the magnetic flux is defined by $\Phi = B \cdot A \rightarrow \text{Emf} = \omega N A B \sin(\omega t)$ for generators, and $\omega = 2\pi f$ and f = frequency of rotation of a loop of N turns of wire of area A.
- * Average Power, $\langle P \rangle = 1/2(V_{\text{peak}} I_{\text{peak}}) = V_{\text{rms}} I_{\text{rms}}$
- * Transformers
- * Lenz Law: The induced magnetic field always fights the change.

Your presentations:

- * As on the practice test 2, I'll include a question on each of your presentations. If you like, you could submit a question on your presentation, one that contains the most important point you made, for example. Send it along to brabson@indiana.edu by Wednesday morning, November 4, 2009.
