PHY 6/75101 December 5, 1997

Classical Mechanics — TEST II

Each question carries the same credit.

1. (a) What real and fictitious forces act on a projectile observed in flight from the earth's surface?
(b) Find an expression for the horizontal plane position $\mathbf{r}(t)$ for a projectile traversing the earth's surface at latitude λ. Assume that at time $t = 0$, the body is moving horizontally at high speed v_0, with negligible friction and in an arbitrary direction. Choose any coordinate system that is fixed relative to the earth, and take the earth's angular velocity to be ω_E. Only the largest non-zero force need be considered, you may assume that the deviation from a straight path is small for all times t of interest.

2. Three identical springs (force constant k) are joined in a loop and are constrained to lie along the circumference of a circle. A mass m is attached to one junction between two springs, and a mass $m + \delta m$ (where δm is small) is attached to each of the remaining two junctions. Find the eigenfrequencies of small vibrations along the arc of the circle, and describe each normal mode.

3. Write a paragraph on any *TWO* of the following. Include mathematical details where necessary, but focus mainly on the underlying concepts.
(a) The physical significance of *products of inertia* (off-diagonal elements in the inertia tensor of a body).
(b) Distinctions between matrices, tensors & dyadics in classical mechanics.
(c) The similarities and differences between normal modes in a vibrating system and principal axes in a rotating system.