

Seminary exercise Nr. 8

Fluid mechanics

1. What fraction of the volume of an iceberg (density 917 kg m^{-3}) would be visible if the iceberg floats in the ocean (salty water, density 1024 kg m^{-3}) and in a river (fresh water, density 1000 kg m^{-3})?
2. An iron anchor of density 7870 kg m^{-3} appears to be 200 N lighter in water than in air. What is the volume of the anchor? How much does it weight in air?
3. At a depth of 10.9 km , the Challenger Deep in the Marianas Trench of the Pacific Ocean is the deepest site in any ocean. Yet, in 1960, Donald Walsh and Jacques Piccard reached the Challenger Deep in the bathyscaph Trieste. Assuming that seawater has a uniform density of 1024 kg m^{-3} , calculate the hydrostatic pressure that the Trieste had to withstand.
4. Calculate the hydrostatic difference in blood pressure between the brain and the foot in a person of height 1.83 m . The density of blood is 1060 kg m^{-3} .
5. A large aquarium of height 5 m is filled with fresh water to a depth of 2 m . The floor of the aquarium consists of a thick plastic 8 m wide. By how much does the total force on the floor increase if the aquarium is next filled to a depth of 4 m ?
6. Define the continuity equation for compressible and incompressible fluid. Determine the physical units of flux in both cases.
7. A garden hose with an internal diameter of 1.9 cm is connected to a (stationary) lawn sprinkler that consists merely of a container with 24 holes, each 0.13 cm in diameter. If the water in the hose has a speed of 0.91 m s^{-1} , at what speed does it leave the sprinkler holes?
8. The aorta is the principal blood vessel through which blood leaves the heart in order to circulate around the body. Calculate the average speed of the blood in the aorta if the flow rate is 5 L min^{-1} . The aorta has a radius of 10 mm . The speed of blood in the capillaries is about 0.33 mm s^{-1} . The average diameter of a capillary is $8 \mu\text{m}$. Calculate the approximate number of capillaries in the blood circulatory system.
9. Ethanol of density $\rho=791 \text{ kg m}^{-3}$ flows smoothly through a horizontal pipe which changes cross-sectional area from $A_1=1.23 \cdot 10^{-3} \text{ m}^2$ to $A_2=A_1/2$. The pressure difference between the wide and narrow sections of the pipe is 4120 Pa . What is the volume flow rate of ethanol?
10. In the old West, a desperado fires a bullet into an open water tank, creating a hole at a distance h below the water surface. What is the initial speed of the water exiting the tank?
11. A pitot tube on a high-altitude aircraft measures a differential pressure of 180 Pa . What is the airspeed of the aircraft if the density of the air is 0.031 kg m^{-3} ?
12. A cylindrical tank with a diameter $D=2 \text{ m}$ is filled with water to a height $H=40 \text{ cm}$. A hole of cross-sectional area $a=6.5 \text{ cm}^2$ in the bottom of the tank allows water to drain out. How long does it take to drain the whole tank?