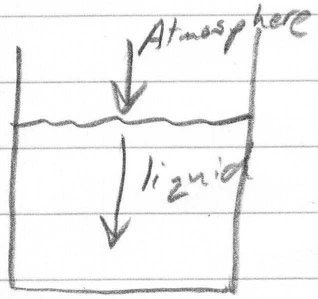
Pressure Questions + Problems

A. $P = \rho g h = 2{,}300\,kg/m^3 (9.8\,m/s^2)(7m)$

$$P = \boxed{157{,}780\ pa}$$

B.



$$P_{Net} = P_{liquid} + P_{Atmosphere}$$

$$= 157{,}780pa + 101{,}357pa$$

$$\boxed{P_{Net} = 259{,}137pa}$$

C. $PV = nRT$

just make up something easy

$$101{,}350pa(V) = \overset{\downarrow}{1}(8.31\,j/Kmol)(245°k)$$

$V = 0.0203m^3$

$1mol = 28.97g$

$1mol = 0.02897kg$

$[(-20°F) - 32](5/9)$

$= -28.9°C$

$-28 + 273.15 = 245°k$

$$\rho = \frac{0.02897kg}{0.0203m^3} = \boxed{1.42\,kg/m^3}$$

1. a) 14.7psi   b) ≈ 101,000pa

2. The air pressure in an empty tire is 14.7psi. The gauge reads the pressure difference between tire pressure and 1atm.

3. $1atm = 101,000 pa = \rho g h = 1000 kg/m^3 (9.8 m/s^2) h$

$$\boxed{h = 10.3 m}$$

4. $P = \rho g h = 1029 kg/m^3 (9.8 m/s^2)(10,924 m) = 1.1 \times 10^8 pa$

$$\frac{39.37\,\cancel{inches}}{1 meter}\left(\frac{1 foot}{12\,\cancel{inches}}\right) = \frac{3.28 feet}{1 m}$$

Dividing top + bottom by 3.28 → $\frac{1 foot}{0.305 m}$

$$35,840 feet \left(\frac{0.305 m}{foot}\right) = \boxed{10,924 m}$$

5. $150 lbs \left(\frac{1 kg}{2.2 lbs}\right) = 68 kg$

$$\rho = \frac{m}{V}$$

$$1000 kg/m^3 = \frac{68 kg}{V}$$

$$V = 0.068 m^3$$

$$0.068 m^3 \left(\frac{1000 l}{m^3}\right) = \boxed{68 l}$$

6. mass = 68 kg = mass of Hg displaced

$$\rho_{Hg} = \frac{m}{V} = \frac{68\,kg}{V} = 14,000$$

$$V_{Hg\ displaced} = 0.00496\,m^3$$

Human Volume = 68 l = 0.068 m³

$$\frac{V_{Hg\ displaced}}{V_{Human}}(100\%) = \frac{0.0049\overset{\overset{8}{\downarrow}}{6}\,m^3}{0.068\,m^3}(100\%) = 7.1\%$$

↗ % in Hg

$$\%\ \text{sticking out} = 100\% - 7.1\%$$
$$\boxed{= 92.9\%}\ \text{sticking out}$$

7. $P = \rho g h = 14,000\,kg/m^3 (9.8\,m/s^2)(0.76\,m) \boxed{= 104,475\,pa}$

$$29.96\ \text{inches} = 2.50\ \text{feet}\left(\frac{0.305\,m}{foot}\right) = 0.76\,m$$

Because 1 is easy, not because it's realistic.

8. Assuming a human is $1m^3$, mass must be 1000kg, so that human displaces 1000kg of dead sea H_2O

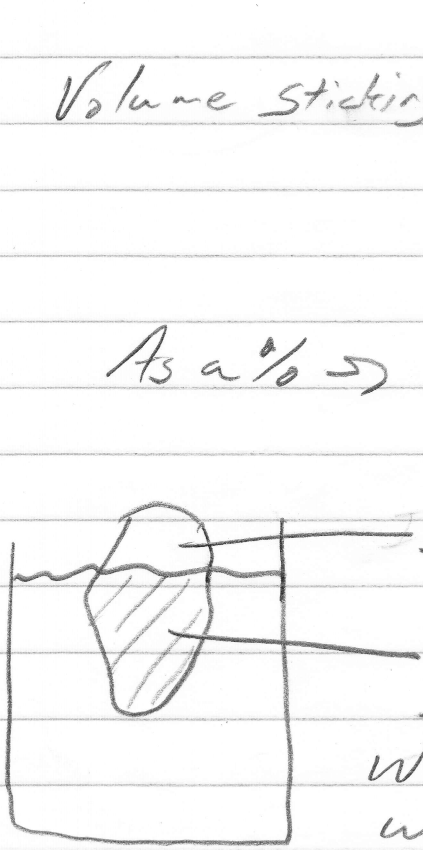
$$\rho = \frac{m}{V} \qquad 1240 kg/m^3 = \frac{1000kg}{V_{displaced}}$$

$$V = 0.806 m^3 \text{ of dead sea } H_2O$$

$$\text{Volume sticking out} = \text{Total Human Vol.} - \text{Displaced } H_2O$$
$$= 1m^3 - 0.806m^3$$
$$= 0.194 m^3$$

$$\text{As a \%} \rightarrow \frac{0.194m^3}{1m^3} = \boxed{19.4\% \text{ sticking out}}$$

9.

