Midterm

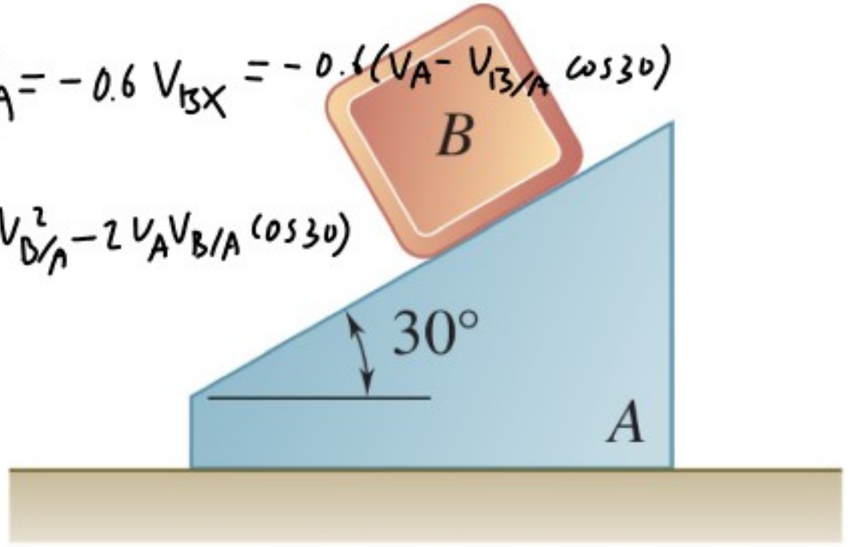
- Take home
- Thursday — Saturday
- All subjects through assignment 7
- Open Notes
- Open Book

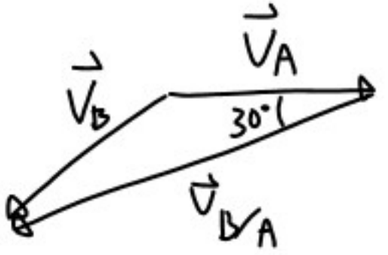
A 15-lb block B starts from rest and slides on the 25-lb wedge A, which is supported by a horizontal surface. Neglecting friction, determine (*a*) the velocity of B relative to A after it has slid 3 ft down the inclined surface of the wedge, (*b*) the corresponding velocity of A.

$$1499 = 9V_{Bx}^2 + 15V_B^2$$

$$V_A = -0.6\,V_{Bx} = -0.6(V_A - V_{B/A}\cos 30)$$

$$= 9(V_A - V_{B/A}\cos 30)^2 + 15(V_A^2 + V_{B/A}^2 - 2V_A V_{B/A}\cos 30)$$





$$\vec{V}_B = \vec{V}_A + \vec{V}_{B/A}$$

$$V_{Bx} = V_A - V_{B/A}\cos 30$$

$$V_B^2 = V_A^2 + V_{B/A}^2 - 2V_A V_{B/A}\cos 30$$

$$V_A = -0.6(V_A - V_{B/A}\cos 30)$$

$$= -0.6V_A + 0.6V_{B/A}\cos 30$$

$$V_A + 0.6V_A = 0.6V_{B/A}\cos 30$$

$$1.6V_A = 0.6V_{B/A}\cos 30$$

$$V_A = \frac{0.6V_{B/A}\cos 30}{1.6} = 0.32V_{B/A}$$

$$1449 = 9(V_A - V_{B/A}\cos 30)^2 + 15(V_A^2 + V_{B/A}^2 - 2V_A V_{B/A}\cos 30)$$

$$= 9(0.32V_{B/A} - V_{B/A}\cos 30)^2 + 15((0.32V_{B/A})^2 + V_{B/A}^2 - 2(0.32V_{B/A})V_{B/A}\cos 30)$$

