

Varmetransport

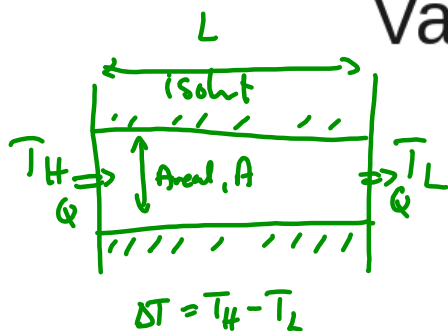


- Varmeledning
- Konveksjon
- Stråling

Hvorfor har elefanten så store ører?

Feb 25-10:14 AM

Varmeledning



Varme strøm: $H = \frac{\text{Energi}}{\text{tid}}$

$$H = \lambda A \frac{\Delta T}{L}$$

↑
Varmeledningssevne

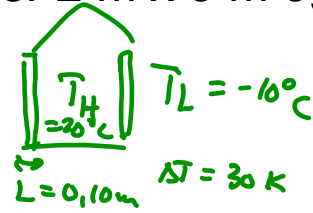
feb 21-13:17

Eksempel:

Husvegg laget av enten tre ($\lambda_t = 0,12 \text{ W/mK}$) eller minaralull ($\lambda_m = 0,04 \text{ W/mK}$). Vegg er 2 m x 5 m og har tykkelsen 10 cm.

$$H = \lambda A \frac{\Delta T}{L}$$

$$2\text{m} \times 5\text{m} = 10\text{m}^2$$

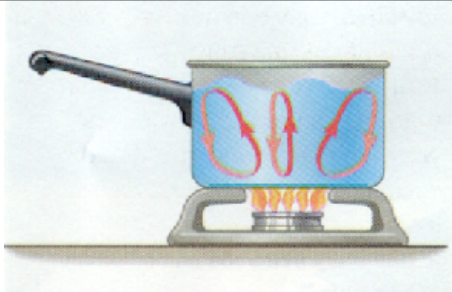


Tre: $H_t = \lambda_t A \cdot \frac{\Delta T}{L} = 0,36 \text{ kW}$

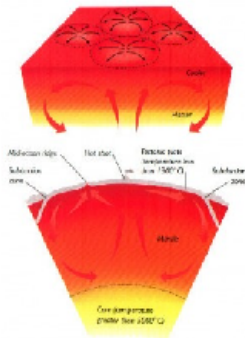
Minaralull:

