PHYSICS 2 - SUMMER 2008
HOMEWORK 4

13.55 Pendulum A is a simple pendulum $\boxed{T_A = 2\pi\sqrt{\frac{L}{g}}}$

Pendulum B is a physical pendulum - Use the parallel axis theorem to find the moment of inertia of the ball for an axis at the top of the string

$$I = I_{CM} + ML^2 \qquad I_{CM} = \frac{2}{5}MR^2 = \frac{2}{5}M\left(\frac{L}{2}\right)^2 = \frac{1}{10}ML^2$$

$$I = \frac{1}{10}ML^2 + ML^2 = \frac{11}{10}ML^2$$

$$T_B = 2\pi\sqrt{\frac{I}{mgL}} = 2\pi\sqrt{\frac{11ML^2}{10MgL}} = \underline{2\pi\sqrt{\frac{11L}{10g}}} = \sqrt{\frac{11}{10}}\,T_A \;\underline{> T_A}$$

13.57

(a) $\boxed{\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}}$ Plugging numbers in $\omega' = 2.5\ \mathrm{rad/sec}$

(b) Critically damped: $\frac{k}{m} - \frac{b^2}{4m^2} = 0 \implies \boxed{b = 2\sqrt{km}}$

$\underline{b = 1.7\ \mathrm{kg/sec}}$

13.61 bv is a force

(a) $[b][v] = N \qquad [b] = \frac{N}{m/s} = \frac{kg\ m/s^2}{m/s} = kg/sec$

(b) See part (b) of problem 13.57 - We solved for critically damped as $b = 2\sqrt{km} \implies [b] = [\sqrt{km}]$

(c) $A = \frac{F_{MAX}}{b}\sqrt{\frac{m}{k}}$ at resonance $\left(\omega_d = \sqrt{\frac{k}{m}}\right)$

Thus, for ~~b=0.2~~ $b = a\sqrt{km}$ we find

$$A = \frac{F_{max}}{a\sqrt{km}}\sqrt{\frac{m}{k}} = \frac{F_{MAX}}{a\,k}$$

for $a=0.2 \implies A = 5\frac{F_{MAX}}{k}$, for $a = 0.4$ $A = 2.5\frac{F_{MAX}}{k}$

Q 14.30

(a) Buoyant force (F_b) only depends on volume of displaced $H_2O \Rightarrow F_b$ same for two blocks

(b) $T + F_b = W$, $T = W - F_b$

Since F_b is same but $W_{Pb} > W_{Al}$, the wire holding up the lead block has the higher tension

(c) Same, because H_2O pressure is the same

(d) Same, same reason as (c)

14.4 $\rho = 19.3\ 10^3\ \mathrm{kg/m^3}$ $V = L^3$

$$m = 10^6\ \$\ \frac{1\ \text{ounce}}{\$426.6}\ \frac{31.1035\ 10^{-3}\ \mathrm{Kg}}{1\ \text{ounce}} = 72.9\ \mathrm{kg}$$

$\rho = \frac{m}{V} \implies V = \frac{m}{\rho} = 3.78\ 10^{-3}\ \mathrm{m^3}$ $L = V^{1/3} = 15.6\ \mathrm{cm}$

14.10 (a) $\Delta p = \rho g \Delta y$ $\rho = 1.06\ 10^3\ \frac{\mathrm{kg}}{\mathrm{m^3}}$ $\Delta y = 1.65\,\mathrm{m}$

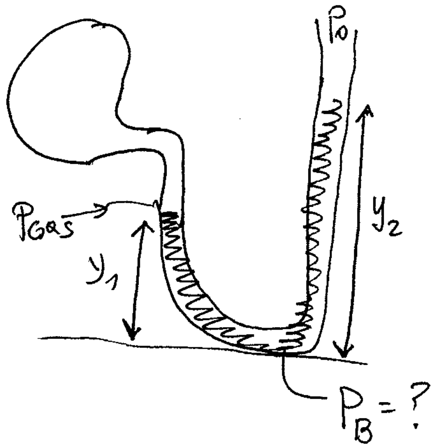
$\Delta p = 1.7\ 10^4\ \mathrm{Pa}$

(b) $\Delta F = \Delta p\, A$

$\Delta F = \Delta p\, \pi D L = 1.61\ \mathrm{N}$

14.16

$y_1 = 3\ cm \qquad \rho = 13.6\ 10^3\ kg/m^3$
$y_2 = 7\ cm$
$P_0 = 980\ millibars = 9.8\ 10^4\ Pa$



