Oscillators

Common characteristics:

- Oscillators have an undisturbed state, the *equilibrium position*.
- When the equilibrium is disturbed, *restoring* effects (e.g. forces) arise which drive the system back to the equilibrium state, but because of its inertia it *overshoots*, which again leads to restoring effects, etc.
- *Energy* has to be provided to initially disturb the equilibrium.
- The energy of the system is conserved in an *undamped* oscillator only. It oscillates between different forms of energy (e.g. potential and kinetic energy).
- In real systems the amplitude of the oscillation decreases as a consequence of *damping*.

Examples of oscillators:

- Mechanical Systems:
    - Gravity as restoring force:
        - mathematical pendulum
        - physical pendulum (pendulum clock, swing, balance)
        - oscillating liquid columns (horseshoe bend manometer)
        - swimming objects (areometer)
    - Elastic forces as restoring force (also in combination with gravity):
        - mass on a spring
        - torsion pendulum (e.g. balance-spring in a watch)
        - pitchforks, rods (xylophone), strings (string instruments), bowls (gong)
        - air columns (wind instruments)
- Electric and Magnetic Systems:
    - electrostatic restoring forces (also in combination with gravity): electroscope, free dipole in electric field
    - magnetic restoring forces: magnetic suspension, compass needle
    - electromagnetic systems: LC-oscillator, microwave resonator, dipole antennae
    - atomic oscillations in molecules and crystals, quartz oscillator
- Chemical Systems:
    - Belousov-Zhabotinsky reaction (periodic change of reduction and oxidation)
- Biological Systems:
    - predator-prey relationship (oscillations in the populations of two species which depend one on the other)