A gimbal pedestal supports a payload in the space shuttle and deploys it when the doors of the cargo bay are opened in orbit. The payload is modeled as a homogeneous rectangular block with a mass of 6000 kg. The torque on the gimbal axis O-O is 30 N·m supplied by a d-c brushless motor. With the shuttle orbiting in a "weightless" condition, determine the time \( t \) required to bring the payload from its stowed position at \( \theta = 0 \) to its deployed position at \( \theta = 90^\circ \) if the torque is applied for the first 45° of travel and then reversed for the remaining 45° to bring the payload to a stop (\( \theta = 0 \)).

**Ans.** \( t = 78.6 \text{ s} \)

1. **Find moment of inertia**
   \[
   I_{\text{block}} = \frac{1}{12} m (b^2 + l^2)
   \]
   \[
   = \frac{1}{12} 6000 (1.5^2 + 2.5^2)
   \]
   \[
   I_{\text{block}} = 4250 \text{ kg·m}^2
   \]
   \[
   I_0 = I_{\text{block}} + mr^2
   \]
   \[
   = 4250 + (6000)(2.05)^2
   \]
   \[
   I_0 = 29465 \text{ kg·m}^2
   \]

2. **Sum moments**
   \[
   EM_0 = I_0 \alpha
   \]
   \[
   30 N·m = 29465 \alpha
   \]
   \[
   \alpha = 1.0182 \times 10^{-3} \text{ rad/s}^2 = 0.05834 \text{ deg/s}^2
   \]

3. **Find time to get to 45°**
   \[
   \theta = \frac{1}{2} \alpha t^2 \ 	ext{ constant} \alpha
   \]
   \[
   t_{45} = \sqrt{\frac{2 \theta}{\alpha}}
   \]
   \[
   t_{45} = \sqrt{\frac{2 (45)}{0.05834}}
   \]
   \[
   t_{45} = 39.28 \text{ s}
   \]

4. **Time to get from 45° to 90° is the same**, so
   \[
   t = 2 t_{45}
   \]
   \[
   t = 78.55 \text{ s}
   \]