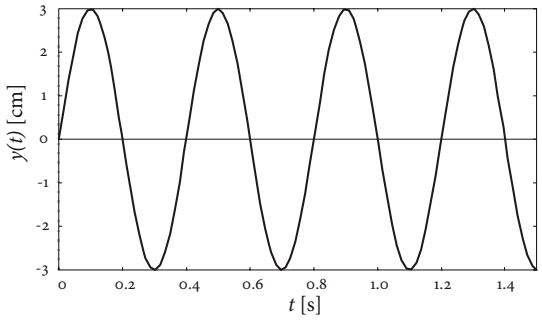
Simple Harmonic Motion

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? Does the velocity at 10 cm from the equilibrium position also change?
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 $r \cdot a_y(t) + s \cdot y(t) = 0$. Find a formal expression for the period.
7. An LC oscillator with capacitance 47 nF has a frequency of 3.7 kHz. Calculate the inductance of the circuit. The inductance is increased by a factor of 23 by introducing an iron core into the coil. How does this affect the frequency of the oscillator?
8. 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.
9. A capacitor with capacitance 150 nF is charged on 5.5 V and then connected to a coil with inductance 6.8 mH. Calculate the current flowing when the voltage across the capacitor has dropped to 2.5 V in two different ways.

Additional Problems

10. A mass of 550 g is attached to a spring with spring 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 and acceleration vs. time.
11. 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 constant.



12. A test tube is immersed in a liquid to a height h_o. After a slight push it starts oscillating around its equilibrium position.
    a) Show that the motion of the test tube 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 in water.

Solutions to Basic Problems: 2. 0.49 m/s, 0.68 m/s²; 3. +25 %, yes; 4. 2.8 s; 5. –17 %; 6. $T = 2\pi \cdot \sqrt{r/s}$; 7. 39 mH, - 79 %; 8. 37 cm; 9. 23 mA