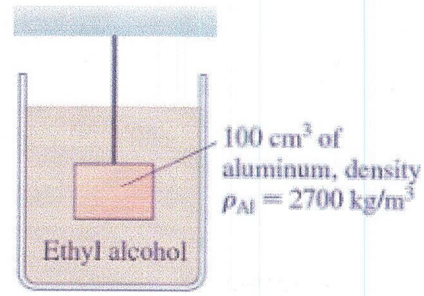
Buoyancy Problems

1. A chunk of ice with a volume of 12 m^3 floats in salt water. What percentage of this floe is underwater?

2. An iceberg floats in salt water. What percentage of the iceberg is submerged?

Prob. 25 What is the tension in the string in the situation shown?



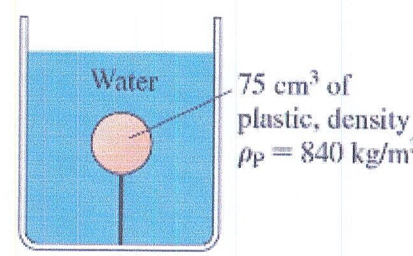
4. Air exerts a buoyant force, just as water does. This is usually ignored, since the density of air is so small that the buoyant force is negligible. But this force does exist, and is what causes helium balloons, for example, to float. Suppose that a hot-air balloon is filled with air of density 0.93 kg/m3, while the cooler air outside has a density of 1.29 kg/m3. Assume that the skin of the balloon is massless, and find the acceleration of the balloon.

5. A sphere of concrete is held completely under the surface in a bucket of water and released.

a. compare the densities of concrete and water and decide whether the sphere will rise, sink, or remain at rest.

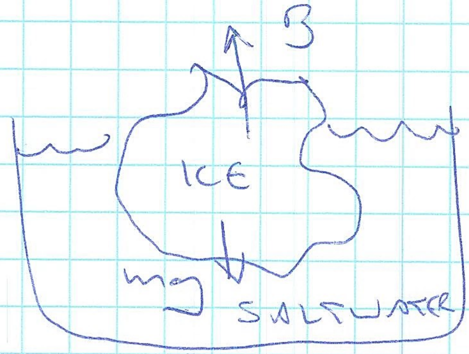
b. solve for the acceleration once you let go.

Prob. 26 Find the tension in the string in the situation shown.



prob. 50 A 6.0 cm tall cylinder floats in water with its axis perpendicular to the surface. The length of the cylinder above water is 2.0 cm. What is the density of the cylinder?

1. $\Sigma F = ma$



$B - W = 0$

$[\rho V g]_{DISP} = [\rho V g]_{ICE}$

$[(1030 \frac{kg}{m^3})] V_{DISP} = [917 \frac{kg}{m^3}](12 m^3)$

$V_{DISP} = 10.68 m^3$

% underwater is $\frac{10.68}{12} = 89\%$

2. Same problem. $V_{ICEBERG}$ is unknown - leave in symbol form.

$\Sigma F = ma$

$B - W = 0$

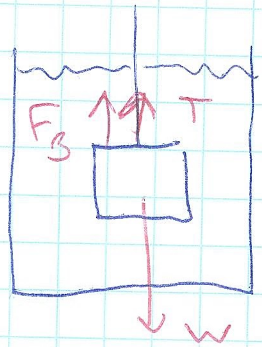
$[\rho V g]_{DISP} = [\rho V g]_{ICEBERG}$

$(1030) V_{DISP} = 917 V_{ICEBERG}$

$\frac{V_{DISP}}{V_{ICEBERG}} = 89\%$

Only the part of the iceberg which is underwater displaces seawater.

13 - 25



$\uparrow +$

$V_f = V_{block}$

since totally submerged

$\Sigma F = ma$

$T + F_B - W = 0$

$T = W - F_B$

$m_{block} = \rho V$
$= (2700\ kg/m^3)(100 \times 10^{-6}\ m^3)$
$= 0.27\ kg$

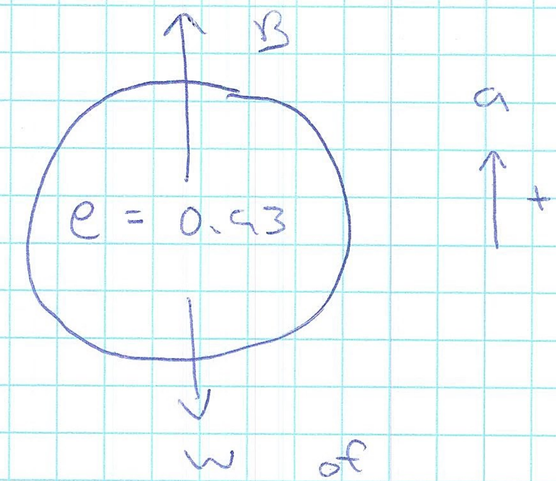
$F_B = \rho_f V_f g$
$= (790\ kg/m^3)(100 \times 10^{-6}\ m^3)(9.8\ m/s^2)$
$= 0.774\ N$

$T = W - F_B$
$= (0.27\ kg)(9.8\ m/s^2) - 0.774\ N$

$T = 1.87\ N$

8.4.

