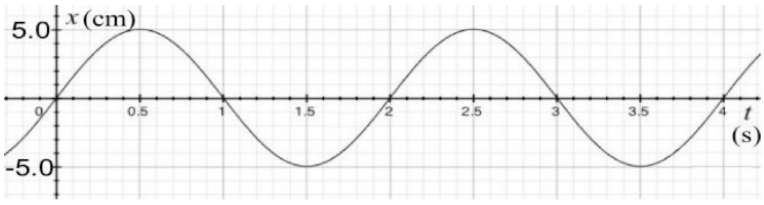
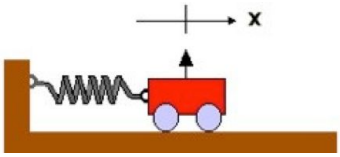
PHYS 234: Recitation 5
(Quiz: Feb 26, 2020)

1. **Estimation:** The amount of energy from the sun that reaches the earth is on the order of 1 kW/m^2. Solar panels are about a meter on each side and have an efficiency of about 10%. Estimate the number of solar panels needed to provide all the electricity in a typical house. *Clearly state your assumptions and how you came to the numbers you estimate.*

2. **Essay:** List the types of energy involved in the oscillation of a damped, horizontal mass-on-spring system, and explain how they are involved.

3. The graph below shows the position x as a function of time t of a cart attached to a spring.





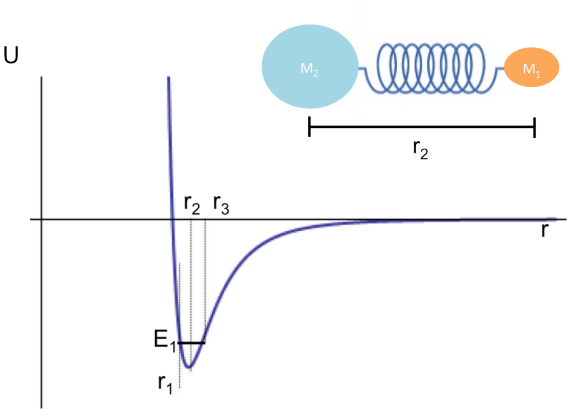
A. Give the numerical values of the period T, angular frequency ω, and amplitude A of the oscillation, to **one significant digit**, including units.

B. If the spring constant is $k = 9$ N/m, find the mass m of the cart, to **one significant digit**, including units.

C. If we quadrupled the mass of the cart, would the period T increase, decrease, or stay the same? If it increases or decreases, by what factor does it increase or decrease?

D. If we quadrupled the amplitude A of the oscillation, would the frequency ω decrease, or stay the same? If it increases or decreases, by what factor does it increase or decrease?

4. A diatomic molecule can be modeled as a mass-spring system. The bottom of the potential energy curve is well approximated by the quadratic curve of simple harmonic motion. The separation between molecules oscillates between a minimum of r_1 and a maximum of r_3, with an equilibrium separation of r_2.



A. If the atoms are separated by $r_2 = 0.13$ nm at time $t = 0$, and $r_3 = 0.14$ nm at time $t = 3 \times 10^{-15}$ s, draw a graph of r as a function of t for the molecule (with numbers and units on the axes).

B. Determine the frequency, amplitude, and period for this oscillation.

C. Draw energy bar charts (total energy, potential energy, and kinetic energy) for the following three points: $r = r_1$, $r = r_2$, and $r = r_3$ (without numbers or units on the axes).

5. If a mass m hung from a vertical spring extends the spring by a distance x, find an expression for the frequency f at which the spring should be driven for maximal resonance, in terms of m, x, and the gravitational acceleration g.