Oscillations Worksheet

******* Use a pencil! *******

Name:____________________________ Partner: ___________________________

1) **Pendulum: Amplitude Dependence**. Make 15 measurements of T vs θ_0, using $L \approx 50$cm, and a metal bob. Your 15 starting angles should be *near* the following points: 2°, 3°, 4°, 5°, 7°, 9°, 12°, 15°, 20°, 25°, 30°, 35°, 40°, 50°, and 55°. Use a stopwatch to determine the total time for 5 periods, and then determine the period by dividing by 5. Plot T vs θ_0. We expected T to be constant, but it clearly is not. Based on the appearance of the plot, have Excel do a parabolic best-fit line for T vs θ_0 (in radians).

a. Write the equation:

$$T = (\qquad \pm \qquad)\text{s}\cdot\theta_0^2 + (\qquad \pm \qquad)\text{s}\cdot\theta_0 + (\qquad \pm \qquad)\text{s}$$

b. Comment on the extent to which this result is constant. Did you include the origin on your vertical scale?

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c. According to your equation, what is T_0 when $\theta_0 = 0°$? ________________________________

d. According to your equation, what is θ_0 (in degrees) when T is $1.01\times T_0$?__________________

e. Over what range of starting angles could you assume the period to be *reasonably* constant (meaning, not varying by more than about 1%)?

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2) **Pendulum: Length Dependence**. Make 10 measurements of T vs. L, all using $\theta_0 = 10°$, and a metal bob. L should vary between 10cm and around 100cm. You may not cut any string, so think before you begin! We expect that $T^2 = k^2 \frac{L}{g}$, so plot T^2 vs. L.

a. Using this result, what is your value of k/π?

$k/\pi =$ ________ $\pm$ ____________________

b. How well does this agree with the expected result? ________________________________

3) **Spring: Hooke's Law**. From a spring, gently hang masses varying from 50 through 500 g in 50 g increments. Do not let them oscillate. Measure the final position y of the bottom hook of the spring for each mass, and then plot $(m\cdot g)$ vs. y. Hint: this k has **nothing** to do with k for the pendulum.

a. What is the spring constant k? ______ $k =$ __________ $\pm$ __________ N/m ______

4) **Spring: Simple Harmonic Motion**. Using a spring, gently hang masses varying from 50 through 500 g in 50 g increments. Cause each to oscillate with an amplitude of no more than 6 cm. Use a stopwatch to determine the total time for 10 periods, and then determine the period by dividing by 10. Plot T^2 vs. m.

Hint: $\omega^2 = k/m$, and $\omega = 2\pi/T$

a. What is the spring constant k? ______ $k =$ __________ $\pm$ __________ N/m ______