

ME 5550 Intermediate Dynamics
Exercises #2 Answers

1. Reference frame $B: (\underline{e}_1, \underline{e}_2, \underline{k})$ along the (x, y, z) axes.

$$\underline{v}_A = L(\dot{\theta}C_\phi \underline{e}_1 - \dot{\phi}S_\phi \underline{e}_2 + \dot{\phi}C_\phi \underline{k})$$

$$\underline{a}_A = L((\ddot{\theta}C_\phi - 2\dot{\theta}\dot{\phi}S_\phi)\underline{e}_1 - (\ddot{\phi}S_\phi + \dot{\phi}^2C_\phi + \dot{\theta}^2C_\phi)\underline{e}_2 + (\ddot{\phi}C_\phi - \dot{\phi}^2S_\phi)\underline{k})$$

2. Reference frames: R (fixed frame), and $C: (\underline{e}_1, \underline{e}_2, \underline{e}_3)$

(The results given here are calculated for the instant shown in the diagram, not for an arbitrary position.)

$${}^R \underline{v}_A = (-r\omega_3 S_\theta)\underline{e}_1 + (r\omega_3 C_\theta)\underline{e}_2 + [r\omega_1 S_\theta - (L + rC_\theta)\omega_2]\underline{e}_3$$

$$\begin{aligned} {}^R \underline{a}_A = & \left[-r\dot{\omega}_3 S_\theta - r\omega_3^2 C_\theta - (L + rC_\theta)\omega_2^2 + 2r\omega_1\omega_2 S_\theta \right] \underline{e}_1 + \\ & \left[r\dot{\omega}_3 C_\theta - r\omega_1^2 S_\theta - r\omega_3^2 S_\theta \right] \underline{e}_2 + \\ & \left[r\dot{\omega}_1 S_\theta - (L + rC_\theta)\dot{\omega}_2 + 2r\omega_2\omega_3 S_\theta + 2r\omega_1\omega_3 C_\theta \right] \underline{e}_3 \end{aligned}$$

3. ${}^R \underline{v}_A = 0.81 \underline{i} - 0.72 \underline{j} + 0.76 \underline{k}$ (m/s) (at the instant shown)

$${}^R \underline{a}_A = 0.64 \underline{i} - 1.392 \underline{j} - 1.92 \underline{k}$$
 (m/s²) (at the instant shown)