$$\vec{a} = \frac{dv}{dt}\vec{e}_t + \frac{v^2}{\rho}\vec{e}_n$$

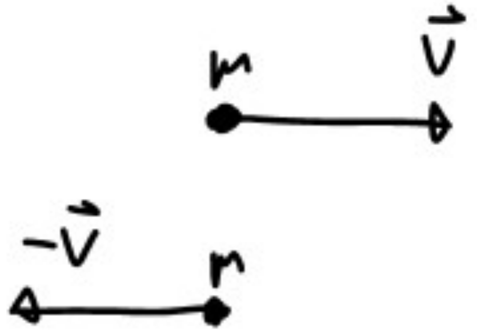
(ρ ← radius)

Newton's Second Law

$\vec{F} = m\vec{a}$ $\qquad$ $\Sigma\vec{F} = m\vec{a}$

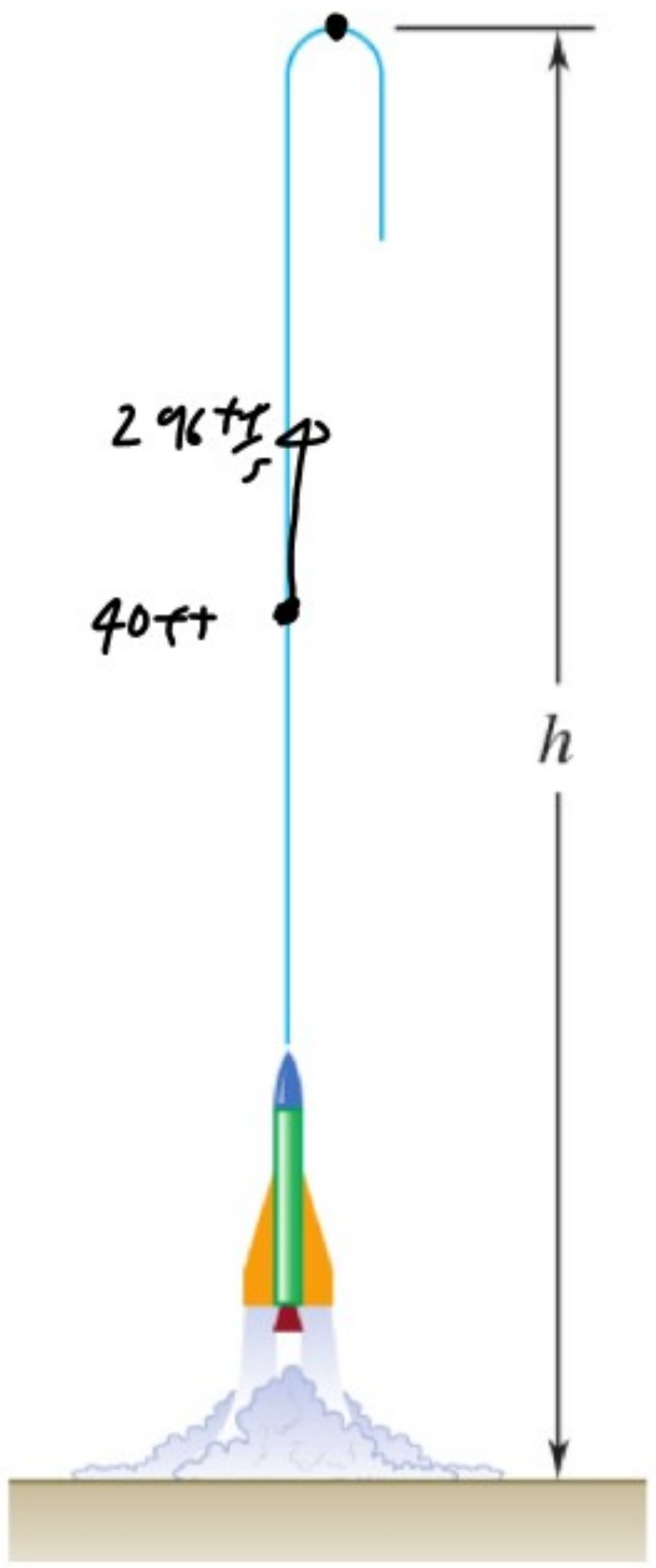
$$\vec{F} = m\frac{d\vec{v}}{dt} = \frac{d}{dt}m\vec{v}$$

