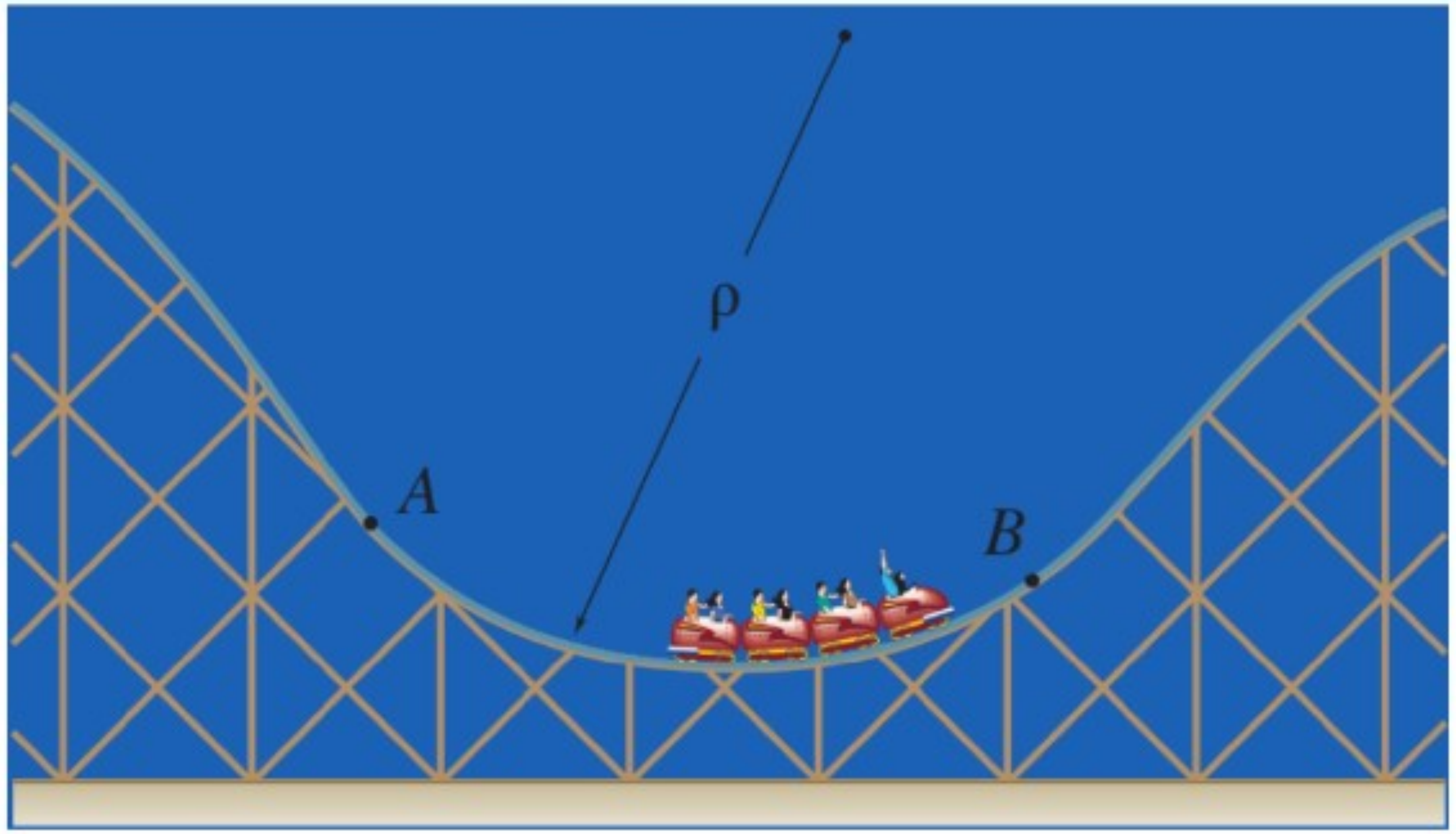
Determine the maximum speed that the cars of the roller coaster can reach along the circular portion AB of the track if $\rho = 25$ m and the normal component of their acceleration cannot exceed 3g.

