Problem Set 5
CIVIL-425 : Continuum Mechanics and Applications

3 April 2025

Exercise 1

Using the principle of conservation of linear momentum, solve the following problems:
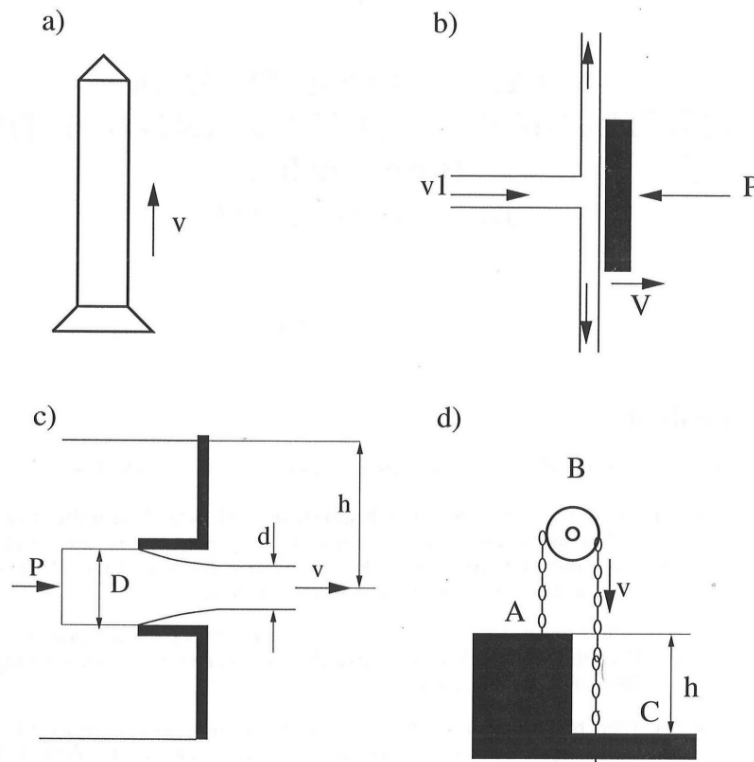

Figure 1: Illustration of the different configurations

a. A rocket of initial mass m_0 (including shell and fuel) is fired vertically at time $t = 0$. The fuel is consumed at a constant rate $q = \frac{dm}{dt}$ and is expelled at a constant speed u relative to the rocket. Derive an expression for the velocity of the rocket at time t neglecting the resistance of air.

b. A stream of water of cross-sectional area A and velocity v_1 strikes a plate which is held motionless by a force P. Determine the magnitude of P knowing that $A = 500mm^2$ and $v_1 = 25m/s$. *optional* What happens if the plate has mass m and is free to move at velocity V?

c. A circular reentrant orifice (also called Borda's mouthpiece) of diameter D is placed at a depth h below the surface of a tank. Knowing that the speed of the issuing stream is $v = \sqrt{2gh}$ and assuming that the speed of approach v_1 is zero, show that the diameter of the stream is $d = D\sqrt{2}$. (Hint: Consider the section of water indicated, and note that P is equal to the pressure at a depth h multiplied by the area of the orifice.)