$\vec{L} = m\vec{v}$ Momentum



$$\vec{F} = \frac{d}{dt}\vec{L} = \dot{\vec{L}}$$

$$T = \frac{1}{2}mv^2$$

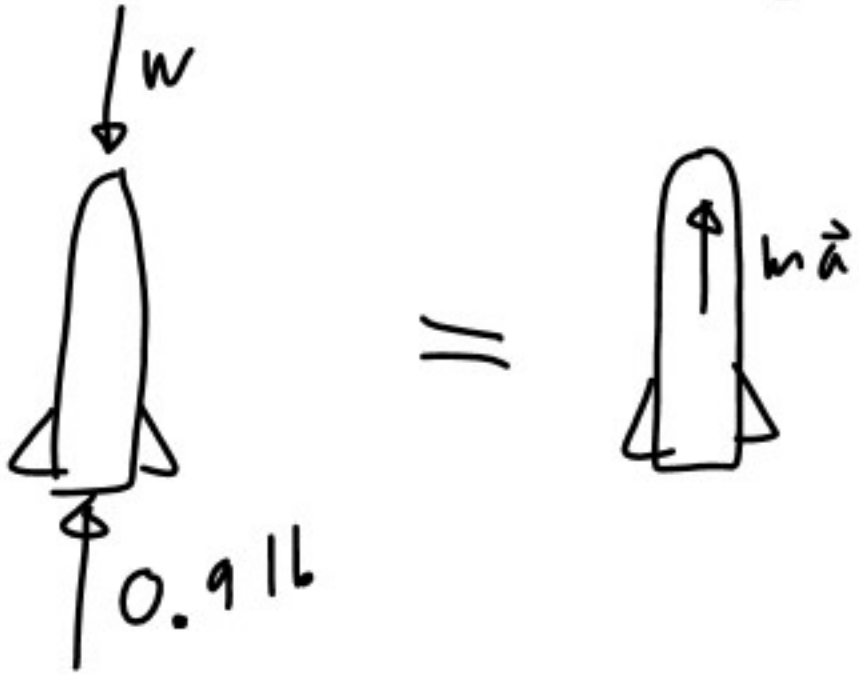


$$0.5\ oz\left(\frac{1\ lb}{16\ oz}\right) = 0.03125\ lb = W$$

$$\frac{W}{g} = m$$

$$\frac{0.03125\ lb}{32.2\ ft/s^2} = 9.7\times10^{-4}\ slugs = m$$

A 0.5-oz model rocket is launched vertically from rest at time $t = 0$ with a constant thrust of 0.9 lb for 0.3 s and no thrust for $t > 0.3$ s. Neglecting air resistance and the decrease in mass of the rocket, determine (*a*) the maximum height h reached by the rocket, (*b*) the time required to reach this maximum height.



