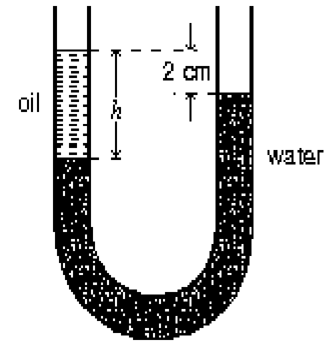
1. The density of water is 1.0 g/cm^3. If h = 20 cm, the density of the oil in the left column of the U-tube shown below is:



A) 0.20 g/cm^3
B) 0.90 g/cm^3
C) 1.0 g/cm^3
D) 1.3 g/cm^3
E) 5.0 g/cm^3

2. One piston in a hydraulic lift has an area that is twice the area of the other. When the pressure at the smaller piston is increased by Δp the pressure at the larger piston:

A) increases by $2\Delta p$
B) increases by $\Delta p/2$
C) increases by Δp
D) increases by $4\Delta p$
E) does not change

3. A boat floating in fresh water displaces 16,000 N of water. How many newtons of salt water would it displace if it floats in salt water of specific gravity 1.10?

A) 12,800 N
B) 14,400 N
C) 16,000 N
D) 17,600 N
E) 19,200 N

4. An object hangs from a spring balance. The balance indicates 30 N in air, 20 N when the object is submerged in water. What does the balance indicate when the object is submerged in liquid with a density that is half of water?

A) 20 N
B) 25 N
C) 30 N
D) 35 N
E) 40 N

5. The dimensions of a wooden raft (density = 150 kg/m^3) are 3.0 m × 3.0 m × 1.0 m. What maximum load can it carry in sea water (density =1020 kg/m^3)?

A) 1350 kg
B) 7830 kg
C) 9200 kg
D) 19,500 kg
E) 24,300 kg

6. A lawn sprinkler is made of a 1.0 cm diameter garden hose with one end closed and 25 holes, each with a diameter of 0.050 cm, cut near the closed end. If water flows at 2.0 m/s in the hose, the speed of the water leaving a hole is:

A) 2.0 m/s
B) 32 m/s
C) 40 m/s
D) 600 m/s
E) 800 m/s

7. Water is streaming downward from a faucet opening with an area of 3.0×10^{-5} m^2. It leaves the faucet with a speed of 5.0 m/s. The cross sectional area of the stream 0.50 m below the faucet is:

A) 1.5×10^{-5} m^2
B) 2.0×10^{-5} m^2
C) 2.5×10^{-5} m^2
D) 3.0×10^{-5} m^2
E) 3.5×10^{-5} m^2

8. A fluid of density 9.1×10^2 kg/m^3 is flowing through a tube at a speed of 5.3 m/s. What is the kinetic energy density of the fluid?

A) cannot be calculated without knowing the pressure
B) cannot be calculated without knowing the elevation
C) 4.8×10^3 J/m^3
D) 1.3×10^4 J/m^3
E) 2.5×10^6 J/m^3

9. Water (density = 1.0×10^3 kg/m^3) flows downhill through a pipe of diameter 1.5 cm. Its speed at the top of the hill is 7.2 m/s. If the hill is 9.5 m high, what is the gravitational potential energy density of the water at the top of the hill relative to the bottom?

A) cannot be calculated without knowing the pressure
B) 120 J/m^3
C) 7.2 x 10^3 J/m^3
D) 9.5 x 10^3 J/m^3
E) 9.3 x 10^4 J/m^3

10. Water (density = 1.0×10^3 kg/m^3) flows through a horizontal tapered pipe. At the wide end its speed is 4.0 m/s. The difference in pressure between the two ends is 4.5×10^3 Pa. The speed of the water at the narrow end is:

A) 2.6 m/s
B) 3.2 m/s
C) 4.0 m/s
D) 4.5 m/s
E) 5.0 m/s

11. A large tank filled with water has two holes in the bottom, one with twice the radius of the other. In steady flow the speed of water leaving the larger hole is ________ the speed of the water leaving the smaller.

A) twice
B) four times
C) half
D) one-fourth
E) the same as

12. Some species of whales can dive to depths of one kilometer. What is the total pressure they experience at this depth? (ρ_{sea} = 1 020 kg/m^3 and 1.01 × 10^5 N/m^2 = 1 ATM.)

a. 9.00 ATM
b. 90.0 ATM
c. 100 ATM
d. 111 ATM
e. 130 ATM

13. Water is flowing at 4.0 m/s in a circular pipe. If the diameter of the pipe decreases to 1/2 its former value, what is the velocity of the water downstream?

a. 1.0 m/s
b. 2.0 m/s
c. 8.0 m/s
d. 16 m/s
e. 4.0 m/s

14. What is the net force inward acting on a spherical bathysphere of diameter 2.00 m at an ocean depth of 1 000 m? (The pressure inside the bathysphere is, hopefully, 1 ATM.) $\rho_{\text{(sea water)}}$ = 1.02 × 10^3 kg/m^3.

a. 1.26×10^4 N
b. 1.26×10^6 N
c. 1.26×10^8 N
d. 1.26×10^{10} N
e. 1.26×10^2 N

15. How much power is theoretically available from a mass flow of 1 000 kg/s of water when it falls a vertical distance of 100 meters?

a. 980 kW
b. 98 kW
c. 4 900 W
d. 980 W
e. 9 600 W

16. A cubical box, 5.00 cm on each side, is immersed in a fluid. The gauge pressure at the top surface of the box is 594 Pa and the gauge pressure on the bottom surface is 1133 Pa. What is the density of the fluid?

