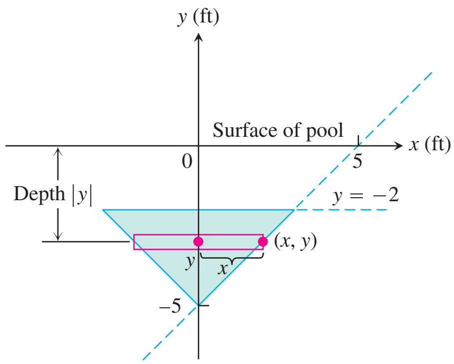
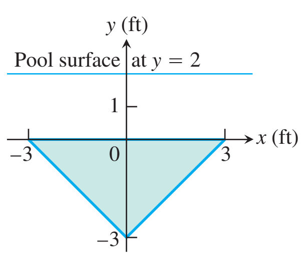
EXERCISES 6.7

The weight-densities of the fluids in the following exercises can be found in the table on page 456.

1. Triangular plate Calculate the fluid force on one side of the plate in Example 1 using the coordinate system shown here.



2. Triangular plate Calculate the fluid force on one side of the plate in Example 1 using the coordinate system shown here.



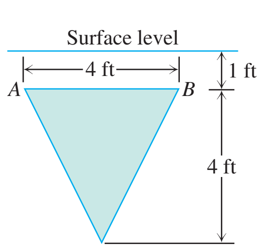
3. Lowered triangular plate The plate in Example 1 is lowered another 2 ft into the water. What is the fluid force on one side of the plate now?

4. Raised triangular plate The plate in Example 1 is raised to put its top edge at the surface of the pool. What is the fluid force on one side of the plate now?

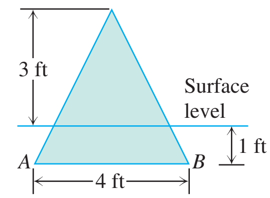
5. Triangular plate The isosceles triangular plate shown here is submerged vertically 1 ft below the surface of a freshwater lake.

a. Find the fluid force against one face of the plate.

b. What would be the fluid force on one side of the plate if the water were seawater instead of freshwater?



6. Rotated triangular plate The plate in Exercise 5 is revolved 180° about line AB so that part of the plate sticks out of the lake, as shown here. What force does the water exert on one face of the plate now?



7. New England Aquarium The viewing portion of the rectangular glass window in a typical fish tank at the New England Aquarium in Boston is 63 in. wide and runs from 0.5 in. below the water's surface to 33.5 in. below the surface. Find the fluid force against this portion of the window. The weight-density of seawater is 64 lb/ft^3. (In case you were wondering, the glass is $3/4$ in. thick and the tank walls extend 4 in. above the water to keep the fish from jumping out.)

8. Fish tank A horizontal rectangular freshwater fish tank with base 2 ft × 4 ft and height 2 ft (interior dimensions) is filled to within 2 in. of the top.

a. Find the fluid force against each side and end of the tank.

b. If the tank is sealed and stood on end (without spilling), so that one of the square ends is the base, what does that do to the fluid forces on the rectangular sides?

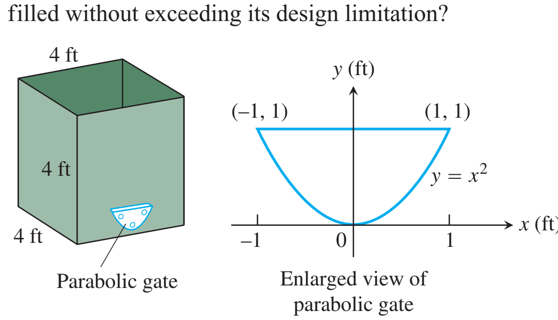
9. Semicircular plate A semicircular plate 2 ft in diameter sticks straight down into freshwater with the diameter along the surface. Find the force exerted by the water on one side of the plate.

10. Milk truck A tank truck hauls milk in a 6-ft-diameter horizontal right circular cylindrical tank. How much force does the milk exert on each end of the tank when the tank is half full?

11. The cubical metal tank shown here has a parabolic gate, held in place by bolts and designed to withstand a fluid force of 160 lb without rupturing. The liquid you plan to store has a weight-density of 50 lb/ft^3.

a. What is the fluid force on the gate when the liquid is 2 ft deep?

b. What is the maximum height to which the container can be filled without exceeding its design limitation?



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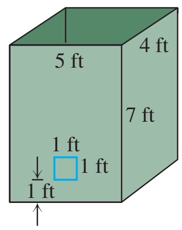
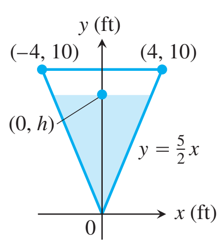
12. The rectangular tank shown here has a 1 ft × 1 ft square window 1 ft above the base. The window is designed to withstand a fluid force of 312 lb without cracking.

a. What fluid force will the window have to withstand if the tank is filled with water to a depth of 3 ft?

