Chapter 3

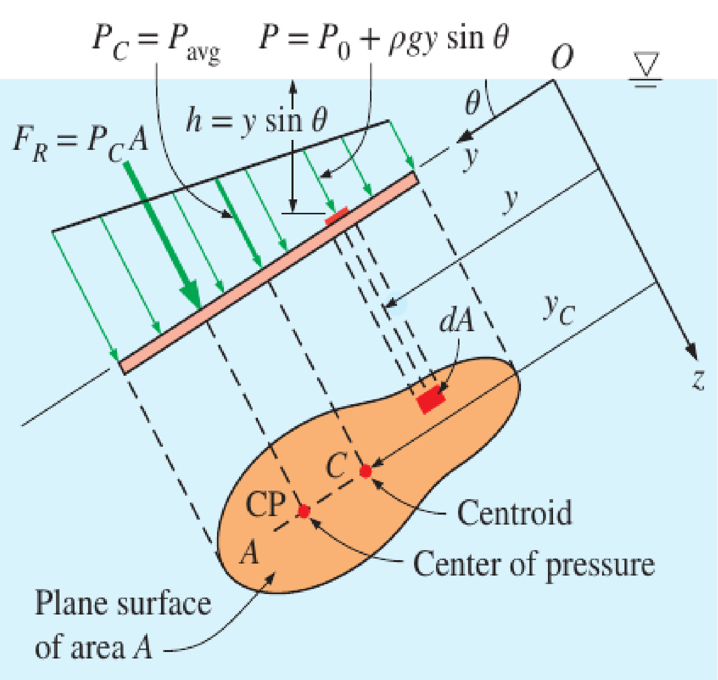
3-1 Pressure Measurement Devices

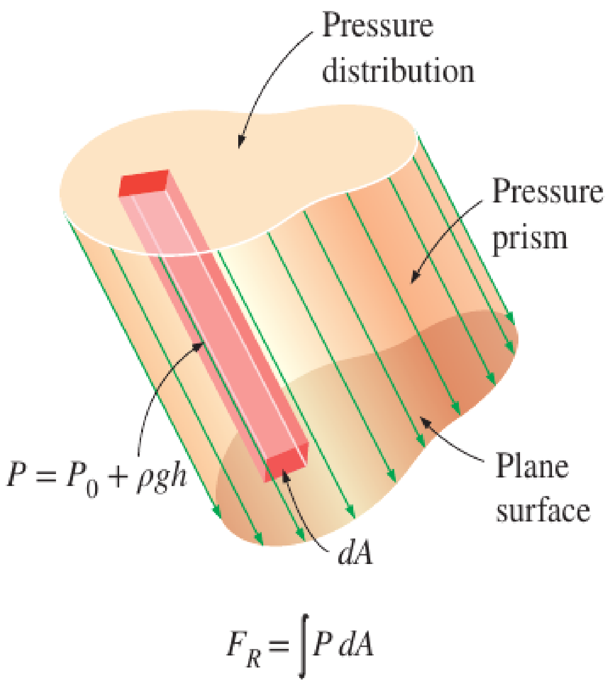
$$P_{\text{gage}} = P_{\text{abs}} - P_{\text{atm}}$$

$$P_{\text{vac}} = P_{\text{atm}} - P_{\text{abs}} = -P_{\text{gage}}$$

3-2 Hydrostatic Forces on Submerged Plane Surfaces

On a plane surface, the hydrostatic forces form a system of parallel forces, and we often need to determine the *magnitude* of the force and its *points of location*, which is called **the center of the pressure**





$$
\begin{aligned}
F_R &= \int P \mathrm{d}A \\
&= P_0 A + \rho g \sin\theta \int y \mathrm{d}A
\end{aligned}
$$

