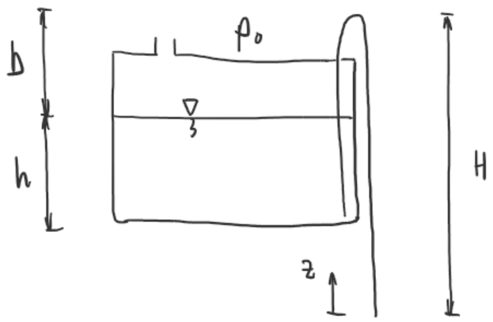
A reservoir, shown in the image, is filled with water of density ρ, and it is drained through a pipe. The reservoir is open to ambient air p_0. The water level height is h in the reservoir, and the highest point of the pipe is b higher than the water level. The height difference between the highest point and the outlet of the pipe is H.



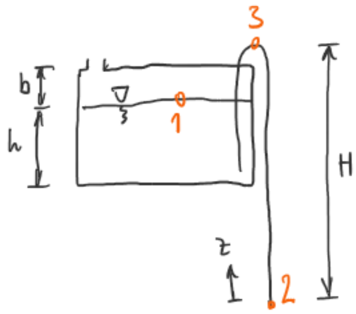
ASSIGNMENTS

a) What is the velocity at the outlet?

b) How much can H be increased (the increase happens downwards, with the highest point staying at the same position) without reaching cavitation, if the vapor pressure of water is p_v? What is the velocity at the outlet in this case?

DATA

$\rho = 1000\ kg/m^3$, $p_0 = 10^5\ Pa$, $h = 0.2\ m$, $b = 0.2\ m$, $H = 2\ m$, $p_v = 10^3\ Pa$



a) BE 1-2

$$\cancel{p_1} + \rho\cancel{\frac{v_1^2}{2}} + \rho U_1 = \cancel{p_2} + \rho\frac{v_2^2}{2} + \rho U_2$$

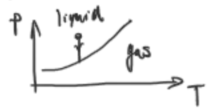
$p_1 = p_0$, $v_1 = 0$, $p_2 = p_0$

$$\frac{v_2^2}{2} = \frac{v_1^2}{2} + (U_1 - U_2)$$

$U_1 - U_2 = g(H-b)$

$$v_2 = \sqrt{2g(H-b)} = 6\ \frac{m}{s}$$

b) $v_2 \uparrow$: $H \uparrow$ limit: cavitation at 3!



BE 3-2

$$p_3 + \rho\frac{v_3^2}{2} + \rho U_3 = p_2 + \rho\frac{v_2^2}{2} + \rho U_2$$

$v_3 = v_2$, $p_2 = p_0$

$$\rho(U_3 - U_2) = p_0 - p_3$$

$U_3 - U_2 = g H_{max}$

$$H_{max} = \frac{p_0 - p_v}{\rho g} = 9.9\ m$$

$$v_{2max} = \sqrt{2g(H_{max} - b)} = 13.93\ \frac{m}{s}$$