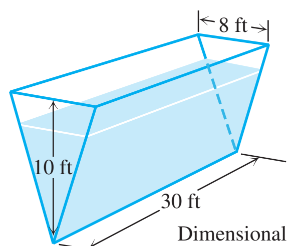
b. To what level can the tank be filled with water without exceeding the window's design limitation?



13. The end plates of the trough shown here were designed to withstand a fluid force of 6667 lb. How many cubic feet of water can the tank hold without exceeding this limitation? Round down to the nearest cubic foot.



End view of trough

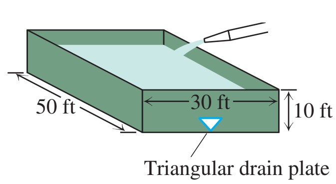


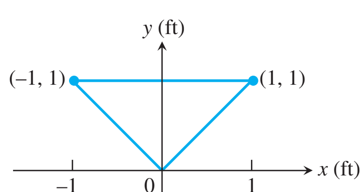
Dimensional view of trough

14. Water is running into the rectangular swimming pool shown here at the rate of 1000 ft^3/h.

a. Find the fluid force against the triangular drain plate after 9 h of filling.

b. The drain plate is designed to withstand a fluid force of 520 lb. How high can you fill the pool without exceeding this limitation?



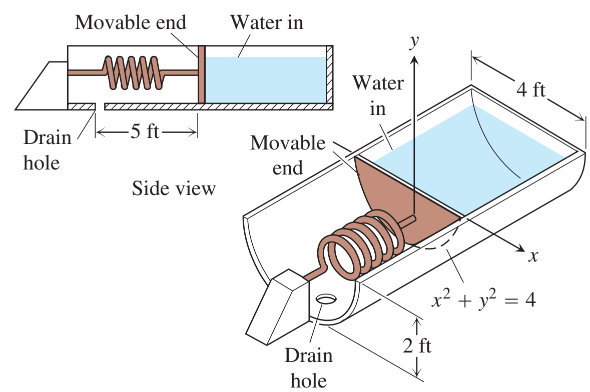


Enlarged view of drain plate

15. A vertical rectangular plate a units long by b units wide is submerged in a fluid of weight-density w with its long edges parallel to the fluid's surface. Find the average value of the pressure along the vertical dimension of the plate. Explain your answer.

16. (*Continuation of Exercise 15.*) Show that the force exerted by the fluid on one side of the plate is the average value of the pressure (found in Exercise 15) times the area of the plate.

17. Water pours into the tank here at the rate of 4 ft^3/min. The tank's cross-sections are 4-ft-diameter semicircles. One end of the tank is movable, but moving it to increase the volume compresses a spring. The spring constant is $k = 100$ lb/ft. If the end of the tank moves 5 ft against the spring, the water will drain out of a safety hole in the bottom at the rate of 5 ft^3/min. Will the movable end reach the hole before the tank overflows?



18. Watering trough The vertical ends of a watering trough are squares 3 ft on a side.

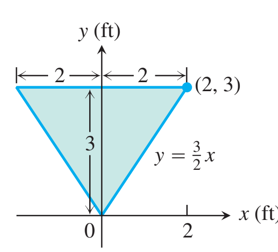
a. Find the fluid force against the ends when the trough is full.

b. How many inches do you have to lower the water level in the trough to reduce the fluid force by 25%?

19. Milk carton A rectangular milk carton measures 3.75 in. × 3.75 in. at the base and is 7.75 in. tall. Find the force of the milk on one side when the carton is full.

20. Olive oil can A standard olive oil can measures 5.75 in. × 3.5 in. at the base and is 10 in. tall. Find the fluid force against the base and each side when the can is full.

21. Watering trough The vertical ends of a watering trough are isosceles triangles like the one shown here (dimensions in feet).



a. Find the fluid force against the ends when the trough is full.

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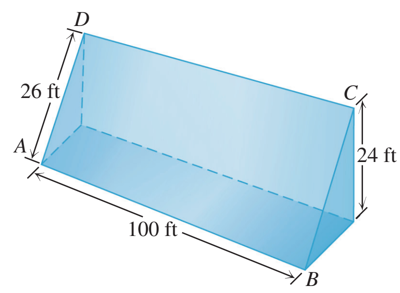
b. How many inches do you have to lower the water level in the trough to cut the fluid force on the ends in half? (Answer to the nearest half-inch.)

c. Does it matter how long the trough is? Give reasons for your answer.

22. The face of a dam is a rectangle, $ABCD$, of dimensions $AB = CD = 100$ ft, $AD = BC = 26$ ft. Instead of being vertical, the plane $ABCD$ is inclined as indicated in the accompanying figure, so that the top of the dam is 24 ft higher than the bottom. Find the force due to water pressure on the dam when the surface of the water is level with the top of the dam.



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