$$
y_c = \frac{1}{A}\int y \mathrm{d}A
$$

$$
I_{xx,O} = \int y^2 \mathrm{d}A = I_{xx,C} + y_C^2 A
$$

and we ca get that

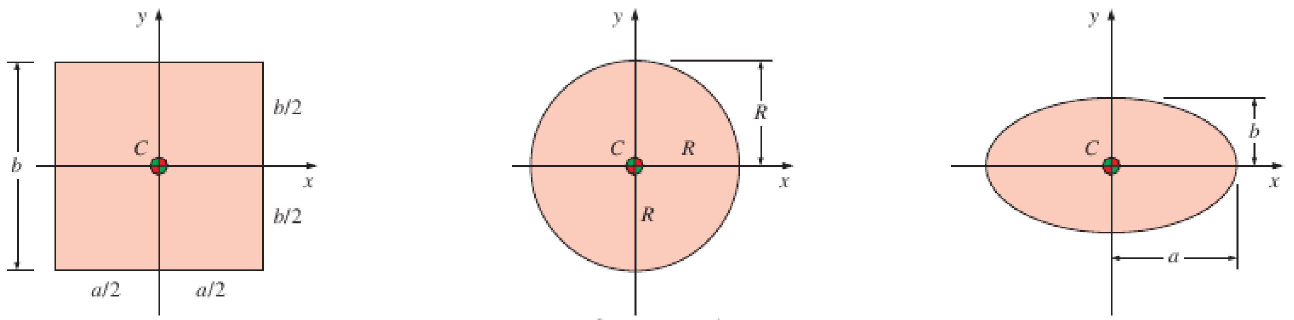
$$
F_R = (P_0 + \rho g y_c \sin\theta) A
$$

$$
\begin{aligned}
y_P F_R &= \int y P \mathrm{d}A \\
&= P_0 \int y \mathrm{d}A + \rho g \sin\theta \int y^2 \mathrm{d}A \\
&= P_0 A y_c + \rho g \sin\theta I_{xx,O} \\
&= P_0 A y_c + \rho g \sin\theta (I_{xx,C} + y_C^2 A)
\end{aligned}
$$

$$
y_P = y_C + \frac{I_{xx,C}}{[y_C + P_0/(\rho g \sin\theta)]A}
$$

if the atmosphere is ignored

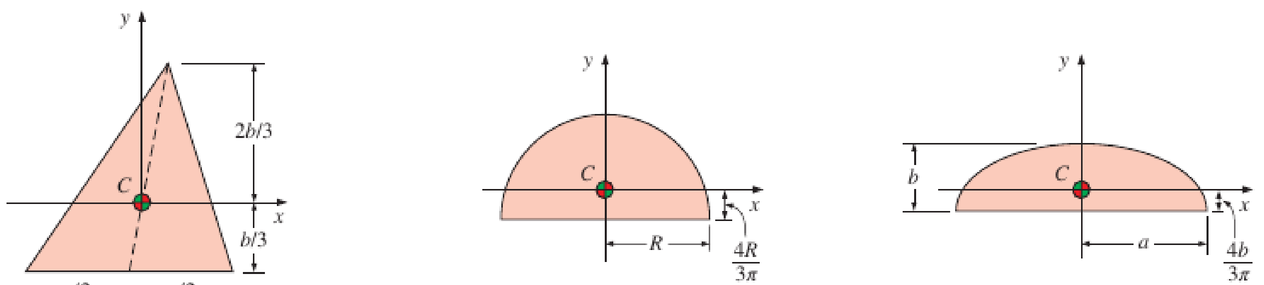
$$
y_P = y_C + \frac{I_{xx,C}}{y_C A}
$$



