1. (a) Assume that you can measure only the position of a particle and time. Formulate the Newton law for two isolated bodies using only these quantities.

(b) Use the results of (a) to define mass. Rewrite the Newton law using this definition.

(c) Use the results of (a) and (b) to define force and show how the three traditional Newton laws are related to this formulation.

2. A block of mass $m$ slides down a frictionless inclined plane under the influence of gravity. The angle of the inclination of the plane is $\theta$. The motion is resisted by a force $F_r = kmv^2$, where $k$ is a constant and $v$ is the (variable) velocity of the block, acting opposite to the direction of motion. The particle starts from rest. Calculate the time needed for the block to move a distance $d$ along the incline. You may need the integrals:

\[
\int \frac{dx}{a^2 - x^2} = \frac{1}{a} \tanh^{-1} \frac{x}{a}, \quad a > 0 \quad |x| < a
\]

\[
\int \tanh(ax)dx = \frac{1}{a} \ln[\cosh(ax)]
\]

3. Two gravitationally bound stars with unequal masses $m_1$ and $m_2$ are separated by a constant distance $d$ and revolve around their center of mass in circular orbits.

(a) Draw a figure showing the trajectories of the stars, their positions at some instant of time, the position of the center of mass, and the forces acting on each star.

(b) Find the dependence of the period of the motion $\tau$ on $d$, $m_1$, $m_2$, and the gravitational constant $G$. 