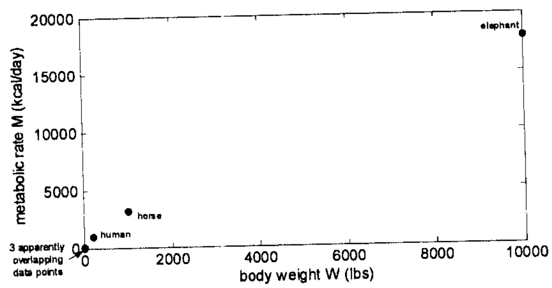
Vogler
Math 17A

POWER LAW FUNCTIONS AND LOG-LOG PLOTS

Q: What is the relationship between body weight and basic metabolic rate in mammals?

	average body weight, W (lbs)		basic metabolic rate, M (kcal/day)	
elephant	10000		18000	
horse	1000		3200	
human	200		960	
cat	8		86	
rat	2		30	
mouse	0.5		10	

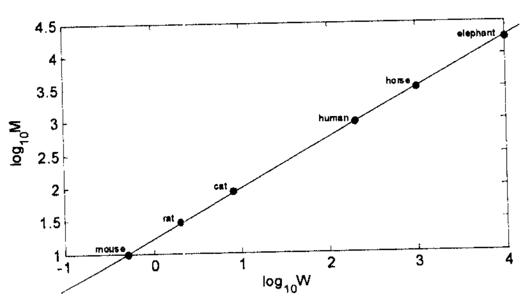


** Weights and metabolic rate vary over "orders of magnitude", causing problems reading graph effectively and making sense out of the data.

Q: What is the relationship between body weight and basic metabolic rate in mammals?

*Transform data (W and M) using $\log_{10}$.

	average body weight, W (lbs)	$\log_{10}(W)$	basic metabolic rate, M (kcal/day)	$\log_{10}(M)$
elephant	10000	4.0	18000	4.3
horse	1000	3.0	3200	3.5
human	200	2.3	960	3.0
cat	8	0.9	86	1.9
rat	2	0.3	30	1.5
mouse	0.5	-0.3	10	1.0



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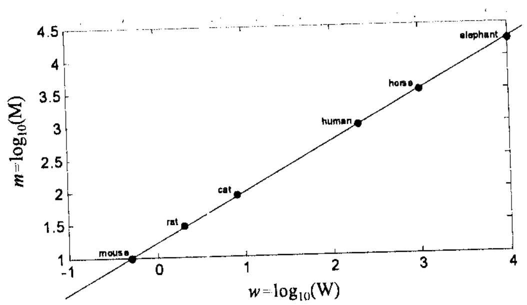

fit log-transformed data (w and m) to straight line; slope=0.75, m-intercept=0.23. → $m = 0.75w + 0.23$

$\log_{10}(M) = 0.75 \log_{10}(W) + 0.23$ ← $w = \log_{10}(W)$, $m = \log_{10}(M)$

Text

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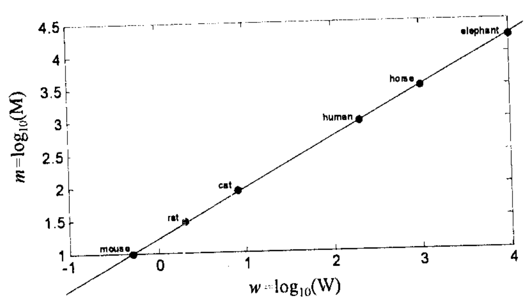

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$\log_{10}(M) = 0.75 \log_{10}(W) + 0.23$ ← $w = \log_{10}(W)$, $m = \log_{10}(M)$

$10^{\log_{10}(M)} = 10^{0.75\log_{10}(W)+0.23}$

$10^{\log_{10}(M)} = 10^{0.23}\, 10^{\log_{10}(W^{0.75})}$

... gives **power law** relationship between weight W and metabolic rate M → $M = 1.7\, W^{0.75}$