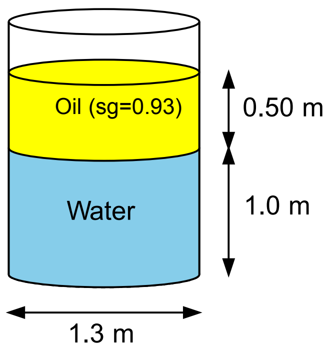
Module 2: Forces Due To Static Fluids (CIVL 318)

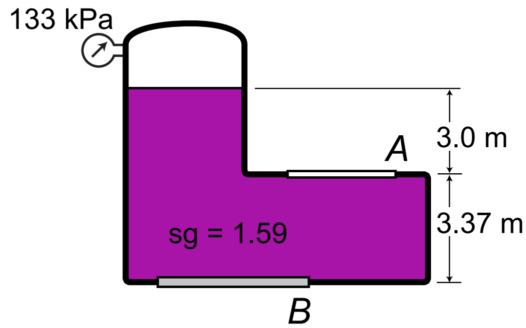
Pressure and forces on plane areas:	$P_{avg} = \gamma h_C$ $F_R = \gamma h_C A$
Centre of pressure for plane areas:	$L_p - L_c = \dfrac{I_c}{L_c A}$

Example 1:



Determine the force exerted by the oil and water upon the bottom plane surface of the barrel

Example 2:



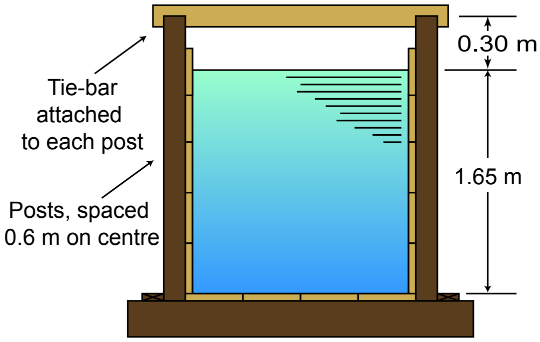
A pressurized tank contains liquid with sg$= 1.59$.
There are rectangular inspection hatches at A
(400 mm $\times$ 250 mm) and at B (500 mm $\times$ 750 mm).

Determine the force exerted by the fluid on the hatch at A.

Exercise 1:

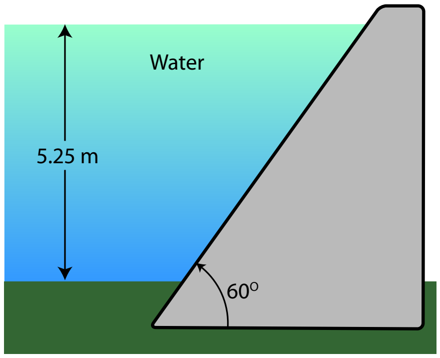
Determine the force exerted by the fluid on the hatch at B
for the pressurized tank in the previous example.

Example 3:



The tie-bars have cross-sectional dimension of 90mm $\times$ 90mm. Determine the normal stress in the tie-bars, and the bearing stress if the vertical posts are cut halfway into each tie-bar. (Assume a pinned connection at the bottom of the sidewalls and treat pressure as though the fluid is static.)

Example 4:



The wall has a rectangular plane area in contact with the water, is inclined at 60° to the horizontal and is 17 m long.

Determine the force exerted on the dam plane area by the water.

Example 5:

A vertical retaining wall supports water to a depth of 4.75 m. There is a rectangular hatch in the wall. The top of the hatch is at a depth of 1.25 m; the hatch is 2.25 m wide $\times$ 1.5 m high.

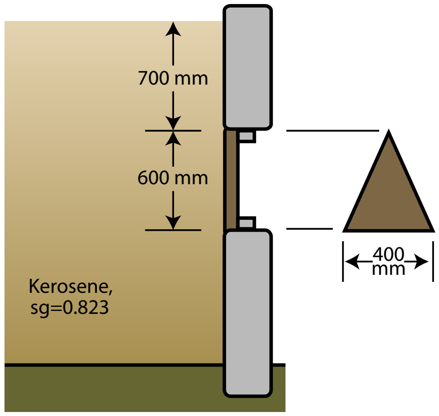
What is the magnitude of the force exerted upon the hatch by the water?

Exercise 2:

A vertical retaining wall supports water to a depth of 6.25 m. There is a rectangular hatch in the wall. The hatch has dimensions $3.75\,\mathrm{m}$ wide $\times$ $1.6\,\mathrm{m}$ height.

At what depth below the surface can the top of this hatch be placed if the maximum allowable force on the hatch is $128\,\mathrm{kN}$?

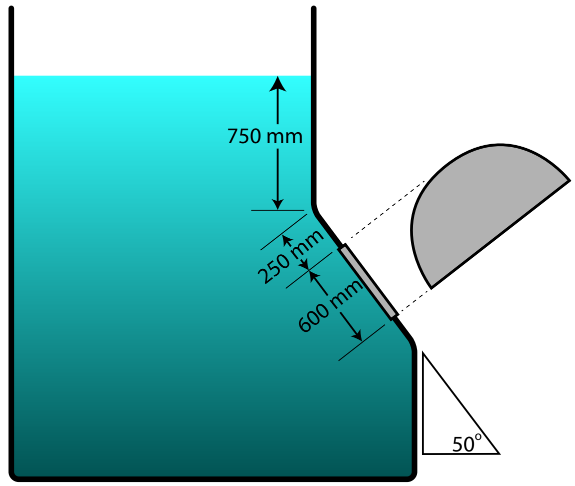
Example 6:



A tank containing kerosene (sg$=0.823$) has a triangular inspection hatch in a vertical sidewall. The hatch has a base of 400 mm and a height of 600 mm. The top of the hatch is located at a depth of 700 mm.