$$H_m = \lambda_m A \cdot \frac{\Delta T}{L} = 0,12 \text{ kW}$$

Feb 28-9:16 AM



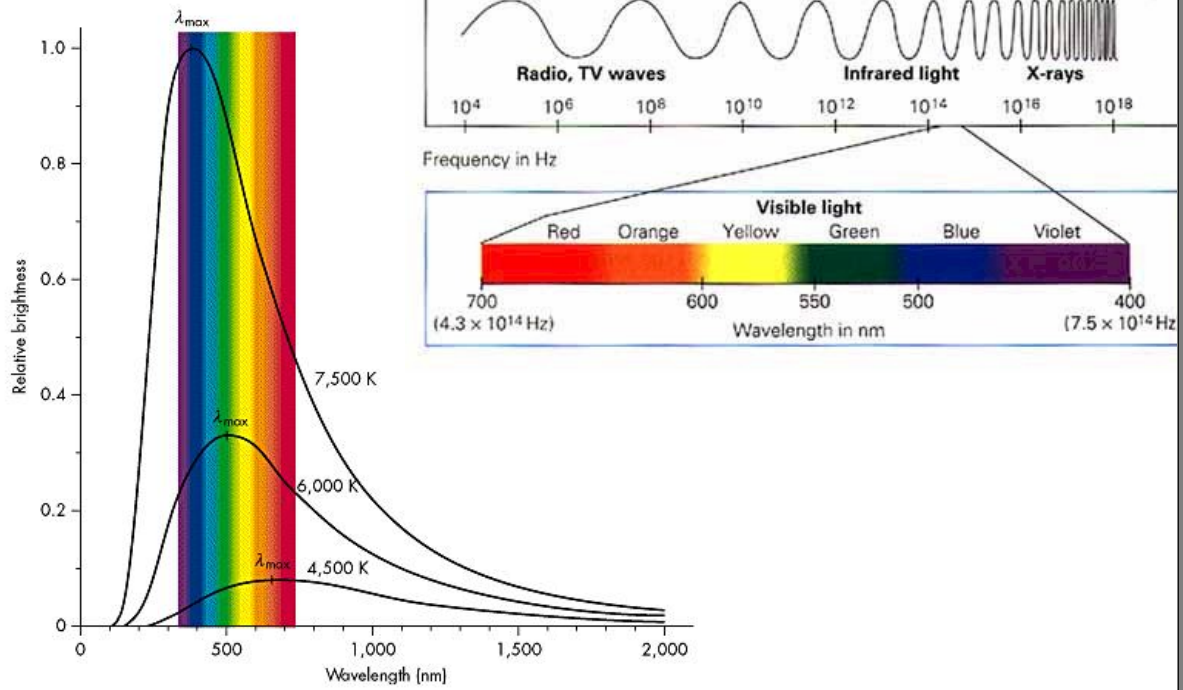
Konveksjon



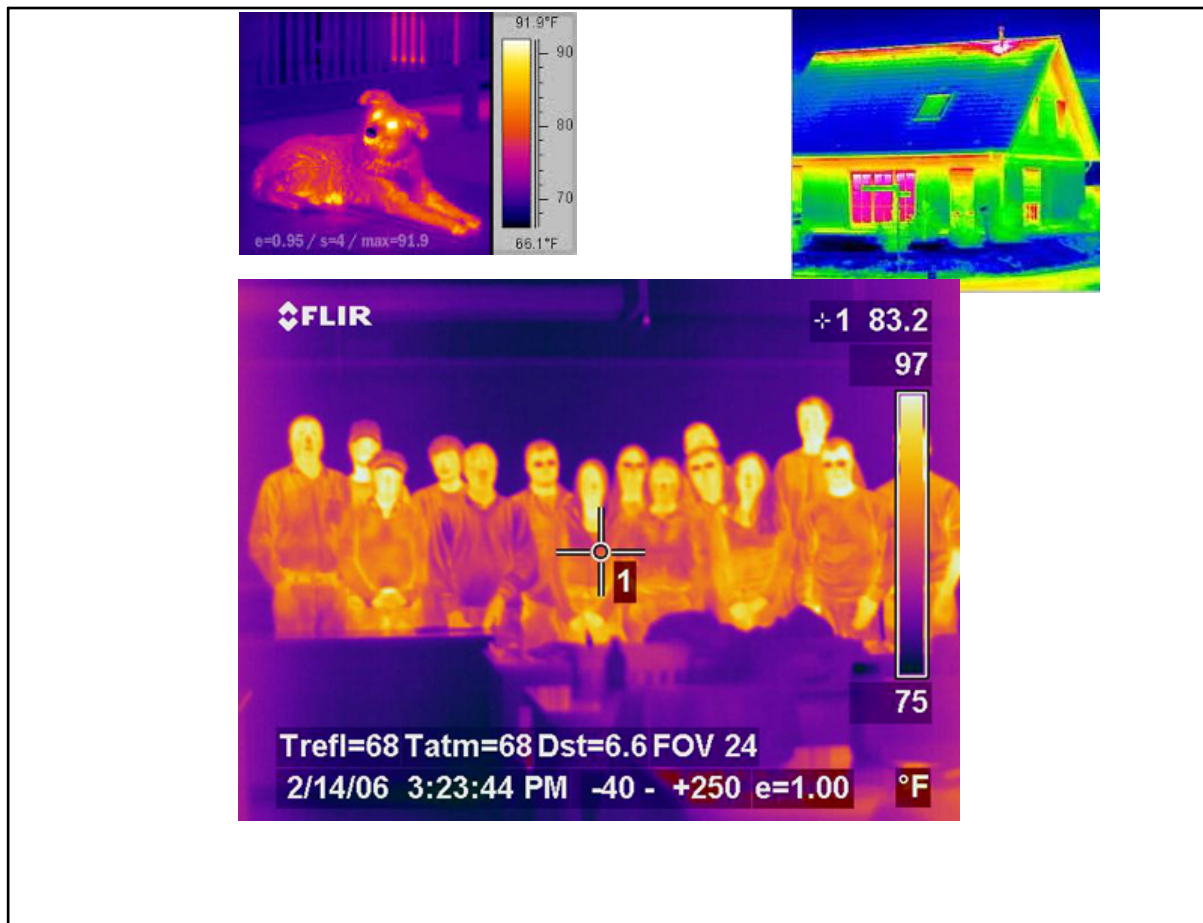
Vindstyrke i Beaufort	Vindhastighet m/s	Termometeret viser (°C)										Folt temperatur (°C)
		15	10	5	0	-5	-10	-15	-20	-25	-30	
Vindstille	0	15	10	5	0	-5	-10	-15	-20	-25	-30	-30
Svak vind	1,6 - 3,3	14	9	3	-2	-7	-12	-18	-23	-28	-33	-33
Lett bris	3,4 - 5,4	10	4	-2	-8	-14	-20	-26	-32	-38	-44	-44
Laber bris	5,5 - 7,9	8	2	-4	-11	-18	-25	-32	-38	-45	-52	-52
Frisk bris	8,0 - 10,7	7	0	-7	-14	-21	-29	-36	-43	-50	-57	-57
Liten kuling	10,8 - 13,8	5	-2	-9	-17	-24	-32	-39	-47	-54	-61	-61
Stiv kuling	13,9 - 17,1	5	-3	-11	-18	-26	-34	-42	-49	-57	-65	-65
Sterk kuling	17,2 - 20,7	4	-4	-11	-19	-27	-35	-43	-51	-59	-66	-66
Liten storm	20,8 - 24,4	4	-4	-12	-20	-28	-36	-44	-52	-60	-68	-68
Forfrysningssfare		Liten			Stor			Meget stor				