$\rho = 1.29\ kg/m^3$



$\Sigma F = ma$

$B - W = ma$

$(\rho V g)_{\substack{FLUID\\DISP\\(COLD\ AIR!)}} - (\rho V g)_{BALLOON} = (\rho V)_{BALLOON}\, a$ air in balloon

Balloon is entirely submerged in air, so

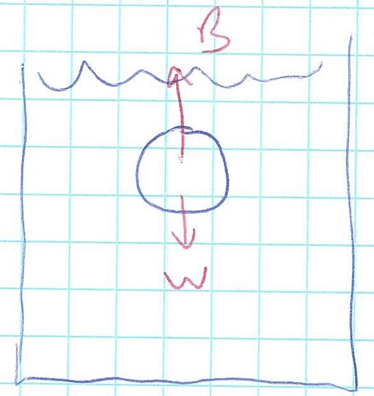
$V_{\substack{FLUID\\DISP}} = V_{BALLOON}$

$\rho_{\substack{COLD\\AIR}}\, g - \rho_{\substack{HOT\\AIR}}\, g = \rho_{\substack{HOT\\AIR}}\, a$

$(1.29)(9.8) - (0.93)(9.8) = (0.93)\, a$

$a = +3.8\ m/s^2$

5.



$+\downarrow$

$\rho_{CONCRETE} = 2200\ kg/m^3$

$\rho_{WATER} = 1000\ kg/m^3$

More dense than water. Should sink.

→ So I am making DOWN the + direction.

$\Sigma F = ma$

$W - B = ma$

$(\rho V g)_{CONCRETE} - (\rho V g)_{DISPL.} = (\rho V)_{CONCRETE}\, a$

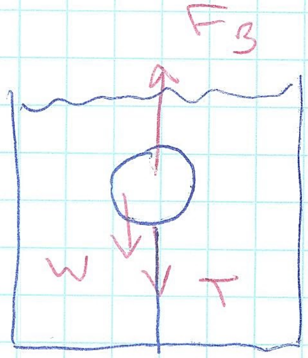
$V_{CONC} = V_{DISP}$: totally submerged.

$(2200)(9.8) - (1000)(9.8) = (2200)\,a$

$a = +5.3\ m/s^2$

DOWN, since +

13 - 26



Completely submerged
$V_f = V_{OBJECT}$

Note $\rho_{PLASTIC} < \rho_{WATER}$, so it wants to float.

$$\Sigma F = ma$$

$$F_B - w - T = 0$$

$$T = F_B - w$$

$$T = \rho_f V_f g - \rho_{ball} V_{ball} g$$

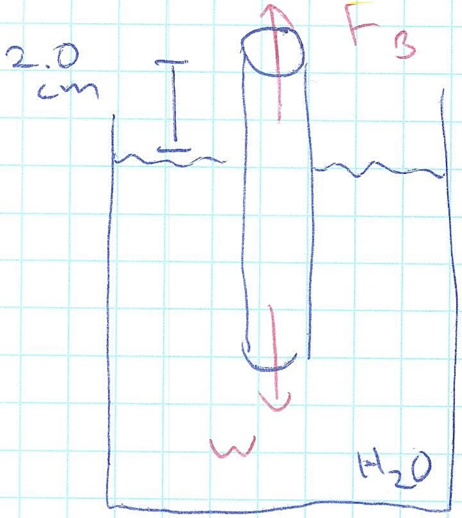
$$T = V g (\rho_f - \rho_{ball})$$

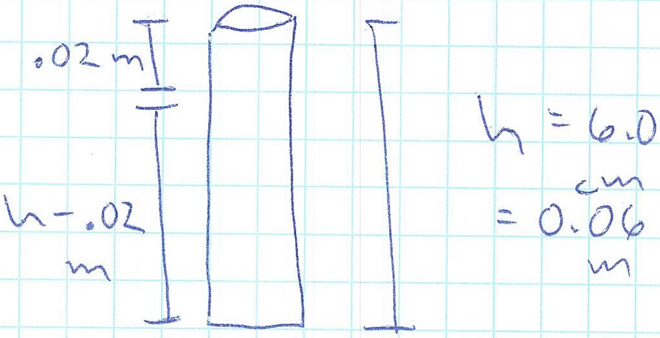
↳ since = 75 cm^3 for both volumes.

$$T = (75 \times 10^{-6} m^3)(9.8 m/s^2)[1000 - 840 kg/m^3]$$

$$T = 0.12 \text{ N}$$

13 - 50





$$\Sigma F = ma$$

$$F_B - w = 0$$

$$\rho_f V_f g = \rho_{CYL} V_{CYL} g$$

$$\rho_f (\pi r^2)[h - 0.02] = \rho_{CYL} (\pi r^2) h$$

$$\rho_f [h - 0.02] = \rho_{CYL} h$$

$$(1000 \text{ kg/m}^3)(0.04 \text{ m}) = \rho_{CYL} (0.06 \text{ m})$$

$$\rho_{CYL} = 667 \text{ kg/m}^3$$