Physics 203 – Principles of Physics III
Homework Chapters 14 and 17
Assignment #1
February 5, 2008

14-14: $\rho gh = (1.00 \times 10^3\ \text{kg/m}^3)(9.80\ \text{m/s}^2)(6.1\ \text{m}) = 6.0 \times 10^4$ Pa. This corresponds to about 6/10 of an atmosphere. In other words, for every 16 meters of water the air pressure increases by about an atmosphere. Ask yourself what the pressure is against the hull of a submarine at a depth of just one football field in depth.

14-26: a) Neglecting the density of the air,

$$V = \frac{m}{\rho} = \frac{W/g}{\rho} = \frac{W}{g\rho} = \frac{(89\,\text{N})}{(9.80\,\text{m/s}^2)(2.7\,\text{x}\,10^3\,\text{kg/m}^3)} = 3.3610^{-3}\,\text{m}^3,$$

or 3.4×10^{-3} m^3 to two figures.

b) $T = W - B = W - g\rho_{water}V = W - g\rho_{aluminum}V\dfrac{\rho_{water}}{\rho_{alu\min um}}$

$$= W\left(1 - \frac{\rho_{water}}{\rho_{alu\min um}}\right) = (89\,\text{N})\left(1 - \frac{1.00}{2.7}\right) = 56.0\,\text{N}.$$

14-40: From Bernoulli's Equation, $p + \rho gy + \frac{1}{2}\rho v^2 = \text{cons}\tan\text{t}$. For heights, i.e. $y_1 = y_2$,

$$p_2 = p_1 + \frac{1}{2}\rho\left(v_1^2 - v_2^2\right) = p_1 + \frac{1}{2}\rho\left(v_1^2 - \frac{v_1^2}{4}\right) = p_1 + \frac{3}{8}\rho v_1^2$$

$$= 1.80 \times 10^4\ \text{Pa} + \frac{3}{8}(1.00 \times 10^3\ \text{kg/m}^3)(2.50\ \text{m/s})^2 = 2.03 \times 10^4\ \text{Pa},$$

where the continuity relation $\dfrac{v_2}{v_1} = \dfrac{A_1}{A_2} = \dfrac{1}{2}$ has been used.

14-51: a) The gauge pressure at the water-mercury interface is just the pressure due to the height of water

$\rho_{water}gh_{water} = (1.00 \times 10^3\ \text{kg/m}^3)(9.80\ \text{m/s}^2)(15.0 \times 10^{-2}\ \text{m}) = 1.47 \times 10^3$ Pa.

b) The gauge pressure at a depth of 15.0 cm – *h* below the top of the mercury column must be the same at all heights in the system or the same as the pressure at the bottom of the column of water, i.e. the pressure calculated in part (a),

$\rho_{Hg}g(15.0 \text{ cm} - h) = \rho_{water}g(15.0 \text{ cm})$, which is solved for $h = 13.9$ cm.

Note that since the height appears on both sides of the equation it is immaterial whether we use centimeters or meters.

14-56: a) The volume of water displaced must be that which has the same weight and mass as the ice. Using the density of water and noting so long as we use consistent units it does not make any difference whether this problem is done in MKS or cgs units,

$$\frac{9.70\,\text{gm}}{1.00\,\text{gm/cm}^3} = 9.70\,\text{cm}^3$$

b) No; when melted, it is as if the volume displaced by the 9.70 gm of melted ice displaces the same volume, and the water level does not change.

c) $$\frac{9.70\,gm}{1.05\,gm/cm^3} = 9.24\,cm^3.$$

d) The melted water takes up more volume that the salt water displaced, and so 0.46 cm^3 flows over. A way of considering this situation (as a thought experiment only) is that the less dense water "floats" on the salt water, and as there is insufficient volume to contain the melted ice, some spills over.

14.80: a) As in Example 14.8, the speed of efflux is $\sqrt{2gh}.$ After leaving the tank, the water is in free fall, and the time it takes any portion of the water to reach the ground is $t = \sqrt{\frac{2(H-h)}{g}}$, in which time the water travels a horizontal distance $R = vt = 2\sqrt{h(H-h)}.$
b) Note that if $h' = H - h, h'(H - h') = (H - h)h,$ and so $h' = H - h$ gives the same range. A hole $H - h$ below the water surface is a distance h above the bottom of the tank.

17-12: In a constant volume gas thermometer pressure is directly proportional to temperature; thus,

$$\frac{T_{\text{platinum}}}{T_{\text{water}}} = \frac{P_{\text{platinum}}}{P_{\text{water}}} = 7.476$$

(7.476)(273.16 K) = 2042.14 K
2042.14 K – 273.15 = 1769ºC.

17-31: a) $\alpha = (\Delta L)/(L_0\Delta T) = (1.9 \times 10^{-2} \text{ m})/((1.50 \text{ cm})(400\ \text{C}°)) = 3.2 \times 10^{-5}\ (\text{C}°)^{-1}$.

b) Thermal stress is given as $P = -Y\alpha\Delta T$.

$Y\alpha\Delta T = Y\Delta L/L_0 = (2.0 \times 10^{11} \text{ Pa})(1.9 \times 10^{-2} \text{ m})/(1.50 \text{ m}) = 2.5 \times 10^9$ Pa.

17-38: Assuming the total heat in is Q = (0.60) x 10 times x $\frac{1}{2}mv^2 \Big/ \text{time}$, then

$$\Delta T = (0.60) \text{ x } 10 \text{ x } \frac{K}{mc} = 6\frac{\frac{1}{2}MV^2}{mc} = \frac{(6)\frac{1}{2}(1.80\,\text{kg})(7.80\,\text{m/s})^2}{(8.00\text{x}10^{-3}\,\text{kg})(910\,\text{J/kg}\cdot\text{K})} = 45.1\text{C}^{\circ}.$$

17-60: The heat lost by the sample (and vial) melts a mass *m*, where

$$m = \frac{Q}{L_f} = \frac{((16.0\,\text{g})(2250\,\text{J/kg}\cdot\text{K}) + (6.0\,\text{g})(2800\,\text{J/kg}\cdot\text{K}))(19.5\,\text{K})}{(334\text{x}10^3\,\text{J/kg})} = 3.08\,\text{g}.$$

Since this is less than the mass of ice, not all of the ice melts, and the sample is indeed cooled to 0ºC. Note that conversion from grams to kilograms was not necessary.

17-68: a) Heat current is defined as $H = \frac{dQ}{dt} = kA\frac{T_H - T_L}{L}$

$$H = (0.040 \text{ W/m}\cdot\text{K})(1.40 \text{ m}^2)\ \frac{(175-35)\,\text{K}}{(4.0\text{x}10^{-2}\,\text{m})} = 196\,\text{W},$$

or 200 W to two figures.

b) The result of part (a) is the needed power input.