Mar 1-1:12 PM

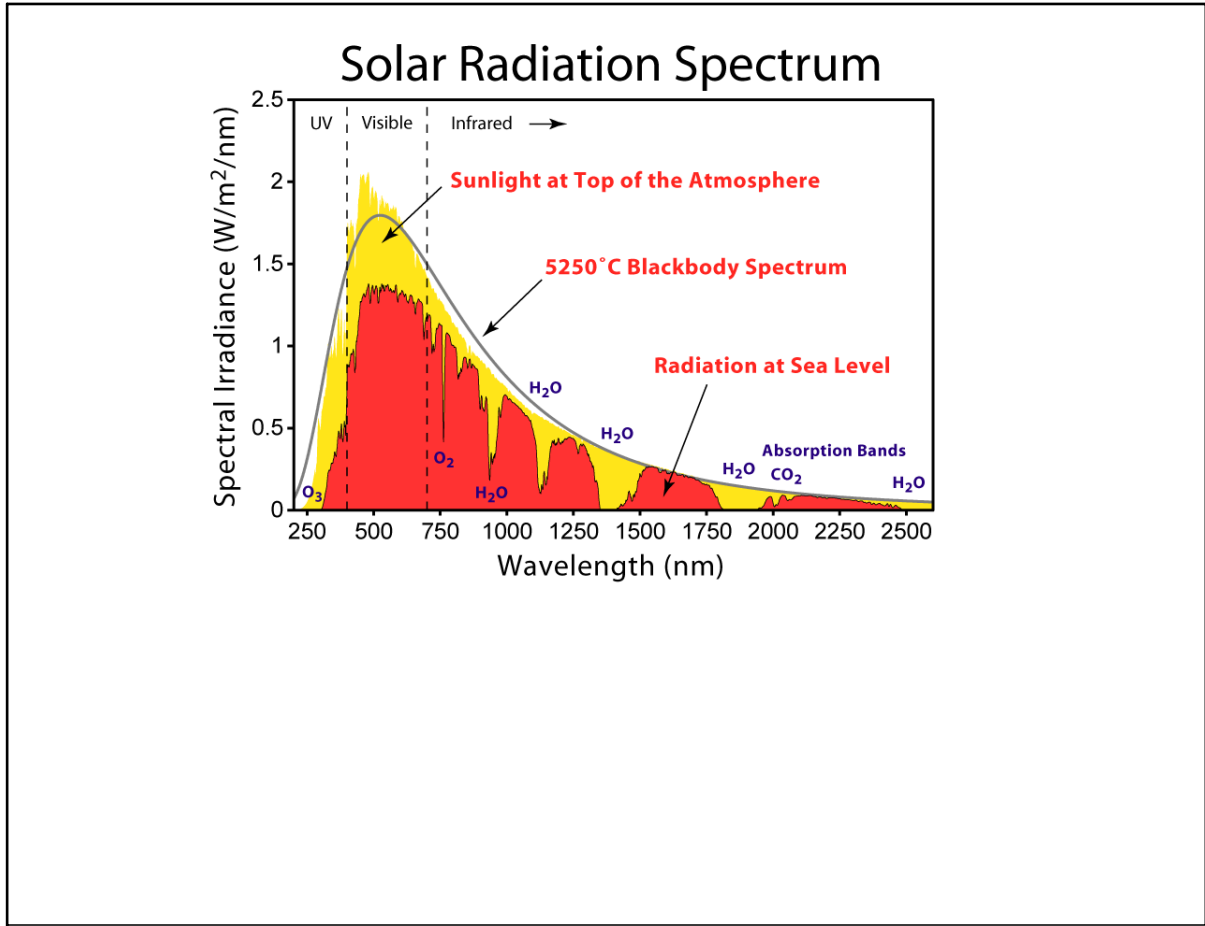
Varmestråling



Mar 1-1:17 PM



Mar 4-12:25 PM



Mar 1-1:54 PM

Stefan-Boltzmanns lov

Area, A

Utskriver effekt
(solt legeme)

$$P = \sigma A T^4$$

$\sigma = 5.67 \cdot 10^{-8} \frac{W}{m^2 K^4}$

Generelt: $P = \sigma \epsilon A T^4$

ϵ emissivitet $0 < \epsilon < 1$

Solt legeme $\epsilon = 1$

Absorption

$P_{abs} = \sigma \alpha A T_s^4$

α absorptivitet $\alpha = \epsilon$

$\epsilon = 1$

$\epsilon < 1$

$$P = \sigma \epsilon A T^4 \quad P_{abs} = \sigma \epsilon A T_s^4$$

Temperatur: $P = P_{abs}$

$$\sigma \epsilon A T^4 = \sigma \epsilon A T_s^4$$

$$T = T_s$$

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Ex: $A = 2,0 \text{ m}^2$, $T_k = 30^\circ\text{C} = 303 \text{ K}$, $T_o = 22^\circ\text{C} = 295 \text{ K}$ $\epsilon = 0,97$

$$P_{\text{ut}} = \sigma \epsilon A T_k^4 = 0,93 \text{ kW}$$

$$P_{\text{in}} = \sigma \epsilon A T_o^4 = 0,8 \text{ kW}$$

$$P_{\text{ut}} - P_{\text{in}} = 94 \text{ W}$$

Deilig forbruk: $2000 \text{ kcal/day} = 8400 \text{ kJ/day}$

$$P = \frac{Q}{t} = \frac{8400 \text{ kJ}}{24 \cdot 60 \cdot 60 \text{ s}} = 97 \text{ W}$$

mai 20-09:43

NEXT-STEP QUESTION

CONCEPTUAL: Physics

You're a consultant for a cookware manufacturer who wishes to make a pan that will have two features:

1. absorb thermal energy from a flame as quickly as possible.
2. have a cooking surface that stays as hot as possible when heated.

You should recommend a pan with the

- a) outer and cooking surface black.
- b) outer and cooking surface shiny.
- c) outer surface shiny and cooking surface black.
- d) outer surface black and cooking surface shiny.



ARBOR SCIENTIFIC
TOOLS THAT TEACH

thank to Dean Baird

Heart
Essential

Feb 21-2:16 PM

$P = \epsilon \sigma A T^4$
 $\sigma = 5.67 \cdot 10^{-8} \frac{W}{m^2 K^4}$

$P_{abs} = \alpha \sigma A T_{amb}^4$

mai 24-08:12

Hvis jorda ikke hadde noen atmosfære...

