

Classical Mechanics — TEST II

Each question carries the same credit.

- What real and fictitious forces act on a projectile observed in flight from the earth's surface?
 - 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.
- 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.
- Write a paragraph on any *TWO* of the following. Include mathematical details where necessary, but focus mainly on the underlying concepts.
 - The physical significance of *products of inertia* (off-diagonal elements in the inertia tensor of a body).
 - Distinctions between matrices, tensors & dyadics in classical mechanics.
 - The similarities and differences between normal modes in a vibrating system and principal axes in a rotating system.