5. *Suppose you have a coffee mug with a circular cross section and vertical sides (uniform radius). What is its inside radius if it holds 375 g of coffee when filled to a depth of 7.50 cm? Assume coffee has the same density as water.*

Solution

$$m = \rho V = \rho\left(\pi R^2 h\right) \Rightarrow R = \left(\frac{m}{\rho \pi h}\right)^{1/2} = \left[\frac{375\ \text{g}}{\left(1.00\ \text{g/cm}^3\right)(\pi)(7.50\ \text{cm})}\right]^{1/2} = \underline{3.99\ \text{cm}}$$

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9. *What is the density of 18.0-karat gold that is a mixture of 18 parts gold, 5 parts silver, and 1 part copper? (These values are parts by mass, not volume.) Assume that this is a simple mixture having an average density equal to the weighted densities of its constituents.*

Solution

	$m(\text{g})$	$\rho(\text{g/cm}^3)$	$V = \frac{m}{\rho}(\text{cm}^3)$
gold	18.0	19.32	0.9317
silver	5.00	10.49	0.4766
copper	1.00	8.8	0.1136
Total	<u>24.0</u>		<u>1.5219</u>

$$\rho_{\text{tot}} = \frac{24.0\ \text{g}}{1.5219\ \text{cm}^3} = \underline{15.8\ \text{g/cm}^3}$$

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11. *As a woman walks, her entire weight is momentarily placed on one heel of her high-heeled shoes. Calculate the pressure exerted on the floor by the heel if it has an area of $1.50\ \text{cm}^2$ and the woman's mass is 55.0 kg. Express the pressure in Pa. (In the early days of commercial flight, women were not allowed to wear high-heeled shoes because aircraft floors were too thin to withstand such large pressures.)*

Solution

$$P = \frac{F}{A} = \frac{mg}{A} \qquad \left(1.50\ \text{cm}^2 = 1.50 \times 0^{-4}\ \text{m}^2\right)$$

$$P = \frac{(55.0\ \text{kg})\left(9.80\ \text{m/s}^2\right)}{1.50 \times 10^{-4}\ \text{m}^2} = \underline{3.59 \times 10^6\ \text{N/m}^2}$$

$$= 3.59 \times 10^6\ \text{N/m}^2 \times \frac{1\ \text{lb}}{4.448\ \text{N}} \times \frac{6.452 \times 10^{-4}\ \text{m}^2}{1\ \text{in.}^2} = \underline{521\ \text{lb/in.}^2}$$

15. *The greatest ocean depths on the Earth are found in the Marianas Trench near the Philippines. Calculate the pressure due to the ocean at the bottom of this trench, given its depth is 11.0 km and assuming the density of seawater is constant all the way down.*

Solution $P = h\rho g = \left(11.0\times10^{3}\ \text{m}\right)\left(1.025\times10^{3}\ \text{kg/m}^{3}\right)\left(9.80\ \text{m/s}^{2}\right) = \underline{1.10\times10^{8}\ \text{Pa}} = \underline{1.09\times10^{3}\ \text{atm}}$

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18. *The aqueous humor in a person's eye is exerting a force of 0.300 N on the* 1.10-cm^2 *area of the cornea. (a) What pressure is this in mm Hg? (b) Is this value within the normal range for pressures in the eye?*

Solution

(a) $$P = \frac{F}{A} = \frac{0.300\ \text{N}}{1.10\ \text{cm}^2}\times\left(\frac{100\ \text{cm}}{1\ \text{m}}\right)^2 = 2.73\times10^{3}\ \text{Pa}\times\frac{1\ \text{mm Hg}}{133.3\ \text{Pa}} = \underline{20.5\ \text{mm Hg}}$$

(b) The range of pressures in the eye is 12–24 mm Hg, so the result in part (a) is within that range.

