Hydrodynamics

Warm-Up questions

Hydrodynamics

i. Viviane and Sebastian would like to build a submarine out of an old water tank.

a) Assume the water tank has a volume of 2000 litres. What is the minimal weight of the submarine such that it can dive?

b) They would like to dive down to a depth of 20m. What is the water pressure at this depth?

c) To look out of the submarine, they build a round window with radius $r = 20\text{cm}$. What force is acting on the window in the depth of 20m?

ii. When it is raining, the water on a roof top is collected by a rain pipe and flows through a vertical downpipe to the ground. We assume a house with a 5m long downpipe and we neglect any kind of friction.

a) How fast is the water flowing at the end of the downpipe?

b) At the lower end of the downpipe we place a water wheel. Assuming there are 10 litres of water per minute flowing through the pipe, what power can the water wheel produce (under ideal conditions)?

iii. In this question we want to investigate the Bernoulli effect. For this we consider a pipe system with a narrowing, see figure 1. At the narrowest position, the diameter is half of the one at the beginning and the end. A little baby submarine is floating in the water, it has therefore always the same speed as the water. We assume the water floats at the widest positions with a speed v_0 and we neglect friction.

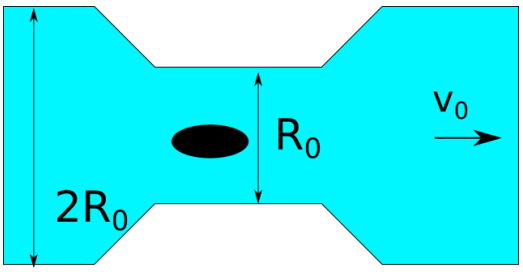

Figure 1:

a) What is the speed at the narrowest position?

b) When floating from the widest to the narrowest position, the submarine gets accelerated, therefore the kinetic energy increases. How much is the increase assuming the submarine has a mass of m?

c) Where does the energy for this acceleration come from? Compare with the Bernoulli equation.