P426 Readings
Week 01

1.

The density of a fluid depends on pressure and temperature based on the equation of state.

2.

Molecules in a fluid are moving in random directions. They collide with each other applying forces in all directions. The net force in the direction normal to a cross-sectional area in the fluid is a measure of pressure. Pressure doesn't have direction because the net force in one direction is the same for any other direction.

3.

The mass will push down on the water on the left side due to gravity, which will push more water to the right side. In equilibrium the pressure on the left side will equal to the pressure on the right side.

$$P_L = P_R$$

where, P_L is the pressure of the remaining water on the left side plus the pressure of the mass. P_R is the pressure of all the water on the right side.

$$P_L = \frac{M_{wL} g}{A} + \frac{M_M g}{A}$$
$$P_R = \frac{M_{wR} g}{A}$$
$$M_{wR} = \rho_w A\,(L + \Delta L)$$
$$M_{wL} = \rho_w A\,(L - \Delta L)$$

L is the length of the water at one side, $L = 1\text{m}$. ΔL is the change in height on each side.

$$P_L = P_R$$
$$g\rho_w\,(L - \Delta) + \frac{M_M g}{A} = g\rho_w\,(L + \Delta L)$$

Solving for ΔL

$$\Delta L = \frac{M_M g}{2\rho_w A}$$
$$\Delta L = \frac{10\text{kg}}{2\,(1000\text{kg}/\text{m}^3)\,(0.1\text{m}^2)}$$
$$\Delta L = 0.05\text{m}$$

So the height of the water on the left is $L_L = 0.95\text{m}$ and the right side has height $L_R = 1.05\text{m}$.

4.

The river moves with speed 1m/s, so in 3hr = 10800s a parcel of water has travelled 10800m downstream. From the information of the two stations and linearly interpolating, we can estimate the concentration as a function of distance downstream from the first station to be

$$\rho(x) = -\frac{50\mathrm{g/m^3}}{100000\mathrm{m}}x + 150\mathrm{g/m^3}$$

At three hours later, the function is

$$\rho(x) = -\frac{50\mathrm{g/m^3}}{100000\mathrm{m}}(x - 10800\mathrm{m}) + 150\mathrm{g/m^3}$$

Now, at the downstream station at this time, concentration is

$$\rho(100000\mathrm{m}) = -\frac{50\mathrm{g/m^3}}{100000\mathrm{m}}(100000\mathrm{m} - 10800\mathrm{m}) + 150\mathrm{g/m^3}$$

$$\rho(100000\mathrm{m}) = 105.4\mathrm{g/m^3}$$