$$= 9(0.29)V_{B/A}^2 + 15(0.59V_{B/A}^2)$$

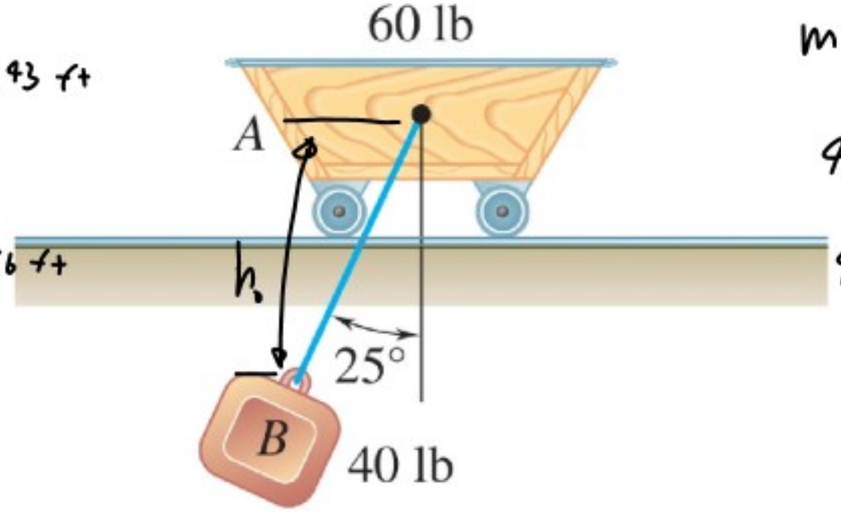
$$1449 = 10.9V_{B/A}^2$$

$$V_{B/A}^2 = \frac{1449}{10.9} = 133$$

$$\boxed{V_{B/A} = 11.5 \text{ ft/s}}$$

$$V_A = 0.32(11.5) = \boxed{3.68 \text{ ft/s}}$$

A 40-lb block B is suspended from a 6-ft cord attached to a 60-lb cart A, which may roll freely on a frictionless, horizontal track. If the system is released from rest in the position shown, determine the velocities of A and B as B passes directly under A.



$L_0 = 0$

$L_A + L_B = 0$

$m_A V_A + m_B V_B = 0$

$60 V_A + 40 V_B = 0$

$90 V_B = -60 V_A$

$V_B = \frac{-60}{90} V_A = -1.5 V_A$

$h_0 = 6 \cos 25 = 5.43$ ft

$h_1 = 6$ ft

$h = 6 - 5.43 = 0.56$ ft

$V_B = -9.15$ ft/s

$m_B g h = T_A + T_B = \frac{1}{2} m_A V_A^2 + \frac{1}{2} m_B V_B^2$

$90 \text{ lb}\, h = \frac{1}{2} \frac{60}{32.2} V_A^2 + \frac{1}{2} \frac{90}{32.2} V_B^2$

$90(0.56) = \frac{1}{2} \frac{60}{32.2} V_A^2 + \frac{1}{2} \frac{90}{32.2} (-1.5 V_A)^2$

