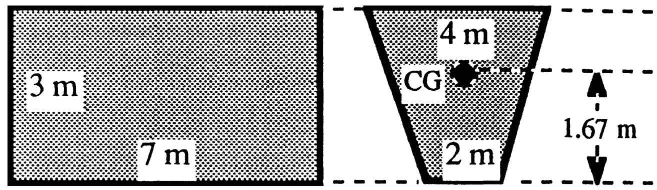

Solution: (a) The total volume of oil in the vat is (3 m)(7 m)(4 m + 2 m)/2 = 63 m^3. Therefore the weight of oil in the vat is

$$W = \gamma_{oil}(\text{Vol}) = (0.85)(9790\ \text{N/m}^3)(63\ \text{m}^3) = \mathbf{524,000\ N} \quad \textit{Ans.}\ \text{(a)}$$

(b) The force on the horizontal bottom surface of the vat is

$$F_{bottom} = \gamma_{oil} h_{CG} A_{bottom} = (0.85)(9790)(3\ \text{m})(2\ \text{m})(7\ \text{m}) = \mathbf{350,000\ N} \quad \textit{Ans.}\ \text{(b)}$$

Note that F is less than the total weight of oil—the student might explain why they differ? (c) I found in my statics book that the centroid of this trapezoid is 1.33 m below the surface, or 1.67 m above the bottom, as shown. Therefore the side-panel force is

$$F_{side} = \gamma_{oil} h_{CG} A_{side} = (0.85)(9790)(1.33\ \text{m})(9\ \text{m}^2) = \mathbf{100,000\ N} \quad \textit{Ans.}\ \text{(c)}$$

These are large forces. Big vats have to be strong!

2.51 Gate AB in Fig. P2.51 is 1.2 m long and 0.8 m into the paper. Neglecting atmospheric-pressure effects, compute the force F on the gate and its center of pressure position *X*.

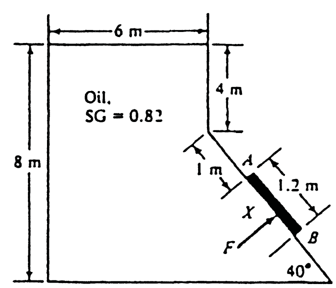

Fig. P2.51

Solution: The centroidal depth of the gate is

$$h_{CG} = 4.0 + (1.0 + 0.6)\sin 40° = 5.028\ \text{m},$$

$$\text{hence} \quad F_{AB} = \gamma_{oil} h_{CG} A_{gate} = (0.82 \times 9790)(5.028)(1.2 \times 0.8) = \mathbf{38750\ N} \quad \textit{Ans.}$$

The line of action of F is slightly below the centroid by the amount

$$y_{CP} = -\frac{I_{xx}\sin\theta}{h_{CG}A} = -\frac{(1/12)(0.8)(1.2)^3 \sin 40°}{(5.028)(1.2 \times 0.8)} = -0.0153\ \text{m}$$

Thus the position of the center of pressure is at $X = 0.6 + 0.0153 \approx \mathbf{0.615\ m}$ *Ans.*