Physics 2010
Fall 2002
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EXAM 4

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Name:_____ Student ID #:_____

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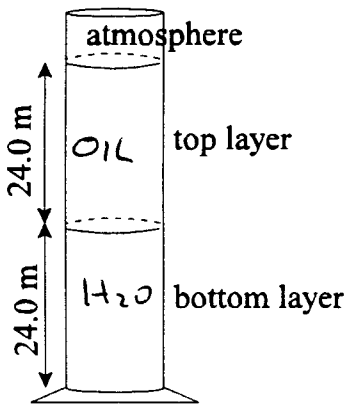
A. Water is poured into a tall glass cylinder until it reaches a height of 24.0 cm above the bottom of the cylinder. Next, olive oil (ρ_{oil} = 920 kg/m^3) is very carefully added until the total amount of fluid reaches 48.0 cm above the bottom of the cylinder. Olive oil and water do not mix. See figure. Take $\rho_{water} = 1.00 \times 10^3$ kg/m^3 and $P_{atm} = 1.01 \times 10^5$ N/m^2.



1. *[4 pts.]* Indicate on the drawing which layer is water and which is olive oil.
2. *[5 pts.]* What is the gauge pressure 10.0 cm below the top of the upper fluid layer in the cylinder.

$P_{GAUGE} = P_h - P_{ATM} = \rho_{OIL} g h_{OIL}$
$= (920\ kg/m^3)(9.8\ m/s^2)(.1\ m)$

$\boxed{P_{GAUGE} = 902\ N/m^2}$

3. *[5 pts.]* What is the gauge pressure on the bottom of the cylinder?

$P_{GAUGE} = P_{BOT} - P_{ATM} = \rho_{OIL} g h_{OIL(TOT)} + \rho_W g h_W$
$= (920\ kg/m^3)(9.8\ m/s^2)(.24\ m) + (10^3\ kg/m^3)(9.8\ m/s^2)(.24\ m)$

$\boxed{P_{GAUGE} = 4520\ N/m^2}$

4. *[5 pts.]* If the cylinder is in the shape of a right circular cylinder with radius of 3.60 cm, what force is exerted on the bottom of the cylinder?

$F_{BOT} = P_{BOT} A = (1.013 \times 10^5\ N/m^2 + 4520\ N/m^2)\,\pi\,(.036\ m)^2$

$\boxed{F_{BOT} = 431\ N}$

B. A 0.200 kg mass is hung from a massless spring. At equilibrium, the spring stretched 28.0 cm below its unstretched length. This mass is now replaced with a 0.500 kg mass. The 0.500 kg mass is lowered to the original equilibrium position of the 0.200 kg mass and suddenly released producing vertical SHM.

1. *[5 pts.]* What is the spring constant for this spring?

FROM $k x_e = mg$

$k = \frac{mg}{x_e} = \frac{(.2\ kg)(9.8\ m/s^2)}{(.28\ m)}$

$\boxed{k = 7.00\ N/m}$

2. *[5 pts.]* What is the period of oscillation for the 0.500 kg/spring system?

$\omega = \frac{2\pi}{T} = \sqrt{\frac{k}{m}}$ $\quad T = 2\pi\sqrt{\frac{.5\ kg}{7\ N/m}}$

$T = 2\pi\sqrt{\frac{m}{k}}$ $\quad \boxed{T = 1.70\ s}$

3. *[5 pts.]* What is the amplitude of this oscillation?

$x_e\,(NEW) = \frac{m_{NEW} g}{k} = \frac{(1.5\ kg)(9.8\ m/s^2)}{7.00\ N/m} = 0.70\ m$

$A = x_{NEW} - x_{OLD} = 0.70\ m - 0.28\ m$

$\boxed{A = 0.42\ m}$