CHAPTER OVERVIEW

15: Fluid Mechanics

Learning Objectives

- Understand the concept of pressure, and how pressure is modelled in a fluid.
- Understand how to model the pressure gradient due to gravity.
- Understand Pascal's Principle and how to model hydraulic lifts and pressure sensing devices.
- Understand how a pressure gradient leads to a force of buoyancy.
- Understand the difference between laminar and turbulent flow.
- Understand the equation of continuity, and the concepts of mass and volumetric flow.
- Understand how to apply Bernoulli's Principle to model the speed and pressure within a flowing fluid.
- Understand how to model the resistance to flow in a pipe using the viscosity of a fluid.

In this chapter, we introduce the tools required to model the dynamics of fluids. This will allow us to model how objects can float, how water flows through a pipe, and how airplane wings create lift. We will start by introducing the concept of pressure and modeling static fluids (hydrostatics) before developing models for fluids that flow (hydrodynamics). Fluids are generally defined as the phase of matter in which atoms (or molecules) are only loosely bound to each other, such as in gases or liquids. Most of the formalism that we develop will apply to any fluid (gas, liquid, plasma), although we will often restrict ourselves to modeling the most simple situations (e.g. laminar flow of an incompressible liquid).

prelude

You are sailing, and the wind is blowing from the north. You want to travel upwind (north). In what direction should you point your boat/sail?

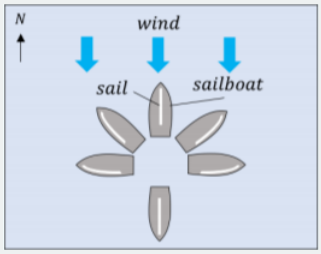

Figure 15.1*: Possible directions you can point your sailboat.*

A. North
B. South
C. Point either East or West
D. Alternate between North-east and North-west
E. You cannot go upwind