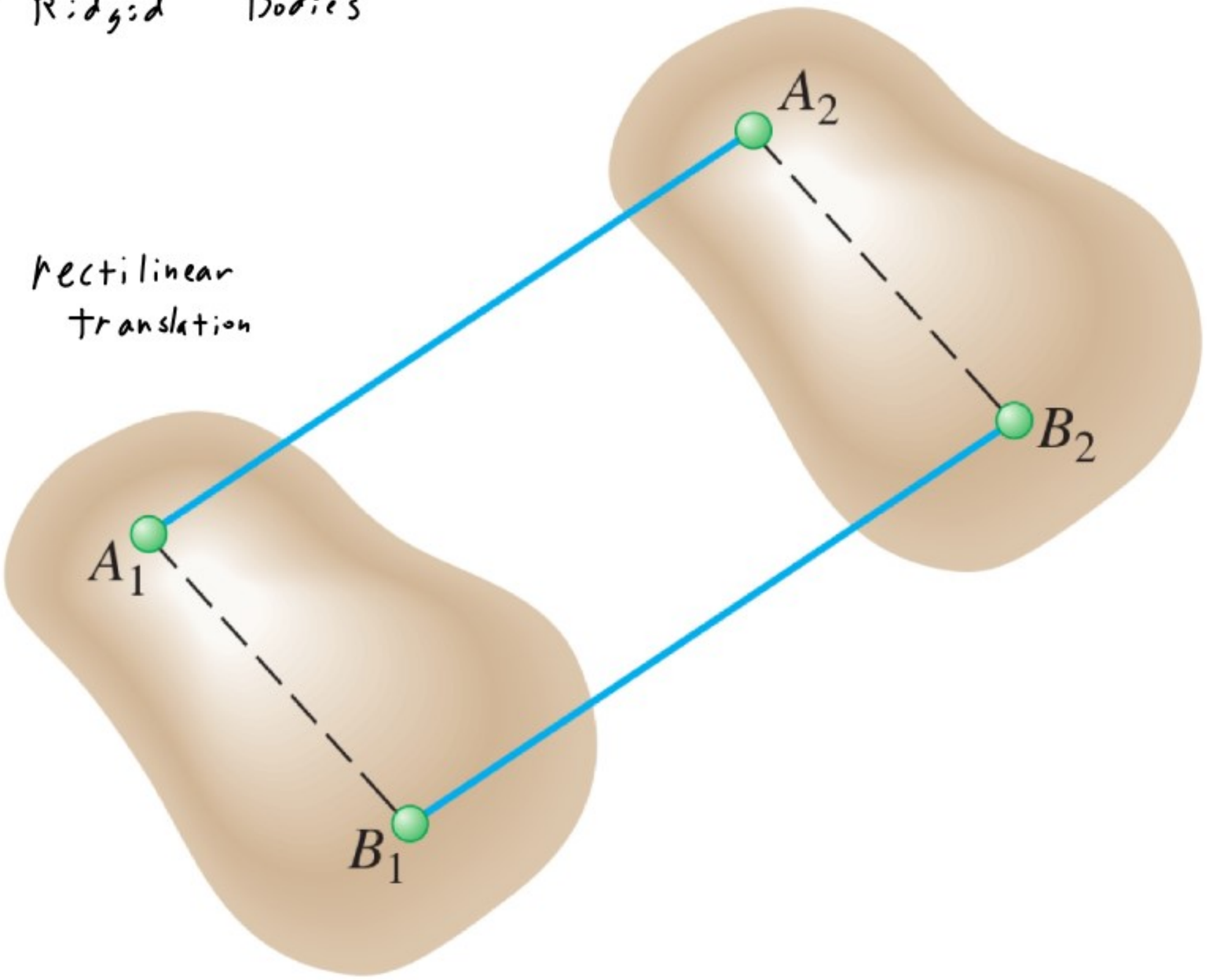
$22.5 = 0.93 V_A^2 + 1.39 V_A^2 = 2.33 V_A^2$

