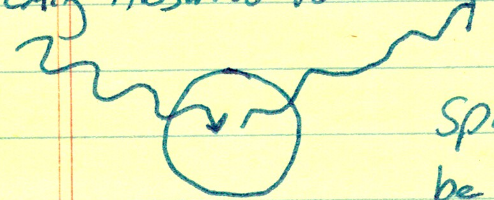
Energy Climate Model — Day 3

Incoming Absorbed Power → outgoing Emitted Power



Space is a vacuum so these should be equal

Power In = Power Out

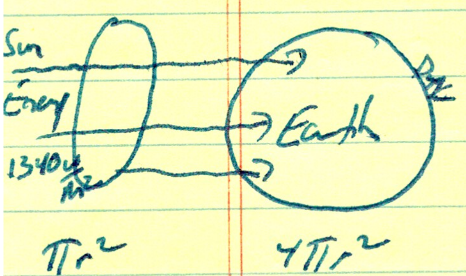
Intensity In = Intensity Out

$I_{in} = \frac{P_{in}}{A}$

How much radiation does the earth Absorb?

Intensity Available = 1340 W/m² Top of Atmosphere

$A = \pi r^2$



Surface Area = $4\pi R^2$

Problem only part of earth is hit

Solution: Picture Circular Disk - All Power going through circle will strike the earth

- We are taking the energy going through the circle & spreading it out over the earth → spreading the Power over an area 4x as great.

$$I_{In} = \frac{1340}{4}$$

More Problems - Some of the light that hits the earth is reflected off & does not heat the earth.

Albedo α = Reflected so $(1-\alpha)$ Absorbed

$$\boxed{I_{In} = \frac{1340\ W/m^2}{4}(1-\alpha)}$$

Output Intensity - Earth is a blackbody radiator so we can use the stephan-Boltzm Eqn. i.e. object @ some temp. Radiating energy

~~Plo~~ $P = \varepsilon A \sigma T^4$ $P = \frac{I}{A}$ T is in Kelvin

so: $\boxed{I_{out} = \varepsilon \sigma T^4}$

Ex. If you want to find the Temp of Earth

Given for Earth
$\alpha = .30$
$\varepsilon = .95$

$I_{In} = I_{out}$

$\frac{1340}{4}(1-\alpha) = \varepsilon \sigma T^4$

$T = \left[\frac{S(1-\alpha)}{4\varepsilon\sigma}\right]^{1/4} = \left[\frac{1340(1-.30)}{4(.95)(5.67\times10^{-8})}\right]^{1/4}$

$= 257K$ or $-16\,^\circ C$ Problem Too Cold

Ignored Radiation coming from the greenhouse effect

10:20 Good

Earth Assume Black Body $I = \sigma T_g^4$ ↑ Atmosphere $\varepsilon\sigma T_A^4$ ↓

Choice C

$\sigma T_g^4 = \sigma T_A^4 \varepsilon$ $\left(\frac{T_g^4}{T_a^4}\right)^{1/4} = \varepsilon^{1/4}$

10:54 Albedo - Fraction of incident Rad is Reflected $\frac{100}{340}$ (B)

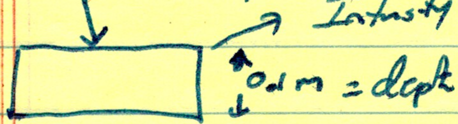
11:37 Show problem & Solution of Video

a. $I = \varepsilon\sigma T_A^4 = .72(5.67\times10^{-8})(242)^4 = 140$

Ignore Part ii

Good Example

Given Intensity in = 300 W/m²



23:07

ICE

Specific heat c = 2000

Density ρ = 920

ε of ICE 0.95

Temp Starts -5°C goes to 0°C

T_{Avg} = -2.5°C or -270.5 K

b) Input Intensity 300 W/m²

c) Time before melts <u>Skip</u>

a) ~~Perf~~ Imperfect Blackbody Radiator - Use Steph Boltz.

$I_{out} = \varepsilon \sigma T^4$

$(.95)(5.67\times10^{-8})(270.5)^4$

$I_{out} = 288 \ W/m^2$