

Set 2: Static Fluid Pressure

6. A water line supplies water from a water tower to a residential area. The line is buried 3.5 m below the ground, and the water level in the tower is maintained at a constant 18.9 m above the ground. There is air space above the water in the tower. If the air pressure is 110 kPa, find the gauge pressure AND the total pressure of the water in the line.
7. A 1.00-m-tall graduated cylinder is filled with mercury, which has a specific gravity of 13.6. The air pressure is 97 kPa. Determine the total pressure at the bottom of the cylinder.
- 8a. A dam is to be built to generate electrical power. The dam will result in the formation of a freshwater lake that could be up to 370 m deep. If the air pressure is assumed to be 120 kPa, what horizontal pressure must be able to be resisted by the bottom of the dam?
- 8b. From Q8a...What percentage of the horizontal pressure at the bottom of the dam is due to the atmosphere?
- 9a. A flat-bottomed barge has the bottom dimensions 12.8 m x 32.8 m. If the floating barge sinks 2.59 m into the Illinois River when loaded, what gauge pressure is exerted by the water to support the barge? (Here, because the air pressure acts downward on the top of the barge and – through the water – upward on the bottom of the barge, the air pressure cancels itself from the calculation and can therefore be neglected.)
- 9b. Based on your answer to Q9a, what is the weight of the loaded barge?
10. If the air pressure is 104 kPa, how tall must a column of water be so that the air pressure is 10.0% of the total pressure at the bottom of the column?

ANSWERS: 6. 220 kPa; 330 kPa 7. 230. kPa 8a. 3.75×10^6 Pa 9a. 25,400 Pa 10. 95.4 m
8b. 3.20% 9b. 1.07×10^7 N

Set 3: Buoyancy and Apparent Weight

11a. A 5.61 kg log is afloat on the Mississippi River. What volume of the log is submerged under water?

11b. When the log from Q11a is placed in an unknown liquid, it floats, displacing $8.32 \times 10^{-3} \text{ m}^3$ of the liquid. Find the liquid's specific gravity.

12a. Gold has a density of $19,300 \text{ kg/m}^3$. What is the buoyant force on a solid gold cylinder with radius 1.75 cm and height 4.12 cm completely submerged in seawater? Seawater's specific gravity is 1.03.

12b. Find the apparent weight in seawater of the gold cylinder from Q12a.

12c. What would the gold cylinder's apparent weight be if it were completely submerged in mercury, which has a specific gravity of 13.6?

13. A canoe has total volume of 1.33 m^3 . When the canoe is outfitted with camping equipment and canoers and is pushed out into the river, it displaces a volume of 0.559 m^3 . What is the overall density of the canoe?

ANSWERS:

11a. $5.61 \times 10^{-3} \text{ m}^3$
11b. 0.674

12a. 0.401 N
12b. 7.10 N
12c. 2.21 N

13. $420. \text{ kg/m}^3$

Set 4: Hydraulics and the Continuity Equation

- 14a. An auto repair shop has a hydraulic lift to elevate cars. A 1640 kg car is placed above a piston having an area of 0.622 m^2 , while the other piston has an area of 0.0655 m^2 . What force must be applied to the smaller piston in order to raise the car?
- 14b. If the car in Q14a must be elevated a distance of 2.06 m, through what effective distance must the smaller piston be pushed?
15. A barber's chair is a hydraulic lift filled with oil. A 97.5 kg customer sits in the 27.2 kg chair, which has a piston below it of area 121 cm^2 . The barber uses a lever to apply a 63.6 N force to the smaller piston. Find the area of the smaller piston.
16. A compression machine for testing concrete cylinders operates on the principles of hydraulics. If a concrete cylinder that is 0.152 m in diameter is crushed by a force of $4.84 \times 10^5 \text{ N}$, find the pressure in the fluid that connects the two pistons of the machine.
17. A level pipe of diameter 0.078 m carries water under pressure at a speed of 0.67 m/s. What does the speed of the water become when the pipe's diameter changes to 0.056 m?
18. A pressurized water pipe in a factory carries water at the rate of 60.4 kg/s. If water travels through the pipe at 1.38 m/s, what is the diameter of the pipe?

ANSWERS:

14a. 1690 N
14b. 19.6 m

15. 6.29 cm^2
16. $2.67 \times 10^7 \text{ Pa}$

17. 1.3 m/s
18. 0.236 m

Set 5: The Bernoulli Equation

19. A level pipe carries water under pressure. At one section of the pipe, the pressure is 14,800 Pa and the water's speed is 2.87 m/s. In an adjacent section, the pressure has increased to 17,300 Pa. Find the water's speed in the adjacent section of pipe.
20. A pipe in a factory carries pressurized water that serves as a coolant in the manufacturing process. At one section of the pipe, the water's pressure is 28,200 Pa and the water's speed is 1.73 m/s. Then, the pipe bends and the water drops 2.16 m into another section of the pipe, where its speed is measured to be 7.21 m/s. Find the pressure in the lower section of pipe.
21. A level pipe carries water under pressure. At point "A" – which has a cross-sectional area of 0.0134 m^2 – the water pressure is 12,500 Pa and the water speed is 2.11 m/s. At point "B," the pressure has increased to 13,900 Pa. What is the area at point B?
22. A pipe in a factory runs vertically, carrying pressurized water away from the pumps on the ground up to a higher elevation. At point "A" – which has a cross-sectional area of 0.00936 m^2 – the water pressure is 55,600 Pa. At point "B," which is at an elevation 2.15 m higher than point A, the pressure is 33,500 Pa and the water speed is 2.35 m/s. What is the cross-sectional area at point B?

ANSWERS: 19. 1.80 m/s

20. 24,900 Pa

21. 0.0219 m^2

22. 0.00745 m^2

Set 6: Review Problems

28. A leisure swimmer wears a life jacket as she floats in a freshwater lake. If the floating mass totals 63.0 kg, find the volume that is below the water's surface.
29. A ferry boat is 5.30 m wide and 9.00 m long. When a van drives onto it to be ferried to the other side of the river, the boat sinks 4.20 cm further into the water. Find the weight of the van.
30. A 73 kg diver is in a 128 kg steel cage to observe sharks below the ocean surface. The cage is supported by a cable anchored to a ship. If the density of seawater is 1030 kg/m^3 , that of steel is 7850 kg/m^3 , and that of the diver is 1400 kg/m^3 , find the tension in the cable. The cable's volume is negligible.
31. A level pipe carries water under pressure. At point "A" – which has a cross-sectional area of 0.0205 m^2 – the water pressure is 14,700 Pa and the water speed is 4.13 m/s. At point "B," the pressure has increased to 18,300 Pa. What is the pipe's diameter at point B?
32. A pipe in a factory runs vertically, carrying pressurized water from pumps on the roof to a lower elevation. At point "A," the pressure is 28,100 Pa and the speed is 3.42 m/s. At point "B," which is 3.84 m lower than point A, the pressure is 68,400 Pa. The pipe diameter at B is 0.346 m. Find the pipe diameter at A.

ANSWERS: 28. 0.0630 m^3 29. $1.97 \times 10^4 \text{ N}$ 30. 1300 N 31. 0.185 m 32. 0.298 m