$\frac{22.5}{2.33} = V_A^2 = 9.65$

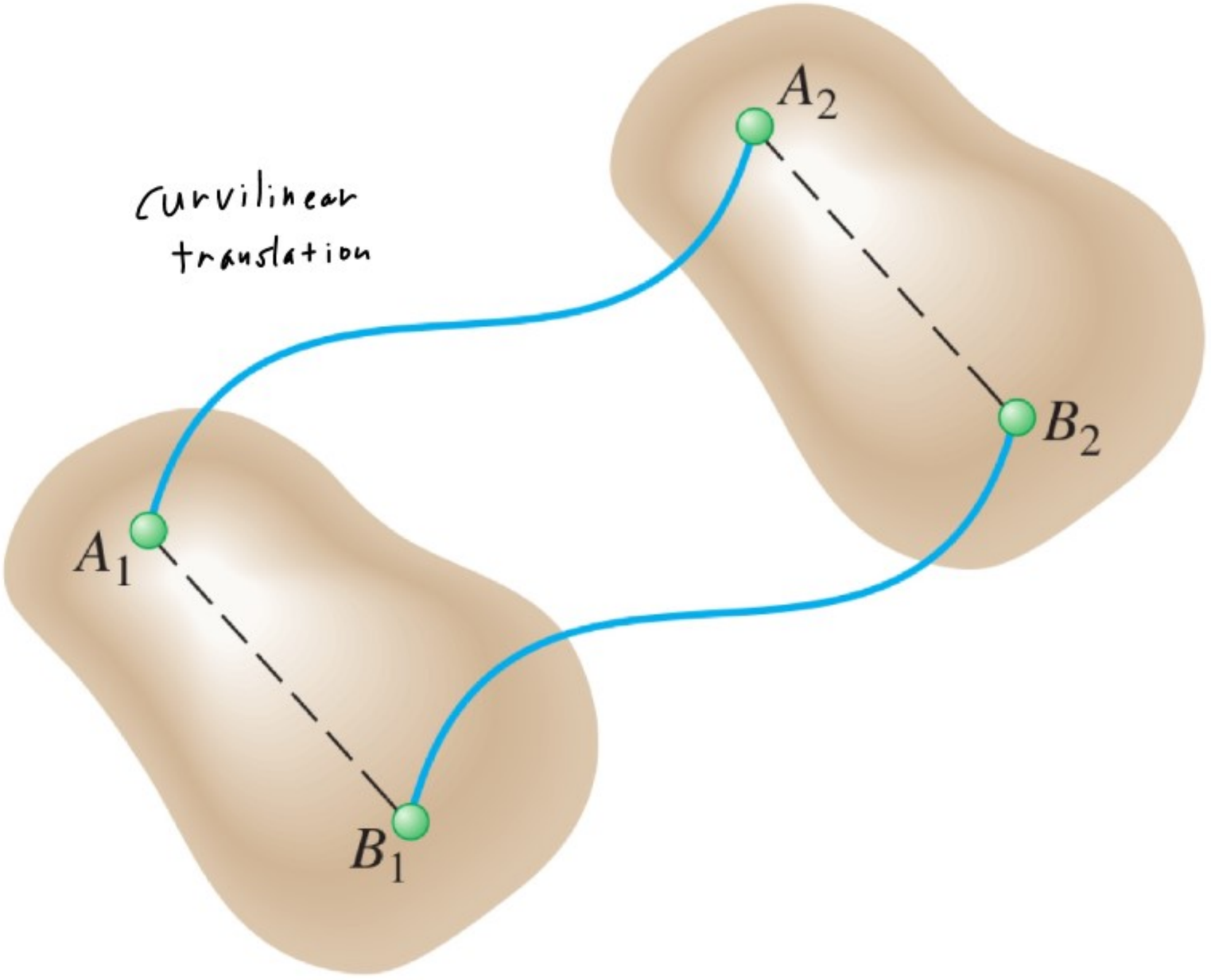
$V_A = 3.1$ ft/s

Kinematics of Rigid Bodies

