國立東華大學
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 107
01-08-2019

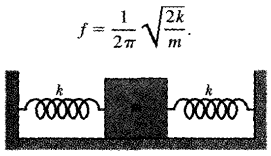
SN:_____, Name:_____

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.

Problems (6 Problems, total 100%)

1. **Spring system:** (15%) Two springs with identical force constant ***k*** are connected as shown in the figure to the right. Prove that the frequency of the oscillation on the frictionless surface is,



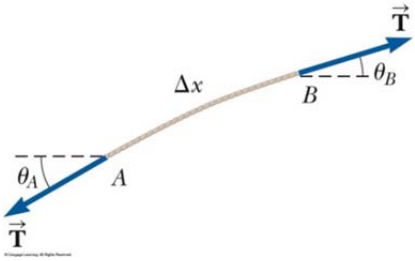
$$f = \frac{1}{2\pi}\sqrt{\frac{2k}{m}}$$

2. **Conservation of energy:** (20%) The gravitational force between two particles with masses ***m*** and ***M***, initially at great separation, pulls them together. What is the speed of either particle relative to the other, when ***d*** is the separation at that instant?

3. **Gravitation:** (15%) The magnitude of the gravitational force between a particle of mass m_1 and one of mass m_2 is given by $F(x) = G\frac{m_1 m_2}{x^2}$, where G is a constant, and x is the distance between two particles.
   (a) What is the corresponding potential energy function $U(x)$? (5%)
   (b) How much work is required to increase the separation of the particles from $x=x_1$ to $x=x_1+d$? (10%)

4. **Doppler effect:** (15%) If a sound wave has a speed ***v*** and frequency ***f***. What is the detected frequency when the source is moving at speed v_s towards the detector and the detector is stationary? Derive this.

5. **Wave equation**: (20%) Suppose you set up a traveling wave in a string. Refer to the figure to the right, if you focused on this section of the string, you can find the mass of the string is oscillating vertically (y-direction) that is it is perpendicular to the wave's travelling direction (say, to the right or in the +x direction). Let the same section, suppose the vibration of the string can be represented as a function ***y(x, t)***; a function of both ***x*** and ***t***; and let the line density of the string be μ, and ***T*** is the tension of the string. Prove that the wave equation describing this wave motion is $\frac{\mu}{T}\frac{\partial^2 y(x,t)}{\partial t^2} = \frac{\partial^2 y(x,t)}{\partial x^2}$.



6. **Escape Speed of a Rock:** (15%) Superman picks up a 20 Kg rock and throws it into the space. What minimum speed must it have at the Earth's surface to move infinitely far away from the Earth?