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 two different forms of energy (e.g. potential and kinetic energy) at twice the frequency of the system's own frequency.
- In real systems the amplitude of the oscillation decreases as a consequence of the *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):
    - spring pendulum
    - 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)