CHAPTER NINE SOLUTIONS

9.3 Using $Y = \dfrac{FL_o}{A(\Delta L)}$ with $A = \pi(d/2)^2$ and $F = mg$, we get

$$Y = \frac{mgL_o}{\pi(d/2)^2\Delta L} = \frac{4(90\ \text{kg})(9.80\ \text{m/s}^2)(50\ \text{m})}{\pi(0.01\ \text{m})^2(1.6\ \text{m})} = 3.5 \times 10^8\ \text{Pa.}$$

9.10 Let W be its weight. Then each tire supports $W/4$, so that $P = \dfrac{F}{A} = \dfrac{W}{4A}$,

yielding: $W = 4AP = 4(0.024\ \text{m}^2)(2.0 \times 10^5\ \text{N/m}^2) = 1.9 \times 10^4\ \text{N}$.

9.14 The gauge pressure of the fluid at the level of the needle must equal the gauge pressure in the artery.

$P_{gauge} = \rho g h = 1.33 \times 10^4$ Pa, so

$$h = \frac{1.33 \times 10^4\ \text{Pa}}{(1.02 \times 10^3\ \text{kg/m}^3)(9.80\ \text{m/s}^2)} = 1.33\ \text{m}$$

9.17 We first find the absolute pressure at the interface between oil and water: $P_t = P_{atm} + \rho g h$, or

$P_t = 1.013 \times 10^5\ \text{Pa} + (7.00 \times 10^2\ \text{kg/m}^3)(9.80\ \text{m/s}^2)(0.300\ \text{m}) = 1.03 \times 10^5\ \text{Pa}$.

This is the pressure at the top of the water. To find the absolute pressure at the bottom, we use: $P = P_t + \rho g h$, or

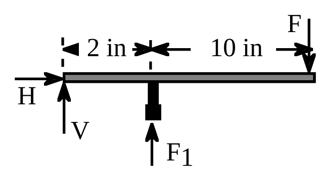
$P = 1.03 \times 10^5\ \text{Pa} + (1.00 \times 10^3\ \text{kg/m}^3)(9.80\ \text{m/s}^2)(0.200\ \text{m}) = 1.05 \times 10^5\ \text{Pa}$.

9.20 Since the frog floats, the buoyant force = the weight of the frog. Also, the weight of the displaced fluid = weight of the frog, so

$\rho_{fluid} V g = m_{frog} g$, or,

$m_{frog} = \rho_{fluid} V = (1.35 \times 10^3\ \text{kg/m}^3)\left(\dfrac{1}{2}\right)\left(\dfrac{4\pi(6.00 \times 10^{-2}\ \text{m})^3}{3.00}\right)$.

Hence, $m_{frog} = 0.611$ kg.

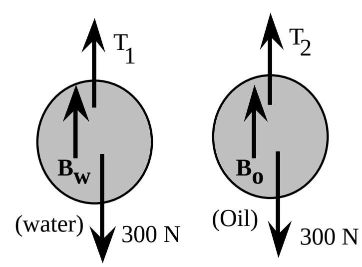


Free-Body diagram of handle

9.26 (a) The forces acting on the object when suspended in water are the tension in the string, T_1, the weight of the object, and the buoyant force, B_w. At equilibrium, we have $B_w = w - T_1 = 300\ \text{N} - 265\ \text{N} = 35\ \text{N}$.

Also, $B_w = \rho_w V g$. Therefore,

$$V = \frac{35\ \text{N}}{(10^3\ \text{kg/m}^3)(9.80\ \text{m/s}^2)} = 3.57 \times 10^{-3}\ \text{m}^3.$$



The mass of the 300 N object is 30.6 kg, and the volume V found above is the volume of water displaced which is also the volume of the object. Thus, the density of the object is:

$\rho_{object} = m_{object}/V = 30.6\ \text{kg}/3.57 \times 10^{-3}\ \text{m}^3 = 8.57 \times 10^3\ \text{kg/m}^3$.

(b) When submerged in the oil, the forces on the object are T_2, the tension in the string, the weight of the object, w, and the buoyant force of the oil, B_o. For equilibrium, we have $T_2 + B_o = w$, or $B_o = w - T_2 = 300\text{ N} - 275\text{ N} = 25\text{ N}$. However, the buoyant force exerted by the oil is also equal to the weight of the oil displaced. The volume of the oil displaced is equal to the volume of the object. Thus, the density of the oil is

$$\rho_{oil} = \frac{m_{oil}}{V} = \frac{w_{oil}}{g\,V} = \frac{25\text{ N}}{(9.80\text{ m/s}^2)(3.57 \times 10^{-3}\text{ m}^3)} = 714\text{ kg/m}^3.$$

ANSWERS TO ASSIGNED EVEN CONCEPTUAL QUESTIONS

2. Both must have the same strength. The force on the back of each dam is the average pressure of the water times the area of the dam. If both reservoirs are equally deep, the force is the same.

6. The buoyant force depends on the amount of air displaced by the objects. Since they have the same dimensions, the buoyant force will be the same on each.

10. The water level on the side of the glass stays the same. The floating ice cube displaces its own weight of liquid water, and so does the liquid water into which it melts.