Physics 432 Name _____

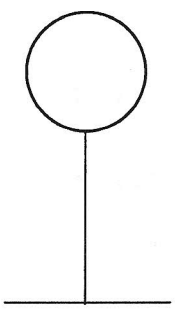
Buoyancy Period _____

Show all of your work, include the correct units, and box your final answer. On this assignment you may choose between doing #1, 2, 3, 4, and 7 or #4, 5, 6, and 7.

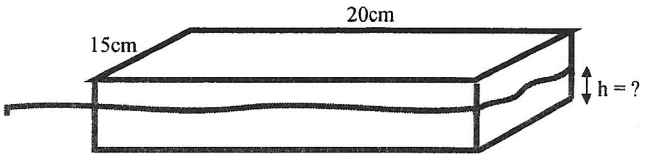
Densities	Volume Equations
$\rho_{air} = 1.29\ kg/m^3$	$V_{sphere} = \frac{4}{3}\pi r^3$
$\rho_{He} = 0.179\ kg/m^3$	$V_{cylinder} = \pi r^2 h$
$\rho_{water} = 1000\ kg/m^3$	

1. How much force is required to hold a beach ball of mass 0.5kg and a radius of 42.5cm under water? Ignore the mass of the air inside the beach ball.

2. A 120g spherical balloon filled with helium is connected to a string. What is the tension in the string if the radius of the balloon is 0.5m? Do **not** ignore the mass of the helium in the balloon.



3. A block of wood measures 20cm × 15cm × 5cm and it floats in water. If it has a mass of 1.0kg, how deep will it press into the water?



4. A spherical balloon filled with helium is held stationary by a young girl. The tension in the string is 0.45 N and the balloon has a radius of 0.35 meters. What is the mass of the balloon? Ignore the mass of the helium.

5. A raft is made of 10 logs lashed together. Each is 33cm in diameter and had a length of 6.1m. How many people can the raft hold before they start getting their feet wet, assuming the average person has a mass of 70 kg? Do not neglect the weight of the logs. The density of wood is 600kg/m^3.

6. An empty weather balloon has a mass of 5.0kg and a radius of 2.879m when fully inflated with helium. A meteorologist wishes to lift instruments that have a total mass of 100kg. Will the balloon be able to rise under these conditions? If so, what will its acceleration be?

7. An empty boat of mass 1000 kg and total volume of 1.5 m^3 is tied to a pier on Lake Michigan during a fierce windstorm attempting to blow the boat out into open water. The angle the rope makes with the boat is 42° and only half of the boat is below the surface of the water. What is the magnitude of the force of the wind?

Answers: 1) 3145 N 2) 4.53 N 3) 0.03 m 4) 0.186 kg
5) 30 people 6) 0.486 m/s^2 7) 2721 N

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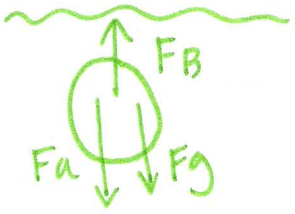


$F_{Net} = F_B - F_a - F_g$

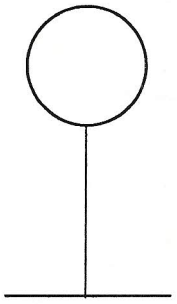
$ma = \rho_{water} g V - F_a - m(9.8\ m/s^2)$

$0 = \left(1000\ \frac{kg}{m^3}\right)(9.8\ m/s^2)\left(\frac{4}{3}\pi(.425m)^3\right) - F_a - (.5kg)(9.8\ m/s^2)$

$0 = 3151.239\ N - F_a - 4.9N$

$\boxed{F_a = 3146.3\ N}$

2. A 120g spherical balloon filled with helium is connected to a string. What is the tension in the string if the radius of the balloon is 0.5m? Do **not** ignore the mass of the helium in the balloon.



$V_{Balloon} = \frac{4}{3}\pi(.5m)^3$

$= .5235\ m^3$

$m_{He} = \rho_{He} V$

$m_{He} = \left(.179\ \frac{kg}{m^3}\right)(.5235\ m^3)$

$m_{He} = .0937\ kg$

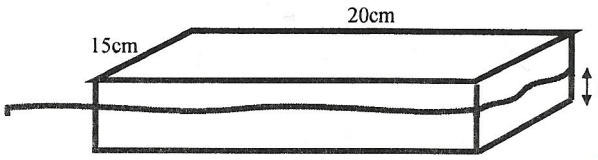
$F_{Net} = F_B - F_g - F_{gHe} - T$

$0 = \rho g V - m(9.8\ m/s^2) - m_{He}(9.8\ m/s^2) - T$

$0 = \left(1.29\ \frac{kg}{m^3}\right)(9.8\ m/s^2)(.5235) - (.12)(9.8\ m/s^2) - (.0937)(9.8) - T$

$\boxed{T = 4.5\ N}$

3. A block of wood measures 20cm × 15cm × 5cm and it floats in water. If it has a mass of 1.0kg, how deep will it press into the water?



3cm

F_B ↑ ↓ F_g

$F_{net} = F_B - F_g$

$0 = \rho g V - m(9.8 m/s^2)$

$0 = (1000 \frac{kg}{m^3})(9.8 m/s^2)(.2 \times .15 \times h) - (1kg)(9.8 m/s^2)$

$9.8 = 294h$ $\quad h = .03 = 3cm$

4. A spherical balloon filled with helium is held stationary by a young girl. The tension in the string is 0.45 N and the balloon has a radius of 0.35 meters. What is the mass of the balloon? Ignore the mass of the helium.

