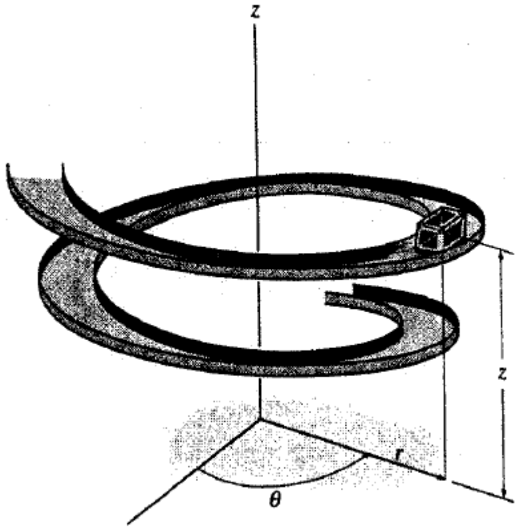
ÇALIŞMA SORULARI- POLAR HAREKET

12-171. The crate slides down the section of the spiral ramp such that $r = (0.5z)$ ft and $z = (100 - 0.1t^2)$ ft, where t is in seconds. If the rate of rotation about the z axis is $\dot{\theta} = 0.04\pi t$ rad/s, determine the magnitudes of the velocity and acceleration of the crate at the instant $z = 10$ ft.



$r = 0.5z$

$z = 100 - 0.1t^2$

Thus,

$r = 50 - 0.05t^2$

$\dot{r} = -0.1t$

$\ddot{r} = -0.1$

$\dot{\theta} = 0.04\pi t$ rad/s $= 0.12566t$ rad/s

$\ddot{\theta} = 0.12566$

$\dot{z} = -0.2t$

$\ddot{z} = -0.2$

At $z = 10$ ft,

$10 = 100 - 0.1t^2$

$t = 30$ s

$r = 50 - 0.05(30)^2 = 5$

$\dot{r} = -0.1(30) = -3$

$\ddot{r} = -0.1$

$\dot{\theta} = 0.12566(30) = 3.76991$

$\ddot{\theta} = 0.12566$

$\dot{z} = -0.2(30) = -6$

$\ddot{z} = -0.2$

$v_r = \dot{r} = -3$

$v_\theta = r\dot{\theta} = 5(3.76991) = 18.850$

$v_z = \dot{z} = -6$

$v = \sqrt{(-3)^2 + (18.850)^2 + (-6)^2} = 20.0$ ft/s **Ans**

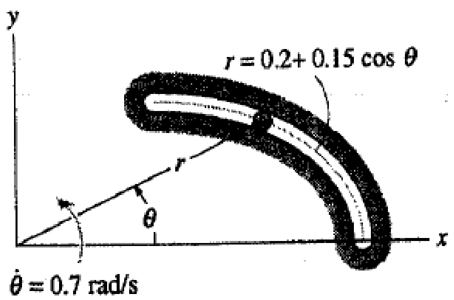
$a_r = \ddot{r} - r\dot{\theta}^2 = -0.1 - 5(3.76991)^2 = -71.16$

$a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta} = 5(0.12566) + 2(-3)(3.76991) = -21.99$

$a_z = \ddot{z} = -0.2$

$a = \sqrt{(-71.16)^2 + (-21.99)^2 + (-0.2)^2} = 74.5$ ft/s^2 **Ans**

***12-168.** The pin follows the path described by the equation $r = (0.2 + 0.15\cos\theta)$ m. At the instant $\theta = 30°$, $\dot{\theta} = 0.7$ rad/s and $\ddot{\theta} = 0.5$ rad/s^2. Determine the magnitudes of the pin's velocity and acceleration at this instant. Neglect the size of the pin.



$r = 0.2 + 0.15\cos\theta = 0.2 + 0.15\cos 30° = 0.3299$ m

$\dot{r} = -0.15\sin\theta\dot{\theta} = -0.15\sin 30°(0.7) = -0.0525$ m/s

$\ddot{r} = -0.15\left[\cos\theta\dot{\theta}^2 + \sin\theta\ddot{\theta}\right] = -0.15\left[\cos 30°(0.7)^2 + \sin 30°(0.5)\right] = -0.10115 \text{ m/s}^2$