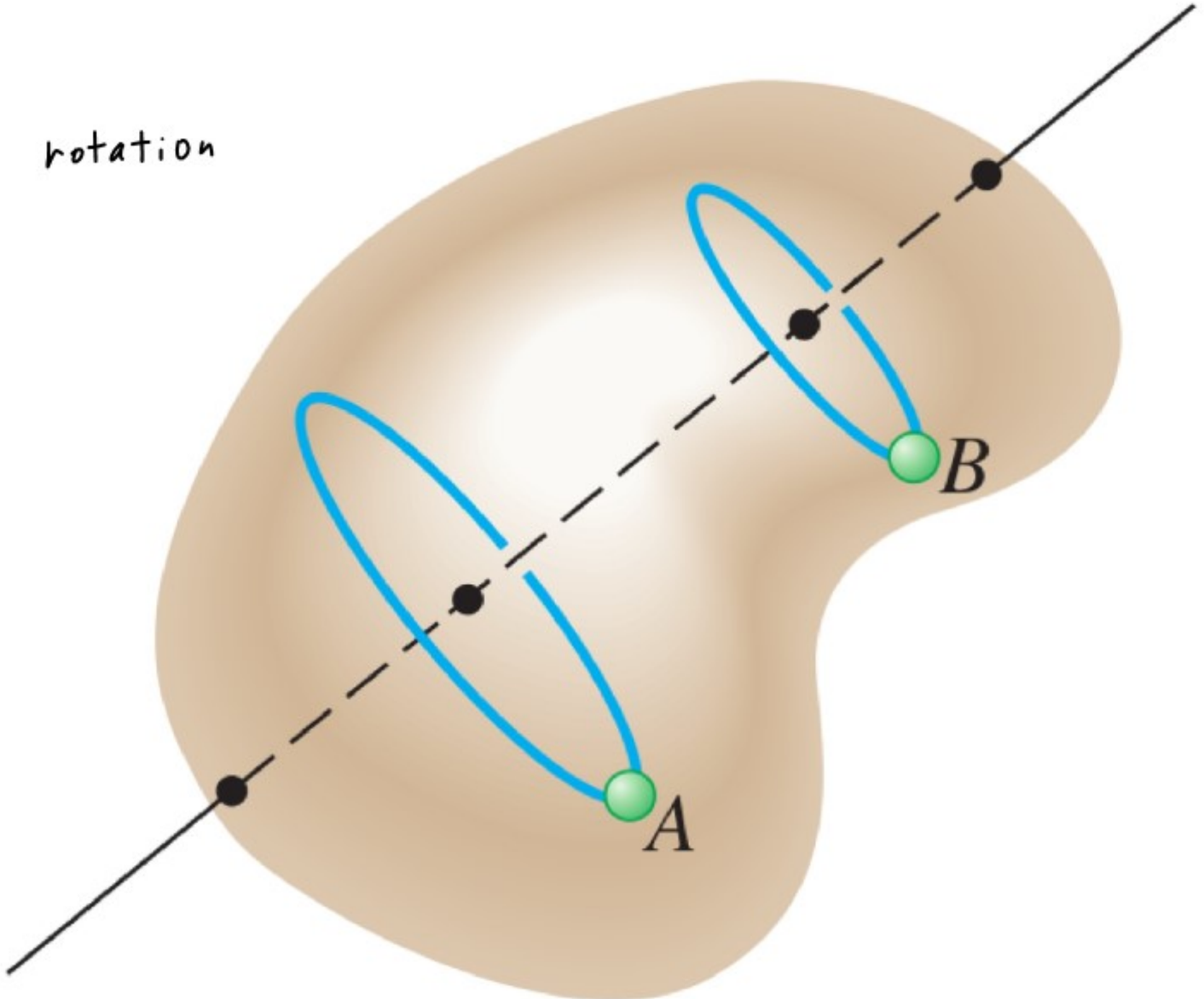
rectilinear translation

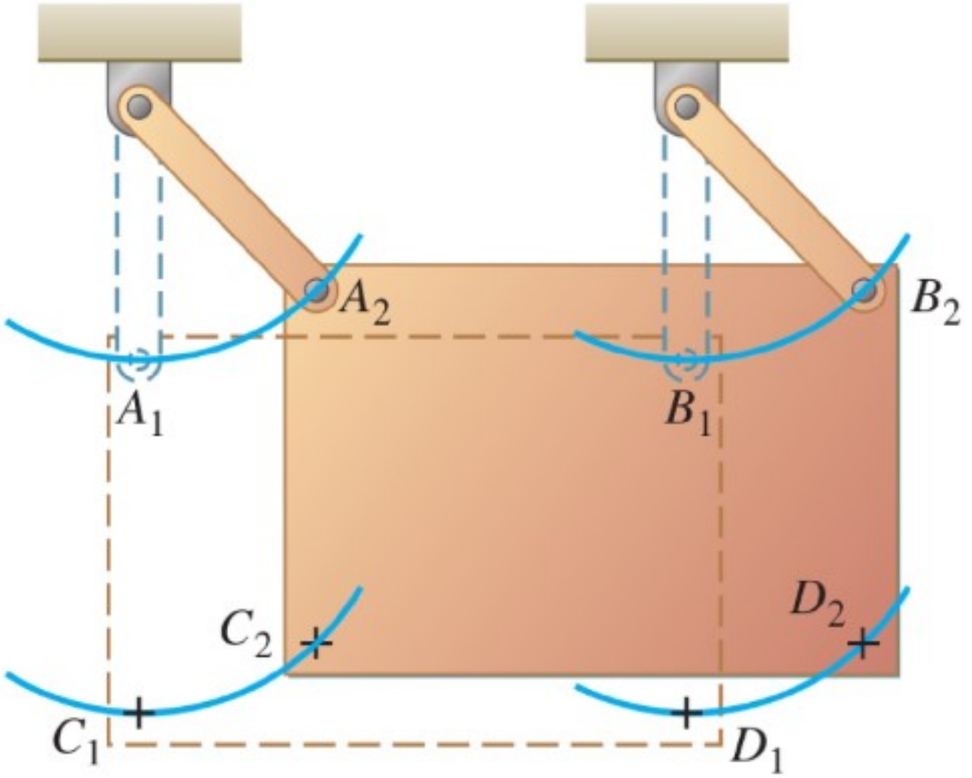


curvilinear translation

