

Due: 19 October 2006

Read Marion & Thornton Chapter 3.

1. Where on Earth (at what latitude) must you be to see a Foucault pendulum precess once every two days?
2. In the Northern Hemisphere at latitude $+30^\circ$ find the initial velocity direction (unit vector) for which there is no initial Coriolis force. Answer in the format (n_x, n_y, n_z) with x =east, y =north, z =up. The magnitude should be 1.
3. Show that the solutions $x(t) = A \cos(\omega t) + B \sin(\omega t)$ and $x(t) = D \cos(\omega t + \phi)$ are equivalent by finding equations relating $(A$ and $B)$ to $(D$ and $\phi)$ and vice versa.
4. Suppose that a spring of force constant k has unstretched and uncompressed length ℓ . The spring is suspended vertically and loaded with a mass m .
 - (a) Find the equilibrium length of the loaded spring (the length of the spring when the mass is not oscillating).
 - (b) Find the natural angular frequency of undamped vertical oscillations.
 - (c) Compare with the natural angular frequency of undamped horizontal oscillations of the same spring with the same mass attached, sliding on a frictionless horizontal surface.
5. For a simple harmonic oscillator (mass on a spring, say) with potential energy U and kinetic energy T
 - (a) Sketch $U(t)$ and $T(t)$ vs. t on the same plot.
 - (b) Sketch $U(x)$ and $T(x)$ vs. x on the same plot.
 - (c) Calculate the time averages of U and T over one cycle.
 - (d) Calculate the space averages of U and T over one cycle.