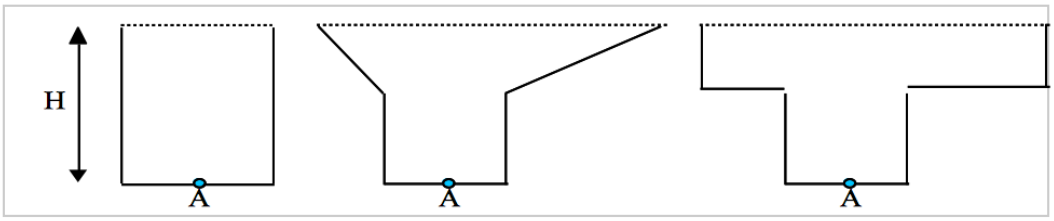
Exercise 1

1) Viscosity: We define kinematic viscosity as $\nu = \mu/\rho$ where μ is the dynamic viscosity (occasionally referred to as molecular viscosity). Try to give a physical interpretation to the kinematic viscosity.

2) Pressure:
   a) The weight of the atmosphere above us is approximately that of two elephants (calculate for yourself). How come a box of matches keeps its shape?
   b) What (if at all) will be the difference in pressure at point A in the following three configurations assuming the same fluid fill both columns? Expain.



3) Eulerian and Lagrangian description of fluid motion: A car is driving straight southward, past a service station, at 100 km/hr. The surface pressure decreases toward the south-east at 1 Pa/km. What is the pressure tendency at the service station if the pressure measured by the car is decreasing at a rate of 16 Pa/hr?

4) Surface gravity waves: In Class we solved the surface gravity wave dispersion relation for an infinite depth.
   a. Solve the same problem for a finite depth H and show that the dispersion relation is $\omega^2 = gk\tanh(kh)$. Follow the derivation from class, and note the new boundary condition at z = -H and conclude how this condition affects the dynamic pressure.
   b. Find the limit of this dispersion relation for deep water $\left(k^{-1} << H\right)$ and for shallow water $\left(k^{-1} >> H\right)$. Show that in deep water the dispersion relation of surface gravity waves can be approximated as $\omega = \sqrt{gk}$ and in shallow water, the dispersion relation can be approximated as $\omega = \sqrt{gH}k$.

5) On 26th of December, 2004, a powerful earthquake occurred near Sumatra in the Indian Ocean (centered at 3.3° N, 95.8° E). More than 250,000 people were claim dead due to the tsunami wave initiated by this earthquake. Assuming that the earthquake occurred at depth of 1000 m estimate the time required for the tsunami wave to reach (i) Sri-Lanka eastern cost (located at 7.3° N, 80.7° E), (ii) the Eastern cost of Africa, look for this event in Wikipedia and compare your result. What will happen to the tsunami wave when it gets close to the shore? What would happen to the wave amplitude then?

6) The waves in the open sea may have an arbitrary orientation of the wave crests, determined by the direction of the wind that caused the waves. Near the shore, the approaching waves always seem parallel to the coast line. Can you explain why?

7) **Bonus:** Write a code which solves the dispersion relation of small amplitude waves from problem 4a. Then, run the program for the following data set: (DEPTH, PERIOD)=(10.0,1000.0), (10.0,100.0), (10.0, 10.0), (10.0,1.0), (10.0, 0.1)