

APPH4200 Physics of Fluids: Homework 5

1. K&C, Chapter 8, problem 2. The correct answer for the velocity in the wind tunnel may seem unrealistic, and strictly, would require us to consider an additional non-dimensional parameter not discussed in class, but that is mentioned in the chapter. Extra credit for saying what this parameter is.
2. Consider the thermal energy equation for an incompressible flow satisfying Fourier's law, eq. 4.68 of K&C. Non-dimensionalize this equation, assuming a single length scale and velocity scale. You should obtain one non-dimensional parameter. Interpret this parameter physically, i.e., what does it mean if it is small or large?
3. Review the deep water equations derived in class. Then, describe the gravity surface waves with viscosity. Assume wavelike solutions, e.g.

$$\eta = \text{Re}\{\eta_0 e^{i(kx - \omega t)}\},$$

where, η_0 is a complex amplitude, and the frequency ω must be assumed complex. Do the disturbances grow or decay in time? Is this physically reasonable? Verify that the phase speed reduces to the expected value in the limit $\nu \rightarrow 0$.