Due Date: 03/10/2020 at 1700hrs

Home Assignment 2

HA2.1. A bead of mass m is constrained to slide down a frictionless right circular helical wire under the influence of gravity. Assume the axis of the helix to be vertical (z-axis), a the radius of the helix, $2\pi b$ the constant pitch length, so that the parametric equation of the helix can be written as $\boldsymbol{r}(\lambda) = a\cos\lambda\ \hat{\boldsymbol{\imath}} + a\sin\lambda\ \hat{\boldsymbol{\jmath}} + b\ \lambda\hat{\boldsymbol{k}}$. Find the constraint force and an explicit solution to the equations of motion. If the wire had been in the shape of a parabola, say $x^2 = 4az, a > 0$, what would have been the equation of motion?

HA2.2. A block of mass m slides down on a frictionless incline. Solve for its equation of motion using D'Alembert's principle and Lagrange's method.

HA2.3. During the boiling of any liquid, a phase transition of takes place from its liquid to vapour state. Assume that during the process of boiling individual molecules do not change their vibrational state of motion, but all their possible translational and rotational degrees of freedom are suddenly restored. Using Boltzmann's law of equipartition of energy, namely an increase by $\frac{1}{2}k_B T_b$ per molecule per degree of freedom, calculate the contributions to the latent heat of vaporization of water, liquid nitrogen and liquid helium at their respective boiling points, $T_b = 373\ \mathrm{K}, 77\ \mathrm{K}$ and $4.2\ \mathrm{K}$, k_B being the Boltzmann's constant $= 1.38 \times 10^{-23}\mathrm{J/K}$.