

Physics Course - Exercises Summer 2009

Stefan Kremer (kremer@tkm.uni-karlsruhe.de)

Revision sheet

Holger Schmidt (hschmidt@tkm.uni-karlsruhe.de)

2.10.2009

---

**1. Exercise: Kinematics and Kinetics**

- (i) Give the  $x(t)$  dependence for a uniform motion?
- (ii) What is the  $x(t)$  dependence for a motion with constant acceleration?
- (iii) State and explain Newton's axioms.
- (iv) Consider a mass point with mass  $m$  on an inclined plane (with angle  $\alpha$  with respect to the horizontal). Give the force (due to gravity) acting on the body! What is its acceleration?
- (v) Reconsider Atwood's machine with two masses  $m_1$  and  $m_2$ . Give the acceleration of the system and the tension force!

**2. Exercise: Energy and Collisions**

- (i) What is energy conservation?
- (ii) How can the velocity from the kinetic energy be obtained?
- (iii) At what height  $h$  will a mass  $m$  stop on an inclined plane when it is moving towards it with velocity  $v$ ?
- (iv) State the energy of a compressed spring.
- (v) How is in general a total elastic collision defined? Name and write down the two corresponding conservation laws.
- (vi) Give in general the conditions for a total inelastic collision.
- (vii) Simplify these for the case that one mass is at rest before the collision and the masses stick together afterwards.

**3. Exercise: Rigid body and Oscillations**

- (i) How is the moment of inertia of a rigid body defined?
- (ii) Derive the moment of inertia of a uniform rod of length  $\ell$  and mass  $m$  with respect to an axis of rotation through the centre.
- (iii) State the energy of a rotating rigid body.
- (iv) Give the parallel axis theorem.
- (v) Write down the equation of motion for an harmonic oscillator and give the general solution.
- (vi) State the equations of motion for a simple pendulum and a physical pendulum.
- (vii) Specify both equations for small angles  $\phi$  and give the solutions.
- (viii) What are the periods of the oscillations?

#### 4. Exercise: Electrostatics

- (i) What is the electric field of point charge  $Q$  and a capacitor with parallel plates of area  $\ell^2$ , charged by a voltage  $U$ ?
- (ii) State the electric force  $\vec{F}$  on a charge  $q$  in an electric field  $\vec{E}$ .
- (iii) How is the electric field  $E$  related to the voltage  $U$  and the distance  $d$  of the plates of a parallel plate capacitor?
- (iv) What kind of motion does a charge  $q$  if it enters a parallel plate capacitor perpendicular to the electric field? Give explicit the  $\vec{r}(t)$  and  $\vec{v}(t)$  dependence and the geometrical path  $y(x)$  for that kind of motion!
- (v) How can the angle be obtained with which such a charge will leave the capacitor?
- (vi) State the definition of the capacitance  $C$ ?
- (vii) What is the capacitance of parallel plate capacitor?
- (viii) What energy does a charge  $q$  gain in such a parallel plate capacitor (i.e. if the capacitor is used as an electron source)?

#### 5. Exercise: Electromagnetism

- (i) State and explain the content of Maxwell's equations.
- (ii) What is the magnetic field of a coil and a wire?
- (iii) How is the magnetic flux  $\Phi$  defined?
- (iv) What is the Lorentz-Force, i.e. the force of the magnetic field  $\vec{B}$  on a charge  $q$ , that moves with velocity  $\vec{v}$ ?
- (v) How can one calculate the force of a magnetic field  $B$  on a wire of length  $\ell$  carrying a current  $I$ ?
- (vi) What kind of path describes a charged particle in homogeneous magnetic field  $\vec{B}$ ?
- (vii) Explain the function of a velocity selector.

#### 6. Exercise: Circuits

- (i) What is the content of the Kirchhoff rules?
- (ii) State Ohm's law.
- (iii) What is the power dissipated in a resistor if a voltage  $U$  is applied?
- (iv) How can the equivalent resistance of two parallel resistors be calculated?
- (v) What is the equivalent resistance of two serial connected resistors?
- (vi) How can a battery with voltage  $U_0$  and internal resistance  $r$  be expressed in a equivalent circuit?
- (vii) What is period of an  $RCL$ -circuit?
- (viii) Sketch the  $I(t)$  dependence of the opening and closing of a  $RL$  circuit.
- (ix) How is the charge depending on time if an  $RC$  circuit is opened or closed?