Innkommende solstråling
 342 W/m²

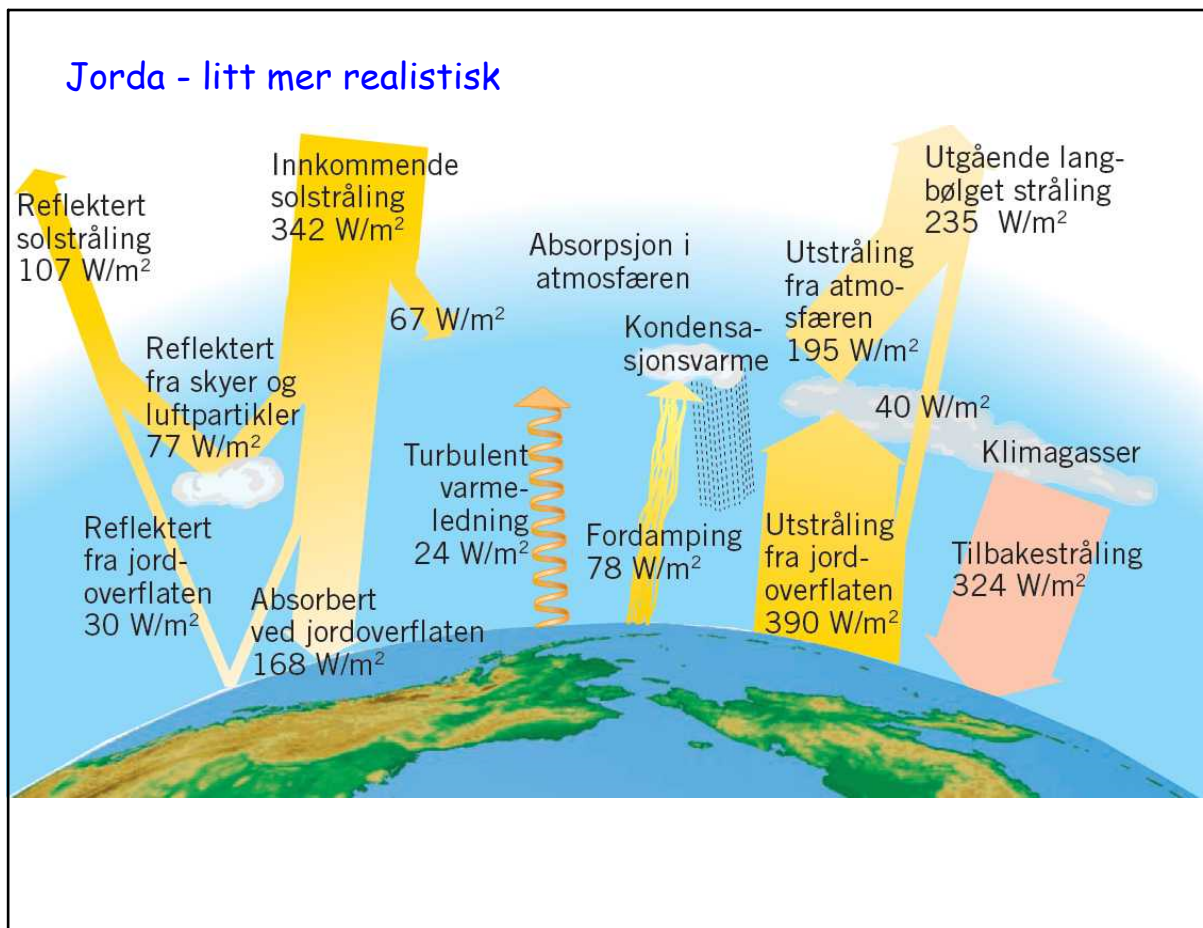
Reflektert solstråling
 107 W/m²

Utgående langbølget solstråling
 235 W/m²

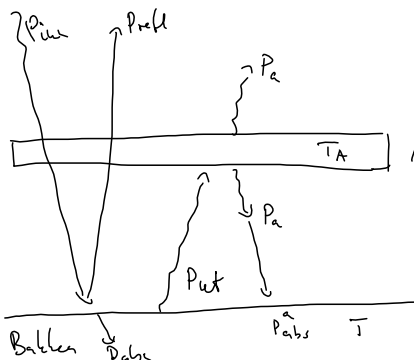
mar 1-18:32

P_{in}
 $P_{refl} = A P_{in}$
 $P_{abs} = (1-A) P_{in}$
 $A = 0.3$
 $P_{abs} = (1-A) P_{in} = (1-A) \pi R^2 S$
 $P_{out} = \sum_1 \sigma A_{ext} T^4 = \sigma 4\pi R^2 T^4$
 $P_{abs} = P_{out} : (1-A) \pi R^2 S = \sigma 4\pi R^2 T^4$
 $T = \sqrt[4]{\frac{(1-A)S}{4\sigma}} = 255K = -18^\circ C$

