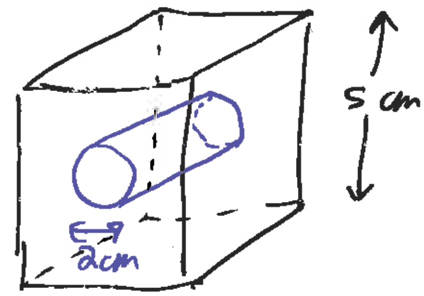
2



$V_{cube} = \ell^3$

$V_{cyl} = \pi r^2 \ell$

$W = mg = 7.50\,N$

a) $\rho = \dfrac{m}{V} = \dfrac{W/g}{V_{cube} - V_{cyl}} = \dfrac{7.50/9.80}{(0.05)^3 - \pi(0.01)^2(0.05)}$

$= \dfrac{7.65306E\text{-}1}{1.25E\text{-}4 - 1.5708E\text{-}5} = 7.00239E3$

$= \boxed{7.00 \times 10^3\ kg/m^3}$

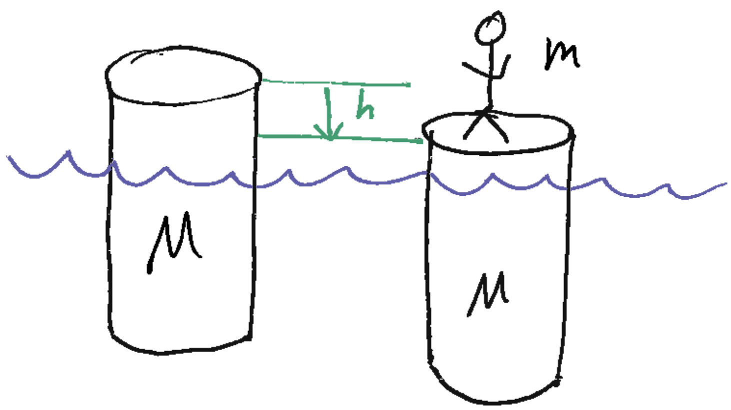
c) This is a little less dense than iron, maybe a different alloy of steel?

b) $W = mg$ & $\rho = \dfrac{m}{V} \rightarrow m = \rho V$

$W = \rho V g = 7E3 \cdot 1.24E\text{-}4 \cdot 9.80 = 8.5093$

$= \boxed{8.51\,N}$

25



Archimedes principle:

$$F_B = \rho_f V_f g$$

The extra weight (mg) is balanced by additional water being displaced, in the shape of a cylinder.

$$m\cancel{g} = \rho_f V \cancel{g}$$

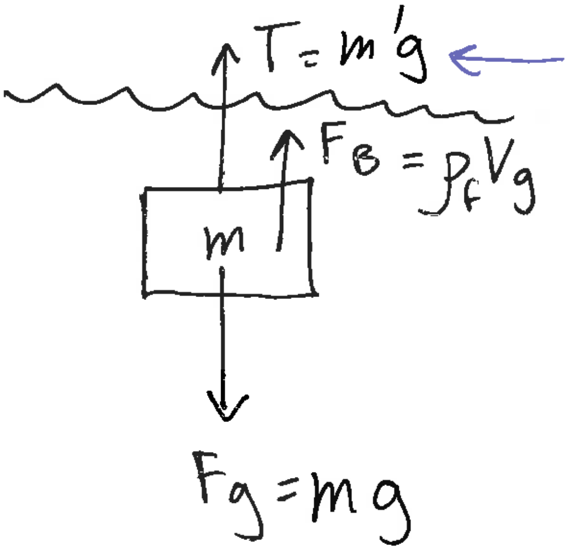
$$m = \rho_f (\pi r^2 h)$$

$$h = \frac{m}{\rho_f \pi r^2} = \frac{70}{1.03E3 \cdot \pi \cdot \left(\frac{0.900}{2}\right)^2} =$$

$$= 1.068\ E{-1}$$

$$= \boxed{0.107\ m} = 10.7\ cm$$

27



T is what gets the apparent weight

$$\Sigma F = ma$$

$$T + F_B - F_g = 0 \rightarrow F_B = F_g - T$$

$$\rho_f V \cancel{g} = m\cancel{g} - m'\cancel{g}$$

$$\rho_{rock} = \frac{m}{V}$$

$$V = \frac{m}{\rho_{rock}}$$

$$\rho_f \frac{m}{\rho_{rock}} = m - m'$$

$$\rho_f \frac{m}{m - m'} = \rho_{rock}$$

$$\rho_{rock} = 1E3\left(\frac{9.28}{9.28 - 6.18}\right) = 2.9935E3$$

$$= \boxed{2.99 \times 10^3\ kg/m^3}$$

Sanity check: Rocks are (2-5) E3 kg/m³, so this is reasonable.