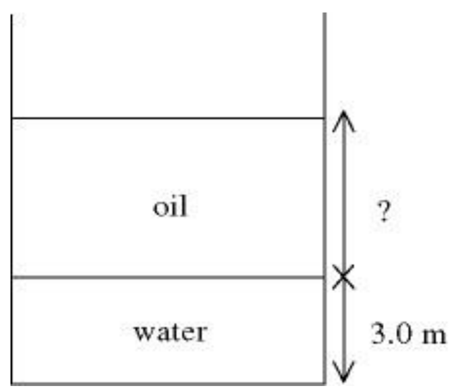
A) 1000 kg/m^3
B) 1100 kg/m^3
C) 1220 kg/m^3
D) 2340 kg/m^3
E) 12,000 kg/m^3

17. The weight of a car of mass 1.20×10^3 kg is supported equally by the four tires, which are inflated to the same gauge pressure. What gauge pressure in the tires is required so the area of contact of each tire with the road is 1.00×10^2 cm^2? (1 atm = 1.01×10^5 Pa.)

A) 11.6×10^5 Pa
B) 11.6×10^4 Pa
C) 2.94×10^5 Pa
D) 2.94×10^4 Pa
E) 2.94×10^3 Pa

18. In the figure, an open tank contains a layer of oil floating on top of a layer of water (of density 1000 kg/m^3) that is 3.0 m thick, as shown. What must be the thickness of the oil layer if the gauge pressure at the bottom of the tank is to be 5.0×10^4 Pa? The density of the oil is 510 kg/m^3.

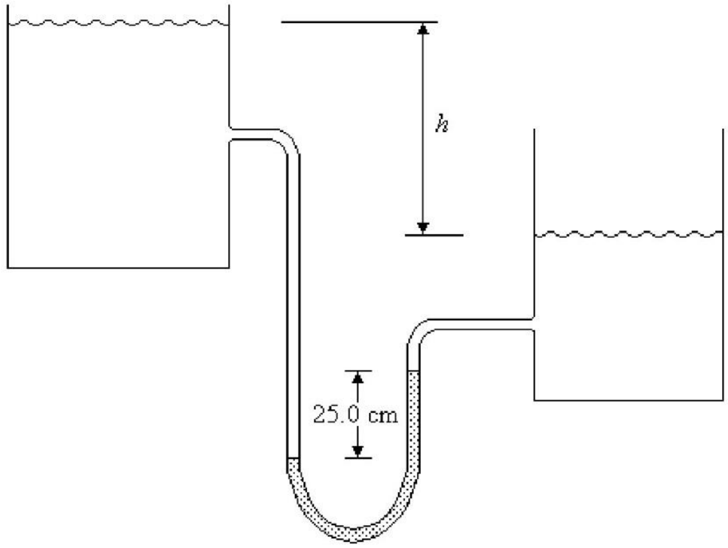
Answer: 4.12 m



19. A board that is 20.0 cm wide, 5.00 cm thick, and 3.00 m long has a density 350 kg/m^3. The board is floating partially submerged in water of density 1000 kg/m^3. What fraction of the volume of the board is above the surface of the water?

A) 0.350
B) 0.650
C) zero
D) 0.200
E) The answer depends on which edge of the board is vertical.

20. The two water reservoirs shown in the figure are open to the atmosphere, and the water has density 1000 kg/m^3. The manometer contains incompressible mercury with a density of 13,600 kg/m^3. What is the difference in elevation *h* if the manometer reading is 25.0 cm, as shown?



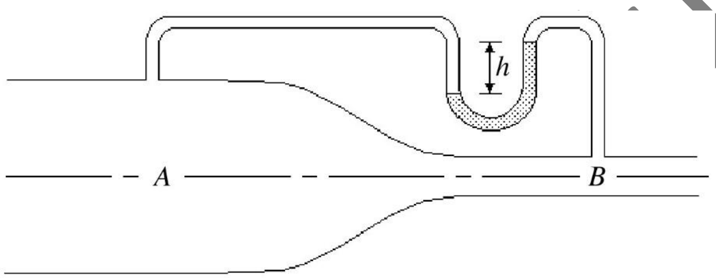
A) 1.58 m
B) 4.20 m
C) 3.75 m
D) 3.40 m
E) 3.15 m

21. A person who weighs 550 N empties her lungs as much as possible and is then completely immersed in water (of density 1000 kg/m^3) while suspended from a harness. Her apparent weight is now 21.2 N. What is her density?
A) 1050 kg/m^3
B) 1040 kg/m^3
C) 1030 kg/m^3
D) 960 kg/m^3
E) 56.1 kg/m^3