$A = ab$, $I_{xx,C} = ab^3/12$
(*a*) Rectangle

$A = \pi R^2$, $I_{xx,C} = \pi R^4/4$
(*b*) Circle

$A = \pi ab$, $I_{xx,C} = \pi ab^3/4$
(*c*) Ellipse



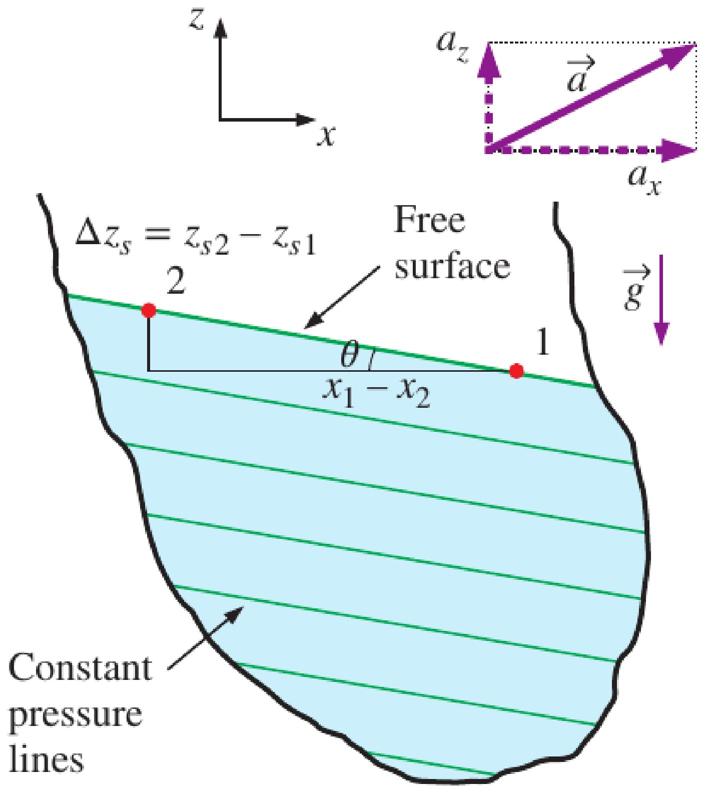
$A = ab/2$, $I_{xx,C} = ab^3/36$
(*d*) Triangle

$A = \pi R^2/2$, $I_{xx,C} = 0.109757R^4$
(*e*) Semicircle

$A = \pi ab/2$, $I_{xx,C} = 0.109757ab^3$
(*f*) Semiellipse

3-3 Fluids in Rigid-Body Motion

Acceleration on a Straight Path

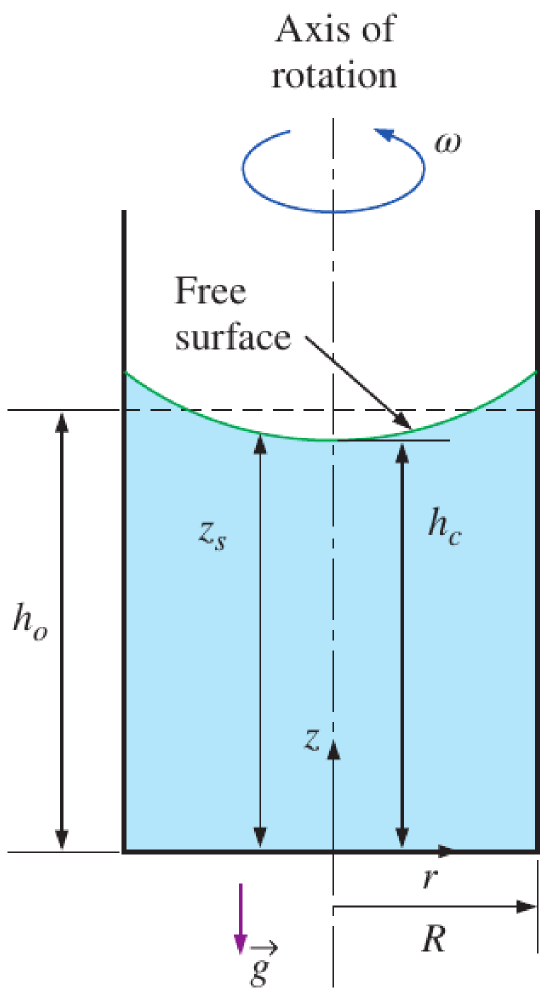


$$\text{Slope} = \frac{\mathrm{d}z}{\mathrm{d}x} = -\frac{a_x}{g + a_z} = -\tan\theta$$

and the pressure distribution is expressed as

$$P = P_0 - \rho a_x x - \rho(g + a_z)z$$

Rotation in a Cylindrical Container



$$z_s = \frac{\omega^2}{2g} r^2 + h_C$$

and the pressure is expressed as

$$P = P_0 + \frac{\rho\omega^2}{2} r^2 - \rho g z$$