Department of Physics
National Dong Hwa University, 1, Sec. 2,
Da Hsueh Rd., Shou-Feng, Hualien, 974, Taiwan

General Physics I, Final 1
PHYS10000AA, AB, AC, Class year 106
01-18-2018

SN:_____, Name:_____

ABSOLUTELY NO CHEATING!

Note: This is a close-book examine. You can use pencil or any pen in answering the problems. Dictionary and Calculators are allowed.

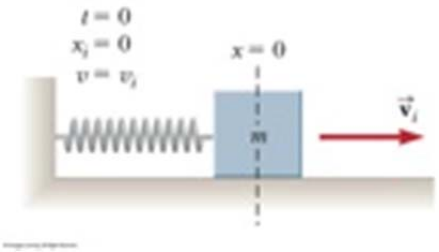
For a second order differential equation, $\frac{d^2x}{dt^2} + ax = 0$, the general solution of this equation is $x(t) = x_0 \cos(at + \phi)$, where x_0 is the maximum, and ϕ is the phase angle.

$N_A = 6\times10^{23}$, R = Gas constant= 8.31 J/mole K, room temperature =300K, 1atm=1.01×10^5 Pa.

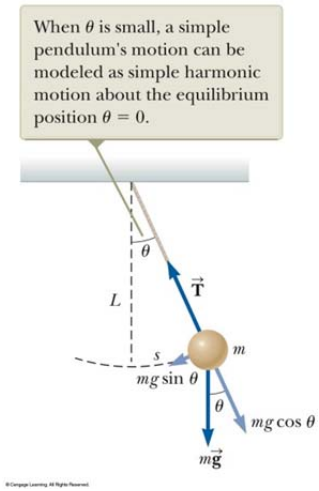
G=Gravitational constant=6.67×10^{-11} m^3 $Kg^{-1}s^{-2}$

$\overline{v_x} = \frac{v_{rms}}{\sqrt{3}}$ for ideal gas.

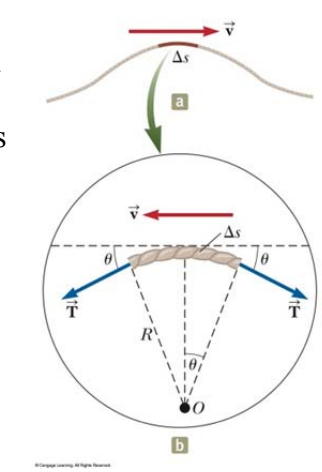
$Sin\,(A \pm B) = Sin\,A\,Cos\,B \pm Cos\,A\,Sin\,B$



Problems (6 Problems, total 120%)



1. **Harmonic Oscillation (20%):** (a, b) Refer to the figure to the right, write down differential equations that can describe the motion for a mass ***m*** attached to a spring of force constant ***k*** and the same mass attached to a pendulum of length ***L***. In both cases, use the given parameters. In the upper case, describe the motion in terms of its displacement ***x***; while in the lower case, describe its motion in terms of the angle***θ***. (c) If we treat the pendulum as a simple harmonic oscillator and look at only the horizontal displace ***s*** at small angle, what will the equation look like?



2. **Speed of waves on String Standing wave (20%)**:

   (a, 10%) Consider a string as shown in the figure to the right, a string wave is set up in the string and the wave travels to the right (the +x direction). What is the speed of the wave, in terms of the parameters to the right?

   (b, 5%) Now if the string were fixed on both ends and we initiate two waves traveling in opposite direction with wave functions can be described as the following:

   $y_1 = A\,Sin\,(kx - \omega t)$

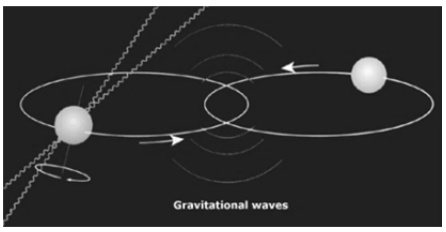
$y_2 = A\ Sin\ (kx + \omega t)$

What will be the resulting wave, expressed using the given parameters. What is the new amplitude of the combined wave?

(c, 5%) Suppose this string is of length ***L*** hanging across the room, what are the frequency (***f***) of the fundamental and first two harmonics?

3. **<u>Doppler Effect</u> (20%)**: A sound source emits a stable sound of frequency ***f*** and sound speed ***V***. A detector is able to detect the sound that can be moving or can be stationary. (a) If the detector is stationary, and source is moving toward to the detector with a speed $\boldsymbol{V_S}$, what will be the detected frequencies?

4. **<u>Gravitational Force</u> (20%)**: The gravitational wave is produced when two star systems merge/collide each other. If the two star systems of mass $\boldsymbol{M_1}$= 2×10^{50} kg and $\boldsymbol{M_2}$= 3×10^{50} kg are orbiting in their own orbitals as shown in figure to the right and if they experience 6×10^{25} ***N*** force during the generation of gravitational wave, Find out the separation distance between them?



5. **<u>Keplers Law</u> (20%)**

   (a) What are the three Kelper's laws?

   (b) If the radius of a planet orbit is r, the mass of the planet is Mp, moving with a velocity V in its orbit, prove the second Kepler's law.

6. **<u>Sound Wave</u> (20%):** Refer to the following figure, suppose a firework charge is detonated at the top of Taipei-101 as show in figure. Due to the explosion if the acoustic pressure is reached the maximum of $\boldsymbol{\Delta P_{max}}$ = 20 Pa at the distance of 1st person $d_1 = 1\times10^3$ m from the explosion, what sound level will be experienced by the 2nd person at a distance of $d_2 = 4\times10^3$ m? Let the speed of sound is constant at 332 m/s throughout the atmosphere, the air absorption rate of sound energy = 10 dB/km, the density of air ρ=1.2 kg/m^3 and $I_0=10^{-12}$ w/m^2.