$$\sum \vec{F} = m\vec{a}$$

$$0.9 - W = ma$$

$$0.9 - 0.03125 = 9.7\times10^{-4}\ a$$

$$\frac{0.9 - 0.03125}{9.7\times10^{-4}} = 896\ ft/s^2 = a$$

$$V = V_0 + at$$

$$V = 896(0.3) = 269 \text{ ft/s}$$

$$y = y_0 + V_0 t + \frac{1}{2} a t^2$$

$$y = \frac{1}{2} 896 (0.3)^2 = 40 \text{ ft}$$

$$V^2 = V_0^2 + 2a(y - y_0)$$

$$0^2 = 269^2 + 2(-32.2)(y - 40)$$

$$269^2 = 2(32.2)(y - 40)$$

$$\frac{269^2}{2(32.2)} = y - 40$$

$$\frac{269^2}{2(32.2)} + 40 = y = \boxed{1160 \text{ ft}}$$

$$V = V_0 + at$$

$$0 = 269 - 32.2t$$

$$32.2t = 269$$

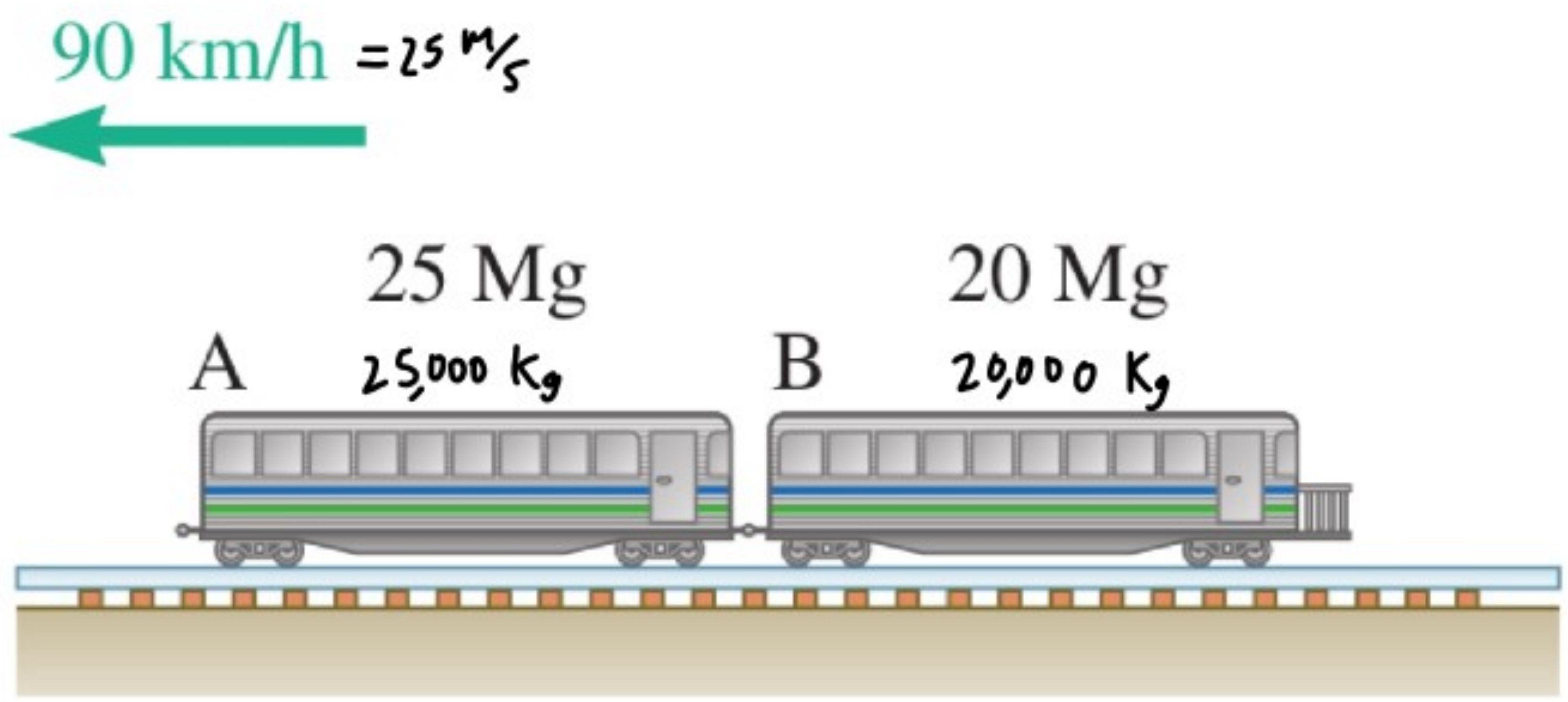
$$t = \frac{269}{32.2} = 8.35 \text{ s}$$

