

Midterm Exam
ECE 597UU/697UU, Fall 2009
(November 12, 2009)

Problem 1 (4 pts. total): *Air pressure*

(a, 2 pts.) Suppose the air pressure p at the surface is 900 hPa and the temperature T is 10 degrees Celsius. What is the density?

(b, 2 pts.) Same as (a). You lift your barometer from the ground to some height h and detect a pressure decrease by 1 Pa. What is the height?

Problem 2 (4 pts. total): *Geostrophic wind*

(a, 2 pts.) There is a high south of Amherst. Where does the wind come from?

(b, 2 pts.) Suppose the sea-level pressure is 1020 hPa at Amherst and 1022 hPa 80 km south of Amherst. What is the geostrophic wind speed?

Problem 3 (3 pts. total): *Melting ice sheet*

(a, 2 pts.) Suppose over the winter a solid ice sheet with a thickness of 10 cm has accumulated. Suppose the temperature rises and the ice is gone after 10 days. Calculate the time-averaged surface heat flux that is required to melt the ice. (The heat of fusion is 334 kJ/kg, and the density of ice is 920 kg/m².)

(b, 1 pt.) Does your result make sense? Explain!

Problem 4 (4 pts. total): *Sirius*

(a, 2 pts.) Sirius is the brightest star on the night sky. It is 8.6 light years away from us, and its luminosity is 25 times the Sun's luminosity. Calculate the radiative flux (in watts per square meter) that we receive from Sirius.

(b, 1 pt.) What is the total radiative power that the Earth receives from Sirius?

(c, 1 pt.) If Sirius would disappear, would there be a measurable climate effect? Explain quantitatively!

Problem 5 (6 pts. total): *Falling sphere*

(a, 3 pts.) Find the frictional force F that a spherical body with radius r falling at speed v through air with density ρ experiences. Use dimensional analysis, based on the ansatz $F = ar^\alpha \rho^\beta v^\gamma$, where a is a dimensionless coefficient.

(b, 3 pts.) Do your values of the exponents α , β and γ make sense or not? Explain!