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Physics 30 - Lesson 41H
Fluid Dynamics
Questions

3) /1 No, not necessarily. This could simply mean that the molecules, although smaller, may be packed tighter together (more molecules per unit volume.) The shape of the molecules has much to do with this.

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4) /1 As the water is heated, the kinetic energy of the water molecules increases and it is turned into vapor. The vapor, which has a high E_k, heats the air within the can and the air molecules also have a high E_k, which forces them to spread out. After the lid is put on, and the heat is removes, the air in the can cools down and the space between the molecules decreases. Since some of the air was forced out when heating, the remaining volume of air is less than before and as the air cools, the outward pressure inside the can becomes less than the inward pretty by the atmosphere, thus the can collapses.

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6) /1 Yes! The depth is limited by the atmospheric pressure through the snorkel and the pressure of the air in the lungs. If the pressure in the lungs is too large for the lungs to expel the air, it is difficult to breath! (There is very little exception for the size of the snorkel!)

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8) /1 The pressure is related to the net force and the area

$$P \ \alpha \ \frac{F}{A}$$

As the area decreases (pin) the pressure increases with the same force applied.

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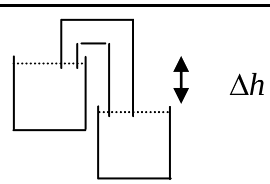
9) /1



The difference in height of the two containers produces a "gauge pressure" which exceeds he atmospheric pressure on the second container. This pressure allows the fluid to flow (against gravity) from container 1 to 2.

$P = P_o + \rho g h$ "gauge pressure" – Pascal's principle

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11) /1 No, it will only rise until the density of the air outside the balloon equals the density of the helium inside the balloon. The other factor that may limit its flight is the pressure. If the outside pressure becomes too small, the inside pressure of the balloon will pop it, also stopping its flight.

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12) /1 It depends on the boat, but in most cases by adding rocks to the barge, it will lower the boat further in the water. But, as you lower the barge, you also increase the volume of the ship's hull that is displacing water (which may cause the boat to rise!) So it depends.

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13) No, Archimedes Principle applies only when the plug is removed. The buoyant force requires an upward force.

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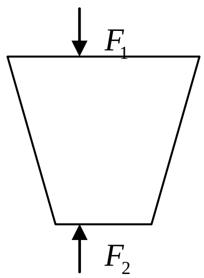

$$F_b = F_2 - F_1 = m_f g$$

The reason it is harder to pull out with more water in the tub is due to the fact that the pressure in a fluid increases with depth. More depth = more pressure.

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14) No, water has the unique property of increasing in volume when I freezes, thus when it
/1 melts, it should actually decrease in volume and the glass should go down in volume.

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16 The fast moving air above the roof creates a lower pressure than the inside pressure in a home. Thus the roof is blown off the top of the house.

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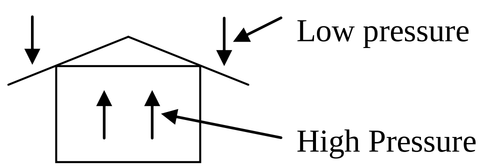

$P \alpha F$ $\therefore$ F is outwards!

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17) The fast moving air above the top of the car causes a lower pressure and the high pressure
/1 inside the car forces the canvas outwards.

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18 The moving air between the two parallel ships creates a low pressure zone which will cause the ships to be "pushed" together by the high pressure on the outsides.

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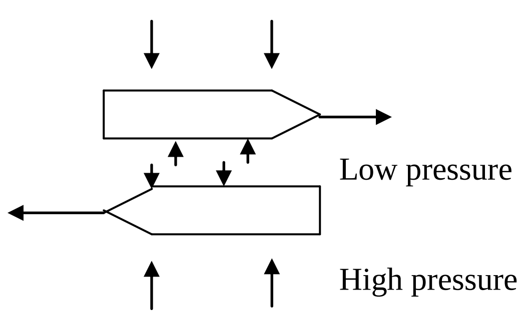

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20) /1	Yes! The low pressure area created b the air around a high speed train would cause enough force to suck a child under it! (Look at the trees as a train (or a car) passes them)

Problems

2) /2	$V = 1.0\times10^8 m^3$ $p = 2.7\times10^3 kg/m^3$ $m = ?$	$p = \frac{m}{V}$ $m = pV = (1.0\times10^8 m^3)(2.7\times10^3 kg/m^3)$ ✓ $\boxed{m = 2.7\times10^{11} kg}$ ✓
3) /2	$m = ?$ $V = (6.5m)(4.4m)(2.7m)$ $V = 77.22m^3$ $p = 1.29kg/m^3$	$m = (77.22m^3)(1.29kg/m^3)$ ✓ $\boxed{m = 99.6kg}$ ✓
8) /2	$\Delta P = ?$ $h = 1.60m$ $p = 1.05\times10^3 kg/m^3$ $g = 9.81m/s^2$	$\Delta P = pgh$ $\Delta P = (1.05\times10^3 kg/m^3)(9.81m/s^2)(1.60m)$ ✓ $\boxed{\Delta P = 1.65\times10^4 N/m^2}$ ✓
9) /4	$P = ?$ $F = ?$ $p = 1.00\times10^3 kg/m^3$ $h = 2.0m$	$P = pgh$ $P = (1.00\times10^3 kg/m^3)(9.81m/s^2)(2.0m)$ ✓ $\boxed{P = 1.96\times10^4 N/m^2}$ ✓ $F = PA = (1.96\times10^4 N/m^2)(8.0m\times15.0m)$ ✓ $\boxed{F = 2.35\times10^6 N}$ ← Both bottom and sides ✓
10) /3	$F = ?$ $A = 2.0m\times1.2m = 2.4m^2$ $P = 1.013\times10^5 Pa$	$F = PA$ ✓ a) $F = (1.013\times10^5 Pa)(2.4m^2)$ $\boxed{F = 2.43\times10^5 N}$ ✓ b) The force on the underside is virtually the same since the Δh is minimal $\boxed{\approx 2.43\times10^5 N}$ ✓