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25. *What force must be exerted on the master cylinder of a hydraulic lift to support the weight of a 2000-kg car (a large car) resting on the slave cylinder? The master cylinder has a 2.00-cm diameter and the slave has a 24.0-cm diameter.*

Solution $$\frac{F_1}{A_1} = \frac{F_2}{A_2} \Rightarrow F_2 = \left(\frac{A_2}{A_1}\right)F_1 = \left(\frac{\pi r_2^2}{\pi r_1^2}\right)mg = \left(\frac{r_2^2}{r_1^2}\right)mg$$

$$= \left[\frac{(1.00\ \text{cm})^2}{(12.0\ \text{cm})^2}\right](2000\ \text{kg})\left(9.80\ \text{m/s}^2\right) = \underline{136\ \text{N}}$$

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32. *Pressure cookers have been around for more than 300 years, although their use has strongly declined in recent years (early models had a nasty habit of exploding). How much force must the latches holding the lid onto a pressure cooker be able to withstand if the circular lid is* $25.0\,\text{cm}$ *in diameter and the gauge pressure inside is 300 atm? Neglect the weight of the lid.*

Solution $$F = PA = (3.00\ \text{atm})\left(\frac{1.013\times10^{5}\ \text{N/m}^2}{1.0\ \text{atm}}\right)\pi\left(0.125\ \text{m}\right)^2 = \underline{1.49\times10^{4}\ \text{N}}$$

Atmospheric pressure outside the cooker can be ignored, since we are given the gauge pressure inside, and the gauge pressure indicates pressure above atmospheric. So, 3 atm measures the pressure difference between the inside and outside of the lid.

34. *A submarine is stranded on the bottom of the ocean with its hatch 25.0 m below the surface. Calculate the force needed to open the hatch from the inside, given it is circular and 0.450 m in diameter. Air pressure inside the submarine is 1.00 atm.*

Solution

$$\text{Water pressure} = P_{\text{w}} = h\rho g$$
$$= (25.0\ \text{cm})\left(1.025\times10^{3}\ \text{kg/m}^{3}\right)\left(9.80\ \text{m/s}^{2}\right) = 2.51\times10^{5}\ \text{N/m}^{2}$$

Since atmospheric pressure is roughly the same inside and outside:

$$P_{\text{net}} = P_{\text{w}} = 2.51\times10^{5}\ \text{N/m}^{2}$$
$$F = PA = P\left(\pi R^{2}\right) = \left(2.51\times10^{5}\ \text{N/m}^{2}\right)\pi(0.225\ \text{m})^{2} = \underline{3.99\times10^{4}\ \text{N}}$$

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37. *Logs sometimes float vertically in a lake because one end has become water-logged and denser than the other. What is the average density of a uniform-diameter log that floats with* 20.0% *of its length above water?*

Solution

$$\text{FS} = \frac{\overline{\rho}_{\text{obj}}}{\rho_{\text{fl}}} \Rightarrow \overline{\rho}_{\text{obj}} = \rho_{\text{fl}} \cdot \text{FS} = \left(1.00\times10^{3}\ \text{kg/m}^{3}\right)(0.800) = \underline{800\ \text{kg/m}^{3}}$$

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51. *A twin-sized air mattress used for camping has dimensions of 100 cm by 200 cm by 15 cm when blown up. The weight of the mattress is 2 kg. How heavy a person could the air mattress hold if it is placed in freshwater?*

Solution

$F_{\text{B}} = \text{total weight.}$ *(Ignore person being in the water)*

$$\text{FB} = \rho g V = (1.21\ \text{kg/m}^{3})(9.8\text{m/s}^{2})(1.0\text{m}\times2.0\text{m}\times0.15\text{m}) = 35.6\ \text{N}$$
$$= \text{weight of person} + \text{mattress weight}$$
$$= \text{weight of person} + (2\text{kg})(9.8).$$

$$\text{Weight of person} = 35.6\text{N} - 19.6\text{N} = \underline{16.0\ \text{N}}$$