Name____________________________
Physics 110 Quiz #6, November 4, 2011

Please show all work, thoughts and/or reasoning in order to receive partial credit. The quiz is worth 10 points total.

1. A weatherglass, shown on the right, is used to give an indication of the change in the weather. If a low pressure weather system approaches

a. the water level in the neck drops.
b. the water level in the neck rises.
c. the water level in the neck remains the same.
d. the change in the water level in the in the neck cannot be determined since air pressure is not known.

2. In the calendar year 2007 the Atlantic hurricane season saw 17 storms with 6 of them hurricanes. A hurricane is a low-pressure system that when it moves over land from the open water, slows down and this dumps huge amounts of water on land and the storms are usually accompanied by strong winds.

a. Suppose that a hurricane is approaching your beachfront house with winds during the hurricane reaching *100 mph (about 45 m/s)*. A hurricane with wind speeds in the range 86 – 110 mph and is called a category 2 hurricane (and if you're ever on Jeopardy this also corresponds to a 12 on the Beaufort wind scale). Let's assume you have closed up your house for the impending hurricane. If the speed inside is close to zero and if the density of air is $\rho = 1.3\ kg/m^3$ what is the difference in pressure between the inside and outside of your house?

$$P_{in} + \tfrac{1}{2}\rho v_{in}^2 + \rho g h_{in} = P_{out} + \tfrac{1}{2}\rho v_{out}^2 + \rho g h_{out}$$
$$\Delta P = P_{in} - P_{out} = \tfrac{1}{2}\rho v_{out}^2 = \tfrac{1}{2}\times 1.3\tfrac{kg}{m^3}\times\left(45\tfrac{m}{s}\right)^2 = 1316.3\tfrac{N}{m^2}$$

where we have assumed that the roof is negligibly thin and we have used the fact that $v_{in} \sim 0\ m/s$.

b. What total force (magnitude and direction) would act on the roof if it were *10 m* by *10 m*? *Express your answer in pounds where 1N ~ ¼ pound.* In what direction would your roof move? Would the roof implode and fall to the floor of your house, or would it blow off and fly away? Explain your answer fully.

$$F = \Delta P \times A = 1316.3\tfrac{N}{m^2}\times(10m\times 10m) = 1.32\times 10^5\ N\times\frac{\frac{1}{4}lb}{1N} = 32{,}900 lb$$

and points vertically upwards from the inside of your house to the outside. To see this we turn to Bernoulli's equation. Since the energy is constant, the pressure is the greatest where the speed is the least. Thus the pressure in the house is greater than outside the house since the speed inside is lower than the speed outside. Thus the difference in pressure produces a lifting force and your roof blows off of your house.

Useful formulas:

Motion in the x, y or z-directions

$r_f = r_0 + v_{0r}t + \frac{1}{2}a_r t^2$

$v_{fr} = v_{0r} + a_r t$

$v_{fr}^{\ 2} = v_{0r}^{\ 2} + 2a_r \Delta r$

Uniform Circular Motion

$a_r = \frac{v^2}{r}$

$F_r = ma_r = m\frac{v^2}{r}$

$v = \frac{2\pi r}{T}$

$F_G = G\frac{m_1 m_2}{r^2}$

Geometry /Algebra

Circles	*Triangles*	*Spheres*
$C = 2\pi r$	$A = \frac{1}{2}bh$	$A = 4\pi r^2$
$A = \pi r^2$		$V = \frac{4}{3}\pi r^3$

$Quadratic\ equation: ax^2 + bx + c = 0,$

$whose\ solutions\ are\ given\ by: \ x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Vectors

$magnitude\ of\ a\ vector = \sqrt{v_x^{\ 2} + v^2_{\ y}}$

$direction\ of\ a\ vector \rightarrow \phi = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

Useful Constants

Linear Momentum/Forces

$\vec{p} = m\vec{v}$

$\vec{p}_f = \vec{p}_i + \vec{F}\Delta t$

$\vec{F} = m\vec{a}$

$\vec{F}_s = -k\vec{x}$

$F_f = \mu F_N$

Work/Energy

$K_t = \frac{1}{2}mv^2$

$K_r = \frac{1}{2}I\omega^2$

$U_g = mgh$

$U_S = \frac{1}{2}kx^2$

$W_T = FdCos\theta = \Delta E_T$

$W_R = \tau\theta = \Delta E_R$

$W_{net} = W_R + W_T = \Delta E_R + \Delta E_T$

$\Delta KE + \Delta U_S + \Delta U_g = 0$

$\Delta KE + \Delta U_S + \Delta U_g = -\Delta E_{dissapative}$

Heat

$T_C = \frac{5}{9}\left[T_F - 32\right]$

$T_F = \frac{9}{5}T_C + 32$

$L_{new} = L_{old}(1 + \alpha\Delta T)$

$A_{new} = A_{old}(1 + 2\alpha\Delta T)$

$V_{new} = V_{old}(1 + \beta\Delta T): \ \beta = 3\alpha$

$PV = Nk_BT$

$\frac{3}{2}k_BT = \frac{1}{2}mv^2$

$\Delta Q = mc\Delta T$

$P_C = \frac{\Delta Q}{\Delta t} = \frac{kA}{L}\Delta T$

$P_R = \frac{\Delta Q}{\Delta T} = \varepsilon\sigma A\Delta T^4$

$\Delta U = \Delta Q - \Delta W$

Rotational Motion

$\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2$

$\omega_f = \omega_i + \alpha t$

$\omega^2{}_f = \omega^2{}_i + 2\alpha\Delta\theta$

$\tau = I\alpha = rF$

$L = I\omega$

$\Delta s = r\Delta\theta : \ v = r\omega : \ a_t = r\alpha$

$a_r = r\omega^2$

Fluids

$\rho = \frac{M}{V}$

$P = \frac{F}{A}$

$P_d = P_0 + \rho g d$

$F_B = \rho g V$

$P_1 + \frac{1}{2}\rho v^2{}_1 + \rho g h_1 = P_2 + \frac{1}{2}\rho v^2{}_2 + \rho g h_2$

Simple Harmonic Motion/Waves

$\omega = 2\pi f = \frac{2\pi}{T}$

$T_S = 2\pi\sqrt{\frac{m}{k}}$

$T_P = 2\pi\sqrt{\frac{l}{g}}$

$v = \pm\sqrt{\frac{k}{m}}A\left(1 - \frac{x^2}{A^2}\right)^{\frac{1}{2}}$

$x(t) = A\sin\left(\frac{2\pi t}{T}\right)$

$v(t) = A\sqrt{\frac{k}{m}}\cos\left(\frac{2\pi t}{T}\right)$

$a(t) = -A\frac{k}{m}\sin\left(\frac{2\pi t}{T}\right)$

$v = f\lambda = \sqrt{\frac{F_T}{\mu}}$

$f_n = nf_1 = n\frac{v}{2L}$

$P = \frac{1}{2}\omega^2\mu v A^2$

Sound

$v = f\lambda = (331 + 0.6T)\frac{m}{s}$

$\beta = 10\log\frac{I}{I_0}; \quad I_o = 1\times10^{-12}\ \frac{W}{m^2}$

$f_n = nf_1 = n\frac{v}{2L}; \ f_n = nf_1 = n\frac{v}{4L}$