Reading # 1

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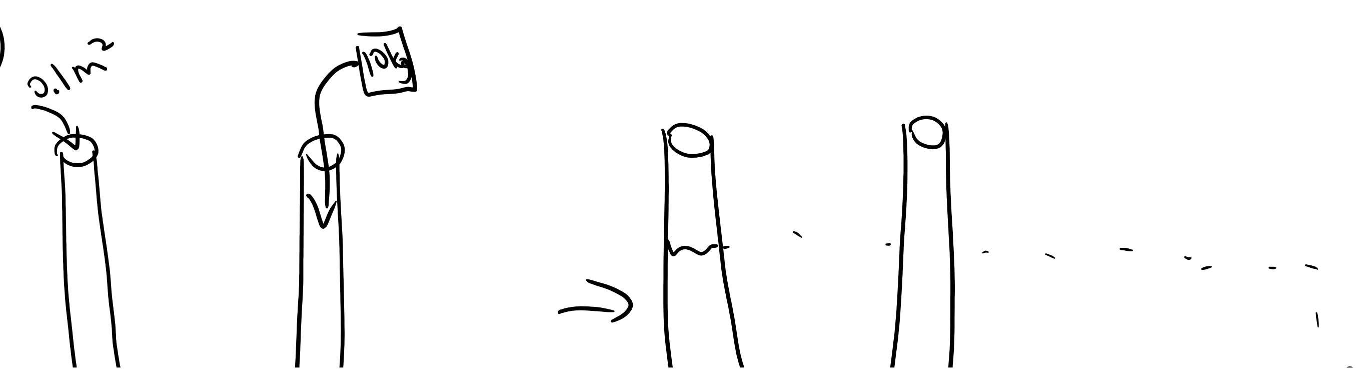
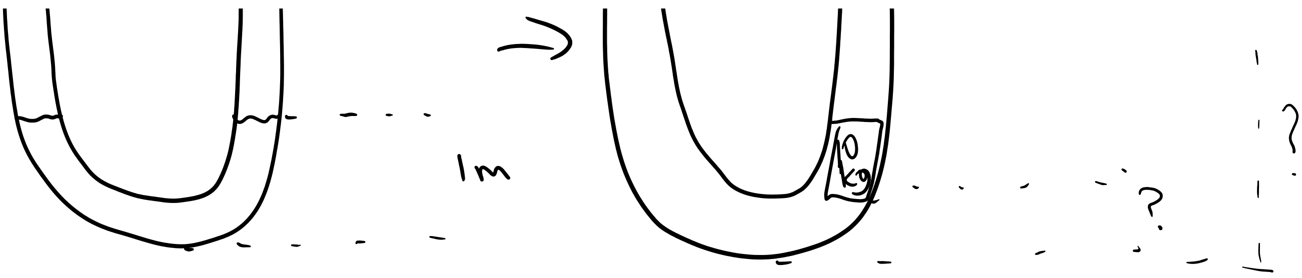
1) Density tends to depend on temperature and pressure as a fluid under high pressure results in more "things" per volume ie: higher density and fluids under high temperature tend to expand thus resluting in less "things" per volume and lower density

2) Pressure is defined as Force per unit area. Thus we can ignore discrete molecular structures and replace them with continuous "blocks" of matter when considering pressure. pressure has no direction because only forces normal to a surface have effect on pressure. since the vector of area is also normal to the surface the vector can be thought of as being divided out leaving a scalar value.

3)





Density of water at ATM $= 1g/cm^3 = \frac{1000\,kg}{m^3}$

Volume of water / length of tube $= \frac{1m^3}{10m}$

The height of water required to offset 10 kg is then given by

$$10\,\cancel{kg} \times \frac{\cancel{m^3}}{1000\,\cancel{kg}} \times \frac{10\,m}{\cancel{m^3}} = 0.1\,m$$

So the water levels are 1.1m on the side with no weight and 0.9m on the other.

4)

$100\,g/m^3$ at $x=0$

$150\,g/m^3$ at $x = 100km$ upstream

$\Rightarrow \rho_{carr.}(x) = \frac{5}{1000m}x + 100$

$\Rightarrow \rho_{caffine}(x) = \frac{5}{10000}x + 100$

Since the river flows at 1m/s in 3 hrs
the water has moved 10800 m

then the density of caffine is given
by

$\rho_{caffine} = \frac{5}{10000}(10800) + 100 = \boxed{105.4 \ g/m^3}$