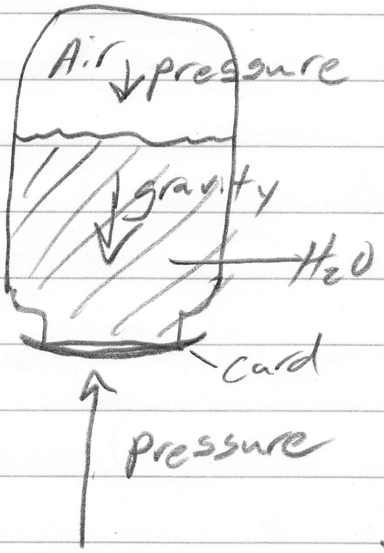


1kg Frozen H_2O: in iceberg

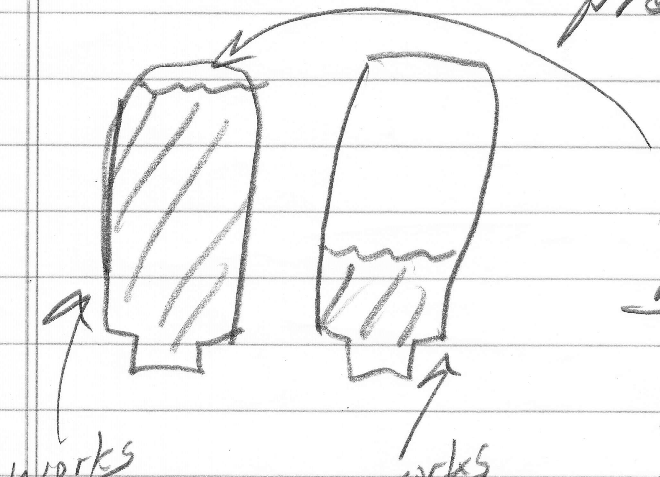
1kg liquid H_2O displaced

When melted, the 1kg frozen water will be exactly the same thing as 1kg liquid H_2O, so it will fill the displaced H_2O's spot perfectly

10.



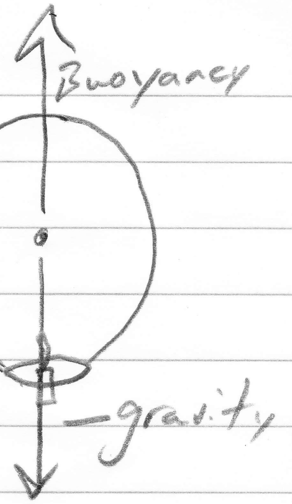
When the jar is turned over, the water drops a little, causing the air in the jar to expand in volume, so its pressure drops. If the pressure in the jar drops enough, the outside pressure is greater than both gravity and the inner pressure put together.



the smaller airspace increases more, proportionally, as the water falls. The water has to fall very little for the air volume to double -- causing the pressure to decrease by ½ (since PV is constant)

11.

a) At neutral buoyancy, the buoyant force = gravity.
Net Force $= \boxed{0N}$



b) $Vol = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi(0.5m)^3 = \boxed{0.524m^3}$

c) Buoyancy = Weight of displaced air

$$\text{Weight of air} = \underbrace{\text{moles}\,(\text{molar mass})}_{\text{mass of air}}(g)$$

$$PV = nRT$$

$60°F = (60-32)\frac{5}{9} + 273.15$

$$101{,}350pa(0.524m^3) = n(8.31\, J/K\,mol)(289.7K)$$

$n = 22.2$ moles

$22.2 \text{ moles}(28.97\, g/mol) = 640.8g = \boxed{0.64kg}$

Mass of air displaced

$$\text{Weight}_{\text{displaced Air}} = 0.64kg(9.8m/s^2) = \boxed{6.28N}$$

F=ma

11. d) Mass of Air displaced = Total Balloon mass (with air)

0.64kg (see previous page)

e) $0.64kg = 0.06kg + \text{Mass of air in balloon}$

Total Balloon mass (plus air)

mass, not including air

Mass of balloon Air = 0.64kg − 0.06kg

Balloon Air Mass = 0.58kg

$$\frac{0.58\,kg}{0.02897\,kg/mol} = 20 \text{ moles}$$

Molar mass (kg/mol)

