1. Given the mass of water and salt water is
\[
\frac{5 \text{ L water}}{1 \text{ L water}} \times \frac{1 \text{ kg water}}{1 \text{ L water}} = 5 \text{ kg water}
\]
\[
\frac{5 \text{ L salt w.}}{1 \text{ L salt w.}} \times \frac{1 \text{ kg water}}{1 \text{ L water}} \times \frac{1.035 \text{ kg salt water}}{1 \text{ kg water}} = 5.175 \text{ kg water}
\]

The gauge pressure is calculated as
\[
P_{\text{gauge}} = \rho gh = \left( \sum \frac{m}{V} \right) g \left( \frac{V}{A} \right) = \frac{g \sum m}{A} = \frac{F_g}{A} = \frac{10(10.175)}{0.02} \approx 5078 \text{ Pa}
\]

Equals 4985 if \( g \) is taken to be 9.8.

2. The additional pressure exerted by the water is
\[
\Delta P = \rho gh = \frac{F_g}{A}
\]
\[
\Delta F = A_1 \Delta P = \frac{A_1}{A_0} \rho V g = 21.6 \text{ N}
\]

3.
\[
P_{\text{gauge}} = \rho gh = 13600 \frac{kg}{m^3} \times 9.8 \frac{m}{s^2} \times 0.31 m = 41316.8 \text{ Pa}
\]
\[
P_{\text{abs}} = P_{\text{gauge}} + P_{\text{atm}} = 41316.8 + 101325 \approx 143 \text{ kPa}
\]

4. The electric field at the origin caused by the +15n is
\[
E_{+15n} = kq \frac{\hat{r}}{|\vec{r}|^2} = kq \frac{\hat{r}}{|\vec{r}|^3} = k \left( \frac{(15n)[(0\hat{i} - 0\hat{j}) - (1.5\hat{i} + 0\hat{j})]}{1.5^3} \right) = -\frac{10nk\hat{i}}{1.5}
\]

The electric field at the origin caused by the -20n is
\[
E_{-20n} = kq \frac{\hat{r}}{|\vec{r}|^2} = kq \frac{\hat{r}}{|\vec{r}|^3} = k \left( \frac{(-20n)[(0\hat{i} - 0\hat{j}) - (0\hat{i} - 2.0\hat{j})]}{2.0^3} \right) = -\frac{10nk\hat{j}}{2.0}
\]

The magnitude of the added electric field is therefore
\[
|E_{15n} + E_{-20n}| = 10nk \sqrt{\frac{1}{1.5^2} + \frac{1}{2.0^2}} = 74.1 \text{ N/C}
\]

5. The electric field near an uniform charged plane is given by
\[
E = \frac{\sigma}{2\epsilon_0}
\]

Using Newton’s second law
\[
a = \frac{F_{\text{net}}}{m_p} = \frac{Eq}{m_p} = \frac{\sigma q_e}{2\epsilon_0 m_p}
\]
Since the electric field and electric force is constant, the acceleration is constant, which implies we can use the kinetic equations.

\[
v^2 = v_0^2 + 2ad \\
0 = v_0^2 - 2ad \\
d = v_0^2 \left( \frac{\epsilon_0 m_p}{\sigma q_e} \right) \approx 1.55 \text{ mm}
\]

6. Letting \( R_1 \) denote the outer radius and \( R_0 \) denote the inner radius. Assuming uniform charge density for the nonconducting shell, we have charge density given by

\[
\rho = \frac{Q_{\text{total}}}{V_{\text{total}}} = \frac{Q_{\text{total}}}{\frac{4}{3} \pi (R_1^3 - R_0^3)}
\]

Creating an Gaussian sphere of \( r = 8 \). Using Gauss’s law, we have

\[
\int E \cdot \hat{n} dA = \frac{Q_{\text{enc}}}{\epsilon_0} \\
E \cdot A = \frac{\rho V}{\epsilon_0} = \frac{\rho \frac{4}{3} \pi (r^3 - R_0^3)}{\epsilon_0} \\
E(4 \pi r^2) = \frac{Q_{\text{total}}}{\frac{4}{3} \pi (R_1^3 - R_0^3)} \frac{4}{3} \pi (r^3 - R_0^3) \\
E = \left( \frac{(r^3 - R_0^3)}{r^2(R_1^3 - R_0^3)} \right) \frac{Q_{\text{total}}}{4 \pi \epsilon_0} = \left( \frac{r^3 - R_0^3}{r^2(R_1^3 - R_0^3)} \right) Q_{\text{total}} k \\
= 3106 \text{ kN/C}
\]

7. The electric field cause by the first wire at \( x \) is given by

\[
E_1 = \frac{2k \lambda_1}{x}
\]

The electric field cause by the second wire at \( x \) is given by

\[
E_2 = \frac{2k \lambda_2}{x - 9}
\]

Letting the sum equals to 0, we have

\[
E_1 + E_2 = 0 \\
\frac{2k \lambda_1}{x} = \frac{2k \lambda_2}{x - 9} \\
\lambda_2 x = \lambda_1 x - 9 \lambda_1 \\
x = \frac{9 \lambda_1}{\lambda_1 - \lambda_2} \\
x = 36 \text{ cm}
\]
8. Letting the fixed charge to be $Q$. The electrical potential energy at the beginning is given by

$$U_e = \frac{kQq}{r}$$

By conservation of energy, the maximum speed is reached when all potential energy is converted into kinetic energy. Then a work is done onto the charge by the electric field. We can then skip the kinetic energy step.

$$U_e = W = Fd$$

$$\frac{kQq}{r} = Eqd$$

$$\frac{kQ}{r} = Ed$$

$$E = \frac{kQ}{rd} = 4495 \text{ N/C}$$

9. Recall that voltage is the distance integral of electric field. Since $E$ only have $x$ component in this case, we have

$$V(x) = - \int E \, dx = -12x$$

plug in

$$V_A - V_B = V(3) - V(6) = -36 + 72 = 36 \text{ V}$$

10. Integrating the path over electric field, with $x_1 > x_0$

$$\Delta V = - \int_{x_0}^{x_1} E \, dx$$

$$= - \int_{x_0}^{x_1} \frac{\sigma}{2\varepsilon_0} \, dx$$

$$= -\frac{\sigma}{2\varepsilon_0} (x_1 - x_0)$$

$$x_1 - x_0 = -\frac{2\varepsilon_0 \Delta V}{\sigma} = -\frac{2(8.85 \times 10^{-12})(-98)}{80 \times 10^{-9}} = 2.16 \text{ cm (if } x_1 > x_0)$$

For the value of travelling toward the plane

$$x_0 - x_1 = -2.16 \text{ cm}$$