Feb 14-1:34 PM



mar 1-18:36



$$P_{abs}^I = \pi R^2 (1-A) S + 4\pi R^2 \sigma T_A^4$$

$$P_{out} = 4\pi R^2 \sigma T^4$$

Atmosfære:

$$\begin{cases} P_{abs} = P_{out} = 4\pi R^2 \sigma T^4 \\ P_{out} = 2 \cdot 4\pi R^2 \cdot \sigma T_A^4 \end{cases}$$

$$4\pi R^2 (1-A) S + 4\pi R^2 \sigma T_A^4 = 4\pi R^2 \sigma T^4$$

$$(1-A) S = 4\sigma T^4 - 2\sigma T_A^4 = 2\sigma T^4$$

$$T = \sqrt[4]{\frac{(1-A)S}{2\sigma}} = 303K = 30^\circ C$$

$$4\pi R^2 \sigma T^4 = 2 \cdot 4\pi R^2 \sigma T_A^4$$

$$T^4 = 2 T_A^4$$

$$T_A = \frac{1}{\sqrt[4]{2}} T$$

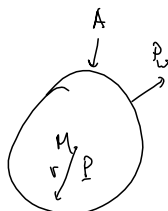
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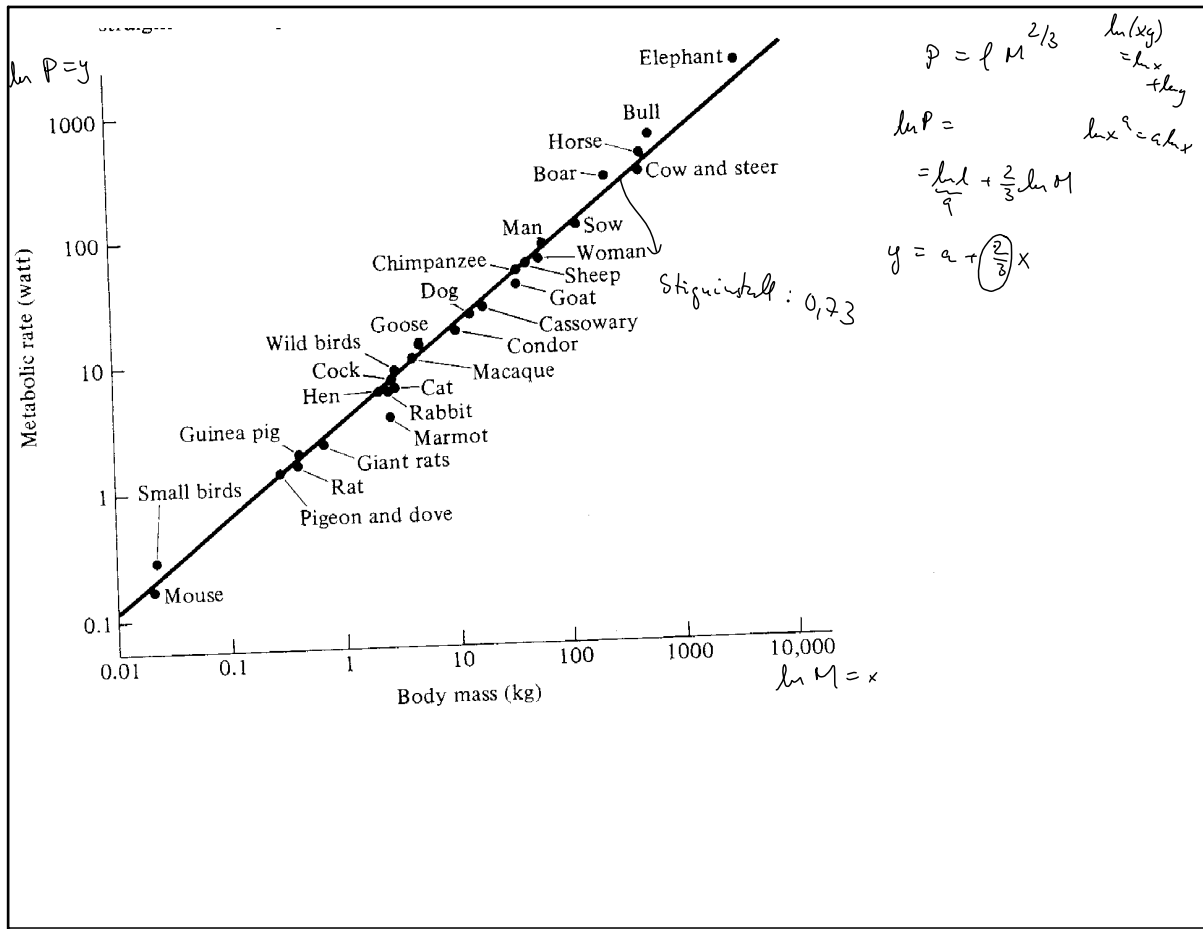
$$H = k \frac{\Delta T}{L} A$$