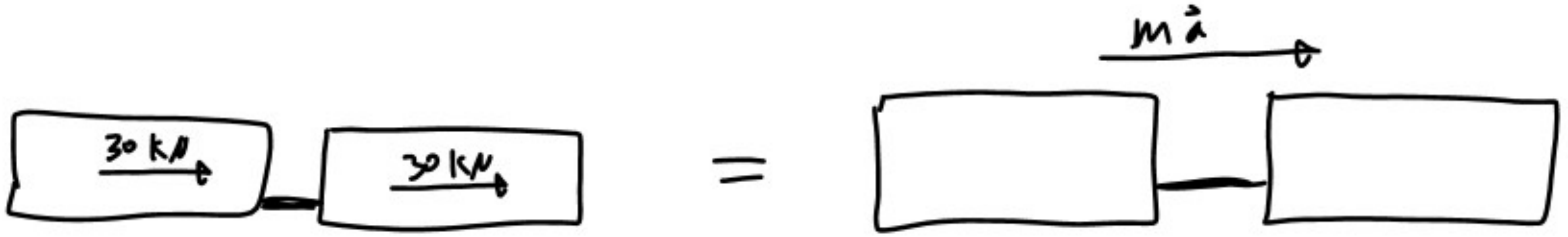
from when the motor turns off

$$\boxed{t = 8.65 \text{ s}}$$

A light train made up of two cars is traveling at 90 km/h when the brakes are applied to both cars. Knowing that car A has a mass of 25 Mg and car B a mass of 20 Mg, and that the braking force is 30 kN on each car, determine (a) the distance traveled by the train before it comes to a stop, (b) the force in the coupling between the cars while the train is slowing down.

1000 kg = 1 Mg





$$m = m_A + m_B = 25000 + 20000 \text{ Kg} = 45000 \text{ Kg}$$

$$\Sigma F = ma$$

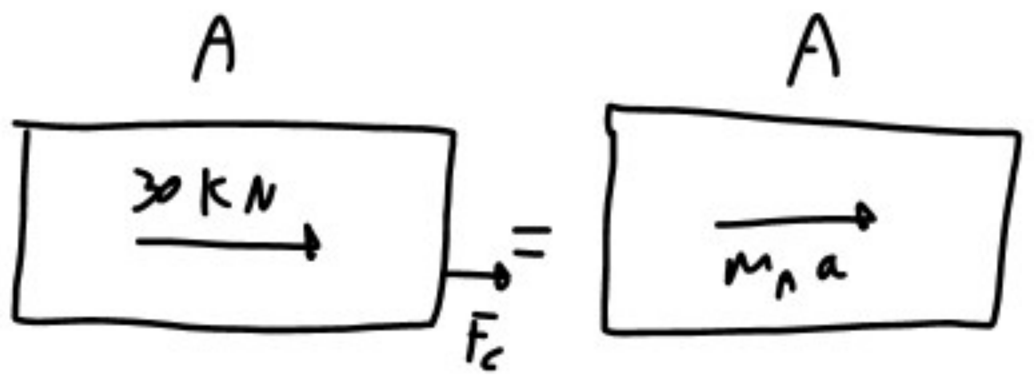
$$30000 + 30000 = 45000\, a$$

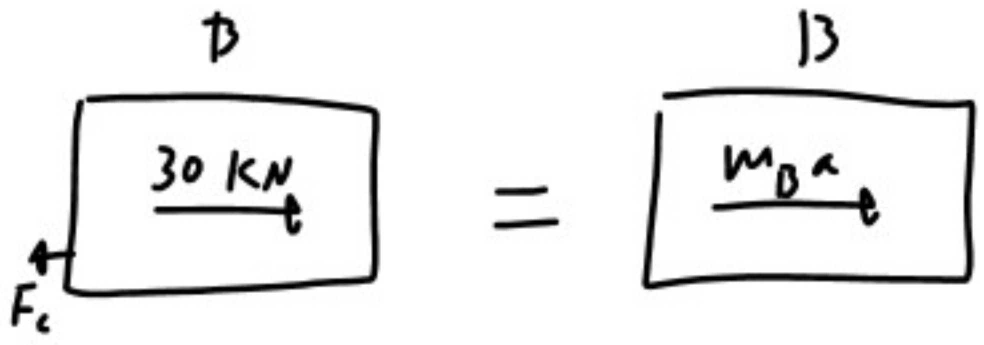
$$\frac{60000}{45000} = 1.33 \text{ m/s}^2 = a$$

$$V^2 = V_0^2 + 2a(x - x_0)$$

$$0^2 = 25^2 + 2(-1.33)(x - 0)$$

$$\frac{25^2}{2(1.33)} = x = \boxed{234 \text{ m}}$$





$30\,kN + F_c = m_A a$

$F_c = m_a a - 30\,kN$

$= 25000\,(1.33) - 30000 = 3250\,N$

$30\,kN - F_c = m_B a$

$30000 - 20000\,(1.33) = F_c = 3400\,N$