TFY4345 Classical Mechanics. Department of Physics, NTNU.

ASSIGNMENT 1

Question 1

Show by direct substitution that the transformed Lagrangian

$$L'(q, \dot{q}, t) = L(q, \dot{q}, t) + \frac{dF(q,t)}{dt},$$

where F is an arbitrary function of q and t, leads to the same equations of motion (the Lagrange equations) as the original Lagrangian $L(q, \dot{q}, t)$.
Hint: Start from the Lagrange equations and use the chain rule for partial derivatives of the function $F(q,t)$.

Question 2

A simple pendulum consists of a point mass m suspended from a massless rod of length ℓ. (Left figure below.) The pivot point is the origin of the coordinate system and the pendulum moves in the xy-plane. Let the gravitational force act in the negative y direction and choose zero potential in $y = 0$.

(a) Write down the coordinates of the point mass in terms of the angle β.
(b) Write down the potential $V(\beta)$, the kinetic energy $T(\beta, \dot{\beta})$ and the Lagrangian $L = T - V$ of the pendulum.
(c) Use the Lagrange equation to obtain the equation of motion for the pendulum.

Question 3

(a) Find the Lagrangian $L = T - V$ for the double pendulum in a uniform gravitational field. (Right figure below.) Choose the angles β_1 and β_2 as coordinates.
(b) Obtain the equations of motion using the Lagrange equations.