Academic Year 2023-24

Tutorial #03

PH100: Mechanics and Thermodynamics

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1. The rate of change of acceleration is sometimes known as "jerk." Find the direction and magnitude of jerk for a particle moving in a circle of radius *R* at angular velocity \omega. Draw a vector diagram showing the instantaneous position, velocity, acceleration, and jerk.

2. A particle moves in a plane with constant radial velocity *4 m/s*. The angular velocity is constant and has magnitude 2 *rad/s*. When the particle is *3 m* from the origin, find the magnitude of (a) the velocity and (b) the acceleration.

3. A particle moves outward along a spiral. Its trajectory is given by $r = A\,\theta$, where *A* is a constant. *A = (1/\pi) m/rad*. θ increases in time according to $\theta = k\,t^2/2$, where *k* is a constant.
   (a). Sketch the motion, and indicate the approximate velocity and acceleration at a few points.
   (b). Show that when the radial acceleration is zero. At what angles do the radial and tangential accelerations have equal magnitude?

4. A 4-kg block rests on top of a 5-kg block, which rests on a frictionless table. The coefficient of friction between the two blocks is such that the blocks start to slip when the horizontal force F applied to the lower block is 27 N. Suppose that a horizontal force is now applied only to the upper block. What is its maximum value for the blocks to slide without slipping relative to each other?

5. Find the center of mass of a thin uniform plate in the shape of an equilateral triangle with sides *a*.

6. A system is composed of two blocks of mass m_1 and m_2 connected by a massless spring with spring constant *k*. The blocks slide on a frictionless plane. The un-stretched length of the spring is *l*. Initially m_2 is held so that the spring is compressed to *l/2* and m_1 is forced against a stop, as shown. m_2 is released at *t = 0*. Find the motion of the center of mass of the system as a function of time.