Worksheet 21: Oscillators

1. A 0.500-kg mass bobs on a spring with amplitude 0.110 m and a period of 0.70 s.
   a. What is its angular speed ω?

   b. What is the spring constant k of the spring?

   c. What is the maximum net force acting on the mass?

   d. What is the maximum acceleration of the mass?

   e. What is the maximum spring potential energy $\frac{1}{2} kx^2$?

   f. What is its maximum speed of the mass?

   g. What is the maximum kinetic energy $\frac{1}{2} mv^2$?

2. The position of a mass on a spring with time is given by the function $A \sin(\omega t)$.
   a. What is the formula for the velocity of the mass as a function of time?

   b. What is the formula for the potential energy U of the spring as a function of time?

   c. What is the formula for the kinetic energy K of the mass as a function of time?

   d. How do the maximum values of U and K compare? (Hint: $\omega^2 = k/m$.)

e. Sketch a graph of the U and K vs. time (plot both values on the same axis).

f. What is the formula for the mechanical energy of the spring-mass system?

3. A torsional oscillator can be thought of as a torsion spring with torque constant k and a rotor with moment of inertia I. Its kinematics follow an angular Hooke's law torque $\tau = -\kappa\theta$ and the angular Newton's second law $\tau = I\alpha$. Its angular displacement is given by the function $\theta = \cos(\omega t + \phi)$.

   What is the value of ω in this function, in terms of the characteristics of the spring and rotor?

4. Find the length of a simple pendulum with a period of oscillation of 2.0 s.