of air in balloon

$$PV = nRT$$

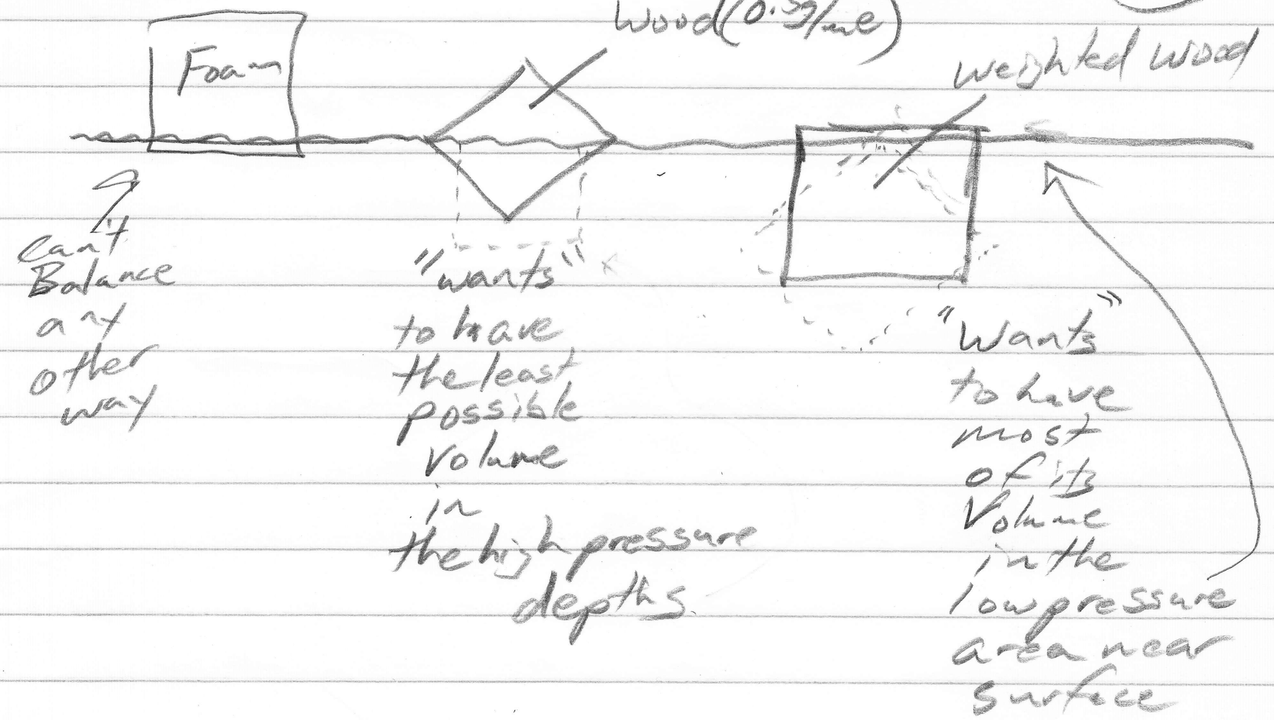
$$101{,}350\,pa(0.524\,m^3) = 20\,mol\left(8.31\,j/K\,mol\right)T$$

$$T = 318.5^\circ K$$

$K - 273.15 \rightarrow = 45.4^\circ C$

$C\left(\frac{9}{5}\right) + 32 \rightarrow = 113.7^\circ F$

12.



can't Balance any other way

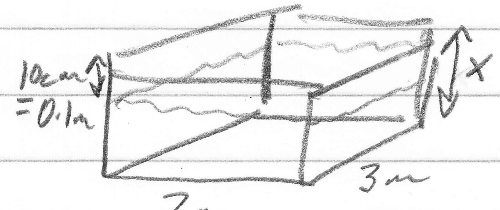
"wants" to have the least possible volume in the high pressure depths.

"Wants" to have most of its Volume in the low pressure area near surface

13. -Float the wood to determine its mass by the displacement of water.
- Push it under (barely) to get volume

$\rho = m/V$

14.



$$\overset{\text{Volume (density)}}{\text{Boat mass}} = H_2O\text{ mass}$$

$$\text{Steel Volume (Steel Density)} = H_2O\text{vol}(\rho_{H_2O})$$

$$\text{Boat mass} = \overset{\text{steel Density}}{(7{,}800\ kg/m^3)}\overbrace{\left\{\left[\underbrace{0.03m(3m)2x + 0.03m(2m)(2x)}_{\text{panel thickness}}\right] + \left[\underbrace{3m\,(2m)(0.03m)}_{\text{Bottom panel}}\right]\right\}}^{\text{steel volume}}$$

$$= 7{,}800\,kg/m^3 \cdot (0.18m^2x + 0.12m^2x + 0.18m^3)$$

$$\text{Boat mass} = 2340\,\frac{kg}{m}x + 1404kg$$

H_2O Volume $= (2m)(3m)(x - 0.1m) = 6m^2 x - 0.6m^3$

H_2O mass $= 1000 kg/m^3 (6m^2 x - 0.6m^3) = 6000 \frac{kg\,x}{m} - 600kg$

$\boxed{\text{Boat Mass} = H_2O \text{ mass (displaced)}}$

$$\underbrace{\boxed{2340 \frac{kg\,x}{m} + 1404kg}}_{\text{Boat mass}} = \underbrace{\boxed{6000 \frac{kg\,x}{m} - 600kg}}_{H_2O \text{ mass}}$$

$$2004kg = 3660 \frac{kg\,x}{m}$$

$\boxed{x = 0.548\,m} \rightarrow$ wall height

* This assumes the weight of the air inside the boat--and the buoyant force of air -- are negligable.