F_B ↑ ↓ F_g, ↓ T

$F_{net} = F_B - T - F_g$

$0 = \rho_{AIR}(9.8 m/s^2)(\frac{4}{3}\pi .35^3 m) - .45N - m(9.8 m/s^2)$

$0 = (1.29 \frac{kg}{m^3})(9.8 m/s^2)(.1795 m^3) - .45N - m(9.8)$

$m(9.8 m/s^2) = 1.82N$

$m = 0.1857 kg$

we want radius... whoops!

F_B ↑ ↓ $F_{g\,people}$, ↓ $F_{g\,wood}$

5. A raft is made of 10 logs lashed together. Each is 33cm in diameter and had a length of 6.1m. How many people can the raft hold before they start getting their feet wet, assuming the average person has a mass of 70 kg? Do not neglect the weight of the logs. The density of wood is 600kg/m^3.

$V_{of\ each\ log} = \pi r^2 h$

$= \pi (.165 m)^2 (6.1m)$

$= .5217 m^3$

$V_{total} = 10 \times .5217 m^3$

$= 5.217 m^3$

$m_{wood} = \rho_{wood} \cdot V$

$= (600 \frac{kg}{m^3})(5.217 m^3)$

$m_{wood} = 3130.39 kg$

$F_{net} = F_B - F_{g\,people} - F_{g\,wood}$

$0 = \rho_{water} V (9.8 m/s^2) - m_{people}(9.8) - F_{g\,w}$

$0 = (1000)(5.217 m^3)(9.8 m/s^2) - m_p(9.8 m/s^2) - 3130.4(9.8)$

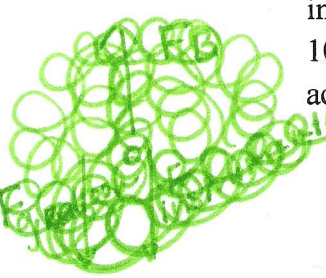
$0 = 20451.92N - m_{people}(9.8 m/s^2)$

$m_{people} = 2086.9 kg$

$\#\ of\ people = \frac{2086.9 kg}{70 kg}$

$= 29.8\ people$

6. An empty weather balloon has a mass of 5.0kg and a radius of 2.879m when fully inflated with helium. A meteorologist wishes to lift instruments that have a total mass of 100kg. Will the balloon be able to rise under these conditions? If so, what will its acceleration be?



$m_{He} = \rho_{He}(V)$

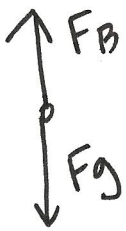
$= (.179 \frac{kg}{m^3})(99.957 m^3)$

$= 17.89 kg$

$V = \frac{4}{3}\pi r^3$

$= \frac{4}{3}\pi (2.879m)^3$

$= 99.957 m^3$



$m_{total} = m_{instruments} + m_{Balloon} + m_{He}$

$m_{total} = 100 kg + 5kg + 17.89 kg$

$m_{total} = 122.89 kg$

$F_{net} = F_B - F_g$

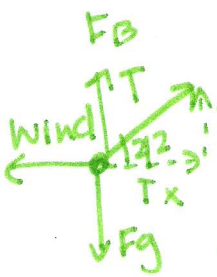
$ma = \rho_{AIR} V(9.8 m/s^2) - m_{tot}(9.8 m/s^2)$

$(122.89 kg)a = 1.29 \frac{kg}{m^3}(99.957 m^3)(9.8 m/s^2) - (122.89 kg)(9.8 m/s^2)$

$a = 4.8 m/s^2$

7. An empty boat of mass 1000 kg and total volume of 1.5 m^3 is tied to a pier on Lake Michigan during a fierce windstorm attempting to blow the boat out into open water. The angle the rope makes with the boat is 42° and only half of the boat is below the surface of the water. What is the magnitude of the force of the wind?

Volume submerged $= 1.5 m^3/2 = .75 m^3$



$F_{net} = F_B + T_y - F_g$

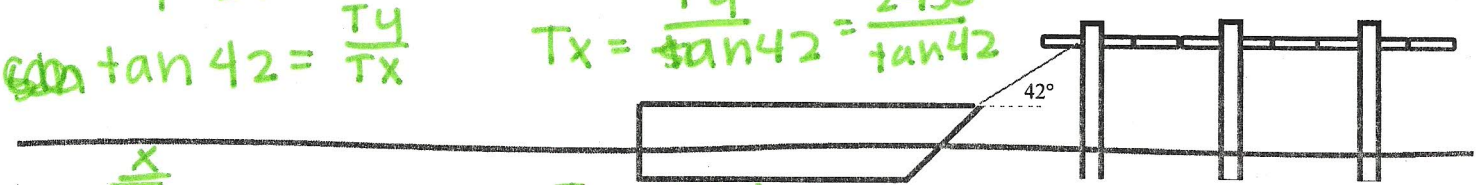
$0 = \rho_{water} V(9.8 m/s^2) + T_y - (1000)(9.8 m/s^2)$

$0 = 1000(.75)(9.8 m/s^2) + T_y - (1000)(9.8 m/s^2)$

$T_y = 2450$

$\tan 42 = \frac{T_y}{T_x}$

$T_x = \frac{T_y}{\tan 42} = \frac{2450}{\tan 42}$



$T_x = 2721 N$

$F_{net} = T_x - F_{wind}$

$0 = T_x - F_{wind}$

$T_x = F_{wind}$

$2721 N = F_{wind}$

Answers: 1) 3145 N 2) 4.53 N 3) 0.03 m 4) 0.186 kg
5) 30 people 6) 0.486 m/s^2 7) 2721 N