A. Water is poured into a tall glass cylinder until it reaches a height of 24.0 cm above the bottom of the cylinder. Next, olive oil (ρ_{oil} = 920 kg/m³) is very carefully added until the total amount of fluid reaches 48.0 cm above the bottom of the cylinder. Olive oil and water do not mix. See figure. Take ρ_{water} = 1.00 × 10³ kg/m³ and \( P_{atm} = 1.01 \times 10^5 \) N/m².

1. [4 pts.] Indicate on the drawing which layer is water and which is olive oil.

2. [5 pts.] What is the gauge pressure 10.0 cm below the top of the upper fluid layer in the cylinder.

\[
P_{\text{Gauge}} = P_m - P_{\text{atm}} = \rho_{\text{oil}} g h_{\text{oil}}
\]
\[
= (920 \text{ kg/m}^3)(9.8 \text{ m/s}^2)(0.1 \text{ m})
\]
\[
P_{\text{Gauge}} = 902 \text{ N/m}^2
\]

3. [5 pts.] What is the gauge pressure on the bottom of the cylinder?

\[
P_{\text{Gauge}} = P_{\text{bot}} - P_{\text{atm}} = \rho_{\text{water}} g h_{\text{water}} + \rho_{\text{oil}} g h_{\text{oil}}
\]
\[
= (1.00 \times 10^3 \text{ kg/m}^3)(9.8 \text{ m/s}^2)(0.24 \text{ m}) + (920 \text{ kg/m}^3)(9.8 \text{ m/s}^2)(0.34 \text{ m})
\]
\[
P_{\text{Gauge}} = 4530 \text{ N/m}^2
\]

4. [5 pts.] If the cylinder is in the shape of a right circular cylinder with radius of 3.60 cm, what force is exerted on the bottom of the cylinder?

\[
F_{\text{bot}} = P_{\text{bot}} A = (1.013 \times 10^5 \text{ N/m}^2 + 4530 \text{ N/m}^2) \pi (0.036 \text{ m})^2
\]
\[
F_{\text{bot}} = 431 \text{ N}
\]

B. A 0.200 kg mass is hung from a massless spring. At equilibrium, the spring stretched 28.0 cm below its unstretched length. This mass is now replaced with a 0.500 kg mass. The 0.500 kg mass is lowered to the original equilibrium position of the 0.200 kg mass and suddenly released producing vertical SHM.

1. [5 pts.] What is the spring constant for this spring?

\[
K = \frac{mg}{x_0} = \frac{(0.500 \text{ kg}) (9.8 \text{ m/s}^2)}{0.28 \text{ m}} = 2000 \text{ N/m}
\]

2. [5 pts.] What is the period of oscillation for the 0.500 kg/spring system?

\[
\omega = \frac{2\pi}{T} = \sqrt{\frac{K}{m}}
\]
\[
T = 2\pi \sqrt{\frac{m}{K}} = 1.70 \text{ s}
\]

3. [5 pts.] What is the amplitude of this oscillation?

\[
X_e (N^2) = \frac{m^2 \omega^2}{K} = \frac{(0.500 \text{ kg})(9.8 \text{ m/s}^2)}{2000 \text{ N/m}} = 0.020 \text{ m}
\]
\[
A = X_e N^2 - X_{old} = 0.020 \text{ m} - 0.038 \text{ m}
\]
\[
A = 0.42 \text{ m}
\]