1. That “Pyramid and Orb” fountain on the South 40 made a lot more sense after President Bush’s speech last night, when it was revealed that this sculpture was actually installed to assist with efforts to spy on Americans with poor artistic taste. Information is transmitted nightly when the orb \((R = 0.5 \text{ m})\) rolls onto a hinge atop the pyramid as shown and rotates at a constant rate of \(\omega_1 = 1 \text{ rad/s}\). At the instant shown, \(\frac{d\theta}{dt} = 0.5 \text{ rad/s}\), \(\frac{d^2\theta}{dt^2} = -1 \text{ rad/s}^2\), and \(\theta = 45^\circ\).

Using any convenient coordinate system,

(a) What is the angular velocity of the orb?
(b) What is the angular acceleration of the orb?
(c) What is the velocity of point A relative to the domestic terrorist?
(d) What is the acceleration of point A relative to the domestic terrorist?

2. When attacked, the orb \((R = 0.5 \text{ m})\) extends massless pastry knives as it leaps onto a rigid shaft \((L = 1.5 \text{ m})\) that extends horizontally from the top of the pyramid. The shaft rotates at the constant rate of \(\omega_1 = 4 \text{ rad/s}\) as the orb spins at the constant rate of \(\omega_2 = 5 \text{ rad/s}\). The mass of the orb is \(M = 1000 \text{ kg}\).

(a) What are the angular velocity and angular acceleration of the orb?
(b) What is the acceleration of the orb’s center of mass?
(c) What moment must the end of the shaft exert on the orb?
(d) What force must the end of the shaft exert on the orb?
3. A domestic terrorist is caught, too late, in a plan to cause widespread obesity amongst the American populace by flinging Pillsbury® crescent rolls using the device pictured below. The linear elastic spring \((k = 264 \, \text{N/m})\) has an unstretched length of 20 cm. The bar \((l = 20 \, \text{cm}, \, m = 1 \, \text{kg})\) is released from rest in a horizontal position. What is the velocity of the launching point (end B) when the bar is vertical?

![Diagram of the device](image1)

4. The terrorist flings a crescent roll into the Bear’s Den, then flees in the ensuing melee to a hideout in deep space to hatch future sinister schemes. His space station consists of a thin ring of mass \(M = 10000 \, \text{kg}\) and radius \(R = 50 \, \text{m}\), with two slender cross bars of mass \(m = 3000 \, \text{kg}\) and length \(2R\).

(a) What constant angular velocity does the space station need so that the acceleration at point A equals 9.81 m/s²?

(b) What average force \(T\) do the thrusters need to apply so that space station accelerates from rest to an angular speed of 0.5 rad/s over a 10 second interval?

![Diagram of the space station](image2)