15] $V_1 = 0.50 m/s$ $\quad$ $V_2 = ?$

$d_1 = 0.04 m$ $\quad$ $d_2 = 0.026 cm$

$A_1 = \pi r^2 = 1.2566E{-3} m^2$ $\quad$ $A_2 = 5.30929E{-4}$

$P_1 = 3.0 atm = 3.03E5 Pa$ $\quad$ $P_2 = ?$

$\Delta y = 5.0 m$

Continuity equation for V_2:

$$A_1 V_1 = A_2 V_2 \rightarrow V_2 = V_1 \frac{A_1}{A_2} = V_1 \left(\frac{d_1}{d_2}\right)^2$$

$$= .5\left(\frac{4 cm}{2.6 cm}\right)^2 = 1.18343$$

$$= \boxed{1.2 \ m/s}$$

Bernoulli for P_2:

$$P_1 + \rho_1 g y_1 + \tfrac{1}{2}\rho_1 V_1^2 = P_2 + \rho_2 g y_2 + \tfrac{1}{2}\rho_2 V_2^2$$

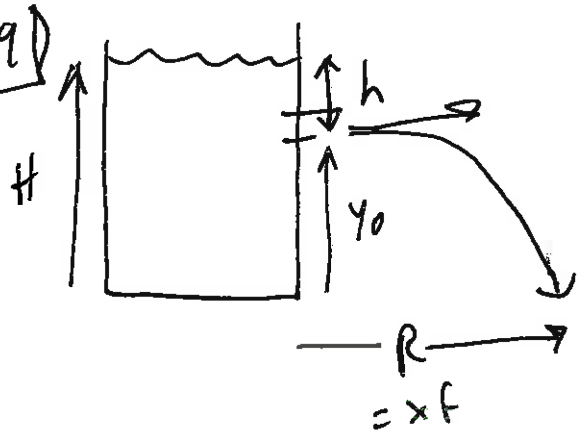
$$P_2 = P_1 + \rho g(-\Delta y) + \tfrac{1}{2}\rho(V_1^2 - V_2^2)$$

$$= 3.03E5 + 1E3 \cdot 9.80 \cdot {-5.0} + \tfrac{1}{2} \cdot 1E3(0.50^2 - 1.183^2)$$

$$= 2.5343E5 = \boxed{2.53 \times 10^5 \ Pa}$$

$$= 2.5 atm$$

89)



Plan:

1) Bernoulli to find V_0 $(= V_2)$

2) Kinematics to find $(x_f =) R$.

1) Bernoulli:

$$\underbrace{\cancel{P_1} + \cancel{\rho_1} g y_1 + \frac{1}{2}\cancel{\rho_1} V_1^2}_{\text{Top of tank}} = \underbrace{\cancel{P_2} + \cancel{\rho_2} g y_2 + \frac{1}{2}\cancel{\rho_2} V_2^2}_{\text{Hole}}$$

→ $P_1 = P_2 = 1\,atm$ → subtract from both sides

→ $\rho_1 = \rho_2 = 1E3\,kg/m^3$ → divide from both sides

$$g \overset{h}{y_1} + \frac{1}{2}\overset{0}{\cancel{V_1}}{}^2 = g \overset{0}{\cancel{y_2}} + \frac{1}{2} V_2^2$$

→ Set height origin at the hole,

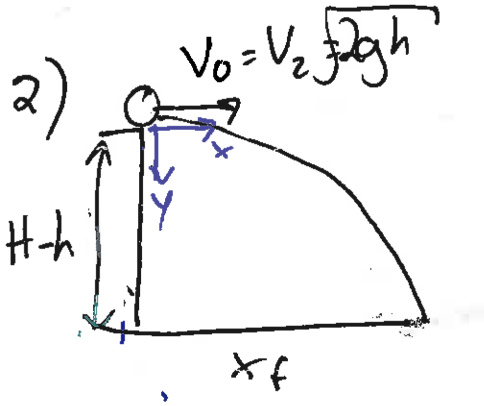
then $y_1 = h$, $y_2 = 0$

$$gh = \frac{1}{2} V_2^2$$

$$V_2 = \sqrt{2gh}$$

(Does this look familiar from energy problems? it should!) ☺

2)



Each water drop is like a projectile shot horizontally off a cliff.

$\underline{x}$	$\underline{y}$
$x_0 = 0$	$y_0 = 0$
$x_f = R$	$y_f = H - h$
$V_{0x} = \sqrt{2gh}$	$V_{0y} = 0$
$V_{fx} = \nearrow$	$V_{fy} =$ don't care
$a_x = 0$	$a_y = g$ (positive)

$$x_f = V_{0x} t$$

$$y_f = \frac{1}{2} a_y t^2 + \cancel{V_{0y} t}^{0} + \cancel{y_0}^{0}$$

$$t = \sqrt{\frac{2y_f}{a_y}}$$

$$x_f = \sqrt{2gh} \cdot \sqrt{\frac{2y_f}{a_y}}$$

$$= 2\sqrt{\frac{gh\,y_f}{g}}$$

a) $\boxed{R = 2\sqrt{h(H-h)}}$

Sanity check: Does it have units of meters?

(b) If you drill another hole at $h' = H - h$:

$$R = 2\sqrt{h'(H-h')}$$

$$= 2\sqrt{(H-h)\cdot(H-(H-h))}$$

$$= 2\sqrt{(H-h)\,(h)}$$

$$= 2\sqrt{h(H-h)}$$ same as before.