

## Classical Mechanics — TEST II

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*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  $\lambda$ . 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  $\omega_E$ . 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  $\delta m$  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.