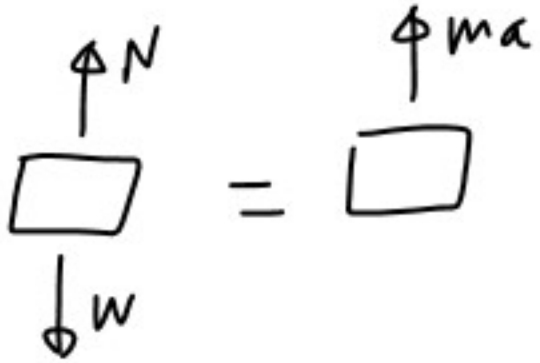


$$a = \frac{V^2}{\rho}$$

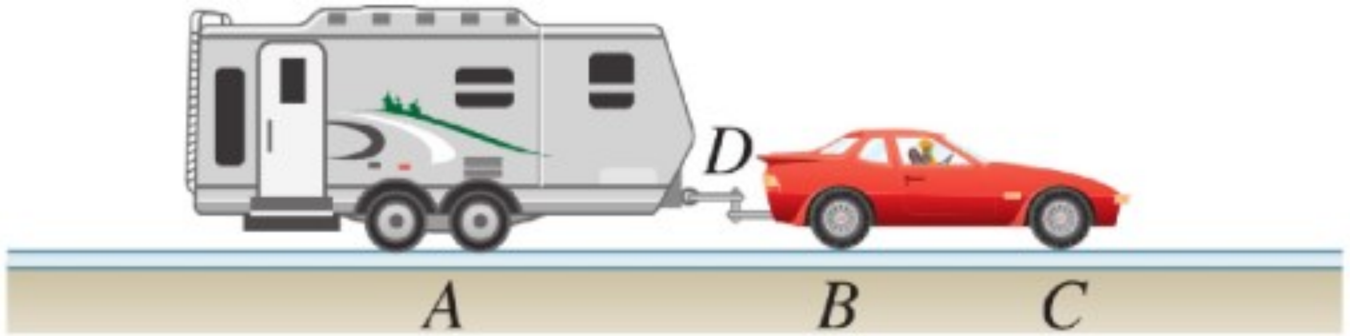
$$3g = \frac{V^2}{\rho}$$

$$3 \cdot 1.8\rho = V^2$$

$$V = \sqrt{3 \cdot 9.8 \cdot 25} = \boxed{27\ m/s}$$



A 1200-kg trailer is hitched to a 1400-kg car. The car and trailer are traveling at 72 km/h when the driver applies the brakes on both the car and the trailer. Knowing that the braking forces exerted on the car and the trailer are 5000 N and 4000 N, respectively, determine (*a*) the distance traveled by the car and trailer before they come to a stop, (*b*) the horizontal component of the force exerted by the trailer hitch on the car.



$T_1 + U_{1\to 2} = \cancel{T_2} \; 0$

$\frac{1}{2} m v^2 = -F d$

$\frac{mv^2}{2F} = \frac{(1200+1400)\,20^2}{2(5000+4000)} = \boxed{57.8 \text{ m}}$

$72 \text{ km/h} \left(\frac{1 \text{ h}}{3600 \text{ s}}\right)\left(\frac{1000 \text{ m}}{1 \text{ km}}\right)$