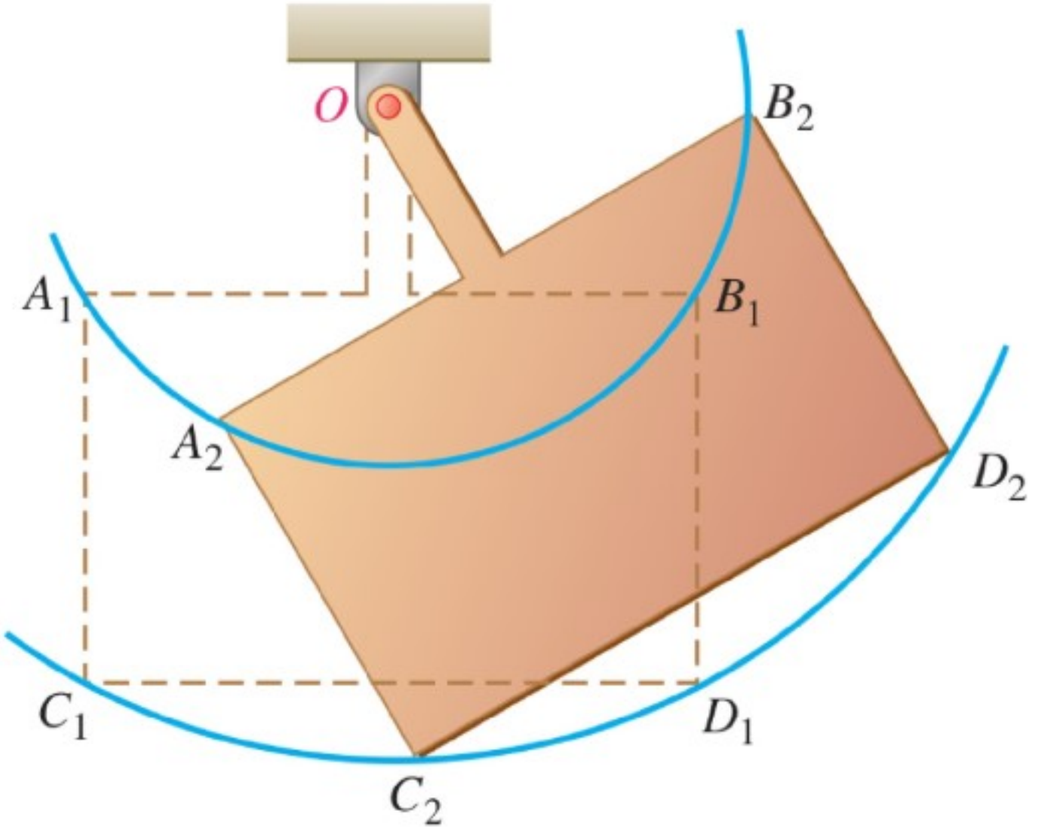


rotation





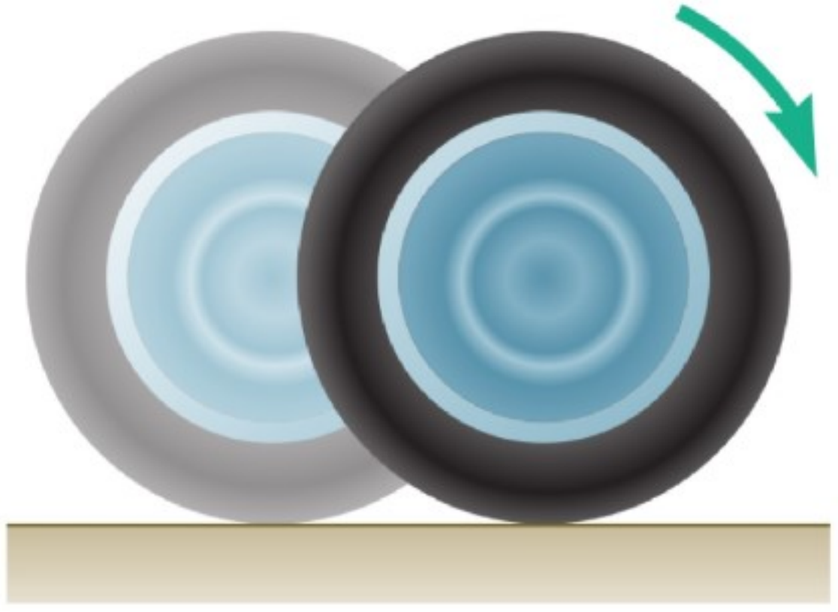
(*a*) Curvilinear translation



(*b*) Rotation