22. A 7.8-kg solid sphere, made of metal whose density is 2500 kg/m^3, is suspended by a cord. When the sphere is immersed in water (of density 1000 kg/m^3), what is the tension in the cord?
A) 46 N
B) 61 N
C) 76 N
D) 92 N
E) 110 N

23. Water flowing through a pipe suddenly comes to a section of pipe where the pipe diameter decreases to 86% of its previous value. If the speed of the water in the larger section of the pipe was 36m/s, what is its speed in this smaller section?
A) 49 m/s
B) 42 m/s
C) 31 m/s
D) 27 m/s

24. Water flows in the horizontal pipe shown in the figure. At point *A* the area is 25.0 cm^2 and the speed of the water is 2.00 m/s. At *B* the area is 16.0 cm^2. The fluid in the manometer is mercury, which has a density of 13,600 kg/m^3. We can treat water as an ideal fluid having a density of 1000 kg/m^3. What is the manometer reading *h*?



A) 0.546 cm
B) 1.31 cm
C) 2.81 cm
D) 2.16 cm
E) 3.36 cm

25. A bucket resting on the floor of an elevator contains an incompressible fluid of density ρ. When the elevator has an upward acceleration *a* the pressure difference between two points in a fluid separated by a vertical distance Δh, is given by:
A) $\rho a \Delta h$
B) $\rho g \Delta h$
C) $\rho(g + a)\Delta h$
D) $\rho(g - a)\Delta h$
E) $\rho g a \Delta h$

26. A bucket resting on the floor of an elevator contains an incompressible fluid of density ρ. When the elevator has a downward acceleration of magnitude *a* the pressure difference between two points in a fluid, separated by a vertical distance Δh, is given by:
A) $\rho a \Delta h$
B) $\rho g \Delta h$
C) $\rho(g + a)\Delta h$
D) $\rho(g - a)\Delta h$
E) $\rho g a \Delta h$

27. A block of wood weighs 160 N and has a specific gravity of 0.60. To sink it in fresh water requires an additional downward force of:
A) 54 N
B) 64 N
C) 96 N
D) 107 N
E) 240 N

28. One end of a cylindrical pipe has a radius of 1.5 cm. Water (density = 1.0×10^3 kg/m^3) streams steadily out at 7.0 m/s. The volume flow rate is:
A) 4.9×10^{-3} m^3/s
B) 2.5 m^3/s
C) 4.9 m^3/s
D) 7.0 m^3/s
E) 48 m^3/s

29. One end of a cylindrical pipe has a radius of 1.5 cm. Water (density = 1.0×10^3 kg/m^3) streams steadily out at 7.0 m/s. The rate at which mass is leaving the pipe is:
A) 2.5 kg/s
B) 4.9 kg/s
C) 7.0 kg/s
D) 48 kg/s
E) 7.0×10^3 kg/s

30. A water line enters a house 2.0 m below ground. A smaller diameter pipe carries water to a faucet 5.0 m above ground, on the second floor. Water flows at 2.0 m/s in the main line and at 7.0 m/s on the second floor. Take the density of water to be 1.0×10^3 kg/m^3. The pressure in the main line is 2.0×10^5 Pa; then the difference in pressure between the main line and the second floor is:
A) 6.9×10^4 Pa with the main line at the higher pressure
B) 2.3×10^4 Pa with the main line at the higher pressure
C) 6.9×10^4 Pa with the main line at the lower pressure
D) 2.3×10^4 Pa with the main line at the lower pressure
E) 9.1×10^4 Pa with the main line at the higher pressure

31. A 6.1-kg solid sphere, made of metal whose density is 2600 kg/ m^3, is suspended by a cord. When the sphere is immersed in a liquid of unknown density, the tension in the cord is 26 N. Find the density of the liquid.
A) 1470 kg/m^3
B) 1400 kg/m^3
C) 1300 kg/m^3
D) 1200 kg/m^3
E) 1100 kg/m^3

32. An empty bottle has an inner volume of 1.31×10^{-4} m3. It has a mass of 112 g when filled with air, and it displaces 1.63×10^{-4} m3 of water when fully submerged. What volume of mercury (ρHg = 13.6×10^{-3} kg/m3) must be added to the empty bottle so that it will just submerge?

a. 3.75 cm3
b. 12.0 cm3
c. 101 cm3
d. 147 cm3
e. 237 cm3

33. An iron block of density ρ_{Fe} and of volume l^3 is immersed in a fluid of density ρ_{fluid}. The block hangs from a scale which reads W as the weight. The top of the block is a height h below the surface of the fluid. The correct equation for the reading of the scale is

a. $W = (\rho_{Fe} - \rho_{fluid})ghl^2$.
b. $W = (\rho_{fluid} - \rho_{Fe})gl^3$.
c. $W = (\rho_{Fe} - \rho_{fluid})gl^3$.
d. $W = (\rho_{Fe} + \rho_{fluid})ghl^2$.
e. $W = (\rho_{Fe} + \rho_{fluid})gl^3$.