$= 20 \text{ m/s}$

N

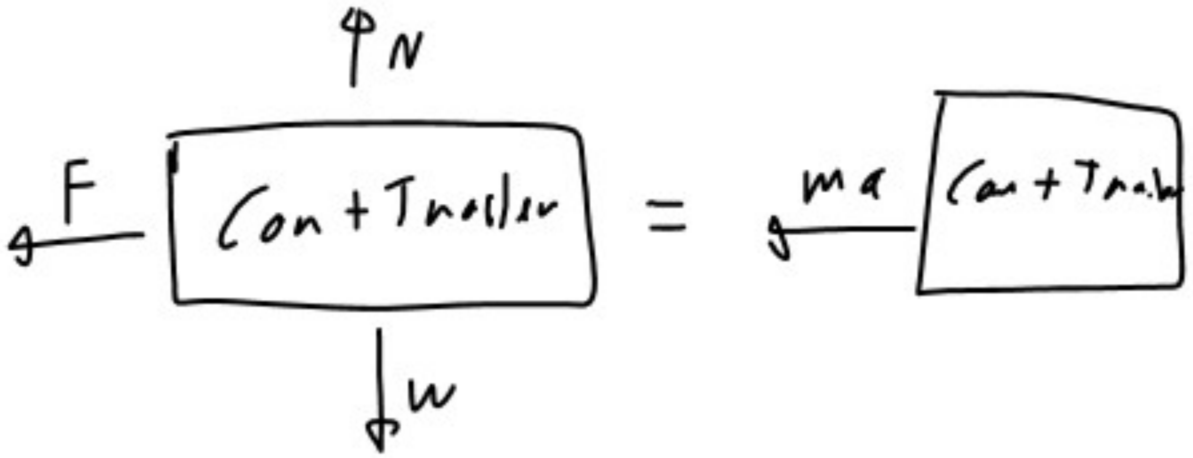
F_t ← car → F_c = ma ← car

W

$F_t + F_c = m_c a$

$F_t + 5000 = 1400(3.46)$

$F_t = 1400(3.46) - 5000 = \boxed{-154 \text{ N}}$

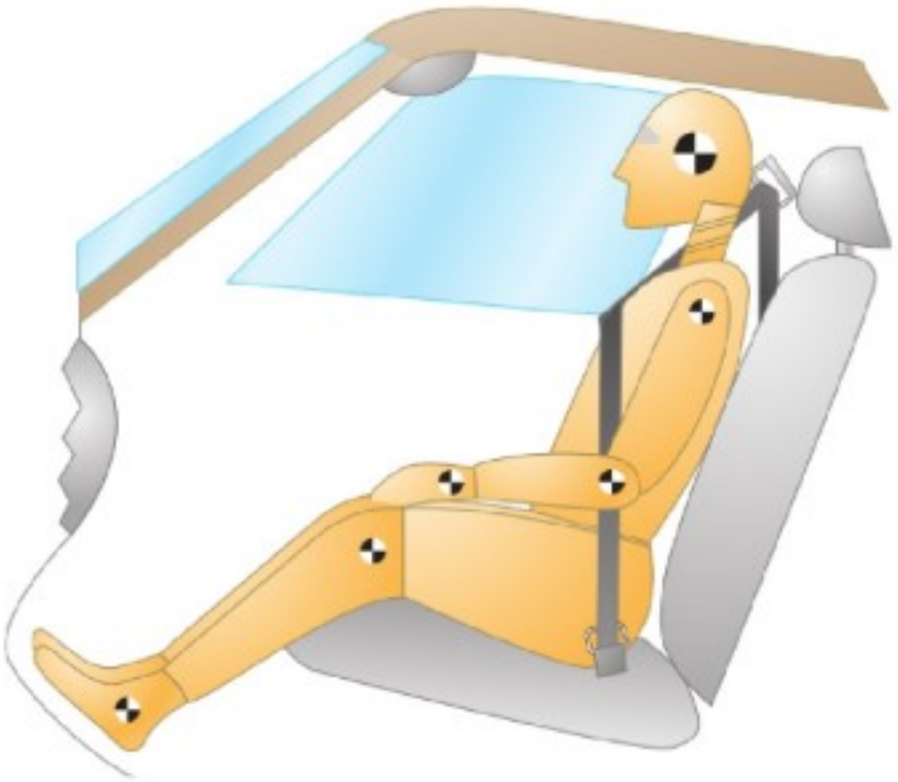


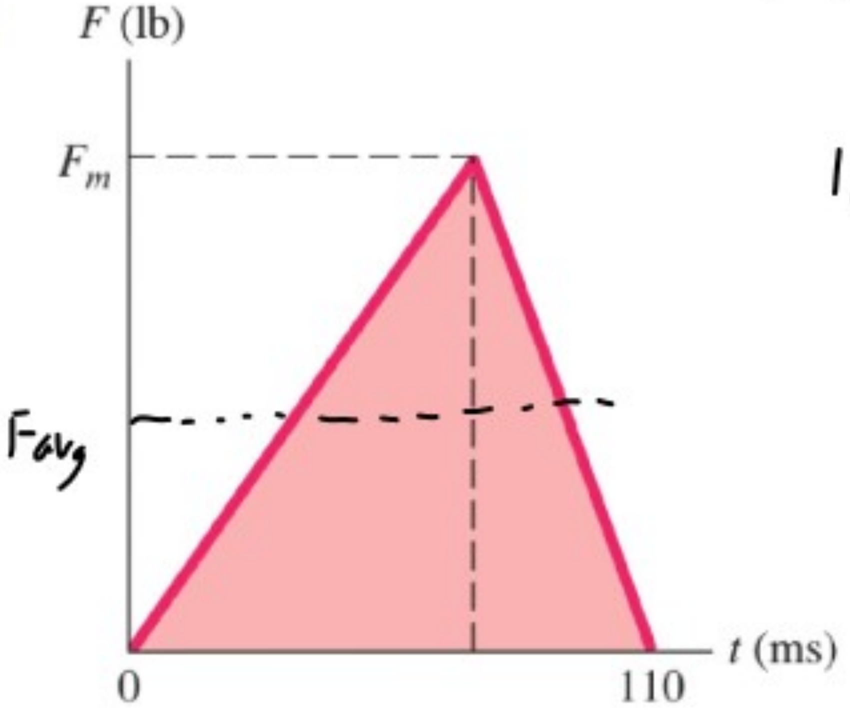
$$F = ma$$

$$a = \frac{F}{m} = \frac{4000+5000}{1200+1400} = 3.46\ m/s^2$$

An estimate of the expected load on over-the-shoulder seat belts is to be made before designing prototype belts that will be evaluated in automobile crash tests. Assuming that an automobile traveling at 45 mi/h is brought to a stop in 110 ms, determine (*a*) the average impulsive force exerted by a 200-lb man on the belt, (*b*) the maximum force F_m exerted on the belt if the force–time diagram has the shape shown.

$$45 \frac{mi}{h}\left(\frac{1\ h}{3600\ s}\right)\left(\frac{5280\ ft}{1\ mi}\right) = 66\ ft/s$$





$$110\ ms\left(\frac{1\ s}{1000\ ms}\right) = 0.11\ s$$

$$\vec{L}_1 + \vec{Imp}_{1\to 2} = \cancel{\vec{L}_2}^{\,0}$$

$$mV + F_{avg}\,\Delta t = 0$$

$$\frac{200}{32.2}\,66 + F_{avg}\,0.11 = 0$$

$$\frac{200}{32.2}\,66 = -F_{avg}\,0.11$$

$$F_{avg} = \frac{-200\cdot 66}{0.11\cdot 32.2} = \boxed{3.727\ \text{Kips}}$$

$$= 3727\ \text{lb}$$

$$\vec{Imp}_{1\to 2} = \int_{t_0}^{t_1} F\,dt = \frac{1}{2}F_m\,\cancel{0.11} = \cancel{0.11}\,F_{avg}$$

