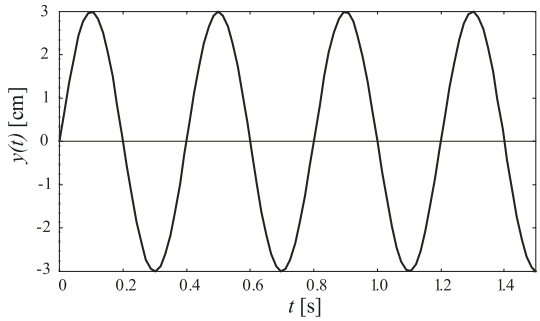
Oscillations

Basic Problems

1. Pick two different examples for a simple harmonic motion and choose the parameters such that their period is exactly 1.0 s.
2. A simple harmonic motion has a period of 4.5 s and an amplitude of 35 cm. Calculate its maximum velocity and acceleration.
3. The amplitude of a mass oscillating on a spring is increased from 20 cm to 25 cm. How does the maximum velocity change accordingly?
4. A mass oscillates on a spring with a period of 2.0 s. A second, identical mass is added. Calculate the new period of the pendulum.
5. The spring of a pendulum is replaced by another spring, increasing the period by 10 %. Calculate the percentage change in the spring constant.
6. A simple harmonic motion is characterised by the formal equation $r\, a_y(t) + s\, y(t) = 0$. Find a formal expression for the period.
7. At 30 cm displacement the kinetic energy of a mass in simple harmonic motion is half of its potential energy. Calculate the amplitude of the oscillation.
8. The figure below displays the oscillation of a spring pendulum (displacement vs. time). The mass of the pendulum is 500 g. Determine its period, angular frequency, frequency, amplitude and total energy. Calculate the spring's elastic constant.



9. The amplitude of an oscillation with linear envelope decreases to 20 % of the initial value within the first 0.3 s. How long does it take the energy to decrease to 50 % of the initial value?
10. Give two examples for situations where resonance is useful and unwanted, respectively.

Supplementary Problems

11. A mass of 550 g is attached to a spring with elastic constant 8.2 N/m. The mass is displaced by 20 cm from its equilibrium position and let go at $t = 0$. Draw diagrams for the displacement, velocity, acceleration and kinetic energy vs. time.
12. A test tube is immersed in a liquid to a height h_0. After a slight push it starts oscillating about its equilibrium position.
    a) Show that the test tube's motion is a simple harmonic motion. Derive a formal expression for the oscillation period.
    b) Calculate the period for a test tube with diameter 2.5 cm and mass 65 g oscillating in water.
    c) Assuming an undamped oscillation calculate the total energy of an oscillation with amplitude 4.7 cm.
    d) What parameters have an effect on the time constant of the damped oscillation?

Numerical Solutions: 2. 0.49 m/s, 0.68 m/s^2; 3. +25 %, yes; 4. 2.8 s; 5. −17 %; 6. $T = 2\pi \times \sqrt{r/s}$; 7. 37 cm; 8. 0.4 s, 2.5 Hz, 15.7 rad/s, 3 cm, 56 mJ, 120 N/m; 9. 0.11 s; 12. 0.73 s; 5.3 mJ