1. A bearded man pirouettes for joy upon being rescued from a deep hole in the ground. Idealize his mud-encrusted beard as a solid square plate of mass \( m \) and dimensions \( b \times b \), as shown (\( b = 10 \text{ cm} \)). If the man rotates at the constant rate of \( \omega = 5 \text{ rad/s} \), to what angle \( \theta \) will his beard rise?

2. Upon being issued a razor, the man fires a rifle in celebration. The bullet has a constant speed relative to the rifle barrel of 2700 km/h (750 m/s). The rifle is spinning at a constant rate \( \omega = 0.05 \text{ rad/s} \), and the rifle's angle of elevation is being changed at a constant rate of \( \frac{d\theta}{dt} = 0.2 \text{ rad/s} \). \( \theta = 75^\circ \).

   (a) What is the angular velocity of the rifle?
   (b) What is the angular acceleration of the rifle?
   (c) What is the velocity of the bullet's center of gravity?
   (d) What is the acceleration of the bullet's center of gravity?
3. The bullet severs the cable supporting one of the concrete sewage pipes waiting to be installed beneath Forest Park Parkway, and it rolls without slipping for 10 meters to the bottom of the incline. The pipe has a mass of 500 kg and an outer radius of 1.5 m. The angle $\theta$ is 20°.

(a) What will be the speed of the center of gravity of the pipe at the base of the incline?

(b) If the pipe rolls 1m back up the incline after hitting the bottom, what was the coefficient of restitution of the impact? Neglect friction along the lower wall during the impact.

4. In order to correct the trajectory of a 10,000 kg alleged weapon of mass destruction, the thrust of engine A will be increased. Just before the increase in thrust at A, the two engines each produce a thrust of 200 kN. The trajectory must be rotated by 1° in 1s. Treat the rocket as a thin, uniform bar that is 60m long. Find:
   (a) The required increase in the thrust of engine A, and
   (b) The linear acceleration of the center of gravity immediately after the thrust is increased at A.