ES265 - Problem Set 2 - Due Thurs Tues 5th Feb

General Advice Problems are divided into S(mall), M(edium) and L(arge). Small problems shouldn't take you more than a couple of minutes. You should not need to use calculators - this is an order-of-magnitude class! Make sure you explain what you are doing - the method is much more important than the final answer. You will get bonus points if you come up with more than one solution to a problem. You're welcome to check your answers on the Internet - but do it AFTER you've done the problem! The final problem in each set (Problem 8 here) requires you to suggest (and solve) a medium-size order of magnitude question of your own. Working together is permitted, but you must each come up with a unique suggested problem.

PROBLEM 1 How much more power is lost through a single pane window than a double pane window during the winter in Canada? Assume in the latter case that $\sim$1 cm of air is between the two panes, and that heat is transferred only by conduction through the air, which is a good assumption for small air gaps. [S]

PROBLEM 2 Derive an expression for how the thickness of blubber (which contains no blood) in marine mammals scales with their radius. You may assume all marine mammals have the same internal temperature. [M]

PROBLEM 3 How much water does a cyclist travelling at 50 km/h for two hours lose due to sweating? [S]

PROBLEM 4 One way of defeating global warming is to increase the Earth's albedo. If we want to offset a 1 °C change in surface temperature, what area of the Earth would we have to paint white? [M]

PROBLEM 5 In the interior of the Earth, density will increase due to increasing pressure P, but will decrease due to the increasing temperature T. Write down an expression for the ratio of these two effects in terms of atomic constants and ΔT and ΔP, where Δ indicates a change. Which effect is more important for the Earth? [L]

PROBLEM 6 Asteroids which formed early enough may have been heated by decay of ^{26}Al. Assume that this material has a total heat output of 3 MJ/kg and it decays completely over 3 Myr. a) For an asteroid of 30 km radius, determine whether heat conduction is important over the timescale of ^{26}Al decay, and thus determine the amount by which the asteroid heats up. b) For a similar asteroid with 5 km radius, determine the maximum central temperature due to ^{26}Al decay. [M]

PROBLEM 7 The Moon probably formed out of a disk of molten material, spanning the distance from roughly 2 to 4 Earth radii. How long did it take this disk to cool? [S]

PROBLEM 8 Suggest, and provide a solution for, a medium-size order-of-magnitude problem on a topic relating generally to heat transfer. The question should be similar to those above, and will be graded on its originality as well as the solution approach. [L]