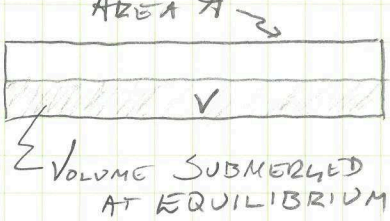
TM5 Pr 3.7

A RAFT FLOATS IN A FLUID DISPLACING A VOLUME V AT EQUILIBRIUM. SHOW THAT THE PERIOD OF SMALL OSCILLATIONS IS

$$\tau = 2\pi\sqrt{\frac{V}{gA}}$$

AT EQUILIBRIUM:



$\Sigma V_{\text{VOLUME SUBMERGED AT EQUILIBRIUM}}$

$$\Sigma F_{EQUIL} = m_R g$$

$$B - m_R g = 0$$

$$(\rho_{FLUID})Vg = m_{RAFT}g$$

$$V = \frac{m_{RAFT}}{\rho_{FLUID}}$$

OSCILLATIONS:

- THE RESTORING FORCE IS PROVIDED BY THE EXTRA BUOYANCY (OR EXTRA WEIGHT).

$$V_{EXTRA} = Ay$$

$$\Rightarrow B_{EXTRA} = (\rho_{FLUID})(Ay)g$$

$\Rightarrow$ NSL IS

$$m_R\ddot{y} = -B_{EXTRA}$$

$$m_R\ddot{y} = -\rho_F Agy$$

$$\ddot{y} + \underbrace{\frac{\rho_F}{m_R}Agy}_{\omega_N^2} = 0$$

$$\Rightarrow \omega_N = \sqrt{\frac{\rho_F}{m_R}Ag}$$

FROM EQUILIBRIUM, $V = \frac{m_R}{\rho_F}$

$$\Rightarrow \omega_N = \sqrt{\frac{Ag}{V}}$$

$$\Rightarrow \boxed{\tau_N = 2\pi\sqrt{\frac{V}{Ag}}} \quad \text{QED}$$