Determine the force exerted on the hatch by the kerosene.

Example 7:

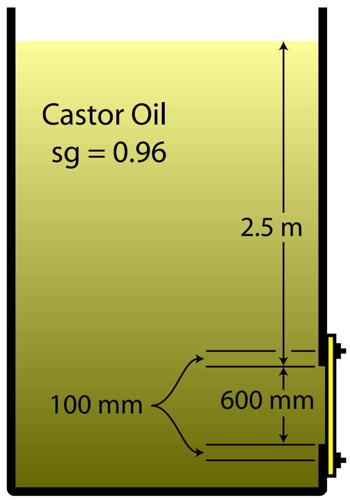


A water tank has a semi-circular inspection hatch, as illustrated.

Determine the force exerted on the hatch by the water.

(For a semi-circle, $\bar{y} = \dfrac{4r}{3\pi}$.)

Example 8:



A tank containing castor oil has a $1.0\,\text{m}$ wide $\times$ $600\,\text{mm}$ high rectangular inspection hatch.

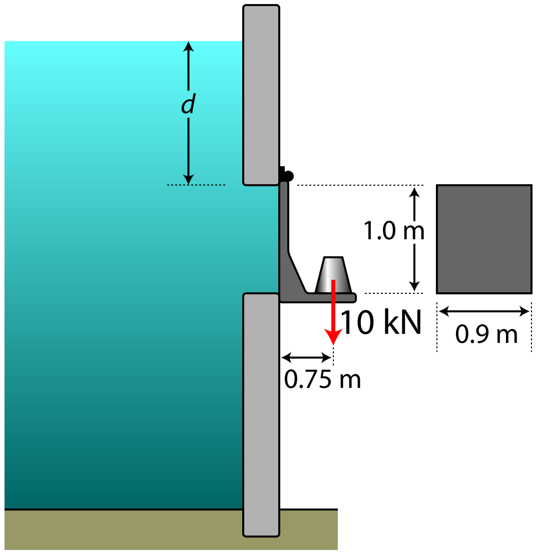
The top of the hatch is $2.5\,\text{m}$ below the surface of the castor oil. The hatch cover is attached to the tank by 8 bolts, four at the top of the hatch and four at the bottom.

The bolts are offset the from the hatch opening by $100\,\text{mm}$, as shown.

Calculate the tension in each of the top and in each of the bottom bolts.

(Assume that all the top bolts have the same tension and that all the bottom bolts have the same tension.)

Example 9:

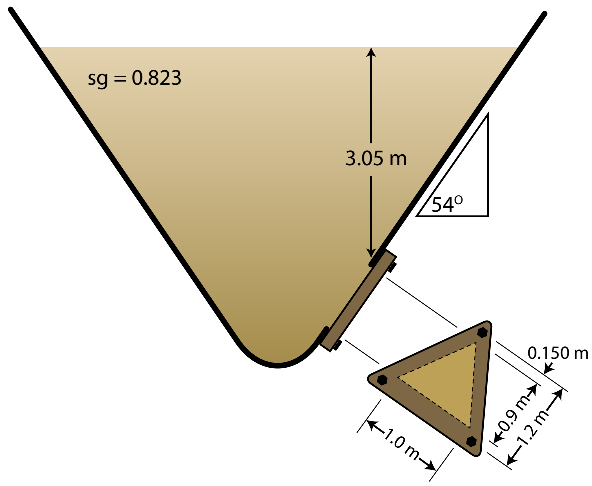


This is an example of a “self-levelling” gate. It is hinged along its top edge

When the water exceeds a certain height, the hydrostatic force on the gate is sufficient to open the gate. Water drains until the level allows the gate to close again.

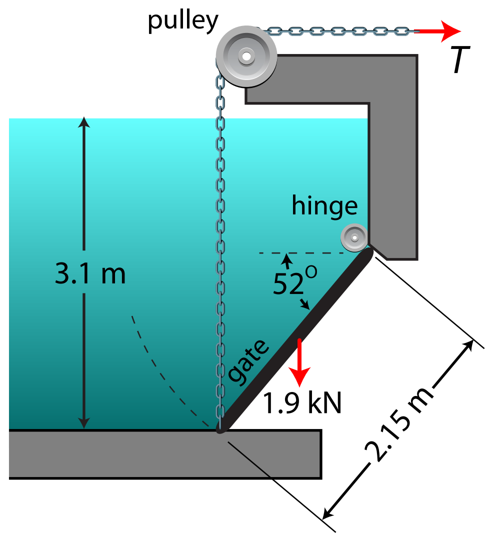
Find the value d for which the gate opens.

Example 10:



Determine the tension T in the upper bolt and tension S in each of the lower bolts.

Example 11:



A rectangular steel gate $(1.5\,\text{m} \times 2.15\,\text{m})$ is used to regulate the level of a water storage pond. The gate has a weight of $1.9\,\text{kN}$ which can be thought of as acting through the centre of the gate.

Determine the force T required to begin to open the gate when the pond has a depth of $3.1\,\text{m}$.