UNIVERSITY OF LEIPZIG
INSTITUTE FOR THEORETICAL PHYSICS
Department: Theory of Elementary Particles

TP3 2017

Lecturer: PD Dr. A. Schiller

List of problems 5

13. Consider the motion of two charged particles (masses $m_{1,2}$, charges $q_{1,2}$) in a homogeneous magnetic field given by the constant vector $\mathbf{B}$. Find the condition under which the motion of the center of mass and the relative motion become decoupled.
    Hint: Use $\mathbf{A} = \frac{1}{2}\,\mathbf{B} \times \mathbf{r}$.

14. Find the Hamilton function for an anharmonic oscillator, the Lagrange function of which is given by

$$L = \frac{1}{2}\, m\, \dot{x}^2 - \frac{1}{2}\, m\, \omega^2\, x^2 - \alpha\, x^3 + \beta\, x\, \dot{x}^2 \,.$$

    Check that the Hamilton's equations of motion are equivalent to the Lagrange's equation of motion.

15. The Lagrangian for a particle in an external field (described by the potential V) in an inertial frame is given by

$$L_0 = \frac{1}{2} m \mathbf{v}_0^2 - V(\mathbf{r}_0)$$

    where the subscripts $_0$ denote the inertial frame.
    Consider a frame of reference rotating with constant angular velocity $\boldsymbol{\Omega}$. Denote all vectors in that frame by vectors without subscripts (e.g. $\mathbf{r_0} \to \mathbf{r}$). Find the Hamiltonian for the particle in that frame.
    Check that the corresponding Hamilton's equations are equivalent to the equation of motion for a particle in that rotating frame.