$\upsilon_r = \dot{r} = -0.0525 \text{ m/s}$

$\upsilon_\theta = r\dot{\theta} = 0.3299(0.7) = 0.2309 \text{ m/s}$

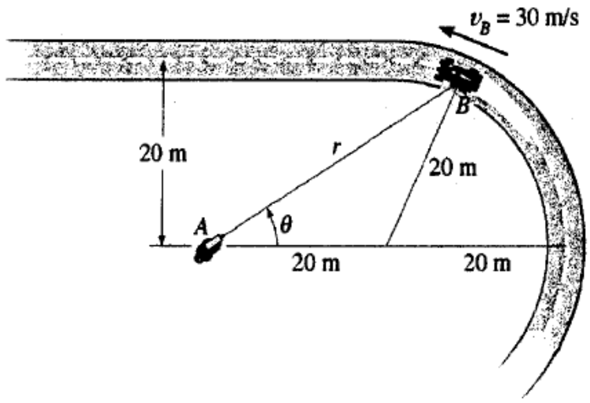
$\upsilon = \sqrt{\upsilon_r^2 + \upsilon_\theta^2} = \sqrt{(-0.0525)^2 + (0.2309)^2} = 0.237 \text{ m/s}$ **Ans**

$a_r = \ddot{r} - r\dot{\theta}^2 = -0.10115 - 0.3299(0.7)^2 = -0.2628 \text{ m/s}^2$

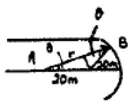
$a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta} = 0.3299(0.5) + 2(-0.0525)(0.7) = 0.09145 \text{ m/s}^2$

$a = \sqrt{a_r^2 + a_\theta^2} = \sqrt{(-0.2628)^2 + (0.09145)^2} = 0.278 \text{ m/s}^2$ **Ans**

12-167. A cameraman standing at A is following the movement of a race car, B, which is traveling around a curved track at a constant speed of 30 m/s. Determine the angular rate $\dot{\theta}$ at which the man must turn in order to keep the camera directed on the car at the instant $\theta = 30°$.



$r = 2(20\cos\theta) = 40\cos\theta$



$\dot{r} = -40\sin\theta\ \dot{\theta}$

$\mathbf{v} = \dot{r}\mathbf{u}_r + r\dot{\theta}\mathbf{u}_\theta$

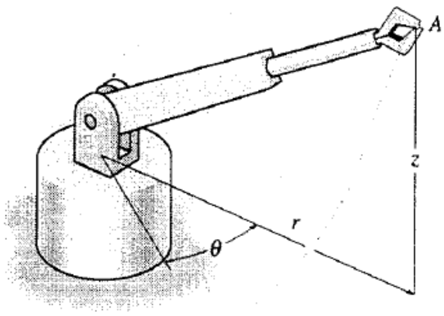
$v = \sqrt{(\dot{r})^2 + (r\dot{\theta})^2}$

$(30)^2 = (-40\sin\theta)^2(\dot{\theta})^2 + (40\cos\theta)^2(\dot{\theta})^2$

$(30)^2 = (40)^2[\sin^2\theta + \cos^2\theta](\dot{\theta})^2$

$\dot{\theta} = \frac{30}{40} = 0.75 \text{ rad/s}$ **Ans**

12-158. For a short time the arm of the robot is extending at a constant rate such that $\dot{r} = 1.5$ ft/s when $r = 3$ ft, $z = (4t^2)$ ft, and $\theta = 0.5t$ rad, where t is in seconds. Determine the magnitudes of the velocity and acceleration of the grip A when $t = 3$ s.



$\theta = 0.5t$ rad $\qquad r = 3$ ft $\qquad z = 4t^2$ ft

$\dot{\theta} = 0.5$ rad/s $\qquad \dot{r} = 1.5$ ft/s $\qquad \dot{z} = 8t$ ft/s

$\ddot{\theta} = 0 \qquad \ddot{r} = 0 \qquad \ddot{z} = 8 \text{ ft/s}^2$

At $t = 3$ s.

$\theta = 1.5 \qquad r = 3 \qquad z = 36$

$\dot{\theta} = 0.5 \qquad \dot{r} = 1.5 \qquad \dot{z} = 24$

$\ddot{\theta} = 0 \qquad \ddot{r} = 0 \qquad \ddot{z} = 8$

$v_r = 1.5$

$v_\theta = 3(0.5) = 1.5$

$v_z = 24$

$v = \sqrt{(1.5)^2 + (1.5)^2 + (24)^2} = 24.1$ ft/s **Ans**

$a_r = 0 - 3(0.5)^2 = -0.75$

$a_\theta = 0 + 2(1.5)(0.5) = 1.5$

$a_z = 8$

$a = \sqrt{(-0.75)^2 + (1.5)^2 + (8)^2} = 8.17$ ft/s^2 **Ans**