General Plane Motion

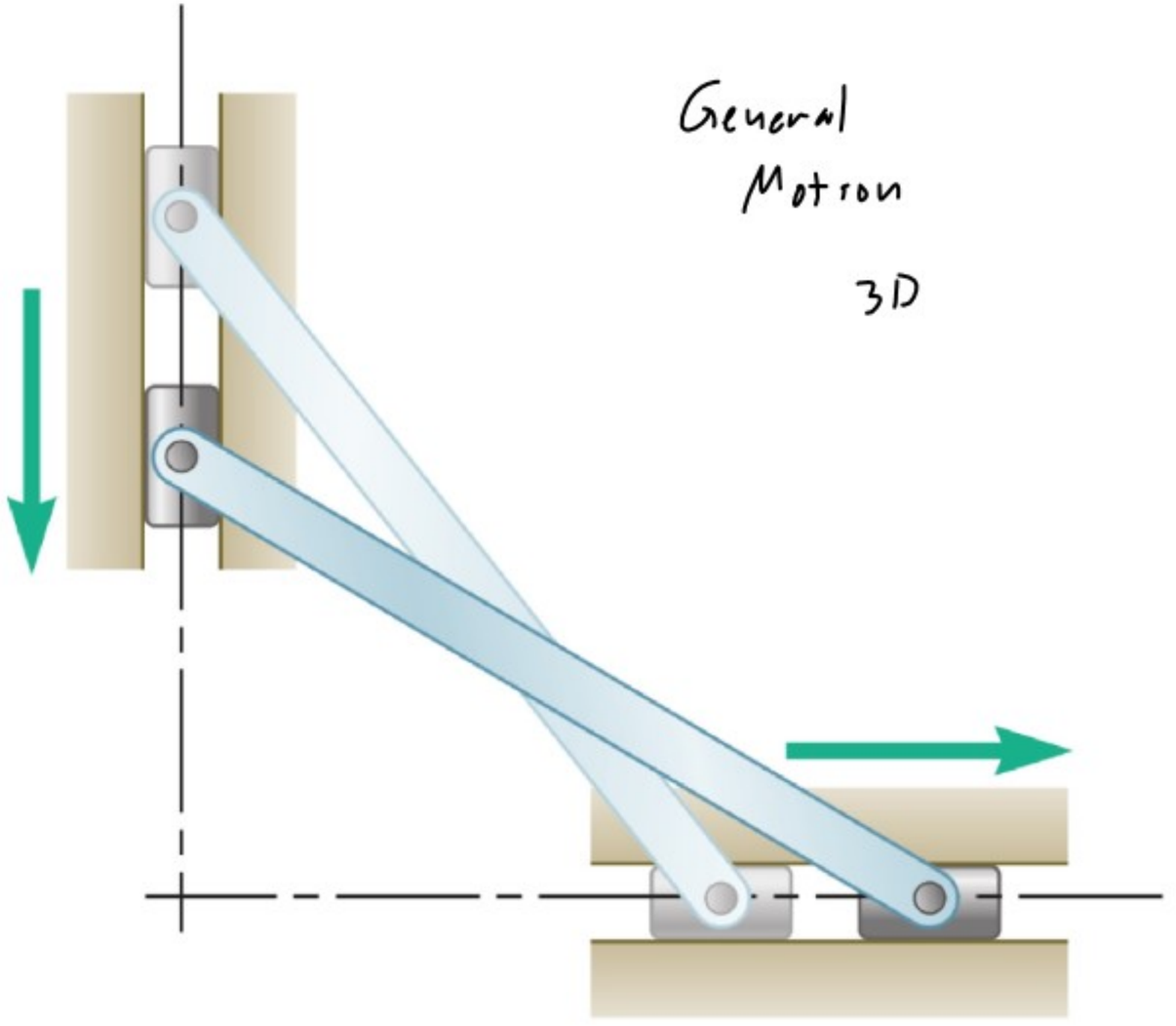
translation
+
rotation



(*a*) Rolling wheel

General
Motion

3D



(*b*) Sliding rod