Northwestern University Department of Physics and Astronomy

PHYSICS 411-0 CLASSICAL MECHANICS

Ian Low, Winter 2010

Course Webpage: http://www.hep.anl.gov/ian/teaching/CM/CM_Winter10.html

ASSIGNMENT #2

Due at 2 PM, January 22nd

Problem 1

Consider an inertial frame K' whose origin coincides with a non-inertial frame K, which rotates with respect to K' with angular velocity $\mathbf{\Omega}(t)$. Starting from the Lagrangian of a free particle in K', first derive the Lagrangian in the K frame. Then use the Euler-Lagrange equation to derive the equation of motion of a free particle in K:

$$m\frac{d\mathbf{v}}{dt} = m\mathbf{r}\times\dot{\mathbf{\Omega}} + 2m\mathbf{v}\times\mathbf{\Omega} + m\mathbf{\Omega}\times(\mathbf{r}\times\mathbf{\Omega}) \ .$$

The second term on the right-hand side is the famous Coriolis force, while the third term is the familiar centrifugal force!

Problem 2

Consider a particle moving along the x-axis in an inertial frame K under the influence of a potential $U(x)$:

$$U(x) = \begin{cases} \infty \ , & \text{for } |x| \geq L \\ 0 \ , & \text{for } |x| < L \end{cases}$$

The momentum along the x-axis is not conserved. Why? Argue that, based on the symmetry property of the setup, it is conserved up to a sign: $\mathbf{p}_i = \pm\mathbf{p}_f$.

Problem 3

Problem 1.10 in Goldstein's.

Problem 4

Problem 1.18 in Goldstein's.

Problem 5

Problem 2.16 in Goldstein's.

Problem 6

Problem 2.22 in Goldstein's.