Physics 112
Exam 1
Winter 1995
#6 Sid Rudolph

Name: _____

Social Security #: _____

TA (circle one): Bird Denholm Harrison Johnston Roberts Wilcox

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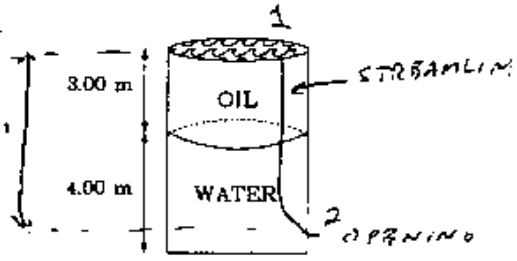
33 PTS

3 A circular tank with a 1.50 m radius is filled with two fluids, a 4.00 m layer of water and a 3.00 m layer of oil. Use $\rho_{oil} = 8.24 \times 10^{2}$ kg and $\rho_{water} = 1.00 \times 10^{3}$ kg/m^3, and $P_{atm} = 1.01 \times 10^{5}$ N/m^2.

kg/m^3



A. 10 PTS What are the gauge and absolute pressures 1.00 m above the bottom of the tank?

$P_{GAUGE} = \rho_{OIL} g h_{OIL} + \rho_{WATER} g h_{WATER}$

$= (8.24 \times 10^{2}\ kg/m^3)(9.8\ m/s^2)(3.00\ m) + (10^{3}\ kg/m^3)(9.8\ m/s^2)(3.00\ m)$

$\boxed{P_{GAUGE} = 5.36 \times 10^{4}\ N/m^2}$

$P_{ABS} = P_0 + P_{GAUGE} = 1.01 \times 10^{5}\ N/m^2 + 5.36 \times 10^{4}\ N/m^2$ $\boxed{P_{ABS} = 1.55 \times 10^{5}\ N/m^2}$

B. 8 PTS A block of material in the shape of a cube (m = 100 kg and side length = 42.0 cm) is released at the top of the oil layer. Where does the block come to rest? Justify your answer. If it comes to rest between two layers, specify which layers and what portion of the block sits in each layer. (NOTE: $V_{cube} = a^3$)

MEAN BLOCK DENSITY

$\rho_{BLOCK} = \frac{m}{V} = \frac{100\ kg}{(.42\ m)^3} = 1.35 \times 10^{3}\ kg/m^3 > \rho_{WATER} > \rho_{OIL}$

BLOCK SINKS TO BOTTOM OF TANK

C. 15 PTS A small 1.00 cm radius opening is made in the side of the tank 0.500 m up from its base (block was removed). What volume of water drains from the tank in 10.0 s?

USE BERNOULLI'S EQ BETWEEN POINTS 1 AND 2.

$P_1 + \rho_{OIL} g h_{OIL} + \rho_{WATER} g h_{WATER} + \frac{1}{2}\rho_{OIL} v_{OIL}^2$

$= P_2 + \rho_{WATER} g h_{WATER} + \frac{1}{2}\rho_{WATER} v_2^2$

$P_1 = P_2 = P_0$

ASSUME $v_{OIL} \ll v_2$

h_{OIL} = DIST FROM OIL-WATER INTERFACE TO TOP OF TANK

h_{WATER} = DIST FROM OIL WATER INTERFACE TO OPENING

$\frac{1}{2}\rho_{WATER} v_2^2 = \rho_{OIL} g h_{OIL} + \rho_{WATER} g h_{WATER}$

$v_2 = \sqrt{\dfrac{(2)\left[(824\ kg/m^3)(9.8\ m/s^2)(3\ m) + (1000\ kg/m^3)(9.8\ m/s^2)(.5\ m)\right]}{1000\ kg/m^3}}$

$\boxed{v_2 = 10.8\ m/s}$

$V_{DRAIN} = A v \Delta t = \pi R^2 v_2 \Delta t = \pi (.01\ m)^2 (10.8\ m/s)\Delta t$

$= \boxed{3.39 \times 10^{-2}\ m^3}$