Fluid Mechanics Answer Key

Problem 1: Will a ball as massive as the cruise ship sink or float? Explain your answer.

Solution: The ball will sink since it is denser than water.

Problem 2: Find the volume of the solid aluminum block that weighs 120 N in air. Note that the density of the aluminum is equal to 2,710 kg/m^3.

Solution: We know that the block weighs 120 N. Calculating for its mass, we have

$$m = w/g$$

$$m = 120\ N/9.8\ m/s^2$$

$$m = 12.24\ kg$$

To find the volume,

$$v = m/\rho$$

$$v = 12.24\ kg/2{,}710\ kg/m^3$$

$$\mathbf{v = 0.0045\ m^3}$$

Problem 3: Passengers attempt to escape from a damaged ship 15 m below the surface. Determine the force they must apply to push out a 0.88 m^2 hatch at that depth. Note that the density of the ocean water is equal to 1025 kg/m^3.

Solution: We know that p = F/A, hence, F = pA. We also know that the pressure in the liquid is ρgh. Hence,

$$F = \rho ghA$$

$$F = (1025\ kg/m^3)(9.8\ m/s^2)(15\ m)(0.88\ m^2)$$

$$\mathbf{F = 132594\ N}$$

Problem 4: What is the density of a 1.5 m^3 ingot that has a buoyant force of 143 N?

Solution: We know that B **=** ρgv. Calculating for the density, we have

$$\rho = B/gv$$

Substituting the values, we will get

$$\rho = 143\ N/(9.8\ m/s^2)(1.5\ m^3)$$

$$\mathbf{\rho = 9.73\ kg/m^3}$$

Problem 5: Water flows through a cylindrical pipe with a radius of 4.0 cm with a speed of 8.0 cm/s. It then enters a smaller pipe of radius 2.0 cm. Find the speed of the water as it flows through the smaller pipe. The height of the pipe is 15 cm.

Solution: We are given the following quantities:

$r_1 = 4.0$ cm, $r_2 = 2.0$ cm, $v_1 = 8.0$ cm/s

We are looking for v_2. To find v_2, we must use the formula

$$v_2 = A_1v_1/A_2$$

The area of the pipe is equal to πr^2. Calculating for A_1 and A_2,

$$A_1 = \pi(4.0\ cm)^2 = 50.3\ cm^2$$

$$A_2 = \pi(2.0\ cm)^2 = 12.6\ cm^2$$

Calculating for v_2,

$$v_2 = (50.3\ cm^2)(8.0\ cm/s)/12.6\ cm^2$$

$$\mathbf{v_2 = 31.9\ cm/s}$$