(a) $P_B = P_0 + \rho g y_2 = 1.07\ 10^5\ Pa$

(b) $p = P_0 + \rho g h$ with $h = 4\ cm$
$p = 1.03\ 10^5\ Pa$

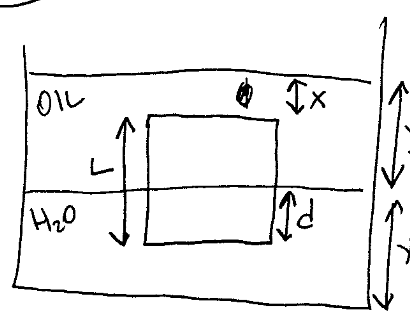
(c) $P_{GAS} = P_0 + \rho g (y_2 - y_1) = 1.03\ 10^5\ Pa$

(d) $P_{GAUGE} = P_{GAS} - P_0 = \rho g (y_2 - y_1) = 5.33\ 10^3\ Pa$

14.17

$P - P_{air} = \rho g h = 10^3 \frac{kg}{m^3}\ 9.8 \frac{m}{s^2}\ 6.1\ m = 6\ 10^4\ Pa$

14.31



$y_1 = 10\ cm \qquad y_2 = 10\ cm \qquad d = 1.5\ cm$
$L = 10\ cm \qquad \rho_{OIL} = 790\ kg/m^3$

(a) $P_{GAUGE} = \rho_{OIL} g x \qquad x + L - d = y_1$

$x = y_1 + d - L = 1.5\ cm$

$P_{GAUGE} = 790 \cdot 9.8 \cdot 1.5\ 10^{-2}\ Pa = \underline{\underline{116\ Pa}}$

(b) $P_{GAUGE} = \rho_{OIL} g y_1 + \rho_{H_2O} g d = \underline{\underline{921\ Pa}}$

(c) $F_b = \left(\rho_{OIL} V_{OIL} + \rho_{H_2O} V_{H_2O}\right) g$ $\qquad V_{OIL} = L^2 (L-d) \quad V_{H_2O} = L^2 d$

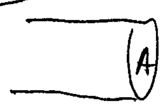
$W = \rho_{WOOD} V_{WOOD}\, g$ $\qquad V_{WOOD} = L^3$

$F_b = W \Rightarrow \quad \rho_{OIL} V_{OIL} + \rho_{H_2O} V_{H_2O} = \rho_{WOOD} V_{WOOD}$

$$\boxed{\frac{\rho_{OIL}(L-d) + \rho_{H_2O}\, d}{L} = \rho_{WOOD}} \qquad \rho_{WOOD} = \underline{821 \text{ kg/m}^3}$$

$m_{WOOD} = \rho_{WOOD} L^3 = \underline{0.821 \text{ kg}}$

14.34 The units are wrong, it should be m^3/s not m/s^3



volume flow rate $Av = F$ $\qquad F = 0.75\ m^3/s$

(a) $v = \frac{F}{A} = \frac{F}{\pi \left(\frac{d}{2}\right)^2}$ $\qquad \boxed{v = \frac{4F}{\pi d^2}}$ $\qquad \underline{v = 472 \text{ m/sec}}$

(b) $v \propto \frac{1}{d^2}$, so if d is three times larger $v = \frac{1}{9}\, 472\ m/s$

$\underline{v = 52.4\ m/s}$

14.40 Torricelli: $v = \sqrt{2gh} = 16.6\ m/s$

Flow rate $F = Av = \pi \left(\frac{d}{2}\right)^2 v = 4.7\, 10^{-4}\ m^3/s$