14)

$\Delta P = ?$

$P_{top} = ?$

/4 $P_{bottom} = 1.013\times10^5 Pa$

$P_{top} = pgh = (1.29kg/m^3)(9.81m/s^2)(410m)$

$P_{top} = 5188.5Pa$

$\Delta P = P_{bottom} - P_{top}$

$\Delta P = 1.013\times10^5 Pa - 5.19\times10^3 Pa$

$\boxed{\Delta P = 9.61\times10^4 Pa}$

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19)

$P = 18atm$

$P = 18(1.013\times10^5 Pa)$

/4 $P = 1.82\times10^6 Pa$

$r = 0.10m$

$F = PA = P(\pi r^2)$

$F = (1.82\times10^6 Pa)(\pi)(0.10m)^2$

$= 5.73\times10^4 N$

$m = \dfrac{F}{g} = \dfrac{5.73\times10^4 N}{9.81m/s^2} = \boxed{5839kg}$

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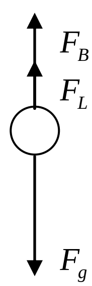
28)

$m = 7.20kg$

$m' = 5.88kg$

$p_{H_2O} = 1.0\times10^3 k/m^3$



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$F_g = mg = (7.20kg)(9.81m/s^2)$

$F_g = 70.6N$

$F_g = mg = (5.88kg)(9.81m/s^2)$

$F_g = 57.7N$

$F_B = F_g - F_L = 70.6N - 57.7N$

$F_B = 12.95N$

$F_B = p_{H_2O} gV$

$V = \dfrac{F_B}{p_{H_2O} g} = \dfrac{12.95N}{(1.0\times10^3 kg/m^3)(9.81m/s^2)}$

$V = 0.00132m^3$

$p_r = \dfrac{m_r}{V_r} = \dfrac{7.20kg}{0.00132m^3} = \boxed{5.45\times10^3 kg/m^3}$

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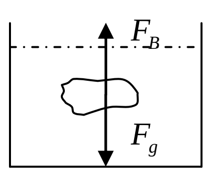
34)



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$F_B = F_g$

$(m_{alc} + m_{H_2O})g = m_A g$

$(0.18 p_{alc} + 0.82 p_{H_2O})\cancel{gV} = p_A \cancel{gV}$

$\left[0.18(0.79\times10^3) + 0.82(1.00\times10^3)\right] = p_A$

$\boxed{p_A = 0.962\times10^3 kg/m^3}$

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51)

/4

$$P = \frac{F}{A}$$

$$F = \Delta PA$$

$$\therefore F = (3.125\times10^5 N/m^2)(250m^2)$$

$$\boxed{F = 7.8\times10^7 N}$$

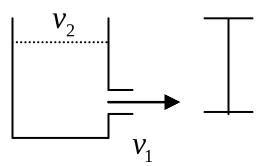
$$P_1 = \frac{1}{2}pv_1^2 = P_2 = \frac{1}{2}pv_2^2$$

$$\Delta P = P_2 - P_1 = \left[\frac{1}{2}pv_1^2\right] - \left[\frac{1}{2}pv_2^2\right]$$

$$\Delta P = \frac{1}{2}(1.00\times10^3 kg/m^2)(25m/s)^2 - 0$$

$$\boxed{\Delta P = 3.125\times10^5 N/m^2}$$

52) Torricellis Theorem



$$\Delta h = h_2 - h_1$$

/4

If $P_1 = P_2$ P

Then $P_1 + \frac{1}{2}pv_1^2 + pgh_1 = P_2 + \frac{1}{2}pv_2^2 + pgh_2$

Becomes $\frac{1}{2}pv_1^2 + pgh_1 = pgh_2$

Assuming $v_2 = 0$ $v_1 = \sqrt{2g\Delta h}$

$$\Delta h = \frac{v_i^2}{2g} = \frac{(8.0m/s)^2}{2(9.81m/s^2)}$$

The pressure head should be $\boxed{\Delta h = 3.26m}$

53) $\Delta P = P_2 - P_1 = pgh$

$$\Delta P = (1.00\times10^3 kg/m^3)(9.81m/s^2)(25m)$$

/3

$$\boxed{\begin{aligned}\Delta P &= 2.45\times10^5 N/m^2\\ \Delta P &= 2.45\times10^5 Pa\\ \Delta P &= 2.42atm\end{aligned}}$$