$$\frac{F_m}{2} = F_{avg}$$

$$F_m = 2F_{avg} = 2\cdot 3.727 = \boxed{7.453\ \text{Kips}}$$

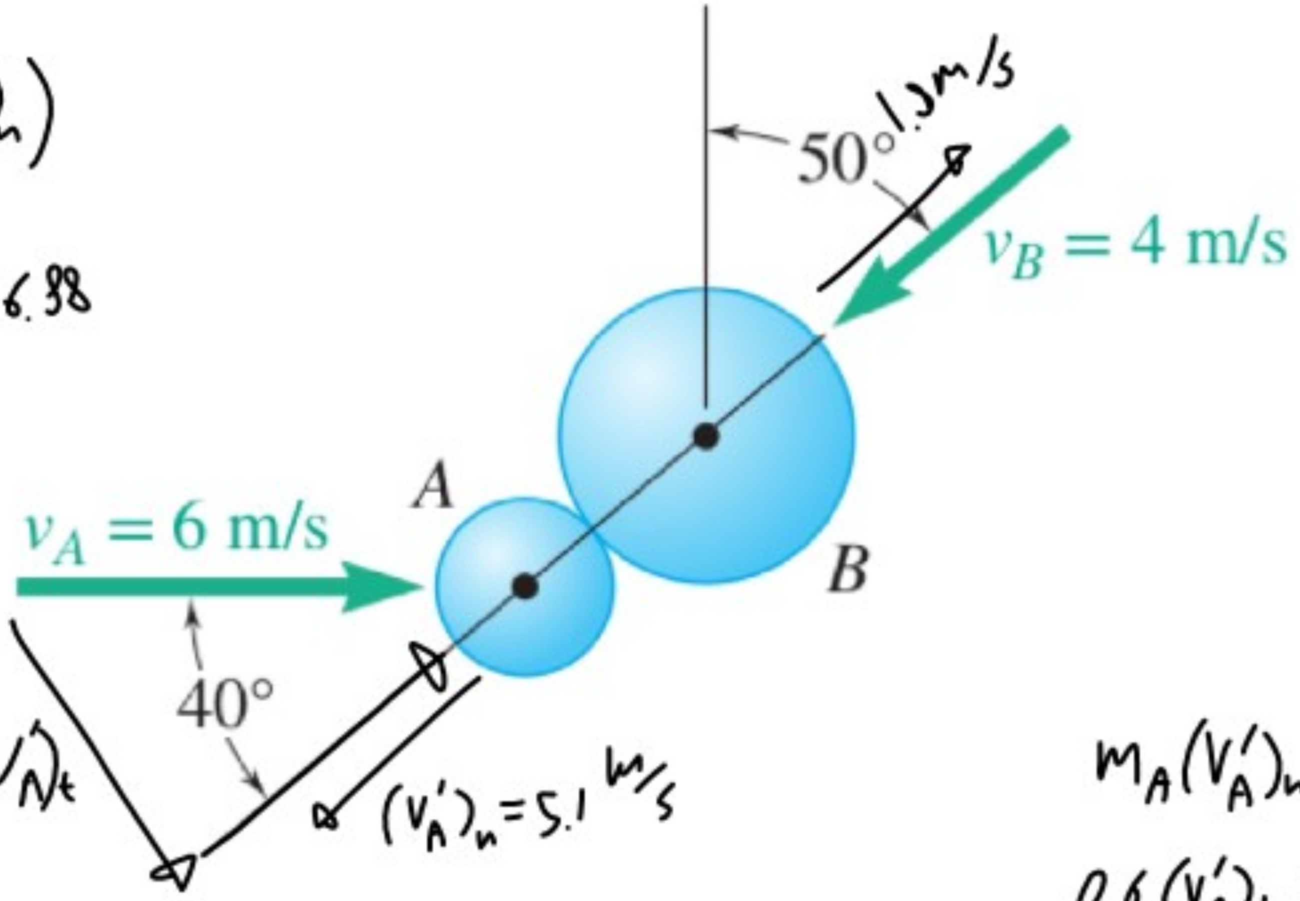
$$= 7453\ \text{lb}$$

A 600-g ball A is moving with a velocity of magnitude 6 m/s when it is hit as shown by a 1-kg ball B that has a velocity of magnitude 4 m/s. Knowing that the coefficient of restitution is 0.8 and assuming no friction, determine the velocity of each ball after impact.

$(V_A')_n - (V_B')_n = e((V_B)_n - (V_A)_n)$

$(V_A')_n - (V_B')_n = 0.8(-4 - 4.6) = -6.88$

$(V_A')_n = (V_B')_n - 6.88$



$(V_A)_n = 6\cos 40 = 4.6$ m/s

$(V_A)_t = 6\sin 40 = 3.86$ m/s

$(V_B)_n = -4$ m/s

$(V_B)_t = 0$

$m_A(V_A')_n + m_B(V_B')_n = m_A(V_A)_n + m_B(V_B)_n$

$0.6(V_A')_n + 1(V_B')_n = 0.6 \cdot 4.6 + 1(-4) = -1.24$

$$0.6\left(\left(V_B'\right)_n - 6.88\right) + \left(V_B'\right)_n = -1.24$$

$$\left(V_B'\right)_n = \frac{361}{200} = 1.8$$

$$\left(V_A'\right)_n = \frac{-203}{40} = -5.1$$