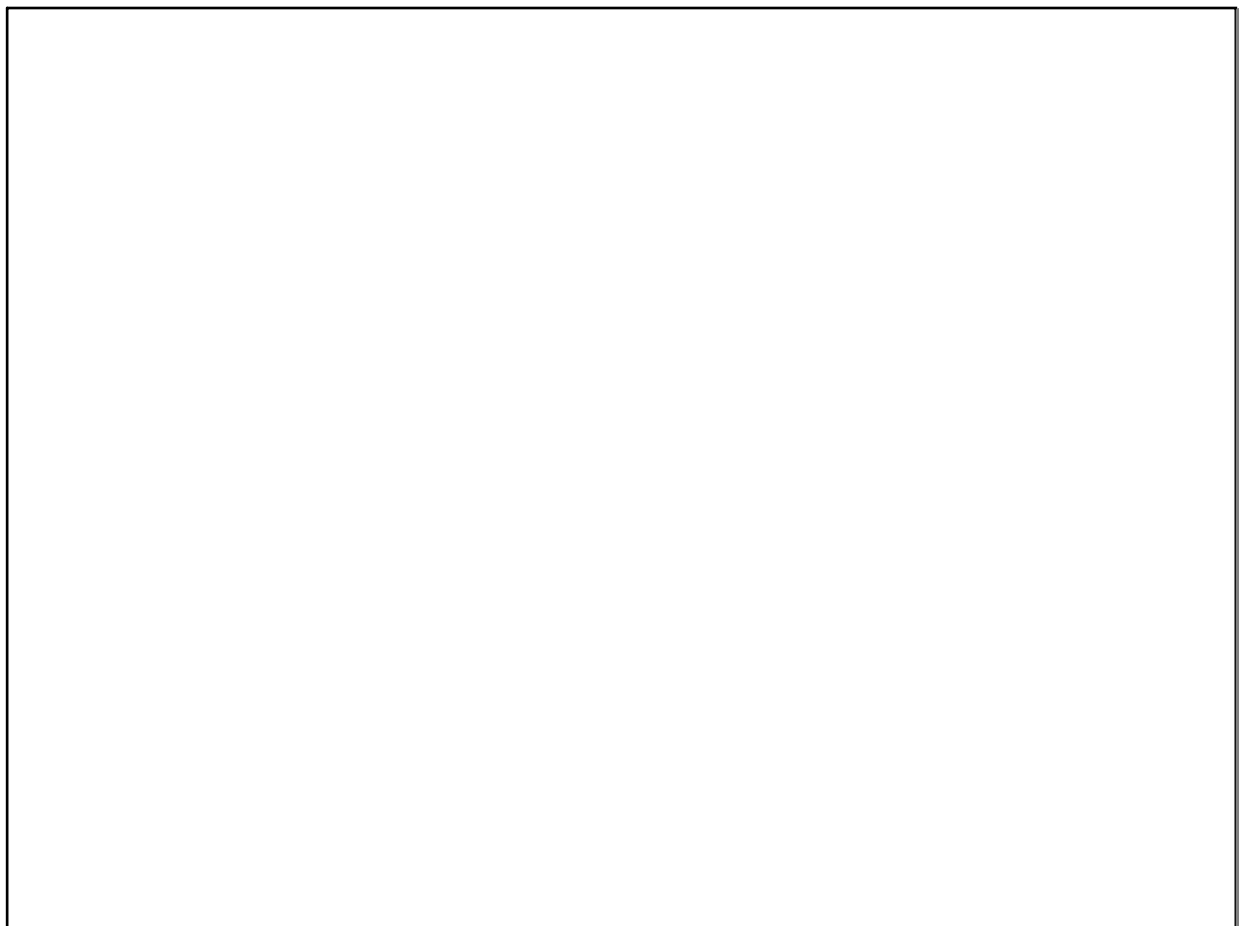
$$P_{ut} = P = k A = l \frac{M}{L} \frac{\Delta T}{L}$$

$$M = c \cdot r^3 = f \cdot A^{3/2} \Rightarrow A = g M^{2/3}$$

$$A = d r^2 \rightarrow r = e \sqrt{A} = c A^{1/2}$$



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Feb 28-11:03 AM

image-9

image-10