1. A rod of length 30.0 cm has linear density (mass-per-length) given by
\[ \lambda = 50.0 \text{ g/m} + 20.0 x \text{ g/m}^2, \]
where \( x \) is the distance from one end, measured in meters. (a) What is the mass of the rod? (b) How far from the \( x = 0 \) end is its center of mass? (c) What is the rotational inertia of the rod about the end? Draw the integration diagram showing \( dm \), etc.

2. A uniform rod is 2.0 m long. The rod is pivoted about a horizontal, frictionless pin located 25.0 cm from the left end of the rod. The rod is released from rest at an angle of 30° above the horizontal and is free to rotate about the pin in a vertical circle. Ignore friction or air resistance. a. What is the angular acceleration of the rod at the instant it is released? Sketch the situation and label the lever arm. b. What is the speed at the bottom of the circle?

3. A particle is located at the vector position \( \vec{r} = (4.00 \hat{i} + 6.00 \hat{j}) \text{ m} \), and the force acting on it is \( \vec{F} = (3.00 \hat{i} + 2.00 \hat{j}) \text{ N} \). What is the torque about (a) the origin and (b) the point having coordinates (0, 6) m? Sketch the vectors for both cases, showing angles too.

4. The density of the Earth, at any distance \( r \) from its center, is approximately
\[ \rho = [14.2 − 11.6 r/R] \times 10^3 \text{ kg/m}^3 \]
where \( R \) is the radius of the Earth. Show that this density leads to a moment of inertia \( I = 0.330 MR^2 \) about an axis through the center, where \( M \) is the mass of the Earth. Sketch everything.

5. A 1.50-kg particle moves in the \( xy \) plane with a velocity of \( \vec{v} = (4.20 \hat{i} − 3.60 \hat{j}) \text{ m/s} \). Determine the particle's angular momentum when its position vector is \( \vec{r} = (1.50 \hat{i} + 2.20 \hat{j}) \text{ m} \).

6. The position vector of a particle of mass 2.00 kg is given as a function of time by \( \vec{r} = (6.00 \hat{i} + 5.00t \hat{j}) \text{ m} \). Determine the angular momentum of the particle about the origin, as a function of time.

7. A rigid, massless rod has three particles with equal masses attached to it as shown. The rod is free to rotate in a vertical plane about a frictionless axle perpendicular to the rod through the point \( P \), and is released from rest in the horizontal position at \( t = 0 \). Assuming \( m \) and \( d \) are known, find (a) the moment of inertia of the system (rod plus particles) about the pivot, (b) the torque acting on the system at \( t = 0 \), (c) the angular acceleration of the system at \( t = 0 \), (d) the linear acceleration of the particle labeled 3 at \( t = 0 \). Draw the situation showing levers etc.