Roller coasters are designed so that the riders will not experience a normal force that is more than 3.5 times their weight against the seat of the car. Determine the smallest radius of curvature of the track at its lowest point if the car has a speed of 5 ft/s at the crest of the drop. Neglect Friction.

The 0.15 kg baseball has a speed of \( v = 30 \, \text{m/s} \) just before it is struck by the bat. It then travels along the trajectory shown before the outfielder catches it. Determine the magnitude of the average impulsive force imparted to the ball if it is in contact with the bat for 0.75 ms.

The jet aircraft is propelled by four engines to increase its speed uniformly from rest to 100 m/s in a distance of 500 m. Determine the thrust \( T \) developed by each engine and the normal reaction on the nose wheel \( A \). The aircraft's total mass if 150 Mg and the mass center is at point \( G \). Neglect air and rolling resistance and the effect of lift.

Determine the angular acceleration of the 25 kg diving board and the horizontal and vertical components of reaction at the pin \( A \) the instant the man jumps off. Assume that the board is uniform and rigid, and that at the instant he jumps off the spring is compressed a maximum amount of 200 mm, \( \omega = 0 \), and the board is horizontal. Take \( k = 7 \, \text{kN/m} \).
\[ v = \frac{5 \text{ ft}}{s} \]

\[ v_g = 0 \]

\[ v_e = 0 \]

\[ v_g = -w (170 \text{ ft}) = -mg (110 \text{ ft}) \]

\[ v_e = 0 \]

\[ \frac{1}{2} mv_0^2 + U^0 = \frac{1}{2} mv_1^2 + V \]

\[ \frac{1}{2} m \left( \frac{5 \text{ ft}}{5} \right)^2 = \frac{1}{2} m v_2^2 - mg (110 \text{ ft}) \]

\[ v_2^2 = 7109 \frac{\text{ft}^2}{s^2} \]

\[ v_2 = 84.3 \frac{\text{ft}}{s} \]

\[ \Sigma F_n = ma_n = \frac{mv^2}{\rho} \]

\[ -w + 3.5w = \frac{w}{g} \frac{v^2}{\rho} \]

\[ 2.5w = \frac{w v^2}{g \rho} \]

\[ \rho = \frac{w v^2}{2.5 g} = \frac{v^2}{2.5 g} \]

\[ \rho = 88.3 \text{ ft} \]
\( V_1 = 0 \)
\( V_2 = \frac{100 \, \text{m}}{5} \)
\( s = 500 \, \text{m} \)
\( T = ? \)
\( N_A = ? \)
\( M = 150 \, \text{kg} = 150 \times 10^3 \, \text{kg} \)
\( a_y = 0 \)
\( a = 0 \)
\( a_x = ? \)
\( W = 1471500 \, \text{N} \)

\[ \sum F_x = 4T = \text{max} \]
\[ T = \frac{\text{max}}{4} = 150 \times 10^3 \, \text{kg} \left( 10 \, \text{m/s}^2 \right) \]
\[ T = 375 \, \text{kN} \]

\[ \sum M_B = W(7.5 \, \text{m}) + 2T(5 \, \text{m}) + 2T(4 \, \text{m}) - N_A(37.5 \, \text{m}) = \text{max}(9 \, \text{m}) \]

\[ 37.5 \, N_A = W(7.5 \, \text{m}) + 2T(5 \, \text{m}) + 2T(4 \, \text{m}) - \text{max}(9 \, \text{m}) \]
\[ 37.5N_A = 1471500 \, (7.5) + 2(375 \times 10^3)(5) + 2(375 \times 10^3)(4) - 150 \times 10^3(10)(9) \]

\[ N_A = 114.3 \, \text{kN} \]
\[ m = 25 \text{ kg} \]

\[ \alpha = ? \]

\[ A_x = ? \]

\[ A_y = 0 \]

\[ \ell = 7 \times 10^3 \frac{N}{m} \]

\[ s = 20 \text{ mm} = 0.2 \text{ m} \]

\[ I_g = \frac{1}{12} ml^2 \]

1. \[ \Sigma F_y = F_s - W + A_y \]

\[ \Sigma F_y = m \alpha \]

\[ \Sigma F_n = A_x = 0 \]

2. \[ \Sigma M_g = I_g \alpha = -A_y (1.5 \text{ m}) \]

\[ \alpha = \frac{-A_y (1.5)}{I_g} \]

Plug into 0

\[ F_s - W + A_y = m r \left( \frac{-A_y (1.5)}{I_g} \right) \]

\[ A_y + 7 \times 10^3 \frac{N}{m} (0.2 \text{ m}) - 25 \text{ kg} (9.81 \text{ m/s}^2) = 25 \text{ kg} (1.5 \text{ m}) (1.5 \text{ m}) - \frac{1}{12} \left( 25 \text{ kg} \right) \left( 3 \text{ m} \right)^2 \]

\[ A_y + 1154.75 \text{ kg} \text{ m}^2 = 3 A_y \]

\[ 1154.75 \text{ N} = -4 A_y \]

\[ A_y = -289 \text{ N} \]

\[ \alpha = \frac{-(-289 \text{ N}) (1.5 \text{ m})}{\frac{1}{12} (25 \text{ kg}) (3 \text{ m})^2} \]

\[ \alpha = 23.1 \text{ rad/s}^2 \]